MARINE SPECIES MONITORING
for the
U.S. Navy's
Hawai`i Range Complex

Department of the Navy

2012 ANNUAL REPORT

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MARINE SPECIES MONITORING
FOR THE
U.S. NAVY'S
HAWAI`I RANGE COMPLEX

2012 ANNUAL REPORT

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EXECUTIVE SUMMARY

This report presents the United States (U.S.) Navy's Year Four level of effort, regulatory compliance, scientific accomplishments, and preliminary data obtained from marine mammal monitoring in the Hawai`i Range Complex (HRC). Year Four encompassed the period from 02 August 2011 to 01 August 2012. As outlined in this report, considerable accomplishments were achieved from visual surveys, passive acoustic monitoring (PAM), marine mammal tagging, use of marine mammal observers (MMOs), and leveraging of additional field efforts from several projects funded by multiple Department of the Navy organizations. Substantial data were collected, most of which are being analyzed in 2012 and 2013 under a multi-year synthesis of results.

The U.S. Pacific Fleet exceeded its monitoring goals as stated in the HRC Monitoring Plan and modified through the 2011 HRC Monitoring Report submitted to the National Marine Fisheries Service (NMFS). Monitoring efforts included vessel and aerial visual surveys, PAM, the use of MMOs on U.S. Navy vessels, tagging of marine mammals, Lookout Effectiveness (LOE) studies, and the use of the Pacific Missile Range Facility's (PMRF's) instrumented range. Data was collected on marine mammal and sea turtle occurrence, distribution and behavior in conjunction with U.S. Navy training events, and MMOs gathered baseline protected marine species data in Hawai`ian waters for use in assessing potential future impacts of these training events.

During Year Four, ten underwater detonation events and two anti-submarine warfare (ASW) events were monitored under the LOE study by deploying MMOs on U.S. Navy surface ships and small vessels. MMOs and U.S. Navy lookouts recorded all marine mammal sightings and implemented mitigation measures (Richie et al. 2012a, Uyeyama et al. 2012, Watwood et al. 2012a, 2012b).

Through the adaptive management process, the Submarine Commander's Course (SCC) was selected as a focus of protected marine species monitoring in the HRC based on proximity to the PMRF, relatively high level of monitoring opportunities, and ability to synergize with existing efforts from the Chief of Naval Operations Energy and Environmental Readiness Division (OPNAV N45). Multiple monitoring platforms worked collaboratively to gather data prior to the SCC training event: (1) a large-vessel survey was used to verify the species for acoustic detection of marine mammals in conjunction with the Marine Mammal Monitoring on Navy Ranges (M3R) Naval Undersea Warfare Center program on the PMRF range; (2) a small-vessel tagging survey collected biopsies and individual identification photographs, verified species acoustically detected in conjunction with the M3R program, and deployed three satellite-tracked tags on odontocetes (toothed whales) prior to the start of the SCC training event; (3) aerial surveys were conducted during the SCC training event by flying elliptical orbits in front of a U.S. Navy warship in order to assess marine mammal occurrence and behavior in the ship's vicinity, and post-SCC aerial surveys were conducted along the shorelines of Kaua'i and Ni'ihau in search of otherwise-undetected marine mammal strandings (Baird et al. 2012a, HDR 2012a, Mobley and Pacini 2012). Before the August SCC, monitoring days were added to an existing OPNAV N45-funded effort at the PMRF in order to deploy satellite tags on marine mammals (Baird et al. 2012b). Between the two exercises, fourteen satellite-tracked tags were deployed on odontocetes in order to examine habitat use, movements and residency patterns. Among the species tagged were short-finned pilot whales (*Globicephala macrorynchus*), rough-toothed dolphins (*Steno bredanensis*), and bottlenose

dolphins (*Tursiops truncatus*). This effort resulted in the first-ever tag deployment on rough-toothed dolphins in Hawai`ian waters.

A large-vessel marine species survey was performed in PMRF waters in conjunction with the Ka'ula Island seabird survey (Richie et al. 2012b). This survey collected marine mammal occurrence and distribution data, and high-quality photographs for the purpose of photo-identification (photo-ID) of individual animals including bottlenose dolphins, spinner dolphins (*Stenella longirostris*), and Hawai`ian monk seals (*Monachus schauinslandi*).

Four bottom-mounted autonomous hydrophones (Ecological Acoustic Recorders [EARs]) were deployed in the waters off Ni'ihau (26 January 2012) and Ka'ula Island (25 April 2102) to collect marine mammal acoustic data. In addition, analysis of historical data collected by eight EARs deployed in the HRC in 2009 and 2010 resulted in the identification of eight marine mammal species. Data were also analyzed from 31 moored hydrophones on the PMRF in conjunction with a 2011 SCC training event, and received sound pressure levels (SPLs) were estimated for twelve humpback whales (*Megaptera novaeangliae*) and four unidentified whale sightings. SPLs for these sightings ranged from 136 to 196.9 decibels referenced to one micropascal (dB re 1 µPa). Received SPLs were also estimated for 10 beaked whale sightings during the same training event; the range was 81 to 139 dB re 1 µPa.

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AMR	Adaptive Management Review
ASW	Anti-Submarine Warfare
CCLME	California Current Large Mammal Ecosystem
dB re 1 µPa	decibel(s) referenced to 1 micropascal
DDG	U.S. Navy Destroyer
DoD	Department of Defense
DoN	Department of the Navy
EAR	Ecological Acoustic Recorder
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ft	foot/feet
FY	Fiscal Year
HIMB	Hawai'i Institute of Marine Biology
hr	hour(s)
HRC	Hawai`i Range Complex
ICMP	Integrated Comprehensive Monitoring Program
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
LO	shipboard lookout
LOA	Letter of Authorization
LOE	Lookout Effectiveness
m	meter(s)
M3R	Marine Mammal Monitoring on Navy Ranges
MDSU	Mobile Diving and Salvage Unit-1
MFAS	mid-frequency active sonar
MHI	Main Hawai`ian Islands
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MTE	Major Training Exercise
NAVFAC	Naval Facilities Engineering Command
NM	nautical mile(s)
NM^2	square nautical mile(s)
NMFS	National Marine Fisheries Service
NPTZ	North Pacific Transition Zone
OASIS	Ocean Acoustical Services and Instrumental Systems
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
OPNAV N45	Chief of Naval Operations Energy and Environmental Readiness Division
PAM	passive acoustic monitoring
photo-ID	photo-identification
PMRF	Pacific Missile Range Facility
PTS	permanent threshold shift
RDT&E	research, development, testing and evaluation
RHIB	rigid-hulled inflatable boat
RIMPAC	Rim of the Pacific
SAG	Scientific Advisory Group
SCC	Submarine Commanders Course
SPL	sound pressure level
TOPP	Tagging of Pacific Predators
TTS	temporary threshold shift
UNDET	underwater detonation
U.S.	United States
USNS	U.S. Navy Ship
USWEX	Undersea Warfare Exercise
yd	yard(s)

INTRODUCTION

Background

The United States (U.S.) Navy developed Range Complex-specific Monitoring Plans, guided by the Integrated Comprehensive Monitoring Program (ICMP), to provide marine mammal and sea turtle monitoring as required under the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973. This report provides Range Complex-specific monitoring results for Year Four (02 August 2011 to 01 August 2012) within the U.S. Navy's Hawai`i Range Complex (HRC).

Integrated Comprehensive Monitoring Program (ICMP)

The ICMP provides the overarching framework for coordination of the U.S. Navy Monitoring Program (DoN 2010). The ICMP has been developed in direct response to U.S. Navy Range permitting requirements established in the various MMPA Final Rules, ESA Consultations, Biological Opinions, and applicable regulations. As a framework document, the ICMP applies by regulation to those activities on ranges and operating areas for which the U.S. Navy sought and received incidental take authorizations.

The ICMP is intended for use as a planning tool to focus U.S. Navy monitoring priorities pursuant to ESA and MMPA requirements. Top priority will always be given to satisfying the mandated legal requirements across all ranges. Any additional monitoring-related research will be planned and prioritized using guidelines provided by the ICMP, consistent with availability of both funding and scientific resources. As a planning tool, the ICMP is a "living document." It will be routinely updated as the program matures. Initial areas of focus for maturing the document in 2011/2012 included further refinement of monitoring goals, adding a characterization of the unique attributes associated with each Range Complex/study area to aid in shaping future monitoring projects, and broader description of the data management organization and access procedures.

The ICMP is evaluated annually through the Adaptive Management Review (AMR) process to: (1) assess progress, (2) provide a matrix of goals for the following year, and (3) make recommendations for refinement and analysis of the monitoring and mitigation techniques. This process includes conducting an annual AMR meeting at which the U.S. Navy and National Marine Fisheries Service (NMFS) jointly consider the prior-year goals, monitoring results, and related scientific advances to determine if modifications are needed to more effectively address monitoring program goals. Modifications to the ICMP that result from AMR discussions are incorporated by an addendum or revision to the ICMP.

Under the ICMP, monitoring measures prescribed in range/project-specific Monitoring Plans and U.S. Navy-funded research relating to the effects of naval training and testing activities on protected marine species should be designed to accomplish one or more of the following top-level goals as currently prescribed in the 2010 ICMP update (DoN 2010):

(a) An increase in our understanding of the likely occurrence of marine mammals and/or ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and/or density of species).

(b) An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammals and/or ESA-listed species to any of the potential stressors associated with the action (e.g., sound, explosive detonation, or expended materials), through better understanding of one or more of the following: (1) the nature of the action and its surrounding environment (e.g., sound source characterization, propagation, and ambient noise levels); (2) the affected species (e.g., life history or dive patterns); (3) the likely co-occurrence of marine mammals and/or ESA-listed marine species with the action (in whole or part); and/or (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and/or ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving, or feeding areas).

(c) An increase in our understanding of how individual marine mammals or ESA-listed marine animals respond (behaviorally or physiologically) to the specific stressor(s) associated with the action (in specific contexts, where possible [e.g., at what distance or received level]).

(d) An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g., through effects on rates of recruitment or survival).

(e) An increase in our understanding of the effectiveness of mitigation and monitoring measures, including increasing the probability of detecting marine mammals (through improved technology or methodology), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and generally to better achieve the above goals. Improved detection technology resulting from these goals will be rigorously and scientifically validated prior to being proposed for mitigation, and meet practicality considerations (engineering, logistical, fiscal).

(f) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization and incidental take statement. The Chief of Naval Operations Energy and Environmental Readiness Division (OPNAV N45) is responsible for maintaining and updating the ICMP, as necessary, reflecting the results of regulatory agency rulemaking, AMRs, best available science, improved assessment methodologies, and more effective protective measures. This is done in consultation with U.S. Navy technical experts, Fleet Commanders, and Echelon II Commands as appropriate, and as part of the AMR process.

Hawai`i Range Complex Year Four Monitoring

The U.S. Navy is implementing systematic improvements to regional marine species monitoring plans in order to increase the likelihood of achieving top-level goals established by the NMFS and the U.S. Navy. Top-level monitoring goals are described in the ICMP that guides the U.S. Navy's monitoring effort. In addition to the framework provided by the ICMP, an independent Scientific Advisory Group (SAG) was initiated in October 2010 to provide scientific recommendations on how the U.S. Navy's Monitoring Program could be more effective, evaluate how current monitoring aligns with the ICMP goals, and further refine regional monitoring recommendations.

One of the SAG's recommendations was for the U.S. Navy to adopt a framework that conceptualizes the continuum of knowledge about marine species. Depending on the species, knowledge may be basic or it may be detailed and sophisticated. The framework starts with information on occurrence of marine mammals on U.S. Navy range complexes, and proceeds through questions of exposure to U.S. Navy training activities, potential responses of animals to exposure, and consequences (if any) of any interactions. Applying the conceptual framework and SAG recommendations informs the U.S. Navy about the appropriate scientific questions that can be addressed within its Range Complexes and how to prioritize projects and locations when constrained by funding availability. Additional recommendations from the SAG included defining new regulatory metrics, better transparency in planning and implementation, collaboration among stakeholders, and better U.S. Navy-wide integration of regional monitoring plans.

In June 2011, the U.S. Navy solicited additional input from researchers at local universities, science centers, and private institutions with research expertise in the Hawai`ian Islands. No funding or promise of funding was associated with this effort. Contributors had expertise across disciplines, species, and techniques and had publications relevant to marine species monitoring in the HRC. After input was collected, the U.S. Navy organized the information into a preliminary matrix of questions. This step was initiated in order to determine what the local scientific community recommends as highest priorities for U.S. Navy-funded marine species monitoring. Currently, this process and document are undergoing internal U.S. Navy review prior to future discussions with NMFS. Additional input for other HRC marine mammal issues can still be considered for future inclusion given scientific merit, prioritization of monitoring, logistic feasibility, and funding needed. The U.S. Navy will integrate the initial SAG recommendations and regional scientific input to propose changes to the regulatory metrics used to evaluate the effectiveness of the monitoring plans. While specifics remain in discussion between the U.S. Navy and NMFS, changes are expected to be phased in by 2013 or 2014.

Monitoring in the HRC in Year Four fulfilled the legally required metrics and made significant contributions to furthering our understanding of the questions established in the ICMP. Highlights include: 1) visual validations of acoustically detected species, photo-identification (photo-ID), and deployment of satellite tags at the Pacific Missile Range Facility (PMRF) which resulted in an increase in our understanding of species occurrence, life history, habitat use and movement in an area in which they may be exposed to U.S. Navy training; 2) estimation of sound pressure levels (SPLs)to which marine mammals may have been exposed during a training event and re-creation of their movements, thereby increasing our understanding of possible exposure and stressor response,; and 3) continued monitoring and analysis of operator-conducted mitigation measures which will result in an increased understanding of the efficacy of mitigation techniques used during anti-submarine warfare (ASW) and underwater detonation (UNDET) events.

In addition to the Fleet-funded Monitoring Plans described above, OPNAV N45 and the Office of Naval Research (ONR) have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Between 2011 and 2012, approximately $2 million was used on funding to academic, agency and contract scientists in Hawai`i. Several significant projects investigating the effect or lack of effect of U.S. Navy training on marine mammals are currently funded and ongoing within the HRC. For example, to leverage scientific expertise and funding availability, both U.S. Pacific Fleet and OPNAV N45 programs integrated certain elements of their programs to address requirements stated in the *Hawai`i*

Range Complex Monitoring Plan (see the 2011 HRC Annual Report - DoN [2011a]). An example of this was the July 2012 marine mammal tagging, and acoustic detection and species confirmation survey with Marine Mammal Monitoring on Navy Ranges (M3R) Naval Underwater Warfare Center (see Dilley and McCarthy 2012) which was funded by the U.S. Pacific Fleet and OPNAV N45.

Design of the Range Complex Monitoring Plans represented part of a new U.S. Navy-wide assessment, and as with any new program, there are many coordinating, logistic, and technical details that continue to be refined. The scope of the original 2008 Range Complex Monitoring Plan (DoN 2008a) was to discuss the background for monitoring as well as to define initial procedures to be used in meeting study objectives derived from the NMFS-U.S. Navy agreements. Monitoring results are presented each year to NMFS and the next year's monitoring goals established based on the adaptive management process.

This report has two main objectives:

1. Present data and results from U.S. Navy-funded marine mammal and sea turtle monitoring conducted in the HRC from 02 August 2011 to 01 August 2012. Included in this assessment are reportable metrics of monitoring as requested by NMFS. This Year Four report will focus mostly on summarizing collected data and providing a brief description of the major accomplishments from techniques used this year, while referring to the more technical discussions in various appendices provided by the scientists who performed the monitoring work on the Range Complex.
2. Continue the adaptive management process by providing an overview of meetings and initiatives over the past year that support proposed revisions to the U.S. Navy's 2012 HRC Monitoring Plan as well as presenting progress made towards development of a strategic plan for U.S. Navy monitoring that has been facilitated by establishing a SAG to review and provide recommendations on the U.S. Navy's Monitoring Program. Proposed changes primarily reflect input received from the scientific community and other stakeholders. An overview of the events that have prompted these most recent adaptive management actions is provided in the following sections.

HAWAI`I RANGE COMPLEX

Monitoring in the Hawai`i Range Complex

Accomplishments from the U.S. Navy's marine species monitoring efforts in the HRC are reported here. The HRC consists of 235,000 square nautical miles (NM^2) (806,000 square kilometers [km^2]) of surface and subsurface ocean areas and special-use airspace for military training and research, development, testing, and evaluation (RDT&E) activities. The HRC includes the PMRF off Kaua'i, which is both a U.S. Pacific Fleet training range and a Fleet and Department of Defense (DoD) RDT&E range. The PMRF includes an instrumented range covering 1,020 NM^2 (3,499 km^2) of ocean area at depths between 1,800 and 15,000 feet (ft; 549 and 4,572 meters [m]). Various subcomponents of the Range Complex are more fully described in the *Hawai`i Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement* (EIS/OEIS) (DoN 2008b). Monitoring efforts are divided into two major categories—those field efforts implemented by the U.S Pacific Fleet as part of HRC compliance monitoring, and those funded by ONR and OPNAV N45. Reporting will primarily focus on the U.S. Pacific Fleet's compliance monitoring required under the Fleet's MMPA permit (Letter of Authorization [LOA]) and ESA Consultation; however, highlights from the U.S. Navy's monitoring are presented below.

In the *Hawai`i Range Complex Monitoring Plan*, the U.S. Navy proposed to implement a diversity of field methods to gather data from marine mammals and sea turtles in conjunction with training events. Studies were specifically designed to meet the goals outlined in the *Introduction*. Metrics (e.g., hours or events) were agreed to by the U.S. Navy and NMFS and used as goals for implementation.

During Study Year Four (02 August 2011 to 01 August 2012), U.S. Pacific Fleet implemented aerial and vessel surveys; embarked marine mammal observers (MMOs) on U.S. Navy platforms; tagged a variety of cetaceans and pinnipeds; and deployed passive acoustic monitoring (PAM) devices. This work builds upon U.S. Pacific Fleet-funded fieldwork that has occurred in the Hawai`ian Islands since monitoring of the Rim of the Pacific (RIMPAC) exercise in 2006.

HAWAI`I RANGE COMPLEX YEAR FOUR (02 AUGUST 2011 TO 01 AUGUST 2012) MONITORING OBJECTIVES

The goal of the *Hawai`i Range Complex Monitoring Plan* as revised (DoN 2011b) is to implement field methods chosen to address the long-term monitoring objectives outlined in the *Introduction*. **Table 1** from the final *Hawai`i Range Complex Monitoring Plan* shows the monitoring objectives agreed upon by NMFS and the U.S. Navy.

Table 1. 2012-2014 monitoring commitments for the Hawai`i Range Complex (DoN 2011b).

Monitoring Technique	Implementation	
Visual Surveys (aerial or vessel) STUDIES 1, 2, 3, 4, 5	120-160 hours before, during, and after ASW training events including major training exercises (MTE), SCC, Unit-Level Training and/or explosive events	Adaptive Management Review (AMR) for FY13
Marine Mammal Observers (MMO) STUDIES 1, 2, 3, 4, 5	MMO team aboard U.S. Navy surface platforms during 2 ASW and 6 explosive events	
Tagging STUDIES 1, 2, 3	Tag a goal of 15 individual marine mammals	
Passive Acoustic Monitoring (PAM) STUDIES 1, 2, 3	• Utilize a combination of autonomous recording devices, and/or sonobuoys and/or towed arrays to gather acoustic data. Continue collaboration of data collection and analysis from additional N45/ONR-funded autonomous PAM devices. Continue data analysis. • Continue use of the Pacific Missile Research Facility instrumented range hydrophones to gather and analyze marine mammal acoustic data	

The U.S. Pacific Fleet began conducting aerial and vessel surveys in conjunction with major training exercises (MTEs) in 2006. Most aerial and vessel surveys from 2006 to 2008 were conducted only before and after training events, with some vessel surveys conducted also during events. These early surveys not only provided data points that are being used for ongoing analyses, but they also provided proof-of-concept data for determining the feasibility of using diverse field methods in the HRC. Based upon lessons learned from those surveys and input from NMFS, the U.S. Navy shaped the studies in the *Hawai`i Range Complex Monitoring Plan* with proven field methods that would provide visual and PAM data to support scientific assessment on the potential effects from U.S. Navy training on protected marine species.

In the *Hawai`i Range Complex Monitoring Plan*, the U.S. Navy committed to using visual surveys (aerial and vessel) and embarking MMOs aboard U.S. Navy vessels during ASW (using sonar) and explosive (UNDET) events to meet its goals. The U.S. Navy also proposed to deploy and analyze data from PAM devices in 2011 and to deploy tagging devices on animals.

HAWAI'I RANGE COMPLEX YEAR FOUR MAJOR TRAINING EXERCISE SUMMARY

Marine mammal sightings made during MTEs comprise a form of compliance monitoring. For the HRC, there were six MTEs in the HRC between 02 August 2011 and 01 August 2012 including multi-strike group exercises titled Undersea Warfare Exercise (USWEX), Rim of the Pacific (RIMPAC), and Koa Kai (a USWEX). (**Table 2**). As part of the transits and training events during those MTEs, U.S. Navy lookouts reported 71 marine species sightings for an estimated 675 marine mammals and 1 sea turtle (**Table 3**).

Table 2. Hawai`i Range Complex major training events from 02 August 2011 to 01 August 2012.

MTE Type	Dates	# of Exercise Days	# of Sea Turtle Sightings	# of Sea Turtles	# of Marine Mammal Sightings	# of Marine Mammals
USWEX	08 Aug - 11 Aug 2011	4	0	0	0	0
Koa Kai	10 Nov - 17 Nov 2011	8	0	0	9	50
USWEX	08 Dec - 10 Dec 2011	3	0	0	3	16
USWEX	14 Dec - 16 Dec 2011	3	0	0	0	0
Koa Kai	30 Mar - 09 Apr 2012	11	0	0	24	64
RIMPAC	29 Jun - 01 Aug 2012	24	1	1	35*+	545*+
Totals:		**53**	**1**	**1**	**71**	**675**

* Includes a Hawai`ian monk seal that was hauled out on Waikiki Beach

\+ includes (voluntary) reports received from foreign vessels

Table 3. Total number of marine mammal and sea turtle sightings observed from U.S. Navy platforms during Hawai`i Range Complex major training exercises from 02 August 2011 to 01 August 2012.

Species Type	# of Sightings	% of Total Sightings	# of Sea Turtles and Marine Mammals	% of Total Number of Sea Turtles and Marine Mammals
Dolphins	24	34	478	71
Whales	42	60	192	28
Pinnipeds	1*	1*	1*	<1*
Sea Turtles	1	1	1	<1
Unidentified Mammal Species	3	4	3	<1
Totals:	**71**	**100**	**675**	**100**

* Includes a Hawai`ian monk seal that was hauled out on Waikiki Beach

Throughout this timeframe, the highest percentage (71 percent) of marine species recorded were dolphins, (**Table 3; Figure 1**).

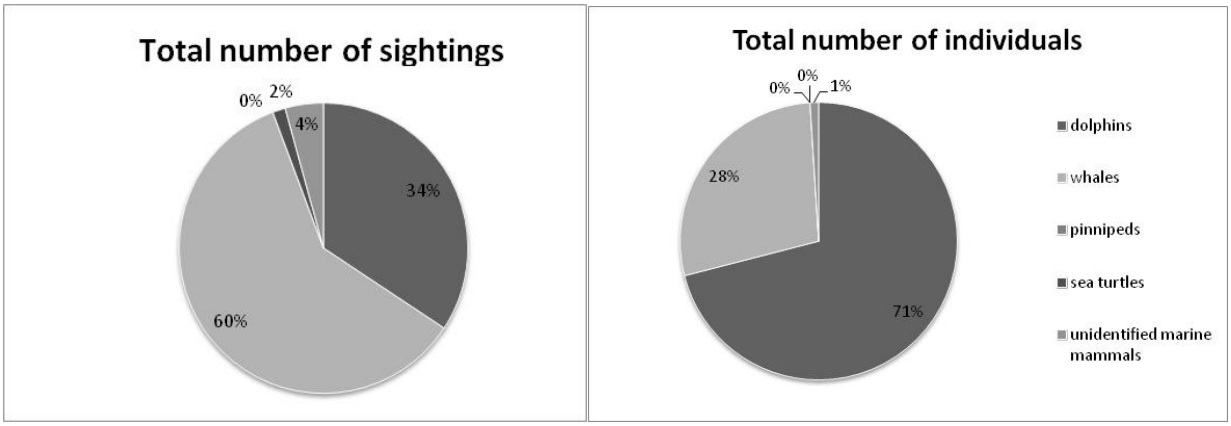

Figure 1. Relative proportions of sightings (left) and number of individuals (right) by species categories during HRC major training exercises 02 August 2011 to 01 August 2012.

Marine mammal sightings are reported at ranges of <200 yards (yd), 200-500 yd, 501-1,000 yd, 1,001-2,000 yd, and >2,000 yd (<183 m, 183-457 m, 457-914 m, 914-1,829 m, and >1,829 m respectively) concurrent with mid-frequency active sonar (MFAS) use (**Table 4**). Fifteen of these were at less than 200 yd (183 m). Ranges associated with potential NMFS criteria levels of permanent threshold shift (PTS) and temporary threshold shift (TTS) (215 and 195 decibels re 1 micropascal squared [dB re 1 μPa^2-s], respectively) are much shorter than 200 yards (183 m).

The three categories of mitigation measures (Personnel Training, Lookout and Watchstander Responsibilities, and Operating Procedures) outlined in the HRC EIS/OEIS (DoN 2008b) and approved by NMFS (NMFS 2012) were effective in detecting marine mammals and sea turtles and appropriately mitigating their exposures to MFAS. Fleet commanders and ship watch teams continue to improve individual awareness and enhance reporting practices. Additionally, two Lookout Effectiveness (LOE) studies were conducted by the U.S. Navy in the HRC and provided data to demonstrate the effectiveness of the U.S. Navy's suite of mitigation measures (see Watwood et al. 2012a, b).

Although photographs confirming species identification are not available, the lookouts attempted to identify some of the marine mammals observed as well as reported behaviors. **Table 4** provides some of the more interesting species reports.

Table 4. Marine mammal sightings observed from U.S. Navy platforms during major training events from 02 August 2011 to 01 August 2012 in the Hawai`i Range Complex. (Note: complete detail can be found in the HRC Exercise Report.)

Mitigation Range* (in yards)	# of Sightings	Total # of Animals	Breakdown by Species Type			
			# of Dolphins	Notable Species Information Reported	# of Whales	Notable Species Information Reported
< 200	15	256	196	Behaviors given for some sightings including "bow riding, jumping out of water, paralleling ship's course"	60	Group size of 1= "killer whale paralleling ships course"
200-500	10	237	230	Behaviors given for some sightings including "surfacing, opening, on surface blowing"	7	Group size of 8 = "Swimming on surface, blowing - believed to be Cuvier's beaked whales"
500-1,000	17	57	15	Behaviors given for some sightings including "breaching"	42	Group size of 1 = "believed to be a Cuvier's beaked whale" Group size of 4 = "sperm whale"
1,000-2,000	4	38	30	Behaviors given for some sightings including "on bow"	8	Group size of 2= "appeared to be Cuviers' beaked whale heading stbd to port" Group size of 4 = "melon-headed whales floating on surface, blowing"
>2,000	13	36	2	Behaviors given for some sightings including "swimming"	34	Group size of 5= "melon-headed whales cruising on surface, shallow dives"

* Note that many sighting ranges were not reported by the ships, so these numbers may be an under-representation of the totals in each category.

HAWAI`I RANGE COMPLEX YEAR FOUR MONITORING ACCOMPLISHMENTS

Marine species monitoring in conjunction with training events has been funded by U.S. Pacific Fleet since 2006. From 2006 to 2008, monitoring efforts focused on visual line-transect surveys conducted before and after training events—collecting visual sighting data, photographs, video, and behavioral observations. Aerial and vessel surveys were conducted during RIMPAC 2006 (Mobley 2006), USWEX events (Mobley 2008a,b, and Smultea et al. 2008), and RIMPAC 2008 (Mobley 2008c, Smultea 2008). Monitoring from 2009 to 2011, and through August of 2012, maintained the same basic level of effort as in previous years (DoN 2011a).

During Year Four (02 August 2011 through 01 August 2012), U.S. Pacific Fleet implemented aerial and vessel surveys in conjunction with ASW training events. The innovative approach begun in 2009 for conducting aerial surveys in close proximity to U.S. Navy training events was continued this year, providing valuable behavioral observations during ASW (using sonar). Through the adaptive management process, the Submarine Commander's Course (SCC) was selected as a focus of protected marine species monitoring. By Year Four, this approach was realized in a layered monitoring approach. MMOs were embarked upon a U.S. Navy ship that deployed MFAS during the SCC (ASW) event (the SCC was selected as a focus of protected marine species monitoring through the adaptive management process), while the vessel was followed by an aerial survey, as well as by an acoustic analyst that followed real-time recordings of the exercise and animals via acoustic recordings made by the PMRF instrumented range. In addition to these activities, PAM devices were deployed to simultaneously monitor waters adjacent to the PMRF range, and satellite tags were deployed onto odontocetes on and near the range before the exercise, such that animal movements during the SCC could be examined. Finally, surveys (i.e., a visual survey with sonobuoys) and after (shoreline surveys for stranded animals) were also conducted. **Table 5** presents a summary of U.S. Navy-funded marine mammal monitoring within the HRC during Year Four.

Table 5. U.S. Navy-funded marine mammal monitoring accomplishments within the Hawai`i Range Complex from 02 August 2011 to 01 August 2012.

Study Type	U.S. Navy EIS/LOA Monitoring	Associated Event Type	U.S. Navy R&D Funded Monitoring	Associated Event Type	MMPA/ESA Requirement	Total Accomplished
Visual surveys Studies 1, 2, 3, 4, 5	1) 96 hr – 11-19 Jan 2012 (vessel) 2) 28.9 hr – 15-25 Feb 2012 (aerial) 3) 42.2 hr – PMRF pre-SCC 15-20 Jan 2012 (vessel) 4) 10.3 hr – Ka'ula survey, 06 July 2012 (vessel) 5) 55.2 hr – PMRF pre-RIMPAC June 2012 (vessel)	1) SCC (ASW) 2) SCC (ASW) 3) SCC (ASW) 4) n/a 5) RIMPAC	Use of M3R array at PMRF for validation of species ID, animal localization (baseline, during and pre-SCC and pre-RIMPAC) 2012	SCC, RIMPAC	120-160 hr before, during and after ASW and/or explosives training events	>232 hr of aerial and vessel surveys
Marine Mammal Observers Studies 1, 2, 3, 4,	1) 48.4 hr - 10-17 Nov 2011 2) 28.4 hr - 13-17 Feb 2012 3) 5.6 hr – 10-11 Aug 2011 4) 7.8 hr – 19 & 26 Oct 2011, 02 Nov 2011	1) Koa Kai (ASW) 2) SCC (ASW) 3) UNDET 4) UNDET	n/a	SCC, Koa Kai	MMO team aboard U.S. Navy surface platforms during 2 ASW and 6 explosive events	2 ASW events and 10 explosive events
Tagging Studies 1, 2, 3	1) 3 tags deployed on cetaceans, all successfully (in conjunction with M3R, Aug 2011) 2) 4 tags deployed on cetaceans, 3 successfully (11-20 Jan 2012) 3) 8 tags deployed on cetaceans, all successfully (PMRF, pre-RIMPAC, June 2012)	1) n/a 2) SCC (ASW) 3) RIMPAC	Use of M3R array at PMRF for validation of species ID, animal localization (baseline, pre-SCC and pre-RIMPAC) 2012	SCC, RIMPAC	Tag a goal of 15 individual marine mammals	15 attempted tag deployments on cetaceans, 14 successful

Study Type	U.S. Navy EIS/LOA Monitoring	Associated Event Type	U.S. Navy R&D Funded Monitoring	Associated Event Type	MMPA/ESA Requirement	Total Accomplished
Passive Acoustic Monitoring Studies 1, 2, 3, 4	1) 7 EARs deployed: 3 off Ni'ihau 26 Jan 2012, recovered and redeployed 21 July 2012; 1 deployed off Ka'ula Island 25 April 2012 2) 18 sonobuoys deployed off Kaua'i pre-SCC 3) Analyzed data from 8 historical PAM (EAR) deployments (2 deployed during RIMPAC 2010 off Ni'ihau, 6 deployed in 2009 and 2010 off Kaua'i and O'ahu) 4) Continued use of PMRF hydrophones to gather and analyze marine mammal acoustic data in conjunction w/ SCC and RIMPAC	1) n/a 2) SCC (ASW) 3) RIMPAC 4) SCC (ASW), RIMPAC	Use of M3R array at PMRF for validation of species ID, animal localization (baseline, pre- SCC and pre-RIMPAC) 2012	SCC, RIMPAC	1) Utilization of a combination of autonomous recording devices, sonobuoys, and/or towed arrays to gather acoustic data 2) Continued collaboration of data collection and analysis from additional OPNAV N45/ONR-funded autonomous PAM devices 3) Continued analysis of PAM data 4) Continued use of the PMRF instrumented range hydrophones to gather and analyze marine mammal acoustic data	Deployment of 7 EARS off Ni'ihau and Ka`ula Island Deployment of 18 sonobuoys off Kaua'i Analysis of data from 8 historical EAR deployments near Kaua'i, O'ahu and Ni'ihau Use of PMRF hydrophones to gather and analyze marine mammal acoustic data in conjunction w/ SCC and RIMPAC

Major Accomplishments from U.S. Pacific Fleet's Year Four Compliance Monitoring in the HRC:

- **Visual (Vessel) Survey**
    - A small-vessel survey occurred during an UNDET from 10 to 11 August 2011, in the Pu'uloa Underwater Range off O'ahu, approximately 1.7 nautical miles (NM) (3.15 kilometers [km]) from Keahi Point, located west of the Pearl Harbor entrance channel. Marine species monitoring occurred from a 27-ft (8.2-m) Boston Whaler before, during, and after the UNDET. The goal of the survey was to observe the monitoring and mitigation effort conducted by the U.S. Navy's Mobile Diving and Salvage Unit (MDSU) in addition to logging marine species sightings (see Richie et al. 2012a).
    - Small-vessel surveys occurred during an UNDET on 19 and 26 October and again on 02 November 2011 in the Pu'uloa Underwater Range. Marine species monitoring occurred from a 27-ft (8.2-m) Boston Whaler before, during, and after the UNDET events. The goal of the survey was to observe the monitoring and mitigation effort conducted by the U.S. Navy MDSU in addition to logging marine species sightings (see Uyeyama et al. 2012).
    - Two-vessels were used to survey for marine mammals and verify the species from acoustic detections of marine mammals from the M3R program on the PMRF range. This effort occurred prior to an SCC that was conducted in the same area during February 2012. Surveys utilized both a 24-ft (7.3-m) rigid-hulled inflatable boat (RHIB) and, for the first time, a dedicated U.S. Navy vessel, the 225-ft (67-m) ocean tug U.S. Navy Ship (USNS) *Sioux* (see HDR 2012a and Baird et al. 2012a, respectively). Primary objectives of the cruise were to: (1) obtain visual sightings of marine mammals detected acoustically by scientists on the PMRF hydrophone range and deploy satellite tags on marine mammals; and (2) collect photographs of marine mammals for species identification and mark-recapture abundance estimates. A secondary objective of the cruise was to collect close-range acoustic data from marine mammals using sonobuoys launched from the survey vessel. Sightings from the larger ship were made of 161 individuals or groups of cetaceans representing eight species including three rarely seen priority species; the Blainville's beaked whale (*Mesoplodon densirostris*), minke whale (*Balaenoptera acutorostrata*), and sperm whale (*Physeter macrocephalus*). The acoustic detections of four species were visually confirmed during this survey including the first visual confirmation of a Blainville's beaked whale acoustic detection at PMRF. There were 13 sightings of five different species of odontocetes with four of the sightings (of four species) cued by the M3R acoustic system at PMRF. Three odontocetes—two short-finned pilot whales (*Globicephala macrorhynchus*) and one rough-toothed dolphin (Steno *bredanensis*)—were tagged with satellite transmitters that transmitted locations for 11.7 to 73.2 days (see HDR 2012a and Baird et al. 2012a).
    - In conjunction with the Ka'ula Island seabird survey, a non-systematic ship-based survey was conducted for marine mammals and sea turtles offshore of Ka'ula and in the waters in a direct line from Ka'ula to Nawiliwili Harbor, Kaua'i on 06 July

2012 (see Richie et al. 2012b). The survey was conducted from the 96-ft (29-m) research vessel *Searcher*. The priorities for the cruise were: (1) a seabird survey conducted by Naval Facilities Engineering Command (NAVFAC)–Pacific terrestrial division (results not reported herein); (2) a count of monk seals (*Monachus schauinslandi*) hauled out along the ledges of Ka'ula; (3) a non-systematic and opportunistic survey of cetaceans which approached the vessel to bow ride during the bird survey at Ka'ula, and collection of dorsal fin photographs of these animals; and (4) a systematic line-transect survey in passing mode during the transit from Ka'ula to Nawiliwili Harbor, as weather permitted. Four marine mammal groups representing three species (total of 84 individuals) were observed during approximately 10 hours (hr) of survey effort. Three monk seals were hauled out on the northwestern ledge of Ka'ula: two adults of unknown sex and one juvenile female. One adult seal had an identifying scar from a cookiecutter shark (*Isistius brasiliensis*) bite behind the right pectoral flipper, but all seals appeared to be in good condition. At Ka'ula, 5 high-quality photographs were collected of individually identifiable bottlenose dolphins (*Tursiops truncatus*) and 16 high-quality photographs were collected of individually identifiable spinner dolphins (*Stenella longirostris*). These photos are catalogued by NAVFAC Pacific at Joint Base Pearl Harbor-Hickam. They have been shared with Cascadia Research Collective and the NMFS-Pacific Islands Fisheries Science Center, which curate existing photo-ID catalogs of bottlenose dolphins and Hawai`ian spinner dolphins.

- **Visual (Aerial) Survey**

  Aerial surveys to monitor marine mammals and sea turtles were conducted during and after an SCC training event on the PMRF hydrophone range between Kaua'i and Ni'ihau from 15 to 25 February 2012 (see Mobley and Pacini 2012). Surveys during the SCC occurred on 3 consecutive days from 15 to 17 February. The goal of the aerial survey was to monitor and report the presence and behavior of marine species before, during and after the training event as well as monitor for any stranded or near-stranded marine mammals along the shorelines of Kaua'i/Ni'ihau following the event. The aerial survey also provided visual verification of acoustically detected marine mammals from the PMRF hydrophone range. These surveys also coincided with the MMOs embarked upon a participating U.S. Navy guided-missile destroyer (DDG) (see *Marine Mammal Observers (MMOs)* below). Overall survey effort was divided into three parts:

  - Ship follows, SCC event (15–17 February 2012): the aircraft flew elliptical orbits in front of the DDG with the goal of finding target species in the vicinity of the DDG and observing and recording their behavior using focal-follow methods. Seven humpback whale (*Megaptera novaeangliae*) pods, one unidentified blackfish species and one sighting of an unidentified sea turtle species occurred during this period.
  - Visual verification (18 February 2012) of species acoustically detected from the PMRF fixed-hydrophone range.
  - Coastline surveys, post-SCC event (23 and 25 February 2012): the aircraft flew along the coastlines of Kaua'i and Ni'ihau in search of otherwise undetected marine mammal strandings. These surveys recorded 101 groups of marine species including 14 groups of green turtles (*Chelonia mydas*), 63 groups of humpback

whales, 21 groups of Hawai`ian monk seals, two groups of spinner dolphins, and one group of identified delphinid species. There were no strandings of any marine species (Mobley and Pacini 2012).

- **Comprehensive Data Atlas**
    - A comprehensive sightings data atlas was created in 2011 (Uyeyama 2011), and recently updated in 2012, to integrate the historical sum of U.S. Navy-sponsored marine species monitoring efforts in the HRC (see HDR 2012b). The report is a semi-comprehensive meta-analysis of monitoring survey effort in the HRC from 2005 to 2012. The goal of this atlas was to process and compile available data from visual surveys performed by both contractor-led efforts and U.S. Navy in-house surveys, in order to: (1) compile a geographic information system-based summation of all survey tracks that can be easily visualized, and (2) construct a geo-referenced database of sightings that can be queried by species, observer platform, Beaufort sea state, season, or other sighting/survey variables. Of the 34 monitoring surveys conducted in the HRC since 2005, 28 have been entered into a comprehensive geo-referenced sightings database. Over 1,100 sightings of more than 5,900 individuals of 20 species are currently catalogued in the database. Planned for inclusion in this database are (1) the remainder of existing HRC sighting and effort data collected to date, and (2) data collected during future HRC monitoring surveys.

- **Passive Acoustic Monitoring**
    - Historical data were analyzed from six EARs deployed in 2009 and 2010 at depths ranging from 341 to 2,204 ft (104 to 672 m) around Kaua'i and O'ahu. Eight marine mammal species were acoustically identified from these data (see Au et al. 2011).
    - Two EARs were deployed on 17 July 2010 for the 2010 RIMPAC exercise, one (deep) at a depth of 2,625 ft (800 m) off the northwestern coast of Ni'ihau and the other (shallow) at a depth of 53 ft (16 m) off the southeastern coast of Ni'ihau (see Au 2012, **Table 6**). From the shallow-EAR, it was determined that most of the whistle events were most likely spinner dolphins; they occurred in the mornings between 0600 and 0900, although they were occasionally detected in the afternoon and at night. From the deep-EAR, deep-diving biosonar activity occurred at dawn, dusk, and night, ranging from 75 percent of detections for sperm whales (*Physeter macrocephalus*) to 87 percent of detections for beaked whales. A combined 59 percent of all clicks were from short-finned pilot whales and Risso's dolphins (*Grampus griseus*). Only 4 percent of all clicks were produced by beaked whales.
    - Four EARs were deployed between 01 August 2011 and 31 July 2012 (**Table 6**). Three were deployed around Ni'ihau on 26 January 2012 and recovered on 21 July 2012. One EAR was deployed off Ka'ula Island on 25 April 2012, but will not be recovered until October 2012. Data analysis is anticipated to take place in the future.

Table 6. EAR deployments in the HRC from July 2010 to August 2012

Date Deployed	Location	Latitude (°N)	Longitude (°W)	Depth (m)	Duty Cycle	Date Recovered	Days in Water	Data Analysis
10 July 2010	Ni'ihau (South)	21° 47.306	160° 11.964	17	30 sec/5 min	20 December 2010	163	Completed*
10 July 2010	Ni'ihau (North-West)	21° 59.613	160° 12.167	732	30 sec/5 min	January 2011	>180	Completed*
30 June 2011	Ka'ula Island	21° 40.827	160° 30.644	577	30 sec/5 min	25 April 2012	299	Approx. 40% complete
26 July 2011	Ni'ihau (North-West)	21° 59.614	160° 12.171	527	30 sec/5 min	26 January 2012	179	Approx. 40% complete
26 July 2011	Ni'ihau (Pueo Pt.)	21° 47.315	160° 01.059	737	30 sec/5 min	26 January 2012	179	Approx. 40% complete
26 July 2011	Ni'ihau (South-West)	21° 46.176	160° 17.557	769	30 sec/5 min	26 January 2012	179	Approx. 40% complete
26 January 2012	Ni'ihau (North-West)	21° 59.614	160° 12.171	527	30 sec/5 min	21 July 2012	177	None-on hold
26 January 2012	Ni'ihau (Pueo Pt.)	21° 57.315	160° 01.059	737	30 sec/5 min	21 July 2012	177	None-on hold
26 January 2012	Ni'ihau (South-West)	21° 46.176	160° 17.557	769	30 sec/5 min	21 July 2012	177	None-on hold
25 April 2012	Ka'ula Island	21° 40.827	160° 30.644	577	30 sec/10 min	Still Deployed	N/A	N/A
21 July 2012	Ni'ihau (North-West)	21° 59.614	160° 12.171	527	30 sec/10 min	Still Deployed	N/A	N/A
21 July 2012	Ni'ihau (Pueo Pt.)	21° 57.315	160° 01.059	737	30 sec/10 min	Still Deployed	N/A	N/A
21 July 2012	Ni'ihau (South-West)	21° 46.176	160° 17.557	769	30 sec/10 min	Still Deployed	N/A	N/A

* Au, W.W.L. 2012. Results of EAR deployment in the waters off Ni'ihau during RIMPAC 2010. Final report submitted by HDR to U.S. Navy NAVFAC Pacific.

- Eighteen sonobuoys were deployed off Kaua'i from the USNS *Sioux* between 11 and 19 January 2012 (see HDR 2012a). Thirteen were deployed in conjunction with marine mammal sightings, and the remaining five were deployed at the beginning of the cruise to test the recording system, or deployed as requested by the M3R team. The data from the sonobuoys have not yet been analyzed, but analysis is anticipated to take place in the future (see HDR 2012a).
- For further information on PAM studies see *Use of Instrumented Underwater Range for PAM at the Pacific Missile Range Facility* below.

- **Marine Mammal Observers (MMO)**
  - Two ASW training events and 10 UNDET events were monitored.
    - A four-person observer team (three U.S. Navy civilian MMOs and one contractor MMO) conducted LOE studies during two ASW training events in the HRC: Koa Kai 12-1 from 10 to 17 November 2011 (see Watwood et al. 2012a), and SCC from 13 to 17 February 2012 (see Watwood et al. 2012b). The MMOs were stationed aboard U.S. Navy destroyers for both exercises. In addition to collection of shipboard lookout (LO) sighting data to assess effectiveness, detailed sighting data were collected by the MMOs including species identification, surfacings, and behavior.
    - Ten UNDET events were monitored: Two UNDETs occurred on 10 August 2011 and one occurred on 11 August 2011. Four UNDETs occurred on 19 and 26 October 2011 (two on each day), and three events occurred on 02 November 2011. All training events were conducted by U.S. Navy MDSU in the Pu'uloa Underwater Range (Danger Zone 334.1370). MMOs observed the monitoring and mitigation effort conducted by the MDSU, in addition to logging marine species sightings (see Uyeyama et al. 2012).

- **Tagging**
  - Several vessel surveys were undertaken off Kaua'i between 21 July and 08 August 2011 in order to: (1) examine spatial use and residency patterns of odontocetes using satellite-tracked tags, (2) provide visual verification of acoustically-detected odontocetes on the PMRF, and (3) obtain individual identification photographs and biopsy samples for assessment of population identity and structure (see Baird et al. 2012b). This effort overlapped the end of Year Three and the start of Year Four monitoring. Although mentioned in the HRC Annual Monitoring Report for Year Three (DoN 2011a), the effort is also described in detail here. During 65 encounters with five species of odontocetes, over 22,000 photos and 48 biopsy samples were collected. Four satellite tags were deployed—three on rough-toothed dolphins (*Steno bredanensis*) and one on a bottlenose dolphin. This effort resulted in the first tags deployed on either of these species in Hawai`ian waters.
  - From 10 to 19 January 2012, vessel based research was conducted off Kaua'i (see *Visual [Vessel]) Survey* accomplishments section) (see HDR 2012a and Baird et al. 2012a). The three goals were: (1) photo-ID, (2) biopsy sampling, and (3) tagging to examine habitat use and movement patterns. A RHIB was used as a platform for all activities. Two individual short-finned pilot whales and one rough-toothed

dolphin were satellite-tagged. Ranging patterns of the pilot whales differed, with one individual circumnavigating both Kaua'i and Ni'ihau and then moving to west of O'ahu, while the other circumnavigated Kaua'i only. The rough-toothed dolphin circumnavigated Kaua'i and covered a broad range of area off Ni'ihau.

- During June to August 2012, in coordination with the M3R program, a tagging team visually-validated detections of four species (rough-toothed dolphin, bottlenose dolphin, short-finned pilot whale, and false killer whale [*Pseudorca crassidens*]. Eight satellite tags were deployed on odontocetes (see Dilley and McCarthy 2012), including the rough-toothed dolphin, bottlenose dolphin, and false killer whale (http://www.cascadiaresearch.org/hawaii/June2012.htm).
- Data collection from tags deployed on Hawai`ian monk seals continued to provide information on habitat use and behavior throughout the Main Hawai`ian Islands (MHI) (see Wilson at al. 2012). The primary objectives of this cooperative research project were to: (1) deploy cell phone tags on monk seals in the MHI; (2) monitor monk seal habitat use and behavior: assess home range sizes and identify foraging areas and potential foraging hot spots of seals in the MHI; (3) identify potential changes in monk seal behavior relative to U.S. Navy activities in the MHI. Monk seals did not travel more than 14.6 NM (300 km) on foraging trips and usually traveled less than 27 NM (50 km). Seals mainly foraged around a single island or adjacent islands (e.g., O'ahu and Kaua'i, or Moloka'i and Lana'i).

  Analysis of monk seal tagging results continued, with home ranges derived from the remaining tracks. Additionally, analysis is underway to compare periods of interest (e.g., where movements differed dramatically from 'normal') with MFAS (53C) use in the vicinity (Wilson et al. 2012).

- **U.S. Navy LOE Studies**

  LOE studies were summarized in DoN (2011a). During this reporting period, a new analysis method has been developed and tested that allows estimation of the probability of animals approaching to within a specified stand-off range without being detected (the "sneak-up probability"). The method is flexible in allowing for a variety of animal surfacing behaviors: "clustered instantaneous," where animal surfacings last just for an instant, but where these surfacings are clustered together in time, interspersed between extended periods underwater; "intermittent," where animals are at the surface for longer periods between dives; and "continuous" where one or more member of each animal group is always at the surface. The method models detection probability in two dimensions (forward of and perpendicular to the vessel), and can model both LO and MMO detections, although it is also possible to focus just on the LO detection probabilities. This method has been tested on simulated data and found to perform satisfactorily for large sample sizes, however the sample size of real data collected from trials to date is insufficient for reliable inferences to be drawn at this time.

  U.S. Navy Fleet training organizations are currently evaluating the preliminary results to determine if improvements in lookout-training programs are warranted. Initial steps in progress include evaluating incorporation of marine mammal survey techniques into watchstander training and revision of Marine Species Awareness Training. As more data is analyzed, other options for improving lookout training will be evaluated as appropriate.

- **Use of Instrumented Underwater Range for PAM at the Pacific Missile Range Facility**

  The bottom-mounted hydrophone arrays at the PMRF are a valuable asset for marine mammal monitoring in the HRC. During the multi-platform survey in January 2012 (see HDR 2012a,-; Baird et al. 2012a, Dilley and McCarthy 2012), the hydrophone range was utilized, through efforts of the M3R team in coordination with contracted survey vessels, to detect, identify and localize vocalizing and clicking marine mammals. Once localized, the M3R team cued the survey vessels on the range to a location where they believed the animals might surface. This coordinated effort resulted in visually-validated detections of four species, assisted in sightings and application of three satellite tags.

  Analysis of acoustic recordings from the hydrophone array during an SCC training event in February 2011, in concert with visual sightings from MMOs aboard a U.S. Navy surface vessel and an survey aircraft, have produced estimated received levels along with reconstructions of animals movements during an ASW training event. Received SPLs were estimated for 12 humpback whales and four unidentified whale sightings. SPLs for these sightings ranged from 136 to 196.9 dB re 1 µPa. Received SPLs were also estimated for 10 beaked whale sightings during the same training event and ranged from 81 to 139 dB re 1 µPa (see Martin and Manzano-Roth 2012, Martin et al. 2012).

  The PMRF hydrophone range was utilized, through efforts of the M3R team in June to August 2012 in coordination with a tagging vessel, to detect, identify and localize vocalizing and clicking marine mammals. Once localized, the tagging vessel vectored to a location where the animals might surface. This coordinated effort resulted in visually-validated detections of four species and application of eight satellite tags (see Dilley and McCarthy 2012).

Metrics Summary

Visual Surveys: Over 232 hr of visual surveys (vessel and aerial) were conducted in conjunction with training events. This met the 120 to 160 hr of survey effort before, during, and after ASW and/or explosive events committed to in the HRC Monitoring Plan for Year Four.

Marine Mammal Observers: The HRC Monitoring Plan for Year Four and the HRC LOA for 2012 call for MMO teams aboard U.S. Navy vessels during two ASW events and six explosive (UNDET) events. MMO teams embarked during two ASW events, meeting this metric for Year Four. MMO teams embarked on a total of 10 explosive events: three in August 2011 and another seven in October/November 2011. This results in a metric exceedance of four monitored UNDET events.

Passive Acoustic Monitoring: Four EARs are currently deployed off Ka'ula and Ni'ihau. Data were analyzed from eight historical PAM deployments. Eighteen sonobuoys were deployed and the PMRF was used in five studies in Fiscal Year (FY) 2012. The HRC Monitoring Plan for Year Four committed to the following: (1) utilization of a combination of autonomous recording devices, sonobuoys, and/or towed arrays to gather acoustic data; (2) continued collaboration of data collection and analysis from additional OPNAV N45/ONR-funded autonomous PAM devices; (3) continued analysis of PAM data; and (4) continued use of the PMRF instrumented range hydrophones to gather marine mammal acoustic data (Dilley et al 2012; Moretti et al 2012).

Tagging: The U.S. Navy's goal for FY 2012 was to tag a total of 15 marine mammals. Fourteen tags were successfully deployed in the field, with one tag loss, during three separate field efforts: July/August 2011 (3); January 2012 (3); and June/July 2012 (8). Surveys were contracted, additional tags were purchased and available in the field and every effort was made to meet the metrics and make up the four tag shortfall from 2010. However, conditions beyond the U.S. Navy's control, such as high seas over much of the field efforts, precluded additional deployments.

OTHER U.S. NAVY-FUNDED RESEARCH IN HAWAI`I

In 2012, the ONR Marine Mammals and Biological Oceanography program and OPNAV N45 both funded research in the Pacific area of responsibility and specifically, in the Hawai`i region. Some of the projects relate to or inform the U.S. Pacific Fleet's Monitoring Program for the HRC and these are summarized below:

Use of Electronic Tag Data and Associated Analytical Tools to Identify and Predict Habitat Utilization of Marine Mammals **– Daniel Costa and Barbara Block, University of California at Santa Cruz**

The researchers are using data from the Tagging of Pacific Predators (TOPP) database to address three objectives:

1. Identify and map focal feeding areas, breeding areas, and migration routes.
2. Model spatio-temporal oceanographic habitat utilization and predict regions of animal occupancy and use based on oceanographic features.
3. Utilize this habitat utilization model framework to assess the impact of displacement from primary feeding areas due to disturbances.

The TOPP program provided 1,791 animal tracks of 23 species including blue whales (*Balaenoptera musculus*), humpback whales, fin whales, sperm whales, California sea lions (*Zalophus californianus*), northern fur seals (*Callorhinus ursinus*), northern elephant seals (*Mirounga angustirostris*), loggerhead turtles (*Caretta caretta*), and leatherback turtles (*Dermochelys coriacea*). Although the project focuses on tagging in the California current, the tagged species move throughout the North Pacific providing insights into habitat across a much broader area.

Results indicated that some species such as blue whales, northern elephant seal, and California sea lions show fidelity to the cool, nutrient rich waters of the California Current Large Marine Ecosystem (CCLME) over multiple seasons. Additionally, leatherback sea turtles migrate from the western Pacific to the CCLME. The researchers characterize the CCLME as an area that retained many tagged species and an attractive area for species undergoing long migrations. The North Pacific Transition Zone (NPTZ) is also named by the researchers as an important area for predators of the Pacific Ocean. The NPTZ is at the northern border of the HRC. It is characterized as an east-west migration corridor and an important foraging ground because it is the location of the transition from subarctic and subtropical waters.

Study of the oceanographic parameters that affect species distribution showed that predator presence had a strong positive relationship with sea surface temperature that peaks at 59 degrees (°) Fahrenheit (15 ° Celsius). They also correlated with areas of high productivity. Much of this is related to the distribution of prey species. Frontal systems aggregate prey species and it appears the predators hunt on either side depending on their temperature preferences. The researchers have not yet addressed the impact of displacement due to disturbance.

Importance of Thin Plankton Layers in Hawai`ian Food Web Interactions: Research Spanning From Physical Circulation to Spinner Dolphins **– Kelly Benoit-Bird and Margaret McManus, Oregon State University and University of Hawai'i at Manoa**

The objectives of this study are to:

1. Quantify layered aggregations of the phytoplankton, zooplankton, and the nearshore sound-scattering layer around Hawai`i
2. Identify the physical, optical, and acoustical characteristics associated with these aggregations
3. Assess the horizontal scales of coherence between these various levels of biological aggregations and understand their interactions
4. Assess the impact of these layers on optical and acoustical measurements in the nearshore environment
5. Determine the effects of layered aggregations on spinner dolphins

The work focused on four trophic levels of the nearshore community including phytoplankton, zooplankton, mesopelagic micronekton, and spinner dolphins on the leeward coast of the island of O'ahu. The study used a series of moorings and 24-hr vessel surveys to assess the biological, chemical and physical features as well as optical and acoustical characteristics of the water column. Results show that the community is subject to bottom-up regulation and the number and density of aggregations in at levels of the food chain were the most significant predictors of variation in adjacent trophic levels, rather than total biomass. Patchiness may be the dominant force regulating the entire system and influencing the distribution of top predators.

Researchers also noted that upward pulses of high-salinity, cooler water from the bottom are tidally driven and influence distribution of the plankton community. This phenomenon has been detected at other Pacific Islands, so it may be a persistent phenomenon affecting the food chain structure in many Pacific Island locations.

Off the leeward coast of O'ahu, plankton layers occur in thin, long patches. About 3.3 ft (1 m) separates phytoplankton and zooplankton layers–phytoplankton is above the zooplankton. The layers occur on either side of a water density step in the water column. It was observed that the mesopelagic micronekton layers occur in significantly deeper water in the presence of a layer of zooplankton. Micronekton abbreviates its vertical migration in the presence of a zooplankton thin layer. This spatial limitation keeps the micronekton deeper and changes their availability to spinner dolphins. This arrangement may have consequences at higher trophic levels if the depth changes the accessibility of the prey field.

Marine Mammals: Hearing and Echolocation at Coconut Island **– Paul Nachtigall, Hawai'i Institute of Marine Biology (HIMB)**

Dr. Nachtigall and his lab have continued their efforts to assess and expand the scientific community's understanding of cetacean hearing. Recently the lab measured the hearing of a stranded Blainville's beaked whale and showed that the frequencies for its best hearing was the same as its published echolocation return frequencies – between 40 and 50 kilohertz (kHz). The

beaked whale that stranded heard relatively well in the mid-frequency sonar range (5.6 kHz) at 79 dB (Pacini et al. 2011).

The lab has also continued work that measures the hearing of a false killer whale, demonstrating the ability of this species to change its hearing during echolocation. There are at least three mechanisms of automatic gain control in odontocete echolocation, suggesting that echolocation and hearing are a very dynamic process. For instance, false killer whales change the focus of the echolocation beam based on the difficulty of the task and the distance to the target. The echo from an outgoing signal can change by as much as 40 dB, but the departing and returning signal are the same strength entering the brain. The lab has demonstrated that with a warning signal, the false killer whale can adjust hearing by 15 dB prior to sound exposure. Nachtigall has begun experiments to determine whether the control of hearing is confined to echolocation.

The lab has also completed comparative measurements in hearing of bottlenose dolphins and harbor porpoises (*Phocoena phocoena*) during echolocation. Both species demonstrate control of hearing in a manner similar to the false killer whale. Evidence indicates that the hearing pathways differ between false killer whales, bottlenose dolphins, and belugas (*Delphinapterus leucas*). Initial work indicates that the hearing pathway of sound in the dolphin may not be through the lower jaw to the acoustic window.

Passive Autonomous Acoustic Monitoring of Marine Mammals: Proof of Concept Demonstration **– Philip Abbot, Ocean Acoustical Services and Instrumentation Systems (OASIS), Inc.**

OASIS demonstrated that they are able to reduce noise and get improved detection ranges using a 16-hydrophone towed array. Using data recorded by this system, they have adapted a spectrogram correlation method originally used for bowhead whales (*Balaena mysticetus*) detection to detect humpback whales. The goal is to have this process applied autonomously in real time. Success rates of detection have been shown to be higher than 70 percent and false detections rates are below 5 percent.

Remote Monitoring of Dolphins and Whales in the High Naval Activity Areas in Hawai`ian Waters **– Whitlow Au and Marc Lammers, HIMB**

The objective of this study is to map the distribution and abundance of whales and dolphins in the waters surrounding the islands of Kaua'i and O'ahu using acoustic methods. To achieve this goal, the scientist distributed ecological acoustic recorders (EARs) around the two islands.

The scientists are analyzing EAR data from Kaua'i near PMRF and Barber's Point off O'ahu using the M3R node and the energy ratio mapping algorithm (ERMA) developed by Holger Klinck and David Mellinger at Oregon State University. They compare the results of the two methods to make positive identification of species such as beaked whales and sperm whales, which are deep-diving echolocating odontocetes. The Kaua'i recordings contain deep-diving echolocating animals almost every day. Short-finned pilot whales were present at Kaua'i more often than other deep-diving odontocetes. Beaked whales had the lowest detection rate. When recordings are compared around the perimeter of Kaua'i, there is no clear area with greater cetacean activity.

O`ahu recordings were analyzed using Triton from Scripps Institution of Oceanography. Some differences in the type of vocal activity were detected around O'ahu. North and Southeast O'ahu

were similar in vocal activity levels, but southwest O`ahu had significantly more low frequency whistling activity than either north or southeast O`ahu. These results suggest that foraging activity, which is mediated by echolocation, may be greatest on the north side of O'ahu and lowest on the southwestern side of the island. In addition, it appears there are both spatial and seasonal variations in the occurrence of different species. Species producing high-frequency whistles (e.g., spinner and pantropical spotted [*Stenella attenuata*] dolphins) were most commonly detected on the north side of O`ahu and peaked in occurrence during summer months, whereas those producing lower frequency whistles (e.g., short-finned pilot whales and false killer whales) were recorded predominantly on the southwest side of O'ahu and were detected most frequently in spring.

Utilizing Pro-Bono Commercial Assets for Marine Mammal Surveys in a High Naval Activity Area in Hawai`ian Waters **– Whitlow Au, HIMB**

Dr. Au and his student, Alexis Rudd, have developed a method for addressing the objective of mapping the distribution and abundance of whales and dolphins in the deep waters between the islands of O`ahu and Hawai'i and the islands of O`ahu and Kaua'i, using the vessels of a moving company that travels between islands. The barges of the moving company pull a system of two tow bodies with a hydrophone to record marine mammal vocalizations. Over 300 hr of data have been collected in all Beaufort sea states, with most data being taken in sea states that would prevent effective visual surveys. All the data collected so far has been geo-referenced and will be combined with remotely sensed oceanographic data in order to correlate detections with environmental variables. Acoustic analysis is currently underway.

HRC ADAPTIVE MANAGEMENT AND 2012-14 MONITORING PLAN

Adaptive management is a critical component of the U.S. Navy's comprehensive monitoring program and has been used over the past four years to adapt field methodology to maximize the effectiveness of data collection. At the national level, the U.S. Navy engaged NMFS, the Marine Mammal Commission, non-governmental organizations, and other researchers in workshops during 2010 and 2011 to refine the monitoring plans for the next phase of MMPA LOAs. On the local level, the U.S. Navy solicited input from researchers at local universities, science centers and private institutions. The contributors had expertise across disciplines, species and techniques and had publications relevant to U.S. Navy marine species monitoring in the HRC. Consolidation of expert input resulted in a matrix of research questions which may be used to guide future monitoring efforts. This important step allowed the scientific community to provide input into U.S. Navy monitoring prioritization and provides transparency to the public on how the U.S. Navy determines monitoring priorities and goals.

The next step in this process which applies to the entire U.S. Navy monitoring program is the finalization of a Strategic Plan. The Strategic Plan is a primary component of the ICMP. It provides the "vision" for U.S. Navy monitoring across geographic regions—serving as guidance for determining how to most efficiently and effectively invest marine species monitoring resources to address ICMP top-level goals, satisfy MMPA (i.e., LOA) regulatory requirements, and answer relevant scientific questions about marine species on U.S. Navy ranges. The objective of creating the Strategic Plan is to continue the evolution of U.S. Navy marine species monitoring towards a single integrated program, incorporate SAG recommendations (provided in DoN 2011a) into the monitoring program, and establish a more transparent framework for soliciting, evaluating, and implementing monitoring work across the Fleet Range Complexes. A draft of the Strategic Plan has been submitted to NMFS Headquarters and will be discussed at the U.S. Navy's annual Adaptive Management meeting in October 2012.

As adaptive management is ongoing, no changes are being recommended for the final period of the 2009-2014 LOA renewal period. **Table 7** contains the U.S. Navy's monitoring commitments for FY13-14 as agreed upon by U.S. Navy and NMFS in the 2012-2014 LOA.

Table 7. FY13-14 monitoring commitments.

Monitoring Technique	Implementation	
Visual Surveys (aerial or vessel)	120-160 hours before, during and after ASW training events including major training exercises (MTE), SCC, Unit Level Training (ULT) and/or explosive events.	Adaptive Management Review (AMR)
Marine Mammal Observers (MMO)	MMO team aboard Navy surface platforms during 2 ASW and 6 explosive events.	
Tagging	Tag a goal of 15 individual marine mammals.	
Passive Acoustic Monitoring (PAM)	• Utilize a combination of autonomous recording devices, and/or sonobuoys and/or towed arrays to gather acoustic data. Continue collaboration of data collection and analysis from additional N45/ONR-funded autonomous PAM devices. Continue data analysis. • Continue use of the Pacific Missile Range Facility instrumented range hydrophones to gather and analyze marine mammal acoustic data.	

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