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Department of the Navy
HAWAII
UNDERSEA WARFARE TRAINING EXERCISE (USWEX)
After Action Report
For Exercises in April 2007

FINAL

10 August 2007

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 Hawai'i Range Complex From January 2007 to January 2009

AND

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

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INTRODUCTION

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

REPORT ORGANIZATION

This report, which contains only unclassified material, provides the information and analyses for two Hawaii Range Complex at-sea major exercises, and is submitted in fulfillment of NDE and BO written requirements.

The report is organized by section in the following order:

Section 1 Exercise Summaries provides exercise specific summary including the starting and ending dates, the number of ships and aircraft participating, and the number of hours of active sonar used.

Section 2 Observations and Mitigation Effectiveness provides an estimated number of marine mammals observed during Undersea Warfare Training Exercise (USWEX) 07-02, and USWEX 07-03 potentially affected or not affected by Anti-submarine Warfare (ASW) operations, noting the nature of any observed effects where possible. In addition, Section 2 assesses the effectiveness of the NDE and BO mitigation and monitoring measures required during exercises with regard to minimizing the use of MFAS in the vicinity of marine mammals.

Appendices contain tables and figures (**Appendix A**), and other supplementary information (**Appendix B**).

BACKGROUND

USWEXs are advanced 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 will conduct anti-submarine warfare exercises (ASW) against submarine targets representing an opposing force. Submarine targets would 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 from one to five surface ships equipped with sonar, with one or more helicopters, and a P-3 aircraft searching for one or more submarines.

Two USWEXs were conducted in the waters off Hawaii on 10-11 April and 17-18 April 2007 (**Table A-1 Appendix A**). The types of ASW training conducted during USWEX involved the use of ships, submarines, aircraft, non-explosive exercise weapons, and other training related devices within portions of the Hawaii Range Complex (**Figure A-1 Appendix A**).

USWEX 07-02 and USWEX 07-03 were planned and prepared by the U.S. Navy prior to receiving the Terms and Conditions of the BO on 23 January 2007. This includes coordinating the logistical arrangements for these advanced training events, ensuring marine species awareness training was provided to exercise participants, and preparation and distribution of the Letter of Instruction (LOI) (**Appendix B**) which reiterates the applicable mitigation measures and explains procedures for reporting marine mammal sightings discussed in Section 2.

The U.S. Navy continues to make improvements to its Fleet instructions to collect relevant data to more fully address the exact language of the Terms and Conditions of the USWEX BO. The Office of Protected Resources (OPR), National Marine Fisheries Service (NMFS) and the U.S. Navy have been coordinating to improve data objectives, data quality, and reporting requirements to assist in the analysis for future USWEXs. This has been a continual, iterative dialog leading to integration of additional monitoring techniques and procedures that will help to advance the state of knowledge on marine mammal distribution and potential MFAS effects or, lack of effects, within the Hawai'i Range Complex. The U.S. Navy will explore establishment of new metrics and processes based on these enhancements to the exercise monitoring program, and plans to integrate new results into future reports.

MFAS equipped platforms participating in USWEX include Ticonderoga-class guided missile cruisers (CG) and Arleigh Burke-class guided missile destroyers (DDG) surface combatants with AN/SQS-53C sonar and associated aviation assets (SH-60B/F/R with AN/AQS-13F or AQS-22 dipping sonar, and AN/SSQ-62B/C/D/E Directional Command Activated Sonobuoy System -DICASS), and P-3 Maritime Patrol Aircraft (MPA) (DICASS sonobuoy).

Total numbers of ASW capable aviation assets participating in a given exercise varies based on maintenance ready aircraft and ship configuration. For instance, early versions of the DDG destroyers, the newest Navy surface combatant, do not have onboard hangers for helicopters. Later versions have hangars and up to two SH-60B/F/Rs. Of more importance than actual aircraft numbers however, is that active sonar use by aviation assets is captured and added to sonar totals reported in this document. MFAS on Los Angeles-class (SSN) submarines (AN/BQQ-5) is seldom used in tactical training scenarios, where passive sonar use is the preferred system in order to maximize the stealth aspects of undersea operations.

SECTION 1 EXERCISE SUMMARIES

EXERCISE SPECIFICS

USWEX 07-02 was conducted from 10-11 April 2007 and involved a CSG (**Table A-1 Appendix A**). Ships assigned to this CSG included: (1) non-MFAS equipped ship and (5) MFAS equipped ships. Other participating units representing support and opposition forces included (2) submarines and (3) MFAS equipped ships, although there was no active sonar use by these supporting platforms. Based on the DDG ships participating in JTFEX 07-03, there were approximately of 8-12 ASW SH-60s helicopters available.

USWEX 07-03 was conducted from 17-18 April 2007 and involved an ESG (**Table A-1 Appendix A**). Ships assigned to this ESG included: (3) non-MFAS equipped ships and (3) MFAS equipped ships. Other participating units representing support and opposition forces included (2) submarines and (2) MFAS equipped ships, although there was no active sonar use by these supporting platforms. Based on DDG ships participating in USWEX 07-03, there were approximately six ASW SH-60s helicopters participating.

MITIGATION MEASURES PERFORMED

All mitigations measures as stated in the 23 January 2007 NDE were adhered both of the Hawaii USWEXs. These 29 NDE measures include specific details for Personnel Training, establish Lookout and Watchstander Responsibilities, mandate specific Operating Procedures, and describe Coordination and Reporting requirements. Observation data from Navy lookout sightings for each exercise is described in Section II.

SECTION 2 OBSERVATIONS AND MITIGATION EFFECTIVENESS

MARINE MAMMALS AND OCEANOGRAPHIC CONDITIONS

Section 2 provides estimated numbers of marine mammals observed in Hawaii waters during USWEX 07-02 and USWEX 07-03. This information is based on analysis of actual events and sightings of marine mammals reported by exercise participants noting the nature of any observed effects. **Table A-2** lists sighting information and **A-4 Appendix A** lists possible marine mammal species occurring in Hawaii waters, highlights the Endangered Species Act (ESA) listed species described in the BO, and shows results for both annual acoustic exposure estimates from DoN (2007) and single USWEX estimated potential exposures.

All detections were made by standard Navy surface ship lookout reporting procedures as detailed in a Commander, THIRD Fleet LOI issued to each CSG and ESG prior to participation in a USWEX (**Appendix B**). No marine mammal sightings were reported by helicopters or P-3s.

Ocean Sea Surface Temperatures (SST) ranged from 22-26°C and general ocean currents in the vicinity of the main Hawaiian Islands were typical for this season (**Figures A-2** and **A-4 in Appendix A**).

The National Data Buoy Center maintains an oceanographic monitoring buoy 170 nm northwest of Kauai (http://mob.ndbc.noaa.gov). Based on data reported from this buoy, wind speeds during the day from 10 to 11 April 2007 (USWEX 07-02) were between 5.6 and 9.2 meters/sec (m/s) (11-18 knots). Wave heights were between 1.9 to 2.4 m (6 to 8 feet). During the day from 17 to 18 April 2007 (USWEX 07-03), wind speeds were between 7.8 to 11.5 m/s (15-22 knots) and wave heights between 2.8 to 3.5 m (9 to 11 feet).

EXERCISE MARINE MAMMAL SIGHTINGS

USWEX 07-02 Observations

During the two days of USWEX 07-02, there were no reported sightings of marine mammals. There were no sightings of floating dead animals, nor reports of concurrent strandings.

A Navy contractor marine mammal biologist was allowed to fly onto the aircraft carrier for USWEX 07-02 as an additional monitoring protocol. While MFAS is only installed on CG and DDG class vessels, the carrier does serve as the information hub for the exercise. The biologist was able to observe the Navy lookouts and procedures over eight non-consecutive hours from 10 to 11 April. Weather conditions during this period were clear with approximately 12 miles (19 km) visibility, swell was about eight feet (2.5 meters), wind was 17.5-22.4 knots (7.1-9.2 meter/second). Air temperature was 74.5-79.2°F (23.6-26.2°C). Neither Navy watchstanders on the carrier nor the biologist reported any marine mammal sightings during this period (**Appendix C**).

USWEX 07-03 Observations

Table A-2 provides a detailed timeline of marine mammal observations made by Navy exercise participants for USWEX 07-03. During the two days of USWEX 07-03, there was only one marine mammal sightings for an estimated total of one large whale. While not geographically plotted, the sighting location was approximately 30 nm northwest of the island of Kauai. There were no sightings of floating dead animals, nor reports of concurrent strandings.

MITIGATION AND MONITORING ASSESSMENT

OVERVIEW

The NDE calls for the U.S. Navy to submit a report to NMFS that includes a discussion of the nature of the effects, if observed, 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 program. In this case, the mitigation measure under the BO are the NDE measures, therefore the discussion is presented together in this section.

This section of the report, therefore, provides an assessment of the effectiveness of the mitigation and monitoring measures. It must also be recognized that ASW proceeds slowly and requires careful development of a tactical frame of reference over time as 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. Thus, lost MFAS time not only equates to lost exercise time but should be considered in the fuller context of its overall impact on the tempo and development of a "tactical picture" shared among exercise participants as they trained toward the goal of improving ASW skills in general.

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 assumed to be employed whenever possible. Given the nature of passive sonar technology and underwater sound propagation, localizing or determining absolute position of an object is more difficult than active sonar.

The U.S. Navy does not have a reporting system to capture the amount of passive sonar employed within a given geographic region. For USWEX 07-02 and USWEX 07-03, there were no reports of passive acoustic detections of marine mammals by exercise participants. Future reports will explore whether metrics for passive acoustic use can be generated, and if marine mammal detections are occurring.

PMRF Acoustic Monitoring

Underwater acoustic recordings of marine mammal vocalization were conducted for a limited time set at the Pacific Missile Range Facility north of Kauai after USWEX 07-03. **Appendix D** contains a detailed description of the program and data results from April 2007 monitoring. The science behind the use of underwater hydrophones for localizing marine mammal is relatively new, and the technologies and techniques described in **Appendix D** will continue to be refined in collaboration with other academic and NMFS-Navy efforts.

Active Sonar

Typically, there are no measurements (calibrated or otherwise) of actual sound levels made during an exercise and none were made during USWEX 07-02 and USWEX 07-03. Source levels, numbers of sources, and frequencies are classified since that information would provide potential adversaries with important tactical data. An explanation of sonar hours as presented in this report is also warranted. Total active sonar hours represent a sum of the total time from a number of individual training events during an USWEX. This value does not represent actual total sonar ping hours. In other words, the ship logs when the sonar was turned on at the beginning of a training event, and reports time until the event is finished. During this period, the MFAS only puts active sound into the water at discrete intervals. Sonar signals are not a continuous source of acoustic energy. For example, surface ship sonar signal consists of a pulse (i.e.

ping) less than two seconds long with approximately a minimum of 30 seconds between successive pings (NMFS 2007).

Given that mitigation measures are designed to minimize interactions between Navy assets and marine mammals, the observations of marine mammals by Navy assets only occurred as infrequent and very brief encounters, the majority of which occurred when there was no MFAS in use.

USWEX 07-02 Assessment

During USWEX 07-02, 265.5 hours of MFAS use was reported.

MFAS is only used during carefully reviewed scenarios and for only a small subset of any given exercise time frame.

There were no reports of ship strikes on marine mammals, and no reports of a vessel maneuvering to avoid the path of a marine mammal.

There was one report of a stranded marine mammal four days after the exercise, but this event can not be associated with MFAS nor other Navy operations. In an email dated 05 July 2007 received from Mr. David Schofield, Marine Mammal Response Network Coordinator NOAA Pacific Islands Regional Office, National Marine Fisheries Service, Mr. Schofield asked if any "naval activities" occurred prior to or on 15 April when a pygmy sperm whale was found stranded at a remote beach off Lanai City, Lanai. While USWEX 07-02 was conducted from 10 to 11 April, this was at least four days prior to the pygmy sperm whale stranding. The closest MFAS use was actually on 10 April, and greater than 100 nm away from the stranding site and geographically closer to Kauai. **No other Navy MFAS was operating within the Hawaiian operating area after 12 April. Finally, pygmy sperm whales and spinner dolphins are the most commonly stranded species within the Hawaiian Islands, and the islands of Oahu, Maui, and Lanai, have the highest reported proportion of these cetacean strandings** (Mazzuca et al., 1999; Maldini et al., 2005).

Therefore sonar use can not be associated with this reported Hawaii stranding based on both time and distance considerations mentioned previously, as well as given typical marine mammal stranding patterns for the region.

USWEX 07-03 Assessment

During USWEX 07-03, 50.1 hours of MFAS use was reported.

MFAS is only used during carefully reviewed scenarios and for only a small subset of any given exercise time frame. During USWEX 07-03 there were no reported sightings of marine mammals concurrent with MFAS operation, and no reports of MFAS having to be secured due to the presence of marine mammals.

Based on limited visual sightings, there were no reported potential marine mammal exposures at 200, 500, 1,000 yards (**Table A-3**).

There were no instances where marine mammals behaved in any erratic, unusual, or anything other than apparently normal manner. There were no reports of ship strikes on marine mammals, and one report of a vessel maneuvering to avoid the path of a marine mammal.

Modeling Estimates Applicable to USWEX 07-02 and 07-03

Table A-4 in **Appendix A** shows estimated marine mammal acoustic exposures from model derived calculations based on regional marine mammal densities, USWEX operational parameters, sound transmission loss, and potential energy accumulated (DoN, 2007). The left hand columns in **Table A-4** are from the USWEX OEA for Alternative 1, which forecast annual impacts from six USEWXs (Table 4- in DoN, 2007). Species order was changed from the original table to highlight ESA listed species first, followed by an alphabetical list of remaining species. The columns to the right in **Table A-4** are a rough approximation of predicted exposures from a single exercise calculated for this report (i.e. animal exposure # divided by 6). In total, acoustic impact modeling predicts an estimated 5,116 Level B sub-TTS and an estimated 37 Level B TTS exposures. However, these numbers of animals were not observed within the Hawaiian Islands operating area by exercise participants.

NDE AND BO ASSESSMENT

All 23 Jan 2007 NDE measures promulgated in the *Mid-Frequency Active Sonar Mitigation Measures during Major Training Exercises or within Established DoD Maritime Ranges and Established Operating Areas* (NDE) section were implemented for COMPTUEX 07-02, JTFEX 07-03, and JTFEX 07-05.

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. As described previously, the three categories of measures, Personnel Training, Lookout and Watchstander Responsibilities, and Operating Procedures as outlined in the NDE, appear effective in detecting and responding appropriately to the presence of marine mammals, when observed. For instance, one BO Term and Condition requests 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 re 1 $\mu Pa^2 \cdot s$.

Since there was only one marine mammal observation during two separate USWEX, and MFAS was not in use at that time, then it would be accurate to state that no observed marine mammal or ESA species were exposed to received energy levels greater than 173 dB re 1 $\mu Pa^2 \cdot s$.

The U.S. Navy acknowledges that this discussion does not account for potential marine mammal species not observed, which is a difficult determination even for the marine mammal scientific community, and is seeking to address this issue as discussed below.

As to the effect of MFAS power reduction and securing due to the presence of marine mammals, there is no additional information that can be added at this time as to the operational effect of these events. There is an effort underway within the operational community to try and articulate exactly what kind of relative effect MFAS mitigation measures have on ASW training.

In regards to impacts not associated with MFAS such as ship strikes, the U.S. Navy has a robust ship strike reporting program and reports from USWEX 07-02 and 07-03 of no ship strikes and of maneuvering to avoid animals provides some evidence that these avoidance measures are effective.

Data Limitations and Improvements

The U.S. Navy is committed to development of robust exercise and long-term range complex monitoring plans that will integrate multiple tools in order to provide better assessment of marine mammal occurrence and possible MFAS effects, or lack of effects.

There may be several reasons for the limited number of marine mammal sightings during the two USWEXs. Actually, the two groups involved in USWEX 07-02 and 07-03, a CSG and an ESG, were the exact same ones in the recently submitted SOCAL AAR report, so the participating vessel count should be similar and individual ships familiar with marine mammal mitigation and reporting requirements.

Reasons for fewer sightings in USWEX (1 sighting) than reported for SOCAL exercises (28-61 sightings) can include:

1) Duration- The shorter duration of each USWEX (2-days) vice the longer JTFEX and COMPTUEX in SOCAL (1-week and 2-3 weeks) means that less time was available for reporting marine mammal sightings. Even for the longer Southern California exercises (two JTFEX and one COMPTUEX), typically only about two to 12 sightings per day were reported during each exercise.

2) Density- There may be potentially lower marine mammal densities, in general, within the Hawaiian operating area. However, fewer Hawaii marine mammal density surveys have been conducted compared to the greater frequency of marine mammal surveys within Southern California waters. The fine-scale distribution of Hawaii's marine mammal populations is less well detailed although some populations are under study (Baird et al. 2005, NCCOS 2005, Baird et al. 2006, Barlow 2006, Chivers et al. 2007, Forney 2007, McSweeney 2007). There is, of course, a significant body of information on the broad seasonal movements of the humpback whales between northern feeding areas and Hawaiian breeding grounds. Although late in the season, April is within the time for humpback whales to be present. Many of the documents toothed whale species in Hawaii seem to be year-round, where in SOCAL there are general seasonal species composition shifts due to water temperature preference and prey availability.

3) Weather- Weather conditions, at least as can be determined from the monitoring buoy northwest of Kauai, indicated that it was possible that moderate sea states during the two USWEX may in some cases made visual sighting of marine mammals more difficult due to sea states conditions. Small deep-diving and cryptic species are typically more difficult to observe when sea states get to and above sea state 3 (Barlow and Gisiner 2006, Taylor et al. 2007). Wind speed and wave heights for 10-11 April were between 11-18 knots and 6-8 feet, while for 17-18 April wind speed and wave heights were between 15-22 knots and 9-11 feet). Given these values, approximate sea states were likely between 2 to 4. **Appendix E** shows the relationships between wind speeds and ocean conditions.

Future reporting requirements will collect more detailed descriptions on marine mammal behavioral observations by Navy lookouts for validation by NMFS. Improvements to reporting requirements are planned for the remaining 2007 and 2008 exercises to better incorporate non-subjective categories of behavioral description, and instead report "what the observer saw", and how long the observation continued. Adding sea state and visibility reports at the time of sighting may result in a better determination of the effective visual monitoring ranges being reported. While identification to species-level would be optimal, that level of detail may not be immediately obtainable from U.S. Navy lookout reports without further training and testing of alternative methodologies to supplement existing shipboard reports. In accordance with the BO, data collection needs to address these questions will be incorporated into future exercises as the U.S. Navy's exercise monitoring program evolves.

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 re 1 $\mu Pa^2 \cdot s$. Data collection needs to address this question. It remains a problematic science issue for even non-Navy marine mammal surveys.

Although not conducted specifically for these April 2007 exercises, ship based and aerial monitoring designed in support of future exercise monitoring and future range complex monitoring is being developed by the U.S. Navy. The USWEX Monitoring Plan is being reviewed and enhanced for FY08 implementation. New information on the scope and results from any exercise monitoring will be provided in subsequent U.S. Navy After Action Reports. The U.S. Navy is looking to integrate additional monitoring tools and techniques in future exercises as the exercise and range complex monitoring plans are designed and implemented.

CONCLUSIONS AND SUMMARY

- Marine mammals were sighted only one time for a total of one large whale over two separate USWEX events of two-days each.
- The one sighting event was during a period when no MFAS was operating, and therefore no exposures to marine mammals occurred based on visual sightings.
- In the one reported sighting, the marine mammal was detected by Navy watchstanders in accordance with Navy standard operational procedures and as reiterated by NDE mitigation measures.
- There were no ship strikes on marine mammals during these exercises and one instance where U.S. Navy vessel maneuvered to avoid crossing a marine mammal's path and increase the separation between the ship and animal.
- Since MFAS was not secured in USWEX 07-02 or 07-03, there were no lost ASW training opportunities.
- Improvements to the U.S. Navy lookout reporting procedures will be implemented for future exercises to better capture metrics on weather conditions during the sighting, and more detailed observations of animal behavior.
- The U.S. Navy is committed to development of robust exercise and long-term range complex monitoring plans that will integrate multiple tools in order to provide better assessment of marine mammal occurrence and possible MFAS effects, or lack of effects. FY08 plans may include various mixes of ship and aerial surveys independent of exercise participants, validation by experienced biologist(s) on lookout effectiveness in observing marine mammals, and use of new research and development technologies to advance the state of marine mammal monitoring.

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APPENDIX A- TABLE AND FIGURES

INTRODUCTION

This Appendix contains material supporting the discussion in the U.S. Navy's combined USWEX After Action Report. It is divided into two Appendices. Appendix A contains tables and figures referred to in the main Report. Appendix B contains the THIRD FLEET Letter of Instruction (LOI) directing exercise participants to comply with NDE and BO conditions, and specifies the exact marine mammal sighting reporting language ships are responsible for providing after the exercise.

Table A-1. Hawaii USWEXs in April 2007.

CSG/ESG	Event Name	Dates	MFAS Use Reported (hours)
CSG	USEX 07-02	10-11 Apr 2007	265.5 hrs
ESG	USWEX 07-03	17-18 Apr 2007	50.1 hrs

Table A-2. Marine mammal sightings and actions by exercise participants during USWEX 07-03. Text in red **Bold** indicate events when MFAS was in use and secured due to marine mammal mitigation. Red text in *Italics* indicates when MFAS was in use, but mitigation other than securing sonar enacted.

Date-Time (local)	Ship Type	Description of Actions Taken	# of animals	MFAS status
04/17-1345	MFAS ship	Surface ship sights 1 "large whale" traveling at 300 yards. **Ship changes course** to open distance between whale and vessel.	1	Not in Use
	1	= total sighting events total number of animals =	**1**	

Table A-3. Sightings during USWEX 07-03 where MFAS mitigation occurred.

Assessment by Range			
Range	**ESA species (potential)**	**MMPA species**	**Comments**
200 yards- Sonar secured (turned off)	0	0	
500 yards- Sonar reduced -10 dB	0	0	
1000 yards- Sonar reduced -6 dB	0	0	

Table A-4. Total annual exposures for sonar and underwater detonations (*left*) from DoN 2007 based on 6 exercise per year (USWEX EA/OES Table 4.3), and estimated exposures per exercise (*right*).

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

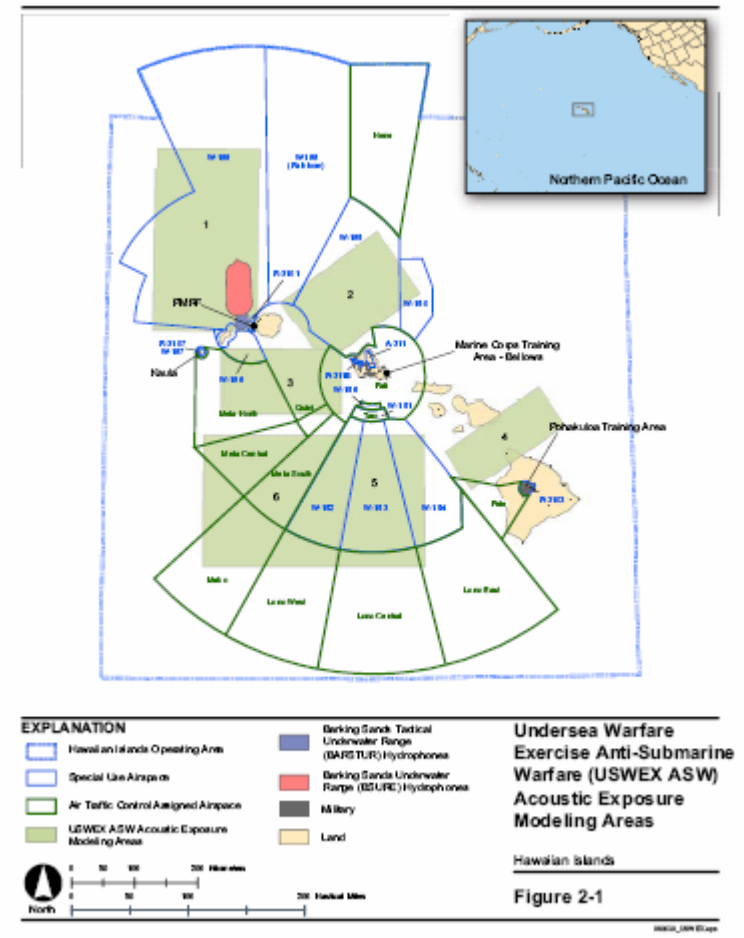
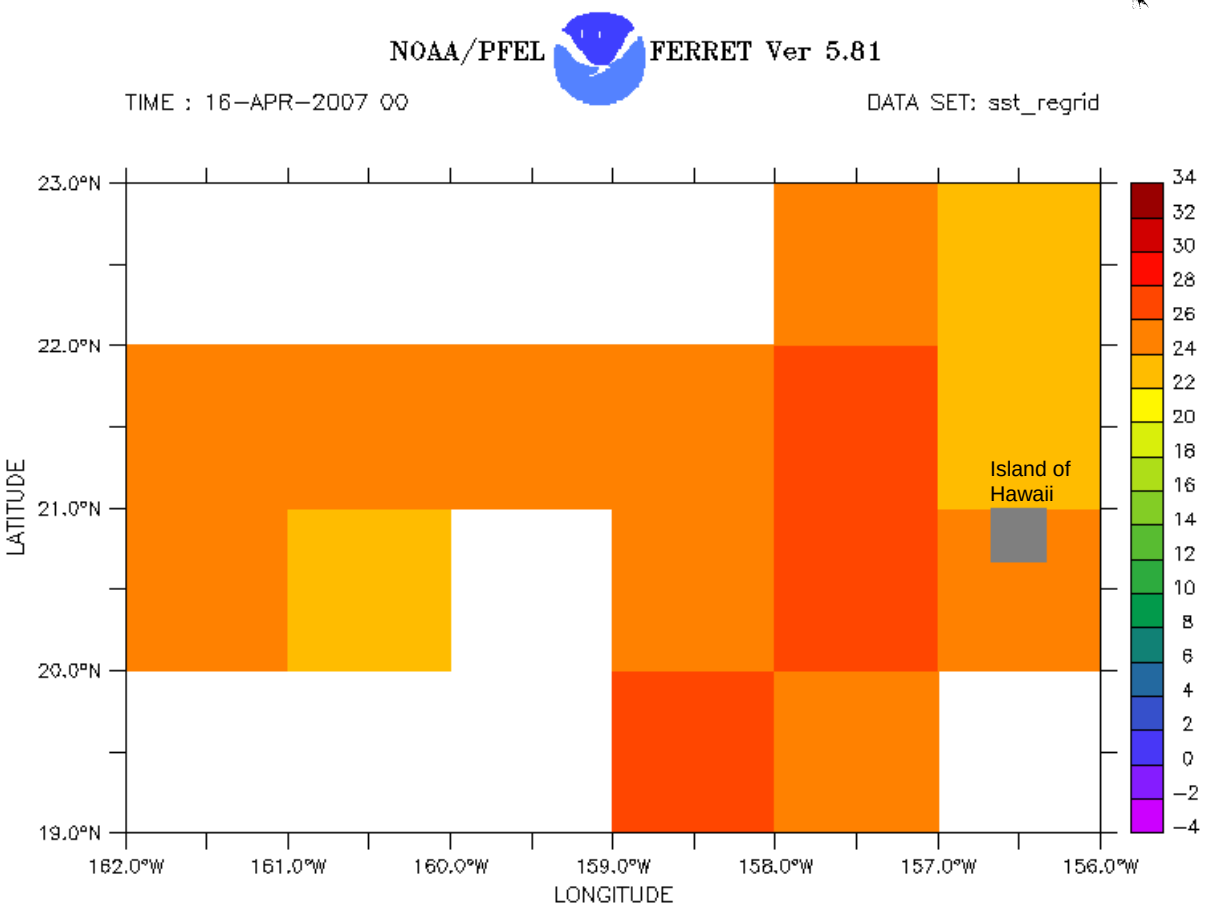


Figure A-1. Hawaii Range Complex and ocean areas associated with USWEX (figure from DoN 2007).



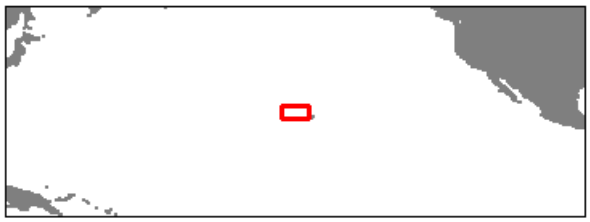


Figure A-2. Monthly mean Sea Surface Temperature (SST) by 1°-latitude increments near the main Hawaiian Island for period of 16 April 2007.
Source: Pacific Fisheries Environmental Laboratory Live Access Server
http://www.pfeg.noaa.gov

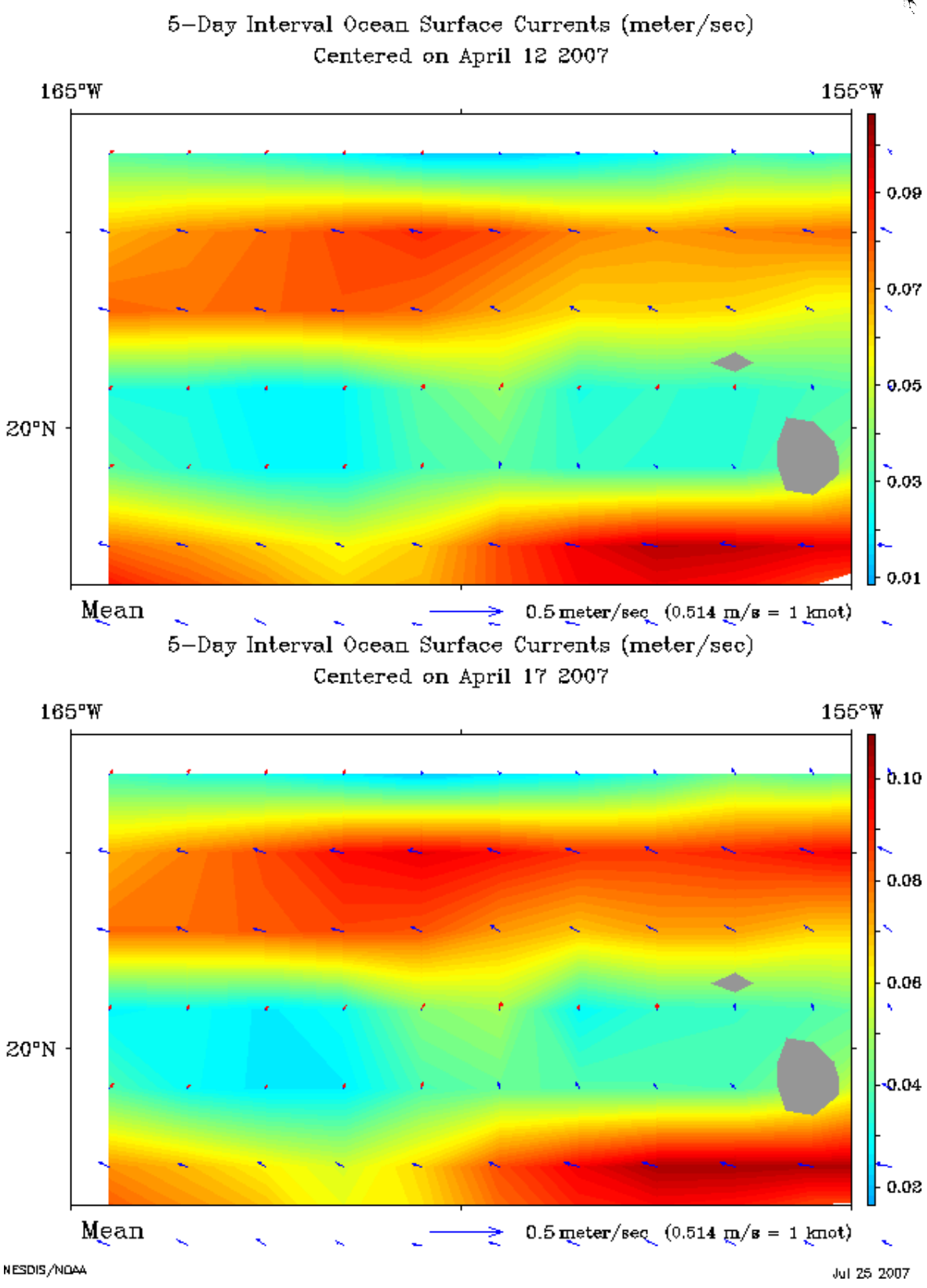


Figure A-4. Ocean surface currents (5-day interval) in vicinity of main Hawaiian Islands for 12 April 2007 (top) and 18 April 2007 (bottom).

APPENDIX B- NDE CONDITIONS AND LETTER OF INSTRUCTION

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.

LETTER OF INSTRUCTION FOR USWEX EXERCISES

SUBJ/MARINE MAMMAL AND ENDANGERED SPECIES LETTER OF INSTRUCTION (LOI) /IN SUPPORT OF xxxxx07-xx//

REF/A/DOC/16USC1361-1372/-/1972//

REF/B/DOC/16USC1531-1544/-/1973//

REF/C/INST/OPNAVINST 5090.1B CH-3/01NOV1994//
REF/D/MSG/SECNAV/181634ZNOV2005//

REF/E/LTR/DOD/23JAN2007//

NARR/REF A IS THE MARINE MAMMAL PROTECTION ACT. REF B IS THE ENDANGERED SPECIES ACT. REF C IS THE ENVIRONMENTAL AND NATURAL RESOURCES PROGRAM MANUAL. REF D IS ALNAV REQUIRING RETENTION OF ALL MID-FREQUENCY ACTIVE SONAR USE LOGS AND MATERIALS RELATED TO MID-FREQUENCY ACTIVE SONAR DUE TO ONGOING LITIGATION IN US FEDERAL COURT. REF E IS NATIONAL DEFENSE EXEMPTION FROM REQUIREMENTS OF THE MARINE MAMMAL PROTECTION ACT FOR CERTAIN DOD MID-FREQUENCY ACTIVE SONAR ACTIVITIES.//

GENTEXT/REMARKS/1. (U) DUE TO POSSIBLE PRESENCE OF PROTECTED MARINE SPECIES WITHIN xxxxx 07-xx OPERATING AREA AND POTENTIAL EFFECTS ON THESE SPECIES FROM USE OF MID-FREQUENCY ACTIVE SONAR, THE FOLLOWING GUIDANCE IS PROVIDED FOR EXERCISE CONDUCT AND REPORTING. THE MAJORITY OF THE GUIDANCE AND INFORMATION IN THIS MESSAGE IS COMPILED FROM EXISTING LAWS AND REGULATIONS FOUND IN REFS A-E.

1.A. (U) MARINE MAMMALS. REF A PROHIBITS HARASSING, CAPTURING, INJURING OR KILLING ANY MARINE MAMMAL (INCLUDING WHALES, DOLPHINS, SEALS AND PORPOISES) IN U.S. WATERS OR ON THE HIGH SEAS. THE TERM HARASS IS INTERPRETED BROADLY AND INCLUDES ACTS OF PURSUIT, TORMENT OR ANNOYANCE WHICH HAVE THE SIGNIFICANT POTENTIAL TO INJURE A MARINE MAMMAL IN THE WILD OR WHICH DISTURBS OR IS LIKELY TO DISTURB A MARINE MAMMAL IN THE WILD BY CAUSING DISRUPTION OF NATURAL BEHAVIORAL PATTERNS, INCLUDING, BUT NOT LIMITED TO, MIGRATION, SURFACING, NURSING, BREEDING, FEEDING OR SHELTERING, TO A POINT WHERE SUCH BEHAVIORAL PATTERNS ARE ABANDONED OR SIGNIFICANTLY ALTERED.

1.B. (U) ENDANGERED SPECIES. REF B PROHIBITS THE TAKING (HARASSING, HARMING, PURSUING, HUNTING, SHOOTING, WOUNDING, KILLING, TRAPPING, CAPTURING OR COLLECTING OR TO ATTEMPT TO DO SO) OF ANY FEDERALLY PROTECTED ENDANGERED OR THREATENED SPECIES UPON THE HIGH SEAS, WITHIN THE UNITED STATES OR IN THE TERRITORIAL SEA OF THE UNITED STATES.

2. (U) REF E SPECIFIES NEW REQUIREMENTS EFFECTIVE THROUGH 23 JANUARY 2009 WHEN USING MID FREQUENCY ACTIVE (1kHz-10kHz) SONAR (MFAS) (E.G. SHIP AND SUB HULL MOUNTED SONAR, HELO DIPPING SONAR AND DICASS SONOBUOYS) DURING MAJOR EXERCISES OR WHEN TRAINING OR CONDUCTING MAINTENANCE WITHIN ESTABLISHED OPERATING AREAS.

2.A. (U) THESE REQUIREMENTS APPLY:

2.A.1. (U) DURING XXXXX 07-0X TRAINING EXERCISES.

2.A.2. (U) TO THE USE OF MFAS SYSTEMS FOR THE PURPOSE OF SEARCHING FOR AND TRACKING OF SUBMARINES AND MINES.

2.B. (U) THESE REQUIREMENTS DO NOT APPLY TO:

2.B.1. (U) OPERATIONAL USE, INCLUDING FORCE PROTECTION AND SAFETY OF NAVIGATION.

2.B.2. (U) UNDERWATER COMMUNICATION SYSTEMS AND FATHOMETERS.

3. (U) A COORDINATED CUSFFC/CPF GUIDANCE MESSAGE WILL BE RELEASED IN THE NEAR FUTURE TO ENSURE COMPLIANCE WITH REF E REQUIREMENTS. IN THE INTERIM, FOR THE PURPOSES OF xxxxxx 07-xx, THE FOLLOWING ACTIONS ARE DIRECTED.

3.A. (U) PERSONNEL TRAINING.

3.A.1 (U) ALL SURFACE SHIP LOOKOUTS AND TOPSIDE WATCHSTANDERS (I.E., OODS, JOODS) AS WELL AS MPA AIRCREWS AND ASW/MIW HELICOPTER AIRCREWS MUST COMPLETE MARINE SPECIES AWARENESS TRAINING (MSAT) BY VIEWING THE U.S. NAVY MSAT DVD. MSAT TRAINING MUST BE REVIEWED PRIOR TO USE OF MFA SONAR. THESE PERSONNEL ARE NOT SOLELY MARINE MAMMAL OBSERVERS AND CAN PERFORM OTHER DUTIES (E.G., LOOKOUT, JOOD).

UNITS SHOULD ALREADY HAVE A COPY OF THE MSAT DVD, WHICH WAS DISTRIBUTED IN AUGUST 2006. IF NOT RECEIVED, CONTACT xxxxxx, TEL: xxx-xxx-xxxx, NIPRNET EMAIL: xxxxxxxxx TO OBTAIN A COPY. THE MSAT TRAINING CAN BE FOUND ON HTTPS:/MMRC.TECQUEST.NET/. IN ADDITION, MARINE MAMMAL TRAINING SLIDES ARE AVAILABLE ON THE xxxxxxx WEBSITE AT xxxxxxx.

3.B. (U) AVIATION UNITS.

3.B.1 (U) MPA AND OTHER AIRCRAFT PARTICIPATING IN ASW EVENTS AND FLYING LOW ENOUGH TO REASONABLY SPOT MARINE MAMMALS SHALL MONITOR FOR MARINE MAMMALS PRIOR TO AND DURING THE EVENT AND REPORT SIGHTINGS TO xxxxxx. IF SONAR IS SECURED (I.E. DICASS SONOBUOY) DUE TO PRESENCE OF MARINE MAMMALS WITHIN 200 YARDS, THEN REPORTING REQUIREMENT DESCRIBED IN PARA 4.A.2 APPLY.

3.C. (U) SONAR OPERATORS.

3.C.1 (U) SUB OPERATORS WILL CHECK FOR PASSIVE INDICATION OF MARINE MAMMALS CLOSE ABOARD PRIOR TO USE OF MFAS. CLOSE ABOARD IS DEFINED AS VISIBLE BEARING RATE ON DIMUS DISPLAY. SHIP OPERATORS WILL CHECK FOR PASSIVE INDICATION OF MARINE MAMMALS ON THE UNDERWATER TELEPHONE IOT ALERT LOOKOUTS PRIOR TO USE OF MFAS. IF MFAS SONAR IS SECURED DUE TO PRESENCE OF MARINE MAMMALS, THEN REPORTING REQUIREMENTS DESCRIBED IN PARA 4.A.2 APPLY AS APPLICABLE AND CAN BE DETERMINED.

3.D. (U) MFAS OPERATIONS.

3.D.1. (U) OPERATE MFAS AT LOWEST PRACTICABLE LEVEL, NOT TO EXCEED 235 DB, EXCEPT FOR OCCASIONAL SHORT PERIODS OF TIME TO MEET TACTICAL TRAINING OBJECTIVES. USE OF MFAS AT SOURCE LEVELS ABOVE 235 DB SHALL BE LOGGED AND REPORTED IAW PARA 4.

3.D.2. (U) PRIOR TO START-UP OR RESTART OF ACTIVE SONAR, OPERATORS WILL CHECK THAT THE BUFFER ZONE DESCRIBED BELOW IN PARA. 3.E IS CLEAR OF MARINE MAMMALS.

3.D.3. (U) HELICOPTERS SHALL OBSERVE/SURVEY THE VICINITY OF EACH ASW EVENT LOCATION FOR 10 MINS PRIOR TO COMMENCEMENT OF THE PROSECUTION (BEFORE DEPLOYING ACTIVE (DIPPING) SONAR). HELICOPTERS SHALL NOT DEPLOY THEIR SONAR WITHIN 200 YARDS OF A MARINE MAMMAL AND WILL SECURE ACTIVE TRANSMISSIONS IF A MARINE MAMMAL CLOSES WITHIN 200 YARDS. IF SONAR IS SECURED DUE TO PRESENCE OF MARINE MAMMALS WITHIN 200 YARDS, THEN REPORTING REQUIREMENT DESCRIBED IN PARA 4.A.2 APPLY.

3.E. (U) HULL MOUNTED MFAS BUFFER ZONES.

3.E.1. PRIOR TO START-UP OR RESTART OF MFAS, OPERATORS WILL CHECK THAT SAFETY ZONES IN PARA 3.E.2-4 ARE CLEAR OF MARINE MAMMALS.

3.E.2. (U) 1000 YARDS. WHEN MARINE MAMMALS ARE DETECTED BY ANY MEANS (AIRCRAFT, LOOKOUT, OR AURALLY) WITHIN 1000 YARDS OF THE SONAR DOME, THE SHIP OR SUBMARINE WILL LIMIT ACTIVE TRANSMISSION LEVELS TO AT LEAST 6 DB BELOW THE EQUIPMENT NORMAL OPERATING LEVEL FOR SECTOR SEARCH MODES. SHIPS AND SUBMARINES WILL CONTINUE TO LIMIT MAXIMUM PING LEVELS BY THIS 6 DB FACTOR UNTIL THE ANIMAL HAS BEEN SEEN TO LEAVE THE AREA, HAS NOT BEEN SEEN FOR 30 MINUTES, OR THE VESSEL HAS TRANSITED MORE THAN 2000 YARDS BEYOND THE LOCATION OF THE LAST SIGHTING.

3.E.3. (U) 500 YARDS. SHOULD THE 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 FOR SECTOR SEARCH MODES. 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 SEEN FOR 30 MINUTES, OR THE VESSEL HAS TRANSITED MORE THAN 2000 YARDS BEYOND THE LOCATION OF THE LAST SIGHTING.

3.E.4. (U) 200 YARDS. SHOULD THE MARINE MAMMAL BE DETECTED WITHIN OR CLOSING TO INSIDE 200 YARDS OF THE SONAR DOME, ACTIVE SONAR TRANSMISSIONS WILL CEASE. WHEN A MARINE MAMMAL IS DETECTED CLOSING TO INSIDE APPROXIMATELY 200 YARDS OF THE SONAR DOME, THE PRINCIPAL RISK BECOMES POTENTIAL PHYSICAL INJURY FROM COLLISION. ACCORDINGLY, IF THE MARINE SPECIES CLOSES WITHIN 200 YARDS, SHIPS AND SUBMARINES SHALL MANEUVER TO AVOID COLLISION TO THE GREATEST EXTENT POSSIBLE, WITH SAFETY OF THE VESSEL BEING PARAMOUNT. ACTIVE SONAR WILL NOT RESUME UNTIL THE ANIMAL HAS BEEN SEEN TO LEAVE THE AREA, HAS NOT BEEN SEEN FOR 30 MINUTES, OR THE VESSEL HAS TRANSITED MORE THAN 2000 YARDS BEYOND THE LOCATION OF THE LAST SIGHTING.

3.E.5. (U) SPECIAL CONDITIONS APPLICABLE TO 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 BOW WAVE, NO FURTHER MITIGATION ACTIONS ARE NECESSARY WHILE THE DOLPHINS OR PORPOISES CONTINUE TO EXHIBIT BOW WAVE RIDING BEHAVIOR.

3.F. (U) LOOKOUTS

3.F.1. (U) ON THE BRIDGE OF SURFACE SHIPS, THERE WILL BE AT LEAST THREE PEOPLE ON WATCH WHOSE DUTIES INCLUDE OBSERVING THE WATER SURFACE AROUND THE VESSEL. IN ADDITION TO THE THREE PERSONNEL ON WATCH, ALL SURFACE SHIPS PARTICIPATING IN ASW EXERCISES WILL HAVE AT ALL TIMES DURING THE EXERCISE AT LEAST TWO ADDITIONAL PERSONNEL ON WATCH AS LOOKOUTS. EACH PERSON ON WATCH WILL HAVE A SET OF BINOCULARS TO AID IN DETECTION OF MARINE MAMMALS. ON SURFACE VESSELS EQUIPPED WITH MFAS, PEDESTAL-MOUNTED BIG EYE (20 X 110) BINOCULARS WILL BE USED TO ASSIST IN DETECTION OF MARINE MAMMALS IN THE VICINITY OF THE VESSEL.

3.F.2. (U) DURING MFAS OPERATIONS, PERSONNEL WILL UTILIZE ALL AVAILABLE SENSOR AND OPTICAL SYSTEMS (SUCH AS NIGHT VISION GOGGLES) TO AID IN DETECTION OF MARINE MAMMALS.

3.F.3. (U) PERSONNEL ON LOOKOUT WILL EMPLOY VISUAL SEARCH PROCEDURES EMPLOYING A SCANNING METHODOLOGY IAW LOOKOUT TRAINING HANDBOOK (NAVEDTRA 12968-B).

3.F.4 (U) AFTER SUNSET AND PRIOR TO SUNRISE, LOOKOUTS WILL EMPLOY NIGHT LOOKOUT TECHNIQUES IN ACCORDANCE WITH LOOKOUT TRAINING HANDBOOK.

4. (U) REPORTS AND DATA COLLECTION.

4.A. (U) ALL UNITS WILL CONTINUE TO SEND SPORTS MESSAGES.

4.A.1. (U) ALL UNITS EMPLOYING MFAS ARE REQUIRED TO SUBMIT AN AFTER ACTION REPORT (AAR), CLASSIFIED AS CONFIDENTIAL. XXXX STRIKE GROUP COMMANDER SHALL CONSOLIDATE ALL REPORTS INTO A FINAL REPORT AND FORWARD TO xxxxxxx, INFO CHAIN OF COMMAND, WITHIN 10 DAYS OF COMPLETION OF THE EXERCISE. THIS TIMELINE IS REQUIRED DUE TO REGULATORY REQUIREMENTS THAT NAVY VERBALLY REPORT MARINE MAMMAL SIGHTING INFORMATION AND IMPACTS TO MFAS OPS TO NATIONAL MARINE FISHERIES SERVICES WITHIN 15 BUSINESS DAYS FROM EXERCISE COMPLETION.

4.A.2. (U) THE FINAL REPORT (SUBJ: MFA MARINE MAMMAL REPORT FOR EXERCISE xxxxx 07-xx) WILL BE COMPRISED OF TWO PARTS. PART ONE WILL REPORT ALL MARINE MAMMALS SIGHTED DURING THE EXERCISE, AND WILL INCLUDE THE DATA LISTED BELOW:

A.DTG OF INITIAL SIGHTING.

B. UNIT AND POSIT (UNIT NAME AND LAT/LONG). NOTE, IF REPORT IS FOR ASW HELO ASSIGNED TO VESSEL, THIS MUST BE REPORTED SEPARATELY FROM SURFACE SHIP REPORTS.

C. DESCRIPTION OF ANIMAL BY SPECIES IF KNOWN, OTHERWISE SPECIFY: DOLPHIN, SM WHALE (SMALL WHALE), LG WHALE (LARGE WHALE), SEAL/SEALION.

D. ESTIMATED NUMBER OF ANIMALS.

E. TRUE BEARING AND RANGE FROM UNIT.

F. ANIMALS BEHAVIOR AT TIME OF SIGHTING: RESTING, TRAVELING (NOTE DIRECTION IN RELATION TO SHIP COURSE), BOW-RIDING, FEEDING/ERRATIC, MILLING (I.E., STAYING IN SAME AREA), JUMPING CLEAR OUT OF WATER, FLIPPER/TAIL SLAPPING, OTHER, OR UNKNOWN).

G. ACTION TAKEN: NONE, ALTER COURSE TO AVOID, MFAS POWER DOWN, MFAS SECURED (I.E. CEASE ACTIVE SONAR TRANSMISSION).

ONLY IN CASES WHERE MFAS IS POWERED DOWN OR SECURED, THE FOLLOWING ADDITIONAL INFORMATION IS REQUIRED IN ORDER TO FORWARD POST-EXERCISE IMPACT ASSESSMENT TO CPF AND NATIONAL MARINE FISHERIES SERVICE:

H. UNIT COURSE AND SPD.

I. ANIMAL COURSE AND EST SPD.

J. ACTION TIMELINE: LENGTH OF TIME MFAS POWERED DOWN, OR SECURED.

K. ACTION IMPACT (I.E. TACTICAL DEGRADATION ASSESSMENT): NONE, SLIGHT, MODERATE, SEVERE.

- REPEAT PARAS. A-L AS NECESSARY TO REPORT ADDITIONAL SIGHTINGS.

SIGHTING SHALL BE IN FORMAT:

A. DTG/ B. UNIT-POSIT/C. DESCRIPT/ D. # ANIMAL/ E. BRNG-RNG/ F. BEHAV/ G. ACTION TAKEN/H. UNIT CRS-SPD/ I. ANIMAL CRS/ J. ACTION TIME/

PART TWO OF THE REPORT WILL PROVIDE A COMMANDER'S ASSESSMENT OF EFFECTIVENESS OF THE MITIGATION MEASURES IMPLEMENTED IN REF E, MAKE RECOMMENDATIONS TO IMPROVE THESE MEASURES, AND REPORT ANY IMPACT TO TRAINING FIDELITY CAUSED BY THESE MEASURES (E.G., SONAR POWER REDUCTION

CAUSED BY MARINE MAMMAL ENTERING BUFFER ZONE). IT IS PARTICULARLY IMPORTANT TO CAPTURE THE IMPACT THAT THESE MEASURES MAY HAVE ON OPERATIONS AND TRAINING.

5. (U) ENSURE WATCHSTANDERS ARE BRIEFED ON THE POSSIBLE PRESENCE OF MARINE MAMMALS AND THAT ALL SIGHTINGS ARE REPORTED TO THE BRIDGE. NOTE, WHALES OFTEN TRAVEL IN GROUPS AND A SIGHTING INDICATES THE POSSIBILITY OF OTHER WHALES IN THE VICINITY.

5.A. (U) UPON SIGHTING A WHALE, ADJUST COURSE AND SPEED AS NECESSARY TO MAINTAIN A SAFE DISTANCE CONSISTENT WITH PRUDENT SEAMANSHIP.

5.B. (U) SIGHTINGS OF ALL WHALES SHALL BE PASSED VIA CHAIN OF COMMAND TO THE CFMCC BATTLE WATCH CAPTAIN IOT ALERT OTHER SHIPS IN THE AREA TO THE POSSIBILITY OF THE WHALES' PRESENCE.

5.C. (U) IN THE EVENT OF A WHALE COLLISION. IF POSSIBLE, TAKE VIDEO AND/OR PHOTOGRAPHS OF THE STRICKEN WHALE.

5.C.1. (U) ATTEMPT TO IDENTIFY DISTINGUISHING CHARACTERISTICS OF THE WHALE INVOLVED. THE "WHALE WHEEL," A DEVICE THAT LISTS VARIOUS SPECIES OF WHALES AND THEIR IDENTIFYING FEATURES, CAN ASSIST IN THIS REGARD.

5.D. (U) REPORTING REQUIREMENTS FOR A WHALE COLLISION. CHAPTER

19-11.3.2 OF REF C PROVIDES GUIDANCE CONCERNING WHALE STRIKES.

5.D.1. (U) IN THE EVENT OF A COLLISION WITH A WHALE OR ON SIGHTING A MARINE MAMMAL FLOATING CARCASS DURING xxxxxx 07-0X, AN APPROPRIATE UNIT SITREP/OPREP MESSAGE MUST CONTAIN THE FOLLOWING ADDRESSEES AND INFORMATION:

A. DATE, TIME AND LOCATION.

B. VESSEL'S COURSE AND SPEED.

C. OPERATIONS BEING CONDUCTED BY THE VESSEL.

D. WEATHER CONDITIONS, VISIBILITY AND SEA STATE.

E. DESCRIBE THE ANIMAL IN AS MUCH DETAIL AS POSSIBLE; E.G., LENGTH, COLOR, CONDITION OF BODY, OTHER DISTINGUISHING FEATURES. DO NOT SPECULATE.

F. NARRATIVE OF INCIDENT, INCLUDING RELATIVE POSITION AND MOVEMENTS OF SHIP AND WHALE.

G. INDICATE IF PICTURES/VIDEOS WERE TAKEN FROM FLIGHT DECK CAMERAS OR OTHER INSTALLED OR PORTABLE CAMERAS.

5.D.2. (U) A VOICE REPORT (VIA ISIC) TO xxxxxx IS ALSO REQUIRED. IF VOICE COMMUNICATIONS ARE NOT AVAILABLE, MAKE REPORT VIA CHAT.

6. (U) ALL UNITS THAT EMPLOY MFAS SHALL ENSURE THEY FULLY UNDERSTAND AND IMPLEMENT THE MITIGATION AND REPORTING REQUIREMENTS PROMULGATED IN THIS MESSAGE.

6.A. (U) COMMANDING OFFICERS SHALL THOROUGHLY REVIEW THIS GUIDANCE WITH KEY PERSONNEL AND WATCHSTANDERS TO ENSURE FULL SITUATIONAL AWARENESS AND COMPLIANCE.

7. (U) REMINDER, NOTHING IN THIS MESSAGE RESTRICTS THE AUTHORITY OF A COMMANDING OFFICER FROM TAKING SUCH MEASURES DEEMED NECESSARY FOR OPERATIONAL FORCE PROTECTION AND SAFETY OF NAVIGATION PURPOSES.//

APPENDIX C- REPORT OF NAVY CONTRACTOR BIOLOGIST EMBARKED ABOARD CVN DURING USWEX 07-02 10-11 APRIL

10 April 2007

10:45 (all times are given as local Hawaii Standard Time): Arrived USS Nimitz aboard C2 Grayhound. Circled for about 20 minutes near the Nimitz prior to landing. No marine mammals or sea turtles observed from the aircraft.

10:45-12:00: Orientation, meeting with the Captain

12:00-17:30: Tour of the watch stander positions with the ANAV officer.

Observations were conducted from the flag bridge using Zeiss 10x42 binoculars. Several big eye binoculars (25x150) were available for use and two watchstander look outs were at approximately the same location with one on the port side and one on the starboard side of the ship. Two watchstander look outs were also stationed on the stern of the ship. Aircraft operations were conducted through most of this time, mostly consisted of F/A 18 launch and recovery with some helicopter operations.

Weather conditions were clear with approximately 12 miles (19 km visibility, swell was about eight feet (2.5 meters), wind was 17.5-22.4 knots (7.1-9.2 meter/second) for a Beaufort sea state of 4-5. Air temperature was 74.5-79.2^{o}F (23.6-26.2^{o}C).

No marine mammals or sea turtles were observed by myself or the watchstander look outs, including the watchstander look outs on the stern of the ship.

17:30-19:50: Observations made from the navigation bridge and "Vultures Row" until darkness. No marine mammals observed by myself and the watchstanders.

At times, the ships conducting ASW activities and surrounding the carrier, were visible in the distance. The ship several hundred miles south-west of Oahu but due to security the exact location was not given.

11 April 2007

07:00-10:15: Observations from the same location as 10 April, the flag bridge using Zeiss 10x42 binoculars. Several big eye binoculars (25x150) were available for use and two watchstanders were at approximately the same location with one on the port side and one on the starboard side of the ship.

Weather conditions were clear with approximately 12 miles (19 km) visibility, swell was about eight feet (2.5 meters), wind was 17.5-25.1 knots (7.1-10.2 meters/second) for a Beaufort sea state of 4-6. Air temperature was 74.5-79.2^{o}F (23.6-26.2^{o}C).

No marine mammals observed by myself and the watchstander look outs.

At times, the ships conducting ASW activities and surrounding the carrier, were visible in the distance. Air operations were being conducted through most of the observation period.

11:15: Departed the USS Nimitz and returned to Hickam Air Force Base.

APPENDIX D- ACOUSTIC SNAPSHOP ANALYSIS FOR MARINE MAMMALS USING PACIFIC MISSILE RANGE FACILITY BOTTOM MOUNTED HYDROPHONES FOR APRIL 2007 AND APRIL 2006

Initial acoustic snapshot analysis results for marine mammal species using Pacific Missile Range Facility bottom mounted hydrophones for April 2007 and April 2006.

Summary:

There is a growing body of research on the use of passive acoustics, both alone and in conjunction with traditional visual surveys, for density estimation for cetaceans. The bulk of this research has been focused on towed hydrophones which are increasingly being used in conjunction with visual line transect surveys. Fixed, bottom mounted hydrophones, such as those at US Navy instrumented ranges; pose different challenges in estimating densities using the accepted distance sampling methodology. A new research effort, described in the next section, is underway to develop sound statistical methods for estimating cetacean densities using bottom mounted hydrophones, which will utilize acoustic hydrophone data from two US Navy instrumented ranges in case studies. Bottom mounted Pacific Missile Range Facility (PMRF) hydrophones operate from as low as 60 Hz to up to 48 kHz and are well suited for detection of multiple species, genera, or families of cetaceans with relatively well understood characteristic acoustic signatures (e.g. humpback whales via their song, Minke whales via their 'boing' sound, and sperm and beaked whales via their echolocation clicks). Other cetacean species are present at PMRF (Baird et. al. 2006, Barlow 2006, Barlow et. al. 2004), but are more difficult to identify solely by acoustic techniques (i.e. various species of *Delphinidae*, *Kogia* and other Mysticeti).

Currently, limited information is available relative to marine mammal species present on, or near, the PMRF underwater ranges at the various times of the year. The best estimates for marine mammal species present in the area come from aerial surveys (Mobley 2005), however minke whales were never sighted during the aerial surveys, while they have been acoustically detected and localized. Acoustic data has been collected from PMRF hydrophones for selected days every year since 2002 and continues today at the rate of two days of acoustic recordings every month. Prior reporting (Tiemann et. al. 2006) dealt with sperm whale localization and automatic (not species specific) detection results. To gain more insight into species present in the area, manual aural and spectrographic analysis of limited amounts of acoustic data has been conducted. Manual analysis is employed, as current automated techniques do not provide reliable species identification. This analysis is being conducted by a US Navy trained acoustic intelligence specialist with over 42 years of experience in sonar analysis. Various automation tools are currently being utilized (e.g. spectrograph display and localization software) and additional efforts are underway to obtain time difference of arrival data via an automated system output (Moretti et. al. 2002). These efforts are being pursued to make the manual analysis more efficient, and eventually allow fully automated analysis for large amounts of data when sufficient marine mammal species classifiers are available.

The current analysis are termed 'acoustic snapshots' with the goal of determining the numbers of, and when possible locations of, readily acoustically identifiable marine mammal species in an area using two dozen or more bottom mounted hydrophones. Snapshot refers to a short duration time window (Buckland et. al. 2001), such that

movement of observed species over the duration of the time window is not a major factor. The current manual analysis process is very laborious in nature and requires significant effort to generate results for each 10-minute acoustic snapshot. The short 10 minute snapshot temporal window is known to under-sample the foraging dive patterns of both Sperm and Beaked whales, however if these signals are detected it does confirm presence of a species in the area. While results from a handful of these 'acoustic snapshots' do provide some new information, such as numbers of different species present in the snapshot, the results are insufficient to understand normal variations in species present. Larger sample sizes are needed to gain some level of understanding of what constitutes normal variations (within a day, over days, weeks, months, seasons and years).

Results for three of these ten-minute 'acoustic snapshots' for multiple range hydrophones (either 24 or 31 phones) are presented. A single snapshot is provided for 15 April 2007 and two snapshots (taken 90 minutes apart) for 18 April 2006, all occurring late in the afternoon. Keeping in mind the very limited sample size and uncertainty in what constitutes normal variations, initial results of the analysis show three species, and a member of the Ziphiidae family, of marine mammals detected on 15 April 2007 (humpback, minke, sperm and beaked whales) and for 18 April 2006 the three species were detected (humpback, minke, and sperm whales). Localized humpback whale individuals are shown overlaid on charts for each of the three acoustic snapshots, along with localization of minke whales and a local area indicated for a single beaked whale for the 15 April 2007 snapshot. Tabular data of vocalizations logged for each species are also presented. Description of the data and analysis methods are provided, along with discussion of the results.

Introduction:

The Pacific Missile Range Facility (PMRF), located off of the western coast of Kauai, Hawaii, is one of the US Navy's instrumented test ranges. Part of PMRF's mission is to utilize passive acoustics to detect, localize and track objects of interest. PMRF's organic assets of bottom mounted underwater hydrophones allow the tracking of objects of interest in real time to support US Navy Pacific Fleet training requirements.

Twenty-four broad bandwidth PMRF hydrophones have been recorded as part of an 2002 – 2006 acoustic monitoring program under Office of Naval Research sponsorship. This ONR effort was concentrated during the winter months of February and March, which coincides with the peak of the humpback whales wintering in the area (Au et. al. 2000). In addition, the ONR effort acoustic data was specifically recorded simultaneously with aerial surveys conducted by Dr. J. Mobley (Mobley 2005) as part of separate ONR effort (North Pacific Acoustic Laboratory). Several days of acoustic recordings are available for a typical year with a limited effort at obtaining out of season acoustic data in the year 2002. The ONR funded acoustic recordings were comprised of the 24 broadband hydrophones available on the range sampled at 44.1 kHz (preserving approximately 20 kHz of bandwidth). At the conclusion of the ONR effort, Pacific Fleet sponsorship continued the acoustic data collection effort at a rate of up to two recordings per month for 2006 and 2007. In 2006 the recordings were sampled at a higher rate (96 kHz) in order to obtain bandwidths of up to 48 kHz on six of the twenty-four hydrophones specifically in response to new information regarding beaked whale echolocation signal frequencies (Johnson et. al. 2004). The twenty-four broadband hydrophones have spacing which vary from no closer than two nautical miles apart to over nine nautical miles separation. This spacing is significantly more than hydrophones available at the US Navy Atlantic Undersea Test and Evaluation Center (AUTEC) instrumented range in

the Bahamas. In March 2007 an additional 7 high pass filtered (8 kHz) hydrophones, with response up to 48 kHz, were added in an attempt to improve the opportunity of detecting beaked whale echolocation signals. These additional seven hydrophones were concentrated (spacing less than 2 nautical miles) in areas around broadband hydrophones on which beaked whales were previously detected and fit with known beaked whale habitat information (MacLeod et. al. 2006, McSweeney et. al. 2007).

Each day of recorded data consists of from 4 hours per day (early year efforts to coincide with aerial over flights) to over 22 hours of continuous monitoring (post 2006) of acoustic data. This data is streamed in real-time to hard disk drives for later duplication, archiving and analysis.

Many marine mammal species are known to reside in the areas around the Hawaiian Islands (Barlow 2004 and 2006). These include species which are recognizable from their known acoustic signatures: Humpback whale song (Payne and McVay 1971); Minke 'boing' sound (Rankin and Barlow 2005); Sperm whale echolocation clicks (Watkins and Schevill 1977); and two species of beaked whale echolocation clicks (Johnson et. al. 2004 and 2006). Other species of marine mammals are more difficult to acoustically identify (e.g. the various dolphins and other small toothed whales) which are also known to occupy the waters around the Hawaiian Islands.

The accepted method for determining marine mammal species densities is based upon distance sampling (Buckland 2001), and typically utilized in visual surveys from surface ships and aircraft. This method is based upon the statistics of the probability of detection function being a known, monotonically decreasing function of distance (horizontal distance off of a track line for line transects or radial distances for point transects). There is no standardized, accepted statistical method current existent for acoustically determining the relative, or possibly even absolute, abundance from multiple fixed, bottom mounted acoustic sensors. However, in 2007 a new start National Oceanographic Partnership Program titled "Density Estimation for Cetaceans from Passive Acoustic Fixed Sensors (DECAF)" is being lead by Dr. Len Thomas, of the University of St. Andrews. The DECAF efforts include co-principal investigators from US Academia (Tyack and Mellinger) and the US Navy (Moretti and Martin), with well-known advisors (Buckland, Barlow and Zimmer). The three-year DECAF effort will be addressing many open issues in dealing with the statistics of marine mammal density estimation using fixed acoustic sensors.

This analysis utilizes what are termed 'acoustic snapshots' for initial investigation. This entails analysis of relatively short period of time, 10 minutes in this case, to obtain a 'snapshot' picture of marine mammal species present as sensed by the hydrophones. Snapshot methods are used for density estimates of terrestrial animals (Buckland et. al. 2001) and 5 to 10 minute windows typically employed. By using the snapshot method, one is able to minimize complications such as accounting for animal movement over observation time. The disadvantage of snapshots are that it only provides indication of the situation at that point in time, and requires many snapshot results in order to say anything about changes over time (short, mid and long term time periods).

The 10-minute 'acoustic snapshot' analysis window is known to temporally under sample sperm, and beaked whale deep foraging dive cycles. These whales utilize echolocation to find prey, such as squid, during these dives. Recent tagging data (Johnson et. al. 2004 and 2006) has shown two species of beaked whales producing clicks during each deep foraging dive, and very low (essentially no) click production when either on the surface, or while performing shallow dives. Deep dive cycle times average 121 minutes

for the Cuvier's beaked whale (*Ziphius cavirostris*) with 58 min average dive time off the coast of Italy, and 139 minutes for the Blainville's beaked whale (*Mesoplodon densirostris*) with 47 minute average dive time in the Canary Islands (Tyack et. al. 2006). Tagged data (no acoustics) for these two species measured in the Hawaiian Island waters agrees favorably with these dive times, with average deep dive times of 68 min for Cuvier's beaked whales and 48 minutes for Blainville's beaked whales (Baird et. al. 2006). Sperm whale deep dives times have been reported from 30 to 50 minutes with a nine-minute inter dive interval (Watwood et. al. 2006). Thus, one can easily miss detection of these species (false dismissal) with a single, or small sample size of, 10-minute snapshot(s). The 10-minute analysis window is currently driven by: the preference to utilize snapshot type analysis until better methods are developed; the high cost of manual analysis; and the desire to get insight into multiple days of acoustic analysis results. As automation efforts improve and the analysis effort continues, additional 10-minute acoustic snapshots will become available which should allow some statistical inferences. Increasing the analysis window to longer periods of time, to better sample the foraging dives would introduce new issues such as animal movement over time.

Humpback whales (one of the more extensively studied whale species) are known to winter in the Hawaiian waters but little is known of many of the other species found in the general area. Beaked whales have been studied off of the big island (Hawaii) using time/depth tags (no acoustics) and are known to have deep dive cycles similar to those reported elsewhere (Baird et. al. 2006). A photographic analysis of ten years of beaked whale data off of the island of Hawaii (McSweeney et. al. 2007) suggests resident populations of beaked whales in the area. The Minke whale is difficult to visually observe and typically found far offshore which accounts for limited knowledge of this species. A visual transect survey utilizing passive acoustics (Rankin et. al. 2005) recently coupled the long known, but unidentified source of, the 'boing' sound to the Minke whales. Subsequent surveys have detected many more Minke acoustically well offshore of the Hawaiian Islands (Rankin et. al. 2007). However, the purpose of the Minke 'boing' sound is still unknown, as is much about the Minke whale in general. Data from the PMRF analysis effort also show that the Minke whales are commonly acoustically detected in the deeper, more offshore, hydrophones via the 'boing' sound during the winter months. Humpbacks detected using the PMRF hydrophones are more commonly found more near shore in shallower waters. Sperm whales appear to be detected throughout the year, while beaked whales have, to date, only been detected a few times.

Methods:

A personal computer based data acquisition system was developed late in 2001 to record up to 32 channels of analog data at sample rates up to 1 MHz. A COTS (Commercial Off-The-Shelf) A/D (Analog to Digital) board samples all 32 channels simultaneously to 16 bits of resolution and data is streamed to hard drive for storage. Recordings conducted from 2002 through 2005 were sampled at 44,100 Hz, while subsequent recordings are sampled at 96,000 Hz. The increase in sample rate was done primarily in effort to better detect Beaked whale echolocation signals, which are now known to have primary energy peaks over 20 kHz (Johnson 2004).

Recordings through 2006 consisted of the twenty-four broadband hydrophones and an IRIG B time signal. Sixteen of the twenty-four broadband hydrophones provide a

bandwidth of between approximately 60 Hz up to 20 kHz, while the remaining six hydrophones have an upper receive limit of 48 kHz. In 2007, an additional seven high pass filtered (8 kHz) hydrophones with an upper receive limit of 48 kHz were added to the data collection effort to better sample for beaked whale echolocation signals.

The acoustic analysis is conducted by an individual with 20 years of service in the US Navy, including duty as a qualified Acoustic Intelligence (ACINT) Specialist certified by the Office of Naval Intelligence (Navy enlisted classification 0416 of which very few individuals have been qualified). The ACINT Specialist worked an additional 22 years after retiring from active duty, as a civilian contractor conducting research for various Navy advanced acoustic programs. The analyst is extremely qualified in infrasonic, sonic, ultrasonic acoustic signals analysis and has had to deal with bioacoustics throughout his career.

Acoustic data is continuously recorded (no gaps) to hard disk drive, along with IRIG time code, for a single recording session conducted in a day. For data management purposes, the data are organized as sequential 10-minute files (to keep each file size under 4Gbytes). Each 10-minute file contains either 24 hydrophones of data (2002 through 2006), or 31 hydrophones of data beginning in 2007. Several computerized tools are utilized in the analysis of the recorded acoustic data. Commercial off the shelf software for audio and spectrogram review of single channels of data (Adobe Audition), and custom developed software for review of 32 channels of data at once. A spreadsheet log is created for each 10-minute file containing the following for each hydrophone; Time of the detected event, Species (or unidentified), Type of sound, Spectral Characteristics, Temporal Characteristics and Comments. The analyst then reviews adjacent hydrophones searching for that identical sound. If the sound is present on at least two additional hydrophones a TDA (time-difference-of-arrival) is then calculated for that sound. The TDAs, to the nearest millisecond resolution, are inserted into a MATLAB based tool to compute the location of the individual which generated the sound. The MATLAB routine was provided by the Naval Undersea Warfare Center, Newport, Rhode Island and includes precise hydrophones locations in x, y, and z, and utilizes a historic sound velocity profile. Source depth is modeled to be at 30 feet for the localization (reasonable for humpbacks, but significantly off for deep diving echo locators such as sperm whales and beaked whales). The longitude, latitude and PMRF Range Coordinates from the localizations are also inserted into the spreadsheet.

For each hydrophone, the analyst must review the same single channel of acoustic data at least three times in order to fully search the spectral data between 60 Hz and up to 48 kHz. Current practice requires nominally 80 hours of analyst effort for each 10 minutes of data for 24 or 31-hydrophone format (including documentation into the spreadsheet). As additional automated techniques become available and are utilized, it will continue to make this process more efficient. Adding to the complexity of this analysis is the fact that when humpbacks are most prevalent, such as in Feb, March and April months, the background noise is essentially the humpback whales song (Au et. al. 2000) being over 15 dB louder than other times of the year. This makes the process of locating the identical sounds of individual humpback whales on adjacent phones difficult, and could also mask other sounds in the same frequency bands.

Results:

Acoustic snapshot results are provided for two separate days, 15 April 2007 and 18 April 2006. The acoustic snapshot for 15 April 2007 was centered at 16:58 Hawaiian standard time (16:53-17:03). Two separate acoustic snapshots were analyzed on 18 April 2006 – one centered at 17:04 and one 90 minutes later at 18:34. This analysis is providing insight into the marine mammal situation that exists on, or near, the PMRF underwater ranges for these three separate points in time during these days. This few of samples are insufficient to statistically say anything relative to normal variations, which may exist over the course of a day, let alone weeks, months or years.

Results are presented in two formats. First, nautical charts of the area are utilized to overlay locations of the five categories (humpback, minke, sperm, beaked whales and unidentified mammals) of localized individuals. Beaked whale detections are also plotted on the charts, as this species is expected to have a detection distance on the order of 4 km from bottom-mounted hydrophones (Tyack et. al. 2006). Sperm whale detections are not plotted in a similar manner due to the fact that the Sperm whale could be tens of miles distant from the hydrophone they are detected on due to the differences in click frequency content and source levels. Sperm whale localizations are obtained occasionally, but none were obtained on these three days. Due to the fact that some marine mammal presence in areas is related to bottom depth and topography, nautical charts with bathymetry contours (soundings in fathoms with lines drawn for each 100 fathom depth increase) are utilized for plotting results. Secondly, tabular data is included to summarize the number of sounds logged in each category and number of localizations obtained for each snapshot analyzed. The tabular data captures detection of species of marine mammals not localized, and therefore not plotted on the charts.

Figure 1 provides a section of a nautical chart for the area overlaid with dots (color coded to species) indicating the location of separate individuals of three marine mammal species (humpback, minke and beaked whales) localized on 15 April 2007 at 16:58 (+/- 5minutes). The scale of the chart covers nearly 55 minutes of longitude and over a degree of latitude. Given this scale the dots indicating marine mammal locations represent an area well over one half minute in diameter (over one half of a nautical mile). There are a total of 19 separate individual humpbacks localized, the majority near the western most tip of Kauai, one localized north of Niihau and one localized south west of Kauai. Eight minke whales are localized scattered throughout the northern (BSURE) range, including localizations off range one to the north and one to the west (plotted at the edges of **Figure 1**). The single beaked whale shown actually represents un-localized data and is plotted near the single hydrophone it was detected on. The nature of the beaked whale sounds compares favorably with *Mesoplodon densirostris* (Johnson 2004, Zimmer 2005). The single localized unidentified marine mammal sound logged consisted of 82 Hz pulses of 227 milliseconds in duration. It is uncertain if these sounds are from a Humpback whale, or some other baleen whale (analysis continues). The only other cetacean species positively identified from this acoustic snapshot are sperm whales. A single detection of sperm whale echolocation clicks was logged, however as no localizations were obtained it was not plotted on figure 1 due to the large area of uncertainty associated with the sperm whale click detection (up to tens of nautical miles).

Figure 2 provides plotted results for localized humpback whale individuals on 18 April 2006 at 17:04 (+/- 5 minutes). A total of 27 humpback whales were localized for this

snapshot, and no other localizations obtained. A majority of the humpback whales are within the 100-fathom contour off of the western end of Kauai. The whales are located in a few groups, with some localization posits within a few hundred yards of other individuals. Two clusters of humpbacks are observed between the 300 and 400-fathom contours (this area of the figures does show finer resolution contour lines). Three separate individuals are also seen in the area between Kauai and Niihau. Localizations, which lie within tens of yards of others, are treated as a single individual (potential negative bias on counts). Localizations, which are hundreds of yards apart and based upon the characteristics of the sounds, are treated as unique individuals. Given the scale of the figure the localization dots can significantly overlap.

Figure 3 also provides plotted results of localized humpback whale individuals localized on 18 April 2006, at 18:34 HST (+/- 5 minutes), or 90 minutes later than results shown in figure 2. While the number of humpback whales agrees favorably to that at 17:04 (26 individuals compared to 27 earlier) their spatial distribution is observed to be different. It is indeterminate from this analysis if some whales stopped vocalizing and other whales initiated vocalizations, or if the spatial distribution represents movement of the same whales, or a combination of these factors. The 18:34 distribution is such that a dozen localizations are within the 100-fathom bathymetry contour. The other 14 localizations lie between the 200 fathom and 1000 fathom contour lines, with an apparent clustering similar to the observation of clusters in figures 1 and 2. One unidentified localization is also plotted in the under 100 fathom waters offshore of Kauai in the vicinity of 4 localized humpback whales (suspect to be a tail fluke, or pectoral fin, slap).

Figures 1 through 3 provide previously unavailable information (numbers and locations of specific marine mammal species on, or near, the PMRF underwater test range). However, keep in mind this is for three snapshots in time and normal variations over time are currently unknown due to the limited sample size. It is also important to understand that these figures do not convey the fact that both minke and sperm whales were detected in all three acoustic snapshots, based upon the presence of their characteristic sounds (only Minke were localized and in only one snapshot). The presence of all species is summarized in tabular format in **Table 1**.

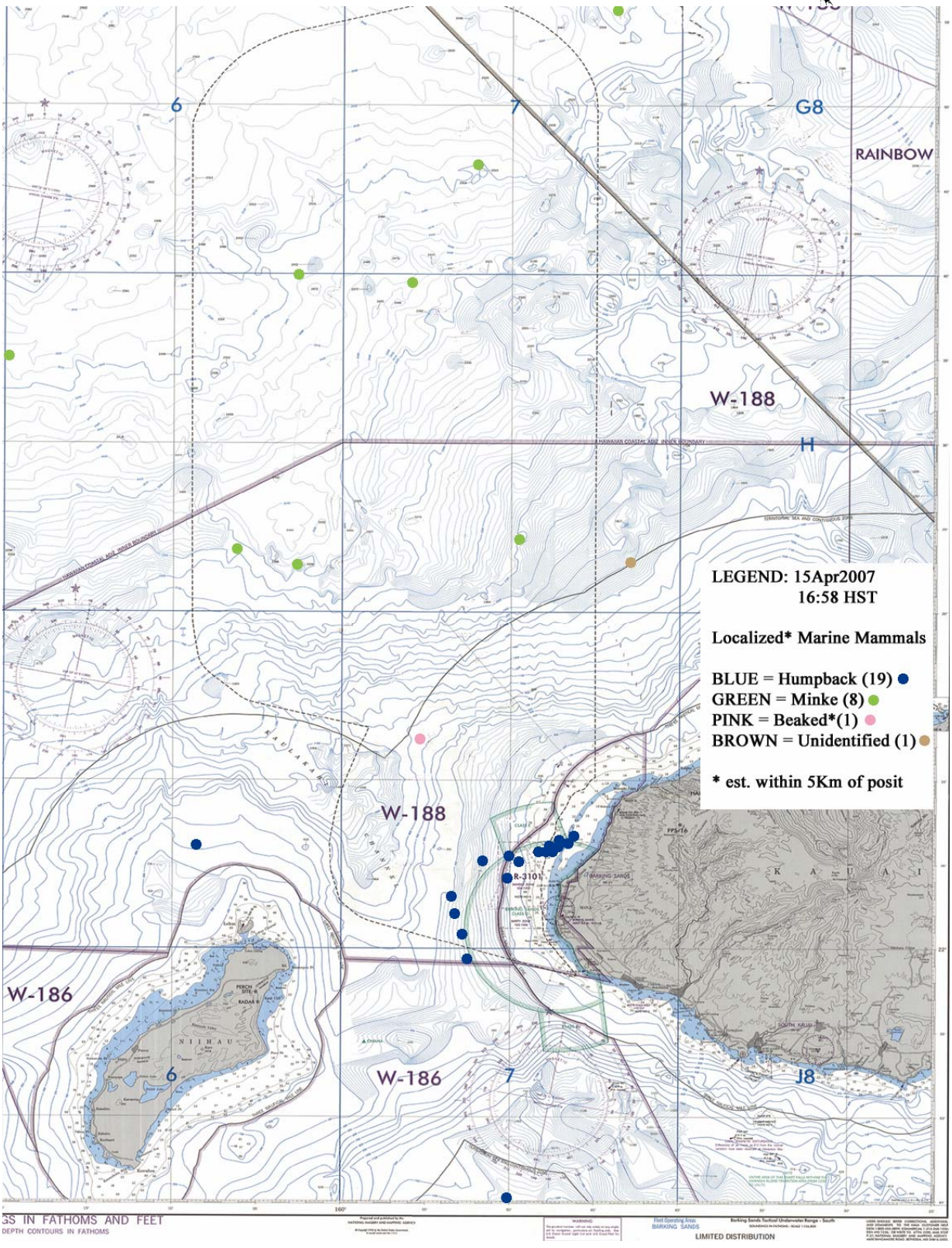


Figure 1 – Localizations using acoustic data on 15 April 2007 between 16:53 and 17:03 Hawaiian standard time using PMRF hydrophones. *The beaked whale posit was not localized, it is plotted as due to it's acoustics and it is certainly within 5 km of the hydrophone it was detected on.*

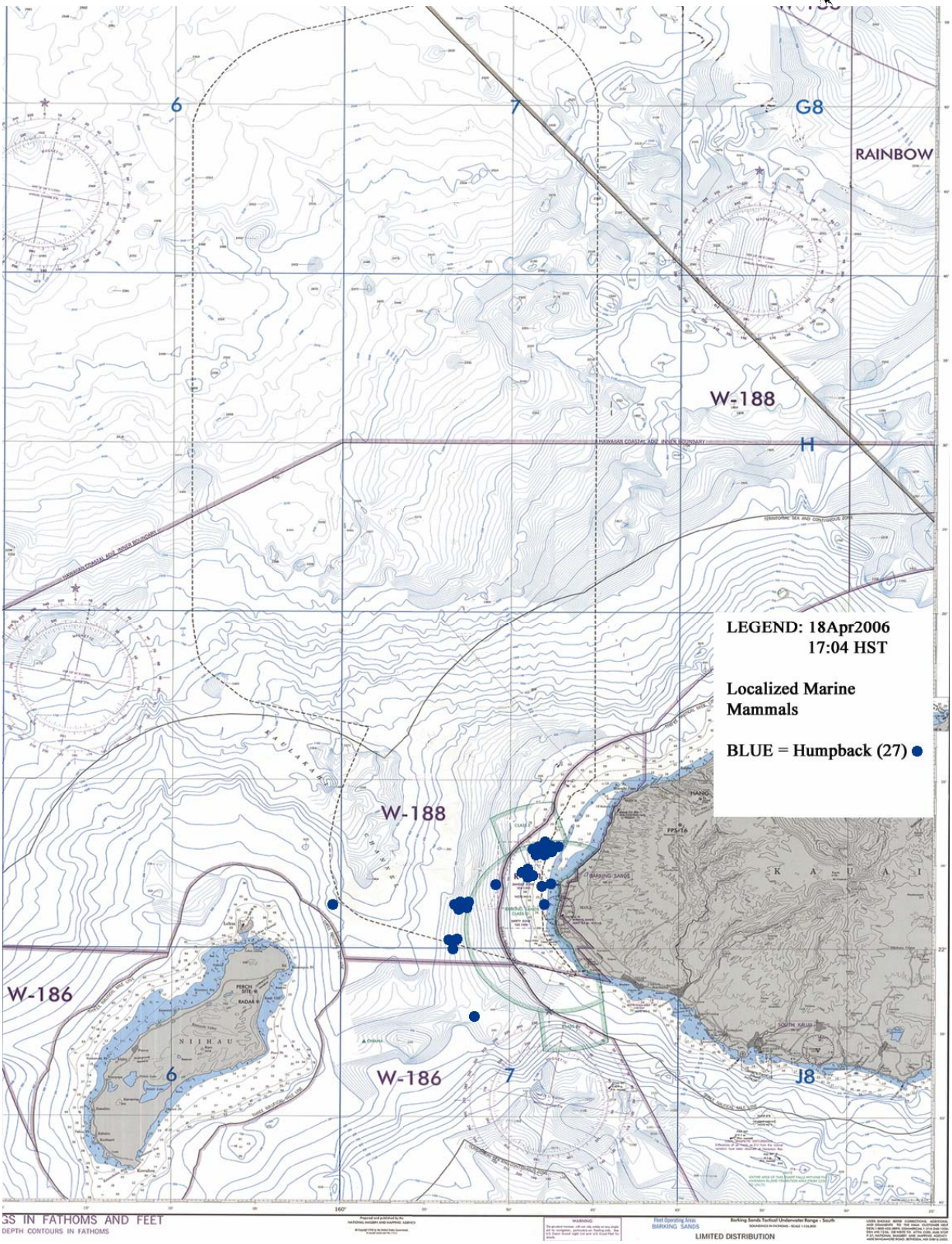


Figure 2 – Localizations using acoustic data on 18 April 2006 between 16:59 and 17:09 Hawaiian standard time using PMRF hydrophones. *Not plotted due to lack of localization are both sperm whales and minke whale characteristic sounds.*

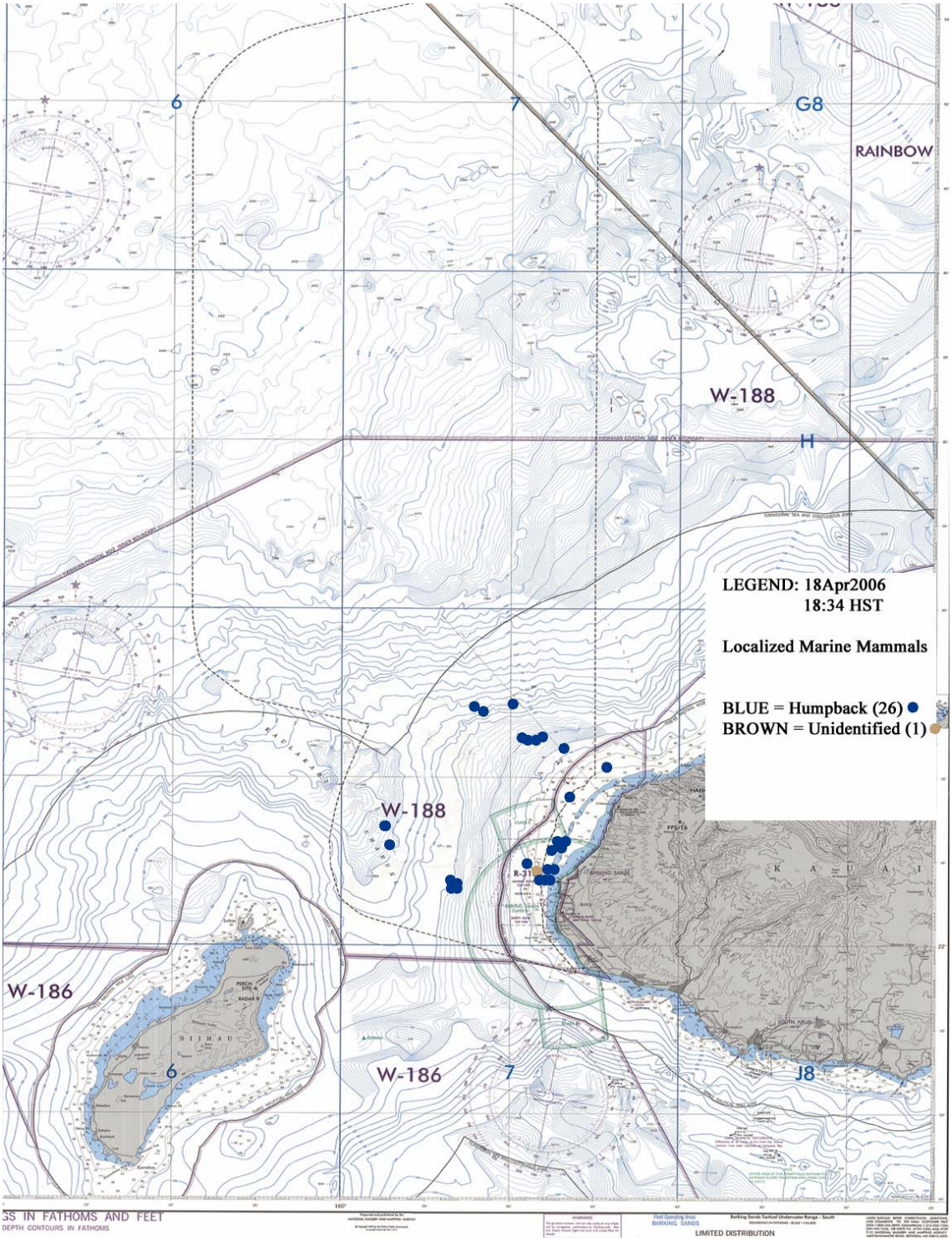


Figure 3 – Localizations using acoustic data on 18 April 2006 between 18:29 and 18:39 Hawaiian standard time using PMRF hydrophones. *Not plotted due to lack of localization are both sperm whales and minke whale characteristic sounds. The unidentified single point is believed to be a tail slap.*

Table 1 provides a summary for each of the three acoustic snapshots reported herin. The analysis results are summarized into five categories (humpback, minke, sperm, beaked whale and unidentified mammal). The numbers of sounds attributed to each category (acoustic cues) logged in the analysis are provided along with the number of individuals localized. The sperm and beaked echolocation clicks are logged as sequences, vice individual clicks. The minke 'boing' call count for the two time periods on 18 April 2006 show an increase of 79% at 18:34 vice 17:04. Insufficient information is currently available to base any hypothesis for this increase in 90 minutes, as the normal variations are unknown. The 102 minke 'boing' sounds logged, with eight individuals localized, on 15 April 2007 is higher than observed for either snapshot on 18 April 2006. While snapshot sample sizes are to small to understand normal variations, the analyst did comment that the 15 April 2007 boing sounds were not only more prevalent, but also of higher signal to noise ratio. This is logical in that the 15 April 2007 Minke boing situation would allow more localizations, indicating the animals are closer to the range, while the lower signal to noise ratio situation in April 2006 are consistent with the animals located off range at greater distances (lower signal to noise ratios and unable to localize individuals).

The humpback results in table 1 show the largest numbers of calls, 107, were logged on 18 April 2006 @ 18:34, while the largest number of individuals localized, 27, occurred on 18 April 2006 @ 17:04. The April 2007 call count (72) and localized individuals (19) are lower than numbers for April 2006. Humpbacks are known to begin their outward migration back to feeding grounds around this timeframe, which should be taken into consideration. It must be reiterated that these three snapshots in time are insufficient to allow any level of understanding of the normal variations. More results are needed to understand short term, mid-term and long term variations.

Table 1 – Summary results for two separate days (15 April 2007 @ 16:53-17:03, 18 April 2006 @ 16:59-17:09 and @ 18:29-18:39). Five categories provided (minke, humpback, sperm, beaked whale and un-identified mammals). Call counts logged (acoustic cues) and number of localized individuals shown. Future efforts may better identify some of the currently unidentified species sounds logged.

Sound source / Date & time	15-Apr-2007 16:53-17:03	18-Apr-2006 18:29-18:39	18-Apr-2006 16:59-17:09
Minke Whale (*Balaenoptera acutorostrata*)			
Call count logged in 10 minute period	102	29	16
Number of localized individuals	8	-	-
Humpback Whale (*Megaptera novaeangliae*)			
Call count logged in 10 minute period	72	107	87
Number of localized individuals	19	26	27
Sperm Whale (*Physeter macrocephalus*)			
Call count logged in 10 minute period	1	10	2
Beaked Whale (*Ziphiidae*)			
Call count logged in 10 minute period	2	-	-
Number of individuals located to specific area	1	-	-
Un-identified Mammal			
Call count logged in 10 minute period	30	23	22
Number of localized individuals	1	1	-

Table 1 also shows the very small detection numbers for both sperm whale and beaked whale echolocation click sequences. The limited amount of temporal data analyzed (three 10 minute snapshots) only provides confirmation of the presence of these species at these times due to their signals being detected. Sperm whales have been localized on other days data analysis, indicating that with enough snapshots the under sampling of

their acoustic echolocation dive cycles might not be an issue. Beaked whale detections have not allowed localization to date due to the large separation of the originally sampled 24 broad band hydrophones. Some localization might be possible with the seven additional hydrophones added early in 2007 as they are spaced in two tighter clusters.

Discussion and Conclusions:

These results provide initial insight into the marine mammal presence on, or near, PMRF for three short, ten-minute, time periods on two separate days, 15 April 2007 and 18 April 2006. This sample size is extremely small and insufficient to make any generalized statements relative to numbers, and species, of marine mammals in the area on these days (only for these three snapshot points of time). Two periods of analysis were conducted on 18 April 2006 separated by only 90 minutes in time. Differences in spatial distributions are observed, but due to lack of understanding normal variations, no definitive conclusions can be made at this time.

This analysis is a start at providing new information into marine mammal density by species over time, for the waters near the Pacific Missile Range Facility. The limited amount of data analyzed does not currently lend itself to statistical analysis for making focused statements about marine mammal presence in the area. The data does inform us of the presence of three species on, or near, the range for both days with quantitative numbers for calls logged and individuals localized. The acoustic detection of a single beaked whale (suspect to be Blainville's) on 15 April 2007 is also significant, confirming presence of beaked whales in the area.

Additional data collections, and analysis, are required to gain more understanding of the normal variations of marine mammal presence at PMRF. Current methods can be utilized to analyze more acoustic snapshots. Future efforts are both underway, and planned for exploring more efficient ways to analyze data (develop and employ more automation). A close relationship also exists with the 2007 NOPP DECAF new start effort, which is focused on developing the statistical methodology for analysis of this type of data (PMRF humpback whale data is planned to serve as a test case for the DECAF effort).

It cannot be stressed enough that there are a number of caveats, which must be kept in mind when utilizing acoustic techniques such as this, for monitoring for marine mammal species. These caveats include:

1) Passive acoustic detection is only able to detect marine mammals which are emitting acoustic sound, and in the case of the PMRF hydrophones, specifically between 60 Hz and either 20 kHz or 48 kHz (hydrophone and PMRF system limitations) with sufficient acoustic energy to be detected.
2) Some species, such as the humpback whales, which are prevalent in this area between the months of Jan and April, typically only have males making sounds (mating song).
3) Each species has different frequency regions for various sounds, different acoustic beam patterns for emitted sounds, and different source levels. Thus, some sounds can be detected on many hydrophones (e.g. sperm whale slow clicks), while other sounds (such as beaked whale echolocation signals) may only be detected on a single hydrophone.
4) Movement, over time, confounds the technical issues in dealing with estimating species densities using distance sampling methodology. In part, this is one reason 'acoustic snapshots' are utilized in this analysis.
5) Species presence in the area may be seasonal (such as humpbacks), transitory, or they could be resident to the area.

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APPENDIX E- U.S. NAVY AND BEAUFORT SEA STATE CODES

Sea State	Beaufort Number	Wind Speed (kts)	Wind description	Beaufort Number Picture
0	0	< 1	Calm	
0	1	1-3	Light air	
1	2	4-6	Light breeze	
2	3	7-10	Gentle breeze	
3	4	11-16	Moderate breeze	
4	5	17-21	Fresh breeze	
5	6	22-27	Strong breeze	

Sea State	Beaufort Number	Wind Speed (kts)	Wind description	Beaufort Number Picture
6	7	28-33	Near gale	
7	8	34-40	Gale	
8	9	41-47	Strong gale	
9	10	48-55	Storm	
9	11	56-63	Violent storm	
9	12	>64	Hurricane	

* Photographs from National Weather Service Observing Handbook No. 1, US National Weather Service.