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Marine Mammal Monitoring

For The U.S. Navy's

Hawaiian Range Complex (HRC)

And

Southern California (SOCAL) Range Complex

FINAL

Annual Report 2009

Volume 1

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Cover Photos: Humpback whales photographed with a telephoto lens from the aircraft during a HRC aerial monitoring survey in Hawaii (Photo by Joe Mobley under NOAA Permit No. 642-1536-03); Common dolphins photographed from the aircraft during a SOCAL marine mammal aerial monitoring off San Diego, California July 2009 (Photo by Lori Mazzuca); mother fin whale and calf observed during the SOCAL Oct 2008 aerial monitoring survey off San Diego (Photo by Lori Mazzuca); Striped dolphin photographed during the HRC June 09 aerial monitoring survey (Photo by Mark Deakos); Blue whale observed underwater and photographed from the aircraft during a SOCAL aerial monitoring survey off San Diego (Photo by Lori Mazzuca)

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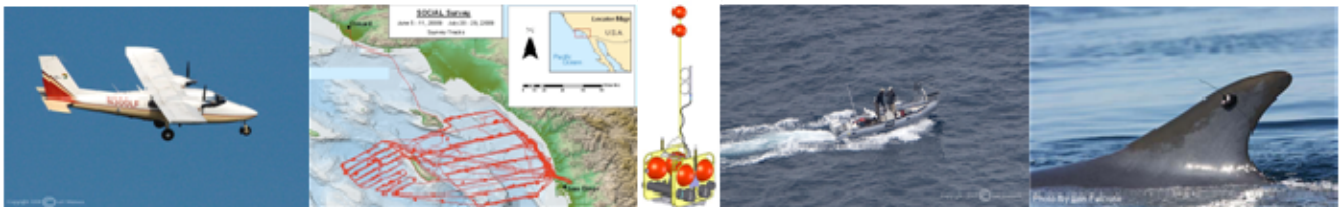
HRC Photos from left to right: Aerial survey track lines for June 2009 in HRC (Graphic courtesy of Marine MMRC-SES), UNDET off Oahu monitored for marine mammal and sea turtles (Photo by Anu Kumar), Spectrogram of minke whale vocalization in PMRF off Kauai (Graphic courtesy of Steve Martin).



SOCAL Photos from left to right: Twin-engine airplane used for marine mammal aerial monitoring (Photo by Lori Mazzuca), serial survey track lines for June and July 2009 in SOCAL (Graphic courtesy of Marine Mammal Research Consultants), Scripps Institute of Oceanography High-Frequency Acoustic Recording Package (Graphic courtesy of John Hildebrand), Rigid-hull Inflatable Boat used for cetacean tagging in SOCAL (Photo by Lori Mazzuca), Fin whale with satellite attached October 2008 (Photo by Erin Falcone).

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14. ABSTRACT: This report presents the level of effort and preliminary data obtained from marine mammal monitoring in the Hawaii Range Complex (HRC) and Southern California (SOCAL) Range Complex. The objective of this research was to provide valid scientific information on basic marine mammal distribution and biology within the HRC and SOCAL, as well as to provide the foundation for analysis on the impacts or lack of impacts to marine mammals from Navy training.

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EXECUTIVE SUMMARY

The goal of this report is to present the level of effort and preliminary data obtained from marine mammal monitoring in the Hawaii Range Complex (HRC) and Southern California (SOCAL) Range Complex.

From August 2008 to 01 August 2009, the U.S. Pacific Fleet funded one million dollars ($1M) in innovative marine species monitoring in support of Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) commitments for the Hawaii and SOCAL range complexes. A basic set of study objectives were developed by Navy and National Marine Fisheries Service (NMFS) Office of Protected Resources NMFS during the MMPA and ESA consultation process in support of the programmatic HRC and SOCAL Environmental Impact Statements. The study objectives provided the framework for range complex specific marine mammal monitoring. The field work accomplished meets the U.S. Pacific Fleets requirements under the MMPA Letters of Authorization for training in the HRC and SOCAL range complexes and focused on the following study questions:

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

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

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

4. What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

5. Is the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol (PMAP), major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

In addition to the U.S. Pacific Fleets monitoring commitments, this year's effort also represented significant contribution from various Navy commands engaged in supporting scientifically unbiased research including Chief of Naval Operations Environmental Readiness (CNO N45), Office of Naval Research and Naval Postgraduate School. These three agencies have extensively funded this type of research for many years, with the objective of providing valid scientific information on basic marine mammal distribution and biology where the Navy trains, as well as to provide the foundation for analysis on the impacts or lack of impacts to marine species from Navy training.

This year's monitoring efforts was the first in a five-year overall commitment, and many of the study objectives have either never been attempted or in their infancy in other regions. Therefore, another primary goal was to validate the mix of monitoring techniques available as they applied to each range complex. The desire is to revaluate planned monitoring for next year based on applicability of any given technique to providing the most appropriate data, likelihood of success, and logistic availability.

During this monitoring period, a number of notable accomplishments were obtained.

Over 19,700 nm of ocean within Southern California offshore marine waters was surveyed over 247 cumulative days and 1,224 hours of total effort as part of U.S. Pacific Fleet Monitoring. Combined visual surveys in SOCAL reported 1,533 sightings for an estimated total of 78,635 marine mammals. The significant distance surveyed and quantity of marine mammal sightings obtained during SOCAL surveys represents the most up-to-date and comprehensive visual surveys for marine mammals in Southern California. Aerial surveys in the HRC successfully used the novel method of close-proximity elliptical transects in front of surface vessels engaged in anti-submarine warfare training. Survey aircraft shared airspace with Navy assets, surveyed between 200-2,500 yards of active surface vessels and obtained focal follows of animals as surface ships approached. Aerial surveys were also used to monitor underwater detonations in HRC.

Use of aircraft for marine mammal monitoring has been demonstrated to have benefits in areas other than traditional presence\absence surveys. Overall, results support the utility of aerial surveys to: (1) collect quantifiable behavioral data known to be indices of stress or disturbance, (2) conduct focal follows of priority cetacean species including video-documentation of underwater behavior, (3) provide the advantage of surveying particular area in one day, providing a "snapshot" of marine mammal numbers, presence, distribution and behavior before, during and after training events; (4) provide a platform from which the behavior and potential reactions of cetaceans to Navy training may be studied without confounding results (vs. from vessels), and (5) locate and identify dead floating carcasses and stranded animals. For instance, in SOCAL unique extended focal follows by airplane were performed for blue, fin, and humpback whales, and Risso's dolphins, and small (<~50) groups of bottlenose dolphins, common dolphins, and Pacific white-sided dolphins. In addition, there were seven systematic assessments of marine mammal reactions to aircraft at various altitudes (one blue whale, one fin whale, two common dolphin spp., and three Risso's dolphins). In the HRC, focal follows were obtained for humpback whales, spinner dolphins, and Risso's dolphins including underwater video.

In the HRC, vessel surveys were used in conjunction with six underwater detonations and one event using mid-frequency sonar. These surveys not only provide baseline data for the training area, but provided opportunity for focal follows and acoustic data to be obtained from cetaceans transiting through the zone of influence. Vessel and small boat surveys allow not only visual observation of marine mammals, but also provides opportunities for obtaining tissue samples for genetic analysis and to attach satellite tags for tracking movement. To date, 12 tags were attached to individual marine mammals in SOCAL, with tags on one bottlenose dolphin, two Cuvier's beaked whale, and one Risso's dolphin representing the first ever tagging of these species in California. The remaining eight tags were on fin whales. Tags using emergent technology were purchased in Hawaii and will be used collaboratively to meet NMFS/Navy goals to tag monk seals in the HRC next year.

Marine mammal observers were deployed on large and small Navy surface vessels during anti-submarine warfare and underwater detonations to gather visual observations, species identification and data that will be used to determine the effectiveness of the Navy's suite of mitigation measures.

Passive acoustic monitoring, although a long term challenge due to the sheer magnitude of vocalization data collected, can offer insights into vocalization and echolocation as a measure of likely foraging success of cryptic, hard to visual spot marine mammals such as beaked whales and sperm whales. Devices were purchased for use in both SOCAL and Hawaii and data collection will ramp up in 2010. For just one 54-day period of recording in SOCAL from one acoustic monitoring device, over 1,302 hours of passive acoustic vocalization data were collected including multiple Cuvier's beaked whales echolocation clicks.

Another technique not originally described in the HRC or SOCAL Monitoring Plans involves the use of photographic identification of individual marine mammal from digital images. PhotoID provides information on sighting and re-sighting of individuals which may help to address subtle concepts such as residence time, large or small scale distribution, or geographic redistribution. In SOCAL alone, over 8,148 digital images and 227 minutes of digital video were taken between August 2008 and 01 August 2009.

The U.S. Navy exceeded its monitoring goals as stated in the range complex specific Monitoring Plans for marine mammal monitoring in the HRC and SOCAL. There were significant accomplishments and substantial data collected, most of which is still undergoing analysis as of this report date. Data will be combined in the first few years of collection and analyzed once data sets are of a sample size that is robust. Additionally, analysis in 2010 will include correlation with operational data from training events.

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List Of Acronyms

AMR	Adaptive Management Review
ARP	acoustic recording package
AS	aerial survey
ASW	anti-submarine warfare
Bf	Beaufort
BiOP	ESA Biological Opinion
CalCOFI	California Cooperative Oceanic Fisheries Investigation
COMPTUEX	Composite Training Unit Exercises
CNO	Chief of Naval Operations
CRC	Cascadia Research Collective
CREEM	Centre for Research into Ecological and Environmental Modeling
dB	decibel
EIS	Environmental Impact Statement
DoN	Department of the Navy
DTAG	digital acoustic recording tag
EAR	Ecological Acoustic Recorder
ESA	Endangered Species Act
FLIP	Floating Instrument Platform
ft	feet
FY	fiscal year
GPS	global positioning service
GUNEX	Gunnery Exercise, Surface-to-Surface
HARP	high-frequency acoustic recording package
HQ	headquarters
HRC	Hawaii Range Complex
IAC2	Integrated ASW Course Phase II
ITA	Incidental Take Authorization
JTFEX	Joint Task Forces Exercise
kHz	kilohertz
LOA	Letter of Authorization
M3R	Marine Mammal Monitoring on Navy Ranges
MDSU	Mobile Diving and Salvage Unit
MFAS	mid-frequency active sonar
MISSILEX	Missile Exercise, Surface-to-Surface
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
MMPI	marine mammal PhotoID
MMRC	Marine Mammal Research Consultants
MMT	marine mammal tagging
MTE	Major Training Exercise
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPG	Naval Postgraduate School
NUWC	Naval Undersea Warfare Center
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
PAM	passive acoustic monitoring
PIFSC	Pacific Islands Fisheries Science Center
PMAP	Protective Measures Assessment Protocol
PMRF	Pacific Missile Range Facility
PTS	permanent threshold shift
R&D	research and development
R/V	research vessel
RDT&E	research, development, testing and evaluation
RIMPAC	Rim Of the Pacific Exercise
RL	receive level
RHIB	Rigid hull inflatable boat
SCC	Submarine Commanders Course
SES	Smultea Environmental Sciences
SHAREM	Ship Anti-Submarine Warfare Readiness and Evaluation Measuring
SINKEX	Sinking Exercise
SIO	Scripps Institute of Oceanography
SOAR	Southern California Offshore ASW Range
SOCAL	Southern California
SPORTS	Sonar Positional Reporting System
SSC PAC	Space and Naval Warfare Systems Center Pacific
SURTASS LFA	Surveillance Towed Array Sensor System Low Frequency Active
SUSTEX	Sustainment Exercises
SWFSC	Southwest Fisheries Science Center
TTS	temporary threshold shift
USWEX	Undersea Warfare Exercise
VS	vessel survey

INTRODUCTION

Background

The U.S. Navy developed Range Complex specific Monitoring Plans 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. In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a) (5) (a) of the MMPA states that National Marine Fisheries Service (NMFS) must set forth "requirements pertaining to the monitoring and reporting of such taking". The MMPA implementing regulations at 50 Code of Federal Regulations §216.104 (a) (13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present. While the Endangered Species Act (ESA) does not have specific monitoring requirements, recent Biological Opinions issued by National Marine Fisheries Service (NMFS) also have included terms and conditions requiring the Navy to develop a monitoring program. Therefore, as a result of the issuance of Range Complex LOAs in early 2009, the Navy published Range Complex Monitoring Plans with specific monitoring objectives for the Hawaii Range Complex (HRC) and Southern California (SOCAL) Range Complex (DoN 2009a,b,c,d).

Based on discussions with NMFS, Range Complex Monitoring Plans were designed as a collection of focused "studies" to gather data that will attempt to address the following questions which are described more fully in the HRC and SOCAL Monitoring Plans:

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

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

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5. Is the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol (PMAP), major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Monitoring methods proposed for the Range Complex Monitoring Plans include a combination of research elements designed to support both Range Complex specific monitoring, and contribute information to a larger Navy-wide science-based program. These research elements include visual surveys from vessel or airplanes, passive acoustic monitoring (PAM), marine mammal observers (MMO), and marine mammal tagging. Each monitoring technique has advantages and disadvantages that vary temporally and spatially, as well as support one particular study objective better than another (DoN 2009a,b). The Navy intends to use a combination of techniques so that detection and observation of marine animals is maximized, and meaningful information can be derived to answer the research

questions proposed above. This also includes incorporation of new techniques (e.g. photo-ID) if warranted.

In addition to Fleet funded Monitoring Plans described above, the Chief of Naval Operations (CNO) Environmental Readiness Division (N45) and the Office of Naval Research (ONR) have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Total investment in this program for fiscal year (FY) 2009 was approximately $22 million, and continued funding at levels greater than $14 million is foreseen in subsequent years. Several significant projects relative to Navy operational impact or lack of impact to marine mammals are currently funded and ongoing within some Navy Range Complexes. For example, in the SOCAL Range Complex, to leverage scientific expertise and funding availability, both Fleet and N45 programs integrated certain elements of their programs to address the requirements as stated in the SOCAL Monitoring Plan (see Section III).

Report Objective

Design of the Range Complex specific Monitoring Plans represented part of a new Navy-wide and regional assessment, and as with any new program, there are many coordination, logistic, and technical details that continue to be refined. The scope of the Range Complex Monitoring Plans was to layout the background for monitoring, as well as define initial procedures to be used in meeting study objectives derived from NMFS-Navy agreements.

Overall, and in support of the above statement, this report has two main objectives:

1) Under the Range Complex LOAs, present data and results from the Navy-funded Range Complex marine mammal and sea turtle monitoring conducted in the HRC and SOCAL during the Study Year from 1 August 2008 to 1 August 2009. Included in this assessment are reportable metrics of monitoring as requested by NMFS. Given the relatively new start of this ambitious program, this first 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 Complexes.

2) Set the foundation for adaptive management review with NMFS for incorporation of proposed revisions to the Navy's FY 2010 Monitoring Plans based on actual lessons learned from FY 2009. This can include data quality in answering the original study questions, assessment of logistic feasibility, availability of monitoring resources, use of new techniques not originally incorporated in this year's Monitoring Plan, and any other pertinent information.

SECTION I- HAWAII RANGE COMPLEX

The HRC consists of 235,000 square nautical miles (nm^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 Pacific Missile Range Facility (PMRF) on Kauai which is both a Fleet training range and a Fleet and DoD RDT&E range. PMRF includes 1,020 nm^2 of instrumented ocean area at depths between 1,800 feet and 15,000 feet. Various subcomponents of the range complex are more fully described in the Final Hawaii Range Complex Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS) (DoN 2008a). Of note and in regards to in-water unit-level training and major training events (MTE) using sonar and explosives, a much more limited subset of the range complex is used.

There are field monitoring efforts within the HRC funded by U.S Pacific Fleet as part of the HRC compliance monitoring, funded by or conducted by the Office of Naval Research (ONR) and by the Environmental Readiness Division of the Chief of Naval Operations (CNO N45). Some of the results from the Navy's Research and Development (R&D) monitoring (CNO N45 and ONR funded efforts) are presented in Part II of this Section.

On February 2, 2009, U.S. Pacific Fleet convened the first meeting of the Hawaii Pelagic Marine Mammal Research Workgroup with government, industry and academic researchers. This meeting was the first of its kind in Hawaii and provided all with the opportunity to present their research and work towards more collaborative efforts. Hawaii marine mammal and bio-acoustic researchers that have current funding to conduct pelagic marine mammal research of particular interest to the Fleet were invited to give presentations on their research. The research areas included passive acoustics, behavioral monitoring, tagging and sensor development (see text box below). The goals of the Workshop were to 1) improve the situational awareness of all parties of on-going Hawaii-based marine mammal research related to Navy training; 2) inform research community on Pacific Fleets research goals stemming from recent compliance documents for the Hawaii Range Complex, and 3) discuss data sharing and potential for sustained collaboration develop a framework for on-going communication (e.g. establish a workgroup). The workshop was attended by thirty-eight individuals including researchers from National Marine Fisheries Service (PIFSC, HWNMS), academia (University of Hawaii (SOEST, HIMB), Scripps Institution of Oceanography), private industry (contractors, researchers), Navy biologists, operators and engineers, and Hawaii federal government (Senator Inouye staff).

Presentations from the first meeting of the
Hawaii Pelagic Marine Mammal Research Workgroup

U.S. Pacific Fleet - Why Navy Trains
U.S. Pacific Fleet- Navy regulatory requirements and monitoring goals
Hawaii Institute of Marine Biology – Overview of captive and wild animal research on hearing thresholds
Hawaii Institute of Marine Biology – Overview of PAM and classification software development. Overview of three programs – EAR development and deployment around Kauai and Oahu, ROCA software for small odontocete call classification, PAM using Station Aloha and other sources
Lockheed Martin – development of passive acoustic classification software for odotocetes
Space and Naval Warfare Systems Center Pacific (SSC Pac) - overview of U.S. Pacific Fleet, ONR funded acoustic data collection at PMRF and the HRC, Density estimation cetacean for cetaceans from passive acoustics (DECAF).
Bio Waves – overview of ONR funded PAM and DECAF project in the HRC
Scripps Institution of Oceanography – Overview of passive acoustic monitoring in the HRC
UH, SOEST - Passive acoustic tracking widely-spaced bottom-mounted hydrophones
UH, SOEST – Ambient sound, acoustic sea gliders
Cascadia Research Collective – Odontocete tagging in the HRC
NMFS/PIFSC – Hawaiian monk seal research in the Main Hawaiian Islands
NMFS/PIFSC – Cetacean research at the Pacific Islands Fisheries Science Center
Cetos Research Collective – overview of prior Cetos contribution to marine mammal monitoring in the HRC
Marine Mammal Research Consultants – overview of prior and ongoing contributions to marine mammal monitoring in the HRC
HWNMS – Ongoing research in the Hawaiian Humpback National Marine Sanctuary
BAE – development of mitigation technology
Guide Star Engineering – development of mitigation technology

Part I- HRC Range Complex Monitoring Plan Accomplishments

In the HRC monitoring plan, the Navy proposed to implement a diversity of field methods to gather field data from marine mammals and sea turtles in conjunction with training events. Studies were specifically designed to meet the questions outlined in the Introduction section of this document. Metrics (e.g. hours or events) were agreed to by Navy and NMFS and used as a goal for implementation.

During the study year (August to August), U.S. Pacific Fleet implemented aerial and vessel surveys, deployed marine mammal observers on Navy platforms and purchased passive acoustic recording devices. Much of this work was a continuation of U.S. Pacific Fleet -funded field work that has occurred in the Hawaiian Islands since the Rim of the Pacific (RIMPAC) exercise in 2006.

All metrics outlined in the HRC monitoring plan were met or exceeded – a significant achievement for the first year. Additional successes included design and implementation of aerial surveys conducting elliptical transects in close proximity (~200-2,500 yds) to Navy surface vessels as well as three types of surveys conducted in close proximity to underwater detonations.

HRC STUDY QUESTIONS OVERVIEW

The goal of the HRC Monitoring Plan (DoN 2008c) is to implement field methods chosen to address the long term monitoring objectives outlined in the Introduction. **Table I-1** from the final HRC Monitoring Plan shows the FY 2009 monitoring objectives as initially agreed upon by the NMFS and Navy.

U.S. Pacific Fleet began conducting aerial and vessel surveys in conjunction with major exercises in 2006. Most aerial and vessel surveys from 2006-2008 were conducted only before and after, however some vessel surveys were conducted during the event as well. These early surveys not only provided data points that will be used in future analysis, 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 Navy shaped the studies in the HRC monitoring plan with proven field methods that would provide visual and acoustic data to support scientific assessment on the potential effects from Navy training on marine species.

In the HRC monitoring plan, the Navy proposed to use visual surveys (aerial and vessel) and marine mammal observers aboard Navy vessels during ASW and explosive events to meet its goals in FY09. Navy also proposed to purchase passive acoustic monitoring devices in 2009 and lay groundwork for purchasing tagging devices in 2010.

Table I-I. FY09 HRC Range Complex marine mammal monitoring obligations under HRC Final Rule, LOA and BiOP.

STUDY 1,3, 4 (exposures and behavioral responses)		
Aerial Surveys	- 40 hours during events including major exercises, intermediate level exercises, or Unit Level Training (ULT) training events using mid-frequency active sonar (MFAS) - During three nearshore explosive events	Adaptive Management Review for FY10 (AMR)
Marine Mammal Observers (MMO)	40 hours during major exercises, intermediate level or ULT MFAS training events	
Vessel surveys (study 3, 4 only)	- 40 hours during events including major exercises, intermediate level exercises, or Unit Level Training (ULT) training events using mid-frequency active sonar (MFAS) - During two nearshore explosive events	
Marine Mammal Tagging (study 1, 3) **Shore-based**	Order tags, secure permit	
STUDY 2 (geographic redistribution)		
Aerial Surveys Before And After Training	- 40 hours during events including major exercises, intermediate level exercises, or Unit Level Training (ULT) training events using mid-frequency active sonar (MFAS)	AMR
Passive Acoustics Monitoring (PAM)	Order devices and determine best location	
STUDY 5 (mitigation effectiveness)		
MMO/ Lookout Comparison	- 40 hours during events including major exercises, intermediate level exercises, or Unit Level Training (ULT) training events using mid-frequency active sonar (MFAS) - 40 hours during two nearshore explosive events	AMR
Aerial Surveys Before And After Training	- 40 hours during events including major exercises, intermediate level exercises, or Unit Level Training (ULT) training events using mid-frequency active sonar (MFAS)	
TOTAL FY 09 Commitment as outlined in DoN 2008c, NMFS 2009a: - up to 120 hours aerial survey plus during three explosive events -40 hours vessel survey plus during two explosive events -120 hours Marine Mammal Observers - Purchase/order PAM devices		

HRC MAJOR TRAINING EXERCISE SUMMARY

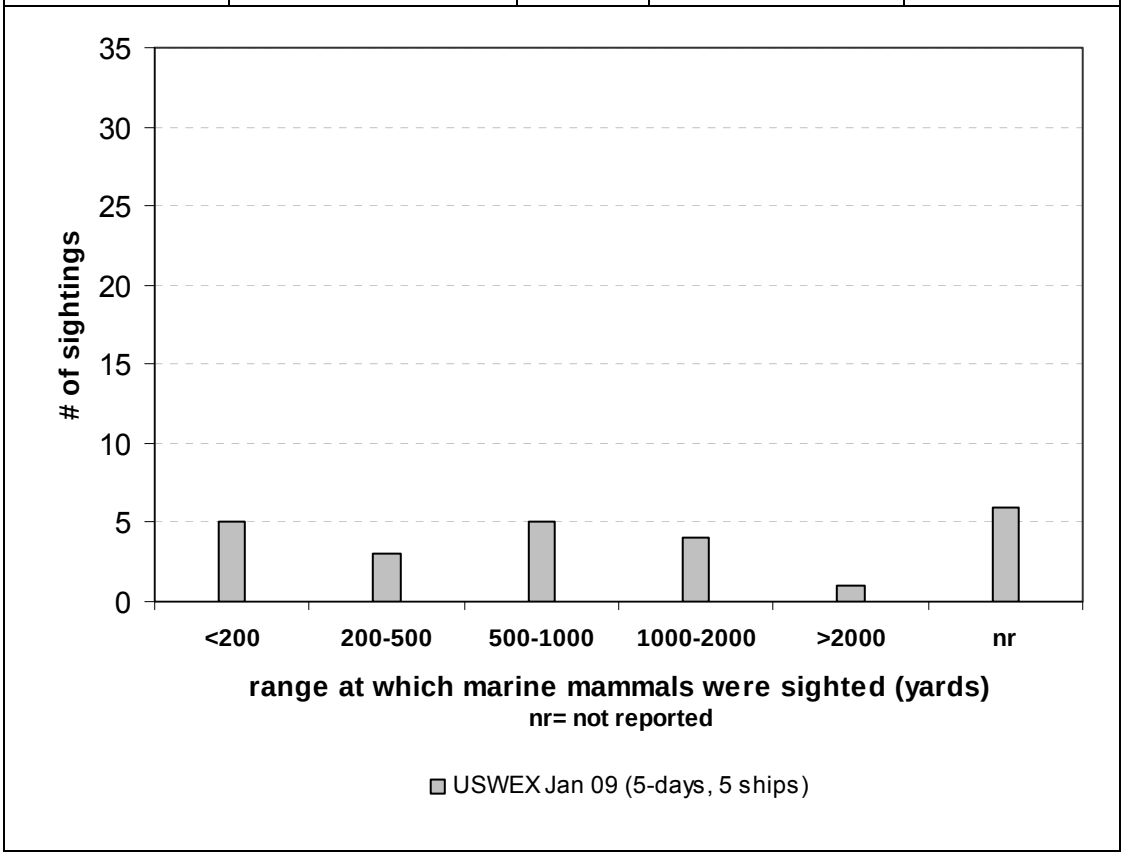
Given the focus on monitoring around Navy at-sea training events, a list of MTEs that occurred in the HRC between August 2008 and August 2009 is provided in **Table I-2**. Marine mammal sightings during MTEs are a form of compliance monitoring and represent substantial numbers of sightings. For HRC, MTEs include Rim of the Pacific exercises (RIMPAC), Undersea Warfare Exercises (USWEX), and Multi Strike Group.

There was only one MTE within the HRC between 1 August 2008 and 1 August 2009. All told, there were only five consecutive cumulative days involving MTEs within HRC out of the approximately 190 days between the MMPA LOA (permit) issuance from the end of Jan 2009 to 1 August 2009.

During transits and training events within the one MTE this period, Navy lookouts reported 24 marine mammal sightings for an estimated 135 marine mammals. There was only one mitigation event when a marine mammal was sighted at a range >500 yards concurrent with MFAS use, and the sonar was powered down (-6 dB) as per applicable mitigation measure.

Table I-2. HRC Major Training Events (MTE) between 01 August 2008 to 03 August 2009.

MTE Type	Dates	# Of Days	# Of Marine Mammal Sightings	# Of Marine Mammals
USWEX	15-19 January 2009	5	24	135



One way to use Navy lookout data to address NMFS' Study question "Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?", is to examine marine mammal sighting data from Navy MTEs and predict likely exposure.

Ranges associated with potential NMFS criteria levels of PTS and TTS (215 and 195 dB re 1 µPa2-s) are much shorter than 200 yards. During the single HRC MTE from January to 01 August 09, there were no sightings of marine mammals at less than 200 yards while MFAS was being used.

The three categories of mitigation measures (Personnel Training, Lookout and Watchstander Responsibilities, and Operating Procedures) outlined in the HRC EIS/OEIS and approved by NMFS (DoN 2008, NMFS 2009a, 2009b) were effective in detecting and appropriately mitigating exposures of marine mammals to mid-frequency sonar. Fleet commanders and ship watch teams continue to improve individual awareness and enhance reporting practices. This improvement can be attributed to the various pre-exercise conferences, mandatory marine species awareness training, and making adjustments based upon the lessons learned. The safety zones were adhered to, and vessels and aircraft applied mitigation measures when marine mammals are visually observed within the requisite zone.

Lookout monitoring adjacent ocean area during 76-mm gunnery exercise (GUNEX) from U.S. Navy frigate (U.S. Navy photo)

HRC MONITORING ACCOMPLISHMENTS

Marine species monitoring in conjunction with training events has been funded by US Pacific Fleet Environmental Office since 2006. From 2006-2008, surveys 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 (Cetos 2007, Mobley 2007, Mobley 2008a,b), RIMPAC 2008 (Mobley 2008c, Smultea and Mobley 2008). Two of these surveys, from a medium-sized research vessel, were also conducted during the training events. One of these, conducted in 2007, was the first to be conducted during a USWEX, and obtained the first focal follow of a marine mammal (a Bryde's whale) while Navy ships were within 15 nm (Cetos 2007). Aerial surveys conducted in 2008 also began incorporating a coastline survey component around the islands closest to the training event in order to investigate any otherwise undetected strandings.

Monitoring expanded to encompass new methods after the finalization of the HRC monitoring plan in early 2009. Novel approaches for gathering data in close proximity to Navy training events were successfully implemented in order to gather data specific to meeting monitoring goals.

Table I-3 presents a summary of the major accomplishments for Navy funded marine mammal monitoring within the Hawaii Range Complex.

Major accomplishments from the U.S. Pacific Fleet's FY 2009 compliance monitoring in HRC include:

- Aerial Visual Survey (Compliance Monitoring)
    - During two Submarine Commanders Course (SCC) training events and one Ultra-C (unit level), aerial surveys were conducted by non-Navy aircraft in close-proximity (e.g. between 200 and 2,500 yards) to Navy surface vessels. For SCC, logistical challenges were overcome by close coordination with PMRF range and P-3 pilots to allow for survey aircraft to share airspace with P-3 and helicopters involved in several training scenarios. This success demonstrates that that during certain training events, contracted aircraft may be used as a method for conducting behavioral monitoring of submerged and at-surface marine mammals.
    - Extended focal follows by airplane were performed for humpback whales, spinner dolphins, and a whale shark. Focal groups further explained in aerial survey discussion.
    - A group of three humpback whales were tracked for a focal follow session of more than one hour. This encounter provided behavioral data before, during and after an approach by a Navy surface vessel.

- Vessel Visual Survey (Compliance Monitoring)
    - Collaborated with NMFS, Pacific Islands Fisheries Science Center (PIFSC) on analysis of visual and acoustic data from a line-transect survey conducted in conjunction with an ASW training event. The survey duration was three weeks, with the training event occurring midway through.
    - NMFS, PIFSC conducted the first small vessel survey conducted in conjunction with Navy underwater detonation events in the Puuloa Training Area. PIFSC obtained a focal follow of spinner dolphins that traveled through the underwater detonation area between events. They also recorded, via hydrophone, the underwater detonation.

- Passive Acoustic Monitoring (Compliance Monitoring)
    - Four HARPs were purchased that will be deployed in September 2009.

- Marine mammal observers
    - MMOs were successfully deployed on two destroyers involved in anti-submarine warfare training events off the PMRF range. The MMOs embarked simultaneously with aerial survey teams. MMOs coordinated aerial surveys during SCC, gathered visual sighting data and data on lookout implementation of mitigation measures.
    - MMOs embarked on small Navy surface vessels with Explosive Ordnance Disposal teams from Mobile Dive and Salvage Unit One (MSDU). The MMOs observed marine species in an underwater detonation area as well as implementation of mitigation measures.

- Hosted the first Hawaii Marine Mammal Pelagic Research Workgroup.

Table I-3. U.S. Navy funded marine mammal monitoring accomplishments within the Hawaii Range Complex from August 2008 to August 2009.

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
Aerial surveys (studies 1,2,3,4,5)	1) 27.5 hours from 18-22 Aug 2008 2) 28.5 hours from 15-19 Feb 2009 3) 48 hours from 17-25 June 2009 4) 3 events on 19 June 2009	SCC (ASW) SCC (ASW) Ultra-C (ASW) 20 lb UNDET	n/a	n/a	ASW = from 80 to 120 hours and 3 explosives events	ASW = 104 hours and 3 explosives events
Marine Mammal Observers (studies 1,3,4,5)	1) 40 hours from 15-19 Aug 2008 2) 40 hours from 15-19 Feb 2009 3) 25 hours from 18-19 June 2009 4) 15 hours from 9-10 June 2009	SCC (ASW) SCC (ASW) 20 lb UNDET 20 lb UNDET	n/a	n/a	ASW = up to 80 hours and 40 hours explosive events	ASW = 80 hours and 40 hours explosive events
Vessel surveys (studies 3,4)	1) 40+ hours from 15-19 Feb 2009 2) 2 events from 17-19 June 2009	SCC Ops (ASW) 20 lb UNDET	n/a	n/a	ASW = 40 hours and 2 explosive events	ASW = 40+ hours and 2 explosive events
Tagging (studies 1,3,4)	Navy entered into discussions with NMFS/PIRO office regarding tagging monk seals in FY10. PIRO has already ordered eight tags for collaborative monk seal tagging next year	n/a	Partial funding, via NMFS/SWFSC, to Cascadia Research Collective	n/a	Order tags and secure permit	NMFS/PIRO has ordered tags for monk seal tagging in FY10.
Passive Acoustic Monitoring (study 2)	n/a	n/a	1) ONR-funded PAM (BioWaves) on PMRF range; 2) ONR-funded PAM (HIMB) around Kauai and Oahu; 3) N45-funded HARP deployed off Hawaii Island (PIFSC/SIO/Cascadia); 4) ONR-funded hearing testing of odontocetes (HIMB); 5) U.S. Pacific Fleet-funded passive data collection and analysis at PMRF (SPAWAR); 6) Tracking with widely-spaced bottom-mounted hydrophones (SOEST); 7) NAVAIR-funded development of trigger and alert sonobuoy system (Guide-Star Engineering); 8) ONR-funded DECAF (density estimation of cetaceans using acoustic fixed sensors) project	n/a	Purchase up to four devices	Purchased four high frequency recording packages (HARPs) to be deployed in 2010 as well as all listed in R&D section

RANGE COMPLEX AERIAL VISUAL SURVEYS

Aerial surveys were conducted during the following ASW and explosive events

- Submarine Commanders Course, August 2008
- Submarine Commanders Course, February 2009
- Ultra-C, June 2009
- Mobile Dive and Salvage Unit One underwater detonations, June 2009

***SCC August 2008 and February 2009*:** Submarine Commanders Course (SCC) is a multi-unit training event focused on underwater warfare training. Study design for use during the SCC was initially conducted in August 2008. This enabled U.S. Pacific Fleet to ensure that it was operationally feasible to have a survey aircraft conduct monitoring within 200-2,500 yds of a destroyer participating in SCC.

Data analysis of sightings, including correlation with training events and mid-frequency active sonar (MFAS) will occur in FY10 and provided in FY10 monitoring report.

August 2008: this is the first survey where a contracted, monitoring aircraft was permitted to operate in very close proximity to a Navy surface vessel. Consequently, maritime patrol aircraft (P-3) pilots and PMRF range requested that the survey aircraft only conduct monitoring surveys when the P-3s were not on site or the participating destroyer was off range. This only provided short windows for monitoring, however. it provided a critical opportunity for PMRF range and P-3 pilots to gauge the responsiveness of the contractor for future close-proximity monitoring.

Aerial surveys to monitor for marine mammals and sea turtles were conducted in conjunction with the August 2008 Navy SCC training event in the on the PMRF instrumented range off Kauai and Niihau, Hawaii. This effort involved assessing the feasibility of conducting searches in front of an Arleigh Burke class navy destroyer, the *USS O'Kane* (*O'Kane*). During monitoring, the *O'Kane* was underway following a non-systematic course and speed and intermittently transmitting hull-mounted MFAS. The goal was to monitor for any changes in the near-surface behavior, orientation, occurrence, and location of animals relative to the vessel's activities using a focal follow method. This included monitoring for any potentially dead, injured, distressed or unusually behaving animals. The approach involved flying elliptical-shaped patterns in advance of the *O'Kane* (**Figure I-1**) that extended from the front of the ship (~200 yards out to ~2,500 yds) over a width of ~2 nm. When range safety conditions precluded accompanying the *O'Kane,* "practice focal follows" were conducted opportunistically when target species were sighted off range.

The survey aircraft was able to accompany the *O'Kane* during 19.0 (67%) of the 28.5 hours (hr) of flight time; the remaining 9.5 hr (33%) while not with the *O'Kane* involved primarily transit time to and from the offshore location of the vessel. During the 9.5 hr away from the *O'Kane*, 20 sightings were recorded (Table I-4), all in nearshore waters of Kauai (18 sea turtle and 2 spinner dolphin groups). Two <10-min opportunistic focal follows were conducted on the two groups of spinner dolphins while flying at an altitude of ~1200-1,500 ft and included digital video recordings of their behavior. These focal sessions demonstrated the feasibility of the behavioral observation method from a circling aircraft. Video was also obtained of a non-target species (whale shark) as it swam >10 yd below the surface in Beaufort (Bf) 6 sea conditions, demonstrating that a large marine species could be tracked underwater, particularly in high beaufort, in the *O'Kane*'s vicinity. A submarine was also observed from the aircraft, at an estimated depth of 100ft. Overall, the monitoring survey effort demonstrated the feasibility of performing search

and behavioral observations of target species without interfering with at-sea naval training involving multiple large vessels, aircraft (both fixed-wing and helicopters) and submarines.

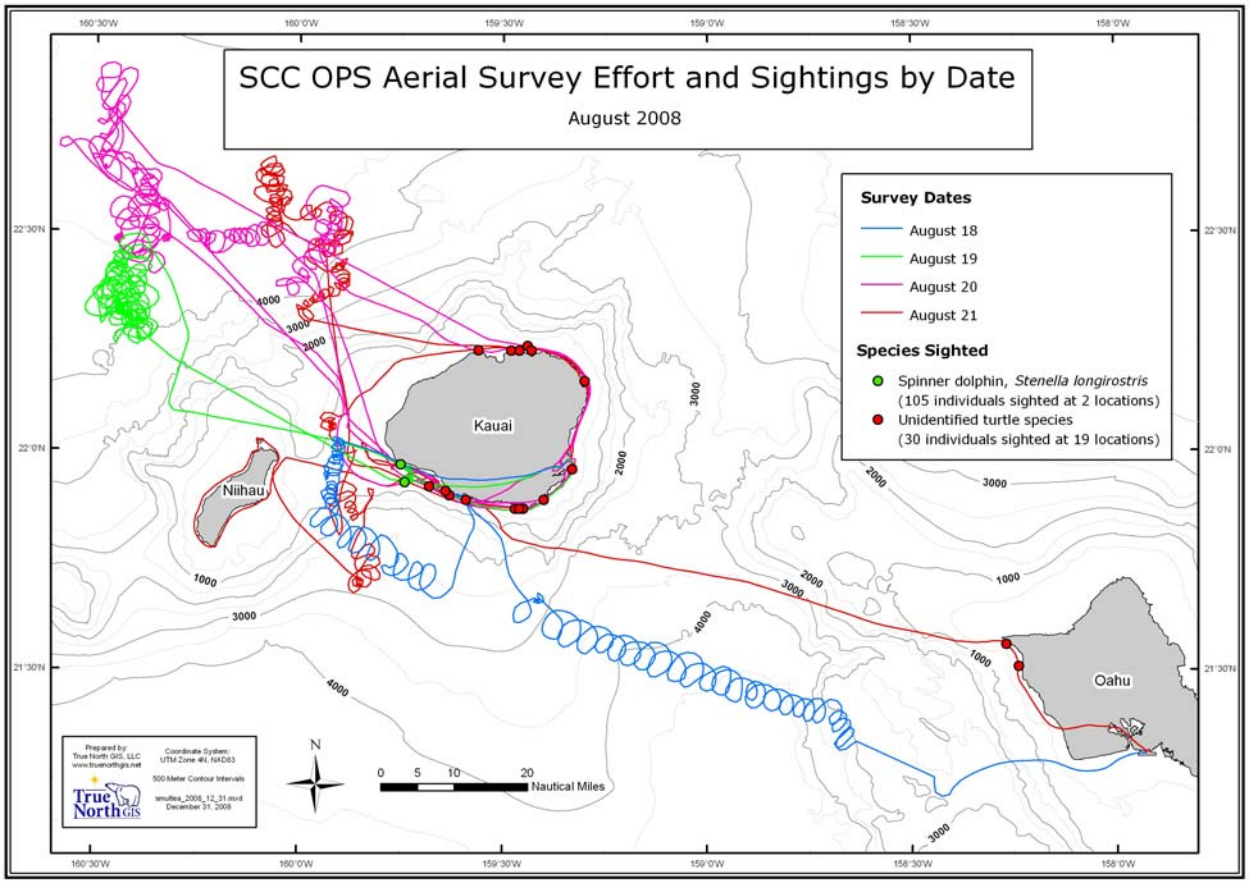


Figure I-1. August 2008 SCC aerial survey in the HRC.
Survey tracks are shown by survey date and locations of marine mammal and sea turtle sightings are also included. Straight-line tracks indicate transit periods, some of which were conducted along the Kauai shoreline. Corkscrew-shaped tracks indicate when the aircraft was accompanying the O'Kane or conducting an opportunistic focal follow.

In addition to surveying along with the surface ships, aerial surveys were conducted of the coastlines of the adjacent islands to confirm that no otherwise undetected strandings had occurred. None were found.

The full survey report is provided in **Appendix A**.

Table I-4. Summary of marine mammal and sea turtle sightings seen from the observer aircraft during Aug 08 survey.

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
19 August	1	Unident. sea turtle.	9:29	21.96	159.33
19 August	1	Unident. sea turtle	9:37	21.89	159.59
19 August	1	Unident. sea turtle	9:38	21.90	159.63

19 August	80	Spinner dolphin (*Stenella longirostris*)	9:41	21.97	159.75
19 August	25	Spinner dolphin	14:30	21.93	159.74
20 August	4	Unident. sea turtle	6:30	21.89	159.40
20 August	2	Unident. sea turtle.	6:36	21.91	159.64
20 August	2	Unident. sea turtle	6:37	21.92	159.68
20 August	1	Unident. sea turtle	8:10	22.23	159.56
20 August	3	Unident. sea turtle	8:12	22.23	159.48
20 August	2	Unident. sea turtle	8:13	22.23	159.46
20 August	2	Unident. sea turtle	8:13	22.24	159.44
20 August	3	Unident. sea turtle	8:14	22.23	159.43
20 August	1	Unident. sea turtle	8:19	22.16	159.30
20 August	1	Unident. sea turtle	9:50	21.87	159.46
20 August	1	Unident. sea turtle	15:16	21.87	159.45
20 August	1	Unident. sea turtle	15:16	21.87	159.47
20 August	1	Unident. sea turtle	15:20	21.91	159.64
21 August	1	Unident. sea turtle	6:51	21.87	159.46
21 August	1	Unident. sea turtle	15:32	21.56	158.27
21 August	1	Unident. sea turtle	15:34	21.51	158.24

February 2009: This survey was conducted using the same methods as the August survey, except that based upon the overall success of the August 2008 effort, the monitoring aircraft was permitted to conduct surveys while helicopters and P-3s were on the range. The details were worked out during several meetings prior to the event. All aircraft movements (including monitoring aircraft) were coordinated by PMRF range control which was critical for safety. As a result, all involved were able to meet their mission with no reported training impacts to surface ships, helicopters or P-3s.

The survey aircraft accompanied the Arleigh Burke class destroyer *USS Russell* (*Russell*) during 13.9 hours (hr) (51%) of the total 27.33 hr of flight time. The remaining 13.43 hr (49%) while not with the *Russell* involved primarily transit time to and from the offshore location of the vessel. A total of 63 (**Table I-5**) sightings were made during the survey period. Most (85%) of these sightings were observed in shallow coastal waters near Kauai during transits to and from the Russell's location, which was typically ~50 nm offshore north or northwest of Kauai. Of this total, only one sighting (a single humpback whale) was seen while the aircraft circled in front of the *Russell* in deep offshore waters for ~11.5 hr over three days (Feb 16-18) during the event. A focal follow was conducted on this whale. An additional seven sightings were seen within view (~20-30 km) on the last survey day (Feb 19) after the event had ended. All seven of these sightings were humpbacks and occurred over shallower, more protected lee waters between Kauai and Niihau in the Kaulakahi Channel while the *Russell* was stationary or in return transit through this channel.

On Feb 19, while the *Russell* was in transit after finishing the event, six focal sessions were conducted in the Kaulakahi Channel between Kauai and Niihau. The *Russell* and/or other similar sized Navy surface vessels were within view (~20-30 km) of the aircraft observers during 8 of the 12 sightings that occurred on Feb 19, including the six focal groups. These focal sessions ranged in duration from a few minutes to ~1-2+ hr (n = 3). The first focal session occurred in Bf 5/6 on a single humpback whale for ~15 min. The biological observers aboard the *Russell* simultaneously tracked this whale as they transited through the area based on communications between aircraft and vessel observers with an aircraft radio. However, the high Bf conditions made it difficult to consistently track this whale.

Subsequent focal sessions started well-ahead of but within view (<20-30 km) of the *Russell* with the goal of trying to collect behavioral data before, during, and after the *Russell* and other Navy vessels were nearby. On only one occasion on Feb 19 was a group of three humpback whales tracked for a focal session near (<4 km) a Navy vessel. This group was followed for ~1 hr before, during, and after two large Navy vessels approached, slowed down, stopped, then continued past the whales in the lee of the Kaualakahi Channel. The group had been exhibiting relatively consistent dive times and number of blows per surfacing, for several surfacing sequences before the two Navy vessels were within several km. As the two Navy vessels approached to within ~0.5-2 km of this group, the whales appeared to change their behavior state, increase their dive times, and reduce the number of blows per surfacing sequence. Reactions/avoidance of this type by some humpback whales to vessels has been documented previously, including in the Hawaiian Islands (e.g., reviewed in Richardson et al. 1995). It is important to note that this one observation does not represent a statistically significant sample size. However, this data point will be pooled with data from subsequent monitoring as well as later correlated with sonar logs. (Note: the field survey report in Appendix B states that the aerial survey team does not believe that sonar was active during the observation).

Overall, at least brief (a few min) digital video recordings were made on 13 of the 15 focal groups. Only two of the videotaped focal groups were near (<4 km) a Navy vessel, only one of which was videotaped near (<3-4 km) the *Russell* during the training event when MFAS may have been operating (Feb 16).

Video was supplemented by data collected on the iPhone and/or handwritten behavioral notes including information on estimated distance to the *Russell* or other vessels, other nearby sightings, etc. Behavior state, frequency of conspicuous surface behaviors, dispersal distance between individuals within a group, respiration and dive times, and periods whales were visible below the surface were also noted as possible.

With a small sample size and no additional analysis, it is not possible to determine the basis for the paucity of sightings by the aerial survey teams while with the Russell in deeper, offshore waters. Available studies indicated that marine mammal densities in offshore areas are typically low, and BSS are typically quite high (Mobley 2008a, Mobley 2008c). These factors suggest that aerial survey teams are unlikely to sight marine mammals and sea turtles near offshore training events whether or not the ships were operating. However, once additional survey data from these offshore regions is gathered, larger sample size is obtained, and analysis is conducted, more robust conclusions may be drawn.

The full survey report is provided in **Appendix B**.

Table I-5. Summary of sightings by species and periods with and without the Russell during the February 2009 SCC OPS aerial survey monitoring.

Species	Within View of *Russell*		Away from *Russell* (i.e., Transit)		Total	
	No. Grps	No. Indiv.	No. Grps	No. Indiv.	No. Grps	No. Indiv.
Humpback Whale (*Megaptera novaeangliae*)	8	14	45	92	53	96 (incl 2 calves)
Unidentified Baleen Whale	-	-	8	8	8	8
Unidentified Dolphin (Probable Bottlenose Dolphin, *Tursiops truncatus*)	1	1	-	-	1	1
Unidentified Sea Turtle	-	-	1	1	1	1
TOTAL	**9**	**15**	**54**	**101**	**63**	**106**

Ultra-C/Unit level training June 2009

Surveys were conducted in conjunction with the Arleigh Burke class destroyer *USS Hopper* (*Hopper*) which was conducting a training assessment called "Ultra-C" in the HRC. ULTRA-C assesses a ship's ability to conduct drills ranging from firefighting, anchoring, and defending the ship in simulated combat situations, to personnel management and completing required schools. Monitoring surveys were conducted in close proximity to *Hopper* during the event (June 17-18) as well as post-event (June 20-25). Following survey methodology developed during SCC in August 2008 and February 2009, the aircraft flew elliptical transects in front of *Hopper* over waters approximately 20-35 km south of Oahu (**Figure I-2**). The survey protocol involved two modes: (a) search mode—searching for target species while accompanying the *Hopper*; and (b) focal follow mode—following a sighting. In focal follow mode, the aircraft was to break off and orbit the sighting to obtain detailed behavioral observations for as long as the sighting was visible/trackable.

Only one sighting was made while surveying in conjunction with *Hopper*. The two unidentified dolphins were initially observed as they traveled away from the *Hopper*. The observation plane circled for several minutes where the dolphins had first been seen but observers were unable to relocate the dolphins in the Beaufort 5 conditions to obtain species identification photos or any further behavior information. No reactions/changes in behavior and no unusual behaviors were noted during the brief period of this sighting.

Four cetacean sightings occurred on the final survey date (June 25) when sea state conditions improved (**Table I-6**, **Figure I-3**). Those sightings included a group of Risso's dolphins, a group of striped dolphins, and a group of spotted dolphins. All three sightings were seen during a Beaufort 3 and were circled to obtain photographs to verify species and composition. No video was taken as photos were considered higher priority to confirm species.

The full survey report is provided in **Appendix C.**

Table I-6. Marine Mammal Sighting Summary by Species.

Asterisk (*) indicates species verified by photographs.

Species	Scientific Name	Total No. of Sightings	Best Estimate of Group Size
Risso's Dolphin*	*Grampus griseus*	1	9
Striped Dolphin*	*Stenella coeruleoalba*	1	12
Spotted Dolphin*	*S. attenuata*	1	30
Unidentified Dolphin	*Delphinidae* sp.	1	2

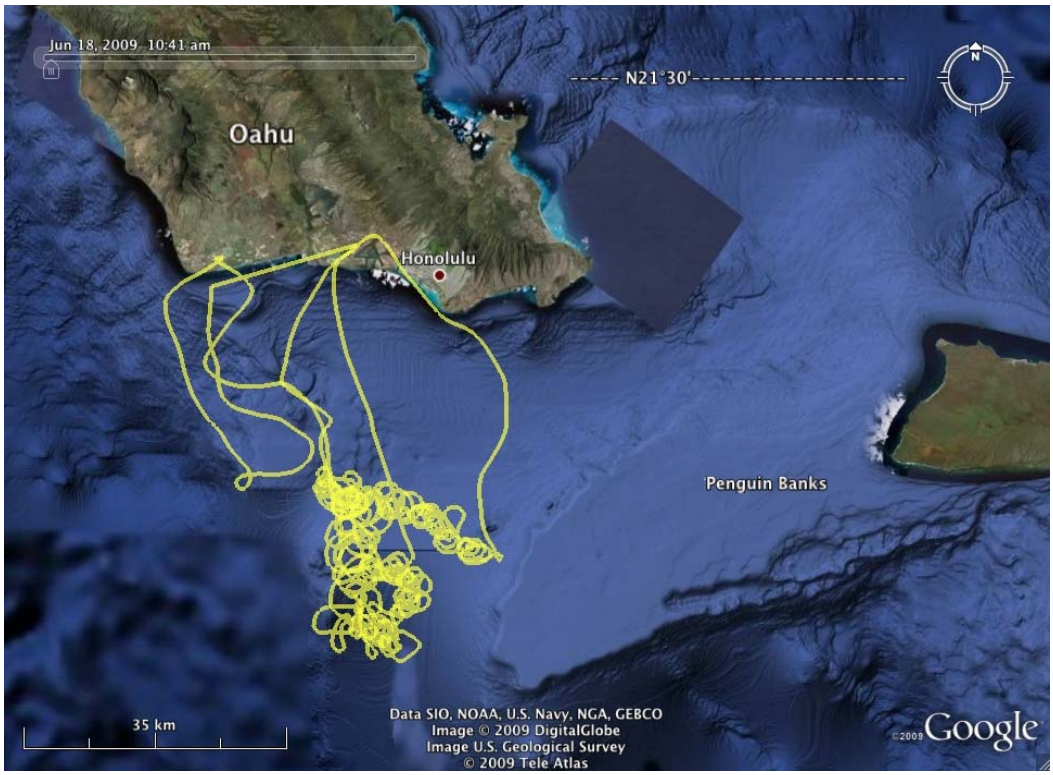


Figure I-2. Survey track from June 18, 2009 during ULT.

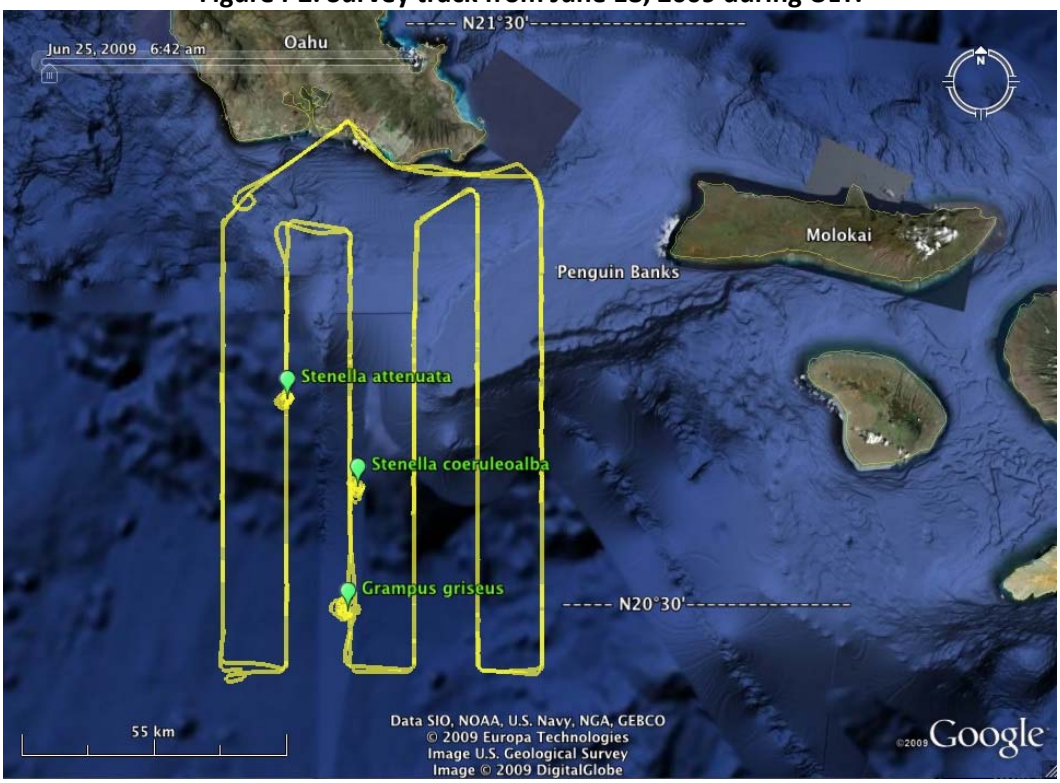


Figure I-3. Survey transects and visual sightings from June 25, 2009 after ULT.

MDSU Underwater Detonations: MDSU conducted six underwater detonations during two days at the Puuloa Training Range off Oahu. Net explosive weight was 20 lb. and underwater detonations were set at a depth of approximately 50 ft.

Aerial monitoring was conducted from a Robinson 44 helicopter flying transects in a 5.75 x 5.75-km grid immediately west of the entrance to Pearl Harbor (**Figure I-4**). Since the grid was located in the final flight approach area to Honolulu International Airport, all survey operations were closely controlled by FAA flight controllers. Systematic observations occurred in the survey grid during two sessions from 0915 to 1150 hrs and from 1250 to 1630 hrs with a break to return to Honolulu Airport to fuel in-between the sessions. Three underwater detonations occurred this day in the center portion of the survey grid. The observation helicopter was present during the first of these three detonation events at approximately 1130 hrs. The two subsequent detonations occurred between 1140 and 1300 hrs while the helicopter was off-site refueling. Post-detonation observations from the helicopter occurred at the survey grid from approximately 1255 to 1625 hrs. Communications were maintained with naval personnel from MDSU via cell phone voice and texting given the close proximity to shore.

All sightings on June 19 were unidentified sea turtles (likely green sea turtles, *Chelonia mydas*). These were highly visible due to the backlighting reflecting from the sand bottom in that area. No unusual behaviors, reactions, or changes in behavior were noted among any of the sea turtles observed.

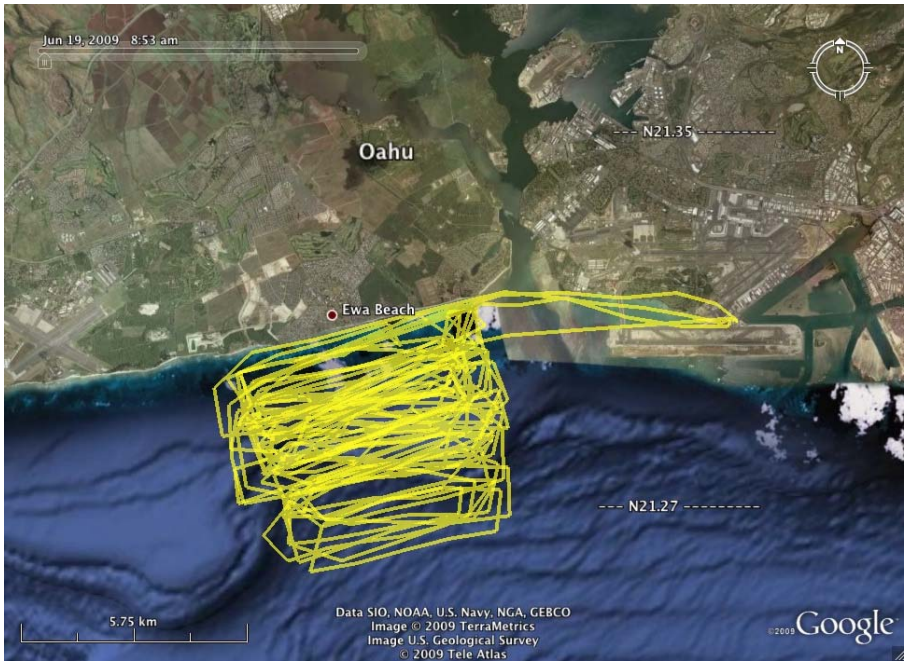


Figure I-4. Survey track from June 19, 2009 during UNDET.
NOTE: Vessel surveys and MMOs aboard MDSU vessels also occurred with this event. See vessel and MMO sections for more information on those surveys.

RANGE COMPLEX MARINE MAMMAL OBSERVERS (MMO)

Navy Marine Mammal Observers were aboard destroyers and small boats during the following ASW and explosive events

- Submarine Commanders Course, August 2008
- Submarine Commanders Course, February 2009
- Mobile Dive and Salvage Unit One (MDSU) underwater detonations, June 2009

Marine mammal observers embarked on Navy surface vessels to gather visual sighting and behavioral data from marine species, as well as gathering data that will be used to evaluate the Navy's suite of mitigation measures, including lookout effectiveness. The embarks, conducted on ships involved in the close-proximity aerial surveys, also facilitated safety and communications with the aerial survey team.

The Navy is in the process of finalizing the lookout comparison study that was outlined in the monitoring plans. The study design is a collaborative effort between Navy, NMFS and academic (e.g. University of St. Andrews) biologists and statisticians. Data and knowledge gained during these early embarks is being used to educate and refine this study design, and also provides anecdotal data that can be used as an index of what or whom the first source of detection (e.g. MMO or lookout) was. See tables in each section for sighting data.

SCC August 2008- Two Navy marine mammal biologists embarked on the *USS O'Kane* during SCC in August 2008 which coincided with the first close-aboard aerial monitoring survey (see Aerial Survey section). MMOs both embarked and returned to Pearl Harbor on the *O'Kane*, observing both during the transit to PMRF, the SCC, refueling-at-sea, and a Gunnery Exercise (GUNEX).

MMOs conducted visual observations from the bridge wings of the *O'Kane* during daylight hours. They worked alongside the Navy lookouts, conducting visual searches for marine species, as well as observing lookout protocol and implementation of mitigation measures. MMOs also coordinated the aerial survey effort via satellite and ships phone, vectoring the monitoring aircraft to marine mammal sightings.

MMOs had one positive marine mammal identification during this embarkation, which were pilot whales first observed at approximately 1,000 yd off the bow. The group of 20-25 animals were first observed by the starboard MMO and reported to the lookout and Officer of the Deck. The pilot whales were heading 180^{o} and approaching *O'Kane*, therefore *O'Kane* secured active sonar and turned sharply to avoid a closer approach to the animals. The animals were observed diving within 25 yd of *O'Kane's* beam. The survey aircraft was notified of the sighting via satellite phone, but due to the delay in reaching them (satellite phone would not connect), the survey aircraft was unable to locate the diving animals again once notified. MMOs also made one brief sighting of an unidentified small whale, however it was not relocated or identified to species.

SCC February 09- As part of this data collection effort, two Navy marine species biologists embarked aboard the *USS Russell (Russell)*. The primary goals of the SCC monitoring effort were to: coordinate transit to the PMRF to allow *Russell* and survey aircraft opportunity to test communications and familiarize ship to transect, collect data on marine mammals observed during operations, achieve close coordination between the contracted aerial survey team, Navy aircraft on the range, range control, and the MMO team aboard *Russell* to facilitate maximizing survey time and project safety. A secondary goal

for the SCC was to familiarize the MMOs with at-sea Navy operations and to gather information to facilitate future MMO opportunities.

Nine marine mammal and sea turtle sightings were recorded by the MMOs (**Tables I-7 and I-8**). Eight of these sightings were of humpback whales, which were primarily sighted within the Kaulakahi Channel between Kauai and Niihau. The one remaining sighting was of a small unidentified sea turtle. Another Navy surface ship involved in the event reported numerous whale sightings during MFAS use, and reported these sightings to the *Russell*. However, their sighting reports were frequently transmitted to *Russell* much later than when the sighting was made, or when the monitoring aircraft was not on station, and therefore could not be verified by them. The full MMO summary is contained in **Appendix D**.

Table I-7. Marine Mammal Observer Sighting Data – Sightings 1-5.

Data Category	Sighting 1	Sighting 2	Sighting 3	Sighting 4	Sighting 5
Sightings Information					
Effort (on/off)	on	on	on	on	on
Date	02/19/09	02/19/09	02/19/09	02/19/09	02/19/09
Time	0857	0900	0930	0940	1028
Location	22° 05.0 N 159° 57.1 W	22° 05.0 N 159°57.1 W	22° 01.82N 159° 48.72 W	22° 02.30 N 159° 55.3 W	21° 57.13 N 159° 53.58 W
Detection Sensor	MMO (Farak)	MMO (Farak)	MMO (Jameson)	MMO (Jameson)	MMO (Farak)
Species/Group	Humpback whale	Humpback whale	Humpback whale	Humpback whale	Humpback whale
Group Size	1	1	3	3	1
# Calves	0	0			0
Bearing (true)	270	210	150	115	210
Distance (yds)	1500	5000	8000	8000	700
Length of contact			30 min	15 min	
Environmental Information					
Wave height (ft)	4	4	2-3	2-3	2
Visibility	unrestricted	unrestricted	10+	10+	unrestricted
BSS	3	3			2
Swell direction (true)	225	225	290	290	225
Wind direction (true)	60	60	255	255	0
Wind speed (kts)	15	15	5.9	5.9	10
% glare	0	0	5	5	10
% cloud cover	10	10	5	5	10
Operational Information					
Active sonar in use?	no	no	no	no	no
Direction of ship travel	180	180	140	90	180
Animal motion	parallel	unknown	unknown	unknown	unknown
Behavior	breach	blow	blow	blow	blow, roll, fluke
Mitigation implemented	N/A	N/A	N/A	N/A	N/A
Comments	2				

Table I-8. Marine Mammal Observer Sighting Data – Sightings 6-9.

Data Category	Sighting 6	Sighting 7	Sighting 8	Sighting 9
Sightings Information				
Effort (on/off)	on	on	on	off
Date	02/19/09	02/19/09	02/19/09	02/19/09
Time	1030	1040	1056	1425
Location	21° 57.13 N 159° 53.58W	21° 56.8 N 159° 45.3 W	21° 56.27 N 159° 52.02 W	20° 59.59 N 158° 10.57W
Detection Sensor	MMO (Farak)	MMO (Jameson)	Navy Lookout	Navy Commanding Officer
Species/Group	Humpback whale	Humpback whale	Humpback whale	Unidentified Turtle [1]
Group Size	2	3	4	1
# Calves	0		unknown	0
Bearing (true)	310	90	275	135
Distance (yds)	3000	2025	5280	10
Length of contact		10 min	5 min	3 min
Environmental Information				
Wave height (ft)	2	2-3	2	2
Visibility	unrestricted	10+	unrestricted	unrestricted
BSS	2		2	2
Swell direction (true)	225	290		105
Wind direction (true)	0	255	200	165
Wind speed (kts)	10	5.9	15	5
% glare	10	5	0	0
% cloud cover	10	5	10	20
Operational Information				
Active sonar in use?	no	no	no	no
Direction of ship travel	180	160	180	45
Animal motion	unknown	parallel	unknown	parallel
Behavior	blow, flipper slap	blow	blows	surface swimming
Mitigation implemented	N/A	N/A	N/A	N/A
Comments	2		3	4

1. MMO not at bridge wing rail during towing exercise. Commanding Officer spotted turtle next to ship and notified MMO.

MSDU Underwater Detonations June 09

Marine Diving and Salvage Unit One (MDSU) performed three underwater detonation events each on 18 and 19 June 2009 for a total of six events in the Puuloa training area. Navy marine species biologists embarked on Navy surface vessels along with MDSU crew. Marine species visual observations and implementation of Navy mitigation measures were observed during six underwater detonations of 20 lb net explosive weight on June 18-19. For safety, two boats are required when setting the underwater detonation. The first boat (Whaler) had the 20 lbs charges and the second boat (Ridged Hull Inflatable Boat [RHIB]) carries the blast caps. There were four Navy divers on the RHIB that set the buoy for the training location. The 30 minute monitoring period commenced immediately. The RHIB then headed toward the perimeter of the 700 yard exclusion zone while the boat with the explosives moved in to set the charge. The RHIB continued in a circle around the exclusion zone. There were two crew members standing on the port and starboard gunwale of the boat, keeping an eye out for marine mammals and sea turtles. The boat with the explosives saw a sea turtle eight minutes into the monitoring period near the training site as they left. The monitoring period was reset to 30 minutes.

After the monitoring period, the RHIB moved in towards the buoy. Two divers with just snorkel gear went in with the blasting cap to attach to the "dog bone" connection point at the surface. The blast cap was wrapped in bubble wrap for flotation and to attempt to keep it dry. Once everything is connected the fuses are pulled and the divers swim immediately to the boat. The fuse has a five minute timer before detonation. Once divers are recovered, the boat moved to a safe distance, roughly 200 yards and waited for the blast. They noticed an inbound private boat heading toward the underwater detonation site and immediately cleared them from the area. After detonation the RHIB moved in immediately to recover expended materials from the blast cap. After that the RHIB team continued to survey the area as the boat with the explosives boat moves back in towards the site to set another charge.

During the second underwater detonation, the whaler team spotted another sea turtle within the exclusion zone and the clock started again from when the turtle was last seen. Approximately 30 minutes after second event, the whaler team spotted a group of about 10-20 spinner dolphins heading towards the site. The UNDET was halted until the dolphins cleared the range. The NMFS monitoring vessel was vectored to the animals and kept up with them, conducting a focal follow as the dolphins moved out of the range. The RHIB team also kept the dolphins in sight and monitored their position. After they were confident that they were outside the exclusion zone the started the clock again and the RHIB team continued to monitor the area as the whaler moved in to set the last charge. The next charge was delayed about an hour and forty-five minutes which included the 30 minute monitoring period. By this time the seas were 5-6, and swells were 5-6 feet. The underwater detonation training concluded at around 1500 hours.

Only a few dead fish were noticed at the surface and at the bottom. The training location was a sandy site away from any reefs. At the end of the day the divers mentioned that there was a 1-2 foot deep crater on the sea floor. On the second day, it was noticed that crater was mostly filled in.

On the second day, the training was delayed by an hour due to a submarine entering the harbor and did not head out till 1030 hrs. The seas were in general rougher (Beaufort 6 with approximately a 6' swell) than the day before. Visibility was very poor from any vessel in the training area. When the team got on station they had to clear the range of private vessels. After the first charge was set, the whaler noticed a private vessel that was spear fishing had moved to within 300 yards of the detonation site. Since they were in a restricted area and a Notice to Mariners (NOTMAR) had been issued, the RHIB asked them to

recall their diver and clear the range. Monitoring continued for the rest of the 30 minute period. Aerial surveys were conducted via helicopter on this day starting at 0800 hrs. The MMOs were able to coordinate with the aerial survey via text messaging and gave them a five minute warning before detonation. The aerial survey team was able to observe the first underwater detonation, before having to land to refuel. Refueling took longer than anticipated and they unfortunately missed the next two detonations and were back on station one minute after the last detonation. For all three underwater detonations, neither the whaler, RHIB, nor the NMFS vessel saw any marine mammals or sea turtles during the monitoring period. Training concluded at 1330 hours. The aerial survey saw only sea turtles out on the site and continued to monitor the site till 1600 hours.

The MDSU teams fully implemented all the protective measures that are required, notably observing all sea turtles and marine mammals prior to the MMOs and contracted marine mammal survey teams. In total, there were six marine species sightings, four sea turtles, one spinner dolphin group and one bottlenose dolphin group by the MSDU UNDET teams. The full report is provided in **Appendix E**.

MSDU dive boat

Spinner dolphin breaching
(during period without detonations)

RANGE COMPLEX SHIP/BOAT VISUAL SURVEYS

- NMFS Main Hawaiian Islands line transect survey, February 2009
- Mobile Dive and Salvage Unit One underwater detonations, June 2009

NMFS, Pacific Islands Fisheries Science Center (PIFSC) cetacean research program conducted two vessel surveys in conjunction with Navy training events. The first was a line-transect survey that was performed on a large National Oceanic and Atmospheric Administration (NOAA) Research Vessel (R/V) during the February 2009 SCC. Navy provided funding for post-survey/training event visual and acoustic analysis which will be reported in the FY10 monitoring report. The second survey, a line-transect and behavioral monitoring survey, was conducted from a small NOAA R/V in conjunction with six underwater detonations at the Puuloa Training Range off Oahu.

Main Hawaiian Islands Line Transect Survey, February 2009

PIFSC conducted a visual and acoustic line-transect assessment survey of cetacean populations within the inner waters of the Main Hawaiian Islands. Their goal was to collect distributional and occurrence data needed to update 2002 abundance estimates. Eighteen days of on-effort survey were completed during the cruise, resulting in 117 sightings of 12 cetacean species, in addition to a number of unidentified cetaceans (**Figure I-5**). Over 1,250 nm of trackline were visually and acoustically surveyed. Sighting data are currently being analyzed to yield new abundance estimates for all observed species. In addition, photo-ID and biopsy samples were collected on several occasions. Limited survey effort was completed within the Navy's PMRF range and north of Kauai.

A towed array was deployed each day to augment visual survey effort. A number of cetacean schools were detected both visually and with the towed array, including pilot whales, false killer whales, spotted dolphins, and bottlenose dolphins. A total of 42 sighted cetacean groups were acoustically detected with the hydrophone array. In addition, another 20 cetacean groups were detected only with the acoustic array; however, in most cases we were unable to locate these groups visually so many are considered unidentified dolphins. There was also nearly continuous acoustic detection of humpback and minke whales during the later part of the cruise while using the 4-element array. A total of 48 sonobuoys were deployed during the survey, of which 32 provided high-quality acoustic data. Nearly all sonobuoy deployments include humpback and minke whale calls, while a smaller portion contain fin whales or sounds from unidentified whales. A sonobuoy was deployed on a sighting of a Bryde's whale and does contain new sounds; however, further processing will be required before conclusive assignment of those sounds to Bryde's whales can be made. No anthropogenic sounds, including military soar, were detected on the acoustic array during the course of this survey.

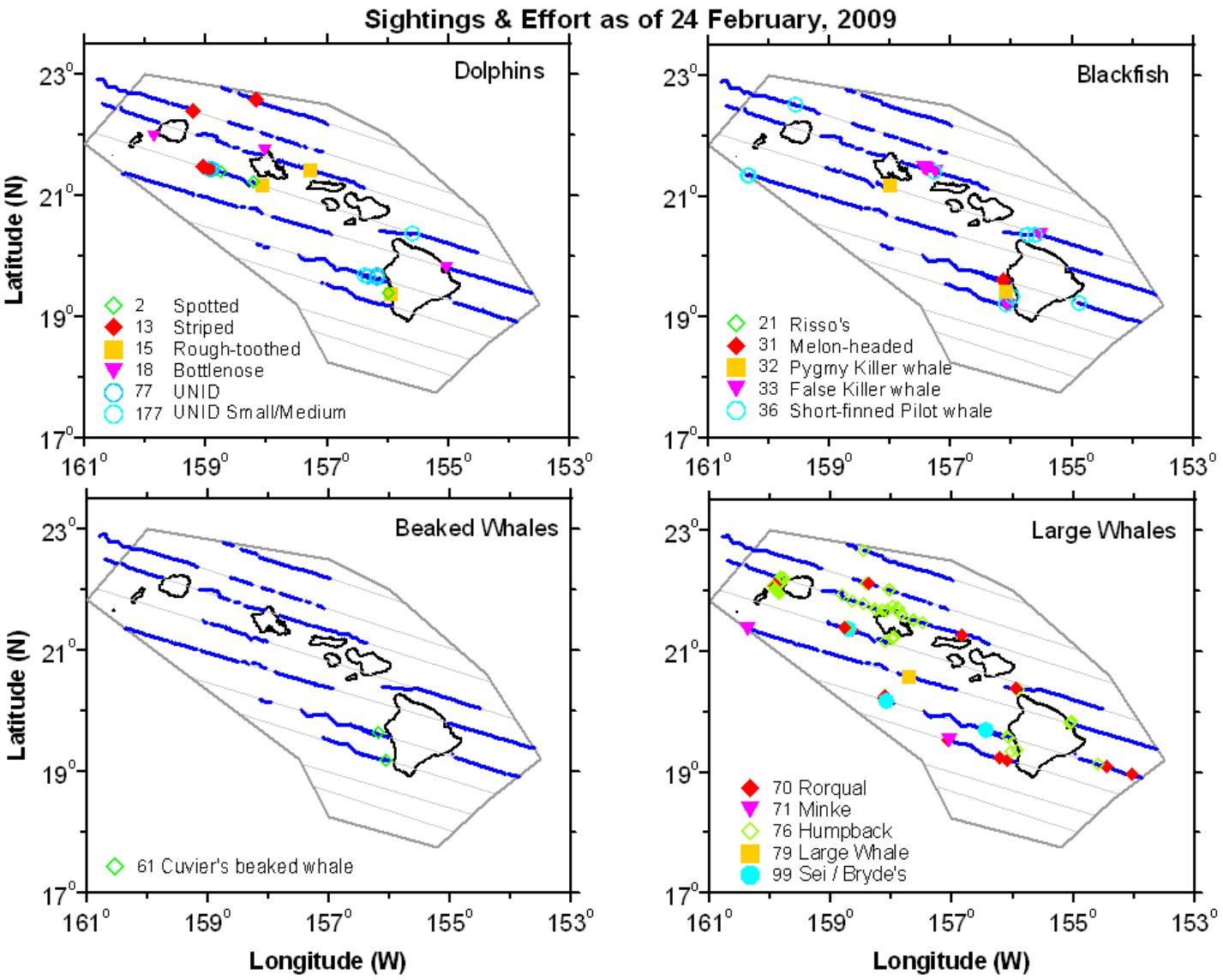


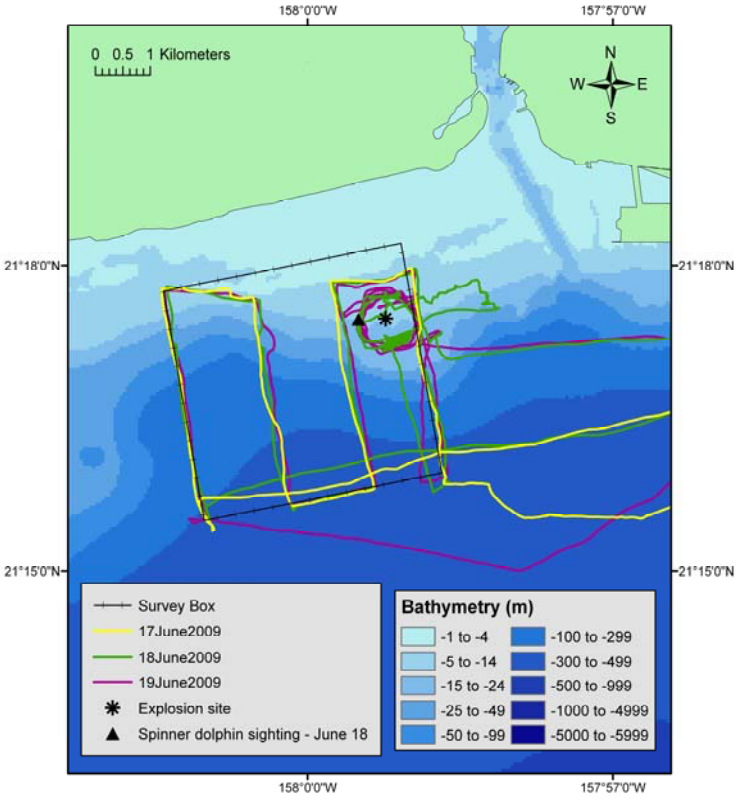
Figure I-5. Visual and acoustic survey effort (blue lines) and cetacean visual sightings during the cruise.

Due to limited pre-survey coordination, dedication of survey effort in close conjunction with SCC was not accomplished. However at least 20 on- and off-sightings were logged in the area north of Kauai alone. Detailed analysis of the visual and acoustic data and comparison with SCC operational data is underway.

Full survey report (Oleson and Hill 2009) provided in **Appendix F**.

Underwater Detonation monitoring at Puuloa Training Range

PIFSC conducted visual occurrence and behavioral observations of marine mammals in association with six explosive events (4 days of monitoring) at Puuloa Training Range. Three explosive events were carried out on each of two days, June 18 and 19. The region surrounding the events was surveyed for marine mammals on the day prior to the events (June 17) in order to assess whether large-scale movement could be observed pre- and post-event, which could possibly be associated with the explosive detonations.



A survey of four gridded-transect lines covering a 2.5 nm x 2.5 nm area was surveyed using a 23 foot fiberglass boat June 17-19. Four experienced observers kept watch for marine mammals, two from an observation tower approximately 6' above the water when conditions permitted, and two from inside the boat. Photographs and biopsy samples were collected of sighted schools when possible in addition to cetacean occurrence and general behavioral information.

Surveys were conducted one day prior to explosives training (June 17), and prior to 3 explosive events on June 18 and June 19. Post-exposure surveys were planned for June 20; however, this survey was cancelled on the morning of the 20th due to very high winds and small craft advisory conditions. The survey track lines were modified slightly once one site due to exposure to breaking waves on the inshore legs of 3 of the transect lines. In addition to pre-exposure surveys June 17-19, we monitored the region around the explosives site during and between explosive events for the occurrence of cetaceans. The Navy explosives team observed a group of spinner dolphins prior to the last explosion on June 18. We proceeded to monitor this group, collecting behavioral observations as they transited through the explosives area, until they had moved beyond 2 mi from the explosion site. No abnormal behavior was observed from this traveling group. Photo-identification pictures were obtained from several animals in the group. There were no other cetacean sightings during the three days of monitoring effort. Acoustic recordings were made of each explosion, though these have not yet been analyzed to determine sound pressure levels at various distances from the explosive site.

The full survey report (Oleson and Hill 2009) is provided in **Appendix F**.

RANGE COMPLEX SHORE-BASED VISUAL SURVEYS

Shore based surveys were not conducted in FY09 as near-shore explosive events adjacent to the high-ground required for monitoring did not occur

RANGE COMPLEX TAGGING

A collaborative effort for FY10 is planned between U.S. Pacific Fleet and PIFSC biologist for tagging monk seals in the Main Hawaiian Islands. A novel telemetry tag that incorporates global position system (GPS), modem (cellular phone) and standard behavior recording technologies will be used. The tags were developed by Sea Mammal Research Unit in order to increase the quality and amount of data researchers obtain in marine mammal telemetry studies. The tags produce high-quality GPS fixes, collects and stores detailed individual dive behavior and haul-out information as well as temperature up-cast profiles. Goal will be to deploy fifteen tags on monk seals in FY10, with each deployment lasting up to three months. Eight were purchased by PIFSC in FY09, the remainder will be purchased in FY10 when Navy funds are provided.

Seals will be tagged on Kauai, Oahu and possibly Molokai with target deployment to cover before, during and after SCC (scheduled for February 2010) and RIMPAC (scheduled for July 2010). PIFSC has the in-house experts and permit to conduct the tagging work. The high resolution GPS data will provide clear details on the marine and terrestrial habitat use of each individual studied in this project. The relatively large sample size may also allow interpolation of habitat use by seals in the main Hawaiian Islands. This study will also provide the first large scale effort to link habitat use and diving so that monk seal foraging hotspots can be determined. Biological samples will also be collected from monk seals during tagging, allowing for standard disease and bio-toxin screening in the lab.

Additionally, U.S. Pacific Fleet has contracted a report on which types of cetacean tagging devices would provide the most relevant data, which will be completed in late 2009.

RANGE COMPLEX PASSIVE ACOUSTIC MONITORING (PAM)

Four High-Frequency Acoustic Recording Packages (HARPs) were purchased this year. They will be deployed in the HRC September 2009 by PIFSC and Scripps Institution of Oceanography. Data collection and analysis will be conducted, in part, by a U.S. Pacific Fleet-funded post-doctoral bio-acoustician who will be located at PIFSC. Additionally, the Navy has contracted a report on which types of devices would provide the most Navy-relevant data which will be completed in late 2009.

In addition, during 2009 U.S. Pacific Fleet continued funding a limited collection of passive acoustic data from the Navy's instrumented underwater range at Pacific Missile Range Facility near Kauai.

This data serves to archive potential marine mammal vocalizations and is being use by scientists at the Space and Naval Warfare Systems Center Pacific to support several research projects funded by ONR.

A summary of 2009 accomplishments at PMRF is provided below:

FY09 Effort and Status Update for PMRF PAM

SPAWAR Systems Center Pacific (SSC PAC)
Steve Martin, steve.w.martin@navy.mil

Summary:

This year methods have been developed (with leverage of two other related projects on which Martin participates) to automatically detect minke whales at the PMRF range using passive acoustics. Work on localization and density estimation for minke whales is still in development. In FY08 methods were developed to automatically detect beaked whales on the PMRF range using passive acoustics. Beaked whale clicks are often detected on hydrophones in the 1000 m to 2000 m-depth range.

Acoustic recordings at PMRF were performed at a rate of 2X per month under U.S. Pacific Fleet funding: each recording provides one the order of a day of data from 31 hydrophones. In addition, an additional 5 days of recordings are available as a result of the related ONR effort "*The ecology and acoustic behavior of wintering minke whales in the Hawaiian Islands area*" being performed in partnership with Thomas Norris (BioWaves). As was done last FY, unless otherwise directed, disks procured to copy late FY09 recordings will be used for continued recordings in FY10.

Great results have been obtained to date from leveraging with two other efforts. The ONR effort with Norris, studying minke whales (*Balaenoptera acutorostrata*) was very successful in FY09. In addition the visual sighting enabled by analysis of PMRF hydrophones in near real-time, post analysis has discovered a very stable spectral feature for an individual minke whale. A copy of Martin's ONR report provides more details on this exciting discovery. In addition, the ability to track a minke whale for nearly six hours using the PMRF hydrophones is also considered a significant accomplishment. Multipaths observed also are of interest to potential single sensor deployments in the deep-water area (discussed further in the ONR report). It is expected ONR will fund the second year of planned effort studying the minke whales at PMRF (Feb-Apr 2010 timeframe).

The related DECAF (Density Estimation of Cetaceans using Acoustic Fixed sensors) project is in process of doing minke whale boing density estimation using data recorded at PMRF in 2006. We have leveraged the DECAF developed Matlab based Minke whale boing detector and have made modifications to obtain sub-hertz resolution data to allow finer discrimination of individual minke whales, and also to provide a relative amplitude feature. Current DECAF effort is progressing for the density estimation of the minke whale boing vocalization. We still need the average boing production rate (over long time frames) in order to determine the minke whale density.

FY10 Plans: Planning on continuing a similar level of effort in FY10 to record data at PMRF 2X per month. Hard disk drive recording media are at PMRF for Oct and Nov 2009. A paper is being prepared for a peer-reviewed journal on findings related to minke whale acoustics.

Part II- HRC Navy Research and Development Accomplishments

In February 2009, U.S. Pacific Fleet hosted the first meeting of the Hawaii Pelagic Marine Mammal Research Workgroup with government, industry and academic researchers. This meeting was the first of its kind in Hawaii and provided all the opportunity to present their marine species monitoring and work towards more collaborative efforts. The majority of their projects were Navy-funded and in the area of passive acoustic monitoring and development of marine mammal detectors.

The following Navy funded projects were conducted in the HRC during 2009.

1. The ecology and acoustic behavior of wintering minke whales in the Hawaiian and Pacific Islands. Being performed by BioWaves, Space and Naval Warfare Systems Center Pacific (SSC Pac), University of St Andrews, and the University of Hawaii. (ONR funded)

Fieldwork was conducted at the Pacific Missile Range Facility in both March (17-28) and April (24-28), 2009. The effort is concentrated on 'boing' sounds which were recently associated with minke whales by Rankin and Barlow in 2005. Boing sounds have been seasonally detected in Hawaiian waters for decades (Thompson and Friedl 1982); speculation was the sounds were from a whale (unknown species).

The U.S. Navy's Space and Naval Warfare Systems Center Pacific was responsible for recording, and conducting analysis of PMRF acoustic data from 24 broadband hydrophones with response in the 1.0 to 2.0 kHz area (minimum) to detect the minke whale vocalizations, commonly called "boings". The primary hydrophones utilized in the study are termed the BSURE range (Barking Sands Underwater Range) and are located northwest of Kauai. The larger part of this overall effort centered around a surface vessel, *R/V Dariabar*, conducting visual search of minke whales, and towing hydrophones to perform detection, classification and localization of minke whales on, and near, the BSURE area (BioWaves – Norris effort). The R/V effort was conducted simultaneously with the monitoring/tracking effort being conducted on the range.

Following is a preliminary assessment from this ONR funded effort:

The Ecology and Acoustic Behavior of Minke Whales in the Hawaiian and Pacific Islands

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website: http://www.bio-waves.net

LONG-TERM GOALS

The long-term goals of this research project are to improve our understanding of the acoustic ecology and behavior of minke whales in the Hawaiian and Pacific Islands. Our specific goals are to develop and use passive acoustic methods that will allow us to survey, track movements, and monitor acoustic (and eventually non-acoustic behaviors) of minke whales. This will provide important information about the behavioral activities of minke whales at winter areas where they congregate in their breeding season. An additional goal is the assessment of localization accuracy for animals located from seafloor hydrophone arrays. This information is needed to estimate densities of calling animals from fixed hydrophones (e.g. the related DECAF research project). Ultimately, the information and methods resulting from this project will allow for more effective conservation and management of this and other species that are vocally active but visually elusive.

OBJECTIVES

Our objectives are to use passive acoustic methods to detect and locate minke whales in the Hawaiian Islands area from a unique sound they produce called the 'boing'. Once animals are located, we collect detailed information on their acoustic and (when visible) non-acoustic behaviors. We will also conduct acoustic line-transect surveys to estimate the abundance of calling animals in the study area. Animals will be located using passive acoustic methods from a quiet research vessel. These data will be used to validate and assess the localization accuracy of fixed seafloor hydrophone arrays located within the same study area. Acoustic data from the these seafloor hydrophone arrays are being collected concurrently with our vessel-based surveys and will be used in a related effort to estimate densities of calling animals from fixed hydrophones.

APPROACH

The study site is a large (> 2000 km2) area of deep ocean waters located to west and northwest of the island of Kauai (Figure 1). This area is outfitted with several widespread sea-floor hydrophone arrays that are part of the Pacific Missile Range Facility (PMRF). Approximately 17 hydrophones from these arrays were used to collect acoustic data from calling minke whales by one of our collaborators, (Stephen Martin, SPAWAR). These data were processed in near real-time to localize calls of minke whales. Coincident with this effort, we deployed and monitored a towed hydrophone array system from an acoustically quiet motor-sailing research vessel (R/V Dariabar). Locations of calling animals based on 'boings' localized on the PMRF array were relayed by satellite phone and VHF radio to the R/V Dariabar so that the same animal could be located by our team. Marine mammal observers maintained watches when conditions were suitable and towed hydrophone arrays were used to obtain real-time localizations of calling animals using target-motion analysis. These data were used to independently validate locations of calling animals. Data from both the seafloor hydrophone array and the towed hydrophone array were post-processed to obtain better location estimates and assess sources of uncertainty in the detection and localization processing systems.

WORK COMPLETED

The field season began on 15 March and ended 28 April 2009. The first week of the field effort (leg I) occurred during moderately poor sea conditions (Beaufort 3-4, 2-3m swell) that eventually deteriorated

to unworkable conditions (Beaufort 4-7, 3-5m swell) by the end of the second week. A decision was made to halt the field effort until conditions improved. Although acoustic and visual data were collected during this period, visual monitoring was greatly compromised. The second half of the field effort commenced on 19April when weather and sea conditions had greatly improved (Beaufort 1-3, swell < 2m) providing a much better opportunity to collect data.

A total of 21 days consisting of approximately 200 hours was spent at sea (including overnight voyages) for the entire field season (Figure 1). Eleven days of effort of effort were completed for leg I, and 10 days of effort for Leg II Effort was primarily conducted during daylight hours and consisted of both visual and acoustic monitoring. In total, approximately ~ 850 km of survey effort was completed inside the study site. A total of 131.5 hours of multi-channel acoustic data from the towed hydrophone arrays was saved to hard drives.

RESULTS

During surveys from the R/V Dariabar at least 777 boings were manually detected from which numerous localizations were made by the bio-acousticians on watch. Automatic detection of boings is underway and is expected to yield additional detections of boings. We are developing semi-automated methods to analyze the archived towed array acoustic data for localizations. From these analyses, encounter rates and perpendicular distances to animals will be estimated. These data will be used to design the 2010 survey to estimate densities of calling animals.

Case Study: On the morning of the 27 April 2009 (the second to last day of field effort) a solitary animal was localized and tracked at the north end of the study site initially using the PMRF seafloor hydrophone array. This animal was located over 30 km from the R/V Dariabar's position at the southern end of the study area. The research vessel motor-sailed to this area and just before noon began acoustically tracking the animal with the towed hydrophone array. The first towed hydrophone array detection of the animal was estimated to at a distance of approximately 10 km. Within approximately two hours of the animal was sighted by a marine mammal observer very close (100-500m) to the seafloor array localizations. A small boat was launched to collect photo-ID data and record behavioral observations from the minke whale. The animal was photographed and observed for over an hour and was consistently associated with a large flock of seabirds that were following and feeding on schools of small (unidentifiable) baitfish. Although we did not directly observe feeding by the minke whale, its behavior was consistent with behaviors associated with feeding (e.g. pursuit of fish school, rapid movements, associating with feeding seabirds).

Data from this case study are currently being re-analyzed in detail, focusing most of the effort on the time-period of the sighting. This will allow an assessment of accuracy for the seafloor hydrophone array. Preliminary results indicate that the seafloor array localizations and the visual sighting location are in close agreement (Figure 1). In addition, towed hydrophone array localization methods are being assessed to identify sources of uncertainty and differences in location estimates due to different localizations algorithms used (Figure 2).

IMPACT / APPLCIATIONS

The towed arrays localizations and visual sighting from the R/V Dariabar were significant because they preliminarily confirmed that the accuracy of the seafloor array localization techniques is relatively good. Assessment of localization accuracy is important for validating the assumptions of methods being used in the related DECAF effort to estimate densities of calling animals from fixed hydrophones (Thomas et al. 2008). We will continue to collect data on this aspect of the project as well as work on improving the accuracy and efficiency of localization techniques. This should result in improvements of passive

acoustic methods from both fixed and towed hydrophones for estimating animal density and abundance.

New and important information about the acoustic and non-acoustic behaviors of minke whales in their winter/spring (presumably breeding) areas was collected from our first field season. The 2009 season resulted in one of only three documented sightings of minke whales near the main Hawaiian Islands made by a research team in (the second was also by our research team 2006), and the only observations of a minke whales feeding in Hawaiian waters. Feeding behavior for minke whales has never been observed in the Hawaiian Islands, and only very infrequently observed for other commonly seen baleen species such as humpback whales. Acoustic behaviors of minke whales are poorly understood, especially for populations in the North Pacific. We have already determined that there are certain characteristics of the boings that are significantly different for animals from western and central (i.e. Hawaiian) North Pacific, an indication that several populations exist. We will continue to examine the acoustic characteristics of boings for additional insights.

RELATED PROJECTS

A related NOPP funded effort by Len Thomas and collaborators, Density Estimation for Cetaceans from passive Acoustic Fixed sensors (DECAF), is being conducted using some of the data collected from our effort and data from our collaborators. Our data will be used to assess and validate localization accuracy. Localization accuracy is important to assess for the assumptions and methods being developed for the DECAF effort.

Other related projects include efforts to record data from PMRF seafloor arrays to localize and track minke whales using boings. These two projects are being conducted by Stephen Martin (SPAWAR-San Diego, CA) and Eva Nosal (University of Hawaii-SOEST), respectively. Mr. Martin is collecting acoustic data from the PMRF hydrophone array concurrently with our field effort. These data were processed in near real-time and are being post-processed by Mr. Martin. Dr. Nosal post-processed the same data from the PMRF seafloor array to estimate localizations using a propagation model-based time-of-arrival (TOA) approach. Results from these efforts will be compared and validated with sighting data and towed array localizations collected from the R/V Dariabar using methods described in this report.

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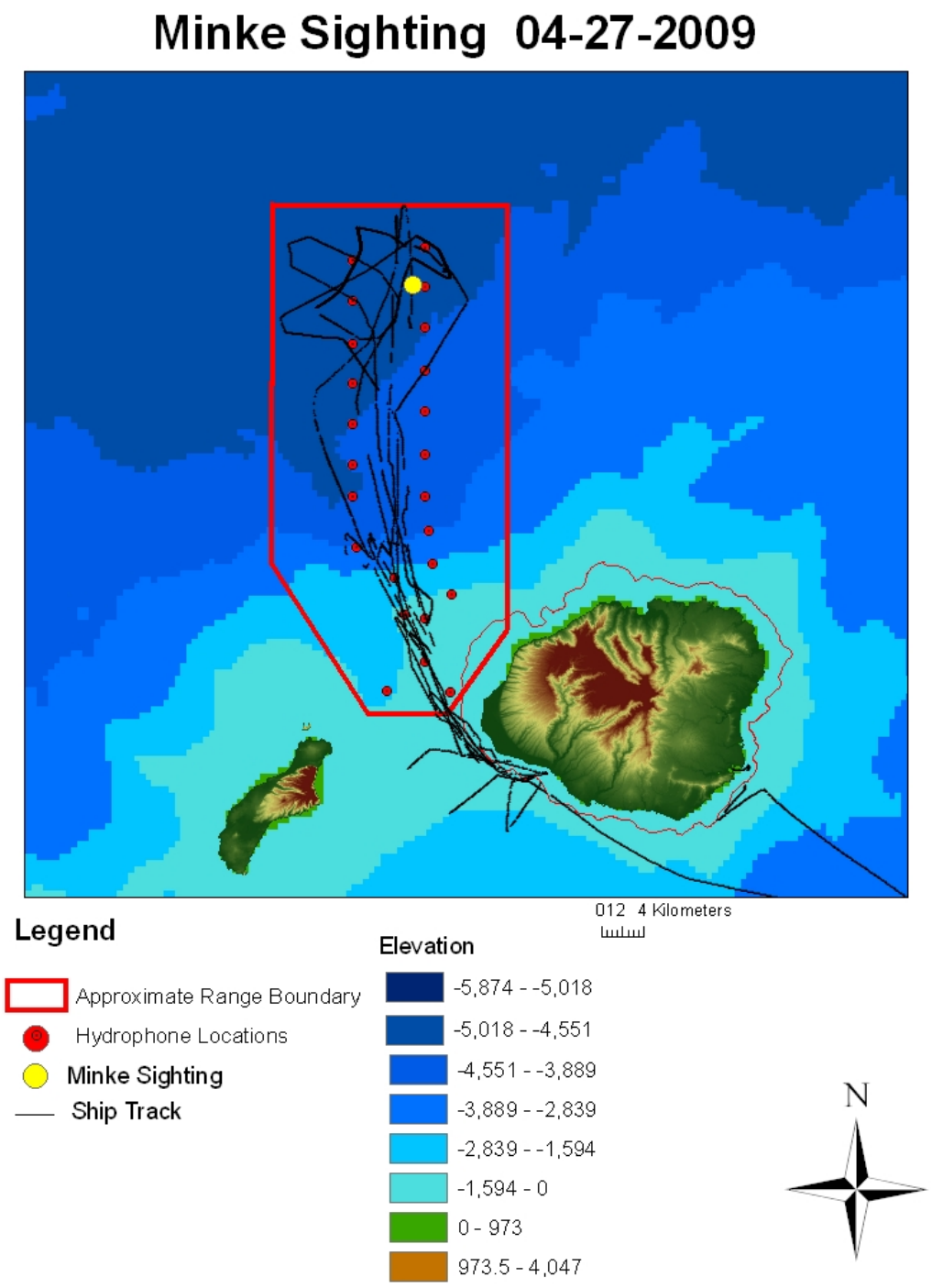


Figure 1. Kauai study area (red polygon, > 2000 km2) with completed ship tracks by the R/V Dariabar for the 21 days of effort resulting in 800 km surveyed for the 1.5 month field effort. Approximate locations of PMRF seafloor hydrophones used in this study designated by red circles. The visual sighting of a minke whale which occurred after locating it acoustically is designated by yellow circle..

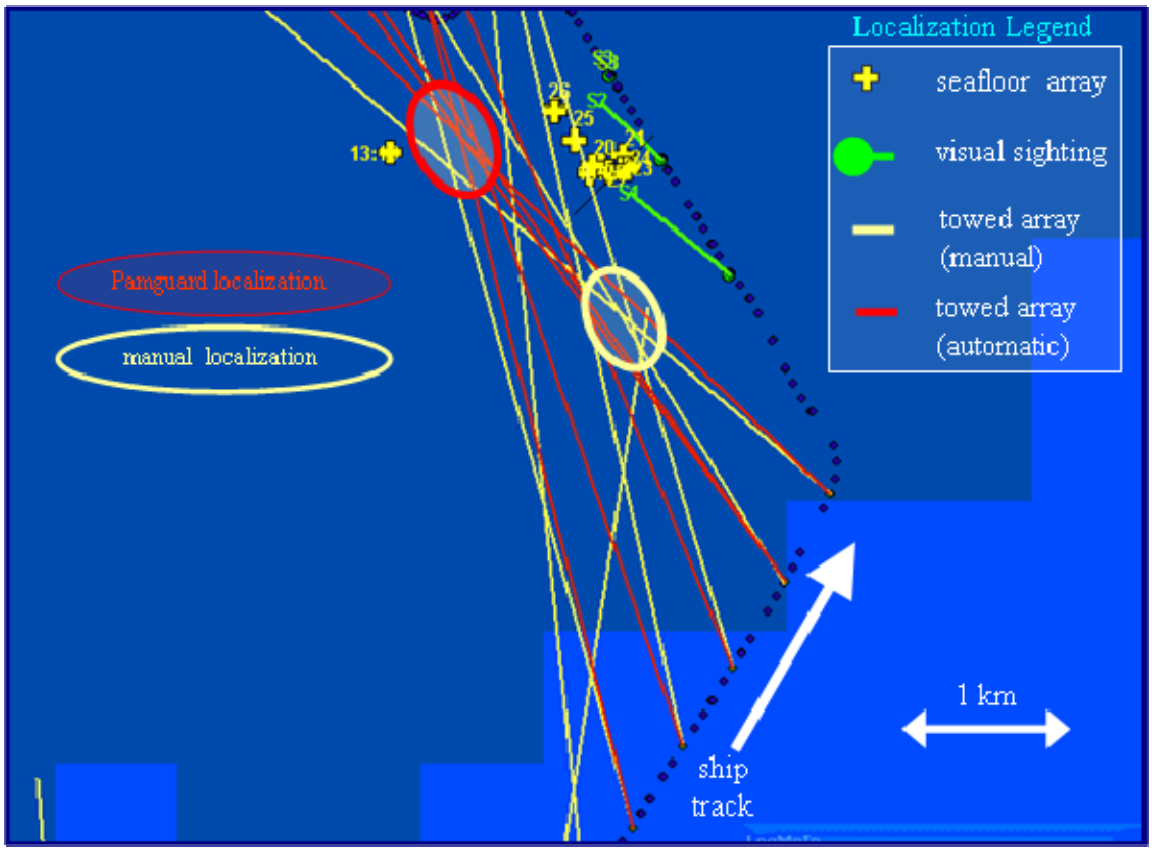
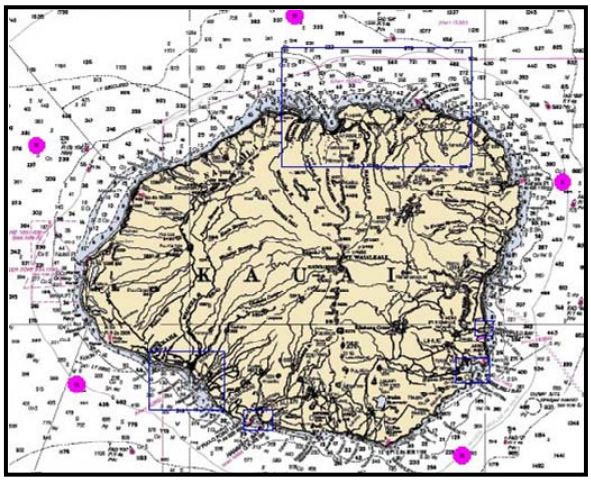
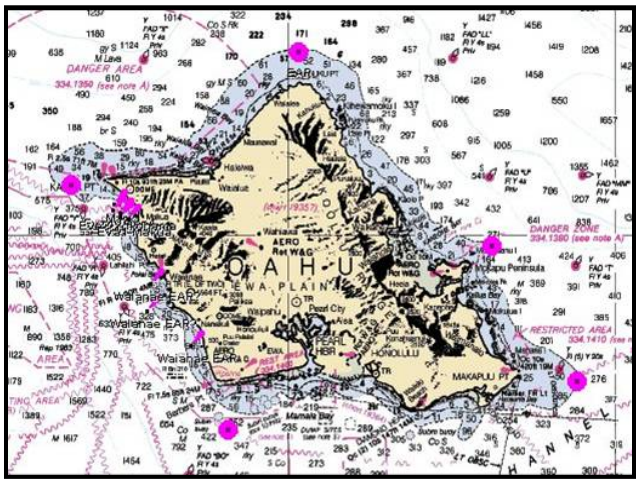


Figure 2. Map of the 27 April visual sightings (green lines) of a minke whale made after the research vessel was vectored towards the region of acoustic localizations made from the seafloor array (yellow crosses). This demonstrates the good agreement of seafloor array localization with the sighted position of the animal. Bearings lines from the towed hydrophone array were processed in real time (sand colored) and semi-automatically post-processed using Pamguard (red). The discrepancy in towed array localization methods is most likely due to uncertainty in the estimated position and heading of the towed hydrophone array.

2. Remote Passive acoustic marine mammal monitoring. Being conducted by Hawaii Institute of Marine Biology (HIMB) (Au/Lammers). ONR funded.

Goals are to use HIMB developed Ecological Acoustic Recorders (EARs) off Kauai and Oahu in order to determine occurrence of different species at mooring locations, determine spatial, temporal and seasonal distribution of different cetaceans species and determine source level of odontocete whistles and baleen whale calls. Ten EARs were deployed in February 2009 around Kauai (2,625 ft depth) and Oahu (<1,312 ft depth) (see charts below). The EARs were retrieved in May, data disk removed, battery changed and redeployed in the same locations. Data collection and analysis efforts are ongoing.





3. High Frequency Recording Package (HARP) Deployment of Hawaii Island. Being performed by Pacific Islands Fisheries Science Center (Erin Oleson), Scripps Institution of Oceanography (John Hildebrand), Cascadia Research Collective (Robin Baird). CNO N45 funded.

The collaborative team deployed a HARP off the Kona (west) coast of Hawaii Island in early 2008. Data collection and analysis of the acoustic data are ongoing.

4. Research on hearing and echolocation of marine mammals . Being performed by Hawaii Institute of Marine Biology (Nachtigall, Mooney). ONR funded

Ongoing research in the following areas: a) Maintain and study marine mammals in the laboratory - controlled studies extrapolated to the field; b) Increase knowledge of marine mammal hearing since there are audiograms for only exist for 14 of 85 cetacean species; c) complete dolphin temporary threshold shift experiment to 53C sonar; d) test assumption that all odontocete hearing is the same since frequently regulations extrapolate from the bottlenose dolphins to all odontocetes; and e) measure whether whale controls what it hears.

5. Passive Acoustic data collection from fixed range hydrophones at Pacific Missile Range Facility. Being performed by Space and Naval Warfare Systems Center (SSC) Pacific (Martin). U.S. Pacific Fleet funded

Since 2006, U.S. Pacific Fleet has funded SSC Pac to conduct passive acoustic recordings two days per month from fixed hydrophone range at PMRF. From 2002-06, SPAWAR received ONR funding to focus on peak whale migration (Feb-Apr). Post analysis was conducted by SSC Pac in 2006-08, providing ten-

minute snapshots of acoustic detections, showing humpback whales, minke whales, sperm whales and other odontocetes. **Table I-9** shows PMRF-available recorded acoustic data by year showing number of separate days sampled, along with number of hours of data available by quarter. ONR funded minke whale research in 2009 increased days and hours of recordings during field tests (see #1 above).

Table I-9. Acoustic data recorded at PMRF.

Calendar year	# days sampled	# hrs* Jan-Mar	# hrs* Apr-Jun	# hrs* Jul-Aug	# hrs* Sep - Dec
2009 (to Jul)	18+TBD	225	180	TBD	TBD
2008	22	90	135	135	135
2007	20	45	135	135	135
2006	22	116	130	122	-
2005	8	93	14	-	-
2004	8	53	7	3	-
2003	6	47	-	-	-
2002	12	45	-	15	8
Total (to Jul 2009)	116	714	601	410	278

Key: * hours of day, which does not include that multiple hydrophones, up to 31, are recorded

6. Tracking with widely spaced bottom mounted hydrophones. Being conducted by University of Hawaii, School of Ocean and Earth Science Technology. ONR funded.

Signal processing methods being developed in order to get accurate 3D animal tracks from recorded vocalizations. Methodology uses sound speed models where needed to improve position estimates, which is particularly important for long range tracking. Effort is using Navy-provided data from PMRF.

7. Develop a low-cost sensor system that can be easily deployed and signal interpreted for estimating the range, direction, size and type of marine species in a volume of ocean. Being conducted by Guide Star Engineering. ONR funded.

The teams goal is to provide the Navy with a sonobuoy based automated sensor alert and communications system. The trigger and alert sonobuoy system (TASS) addresses unmanned detection/classification/localization surveillance. The communications system addresses long range intelligence surveillance reconnaissance secure communications and data link challenges

8. DECAF effort – Density Estimation of Cetaceans using Acoustic Fixed sensors. Lead PI is University of St. Andrews CREEM (Dr. Len Thomas), w/NUWC, Woods Hole Oceanographic Institution, Oregon State University and SSC Pac participation. ONR funded. Information available online at:
http://www.creem.st-and.ac.uk/decaf/

Participants have conducted a case study for beaked whale density at AUTEC and are in the process of a minke whale density case study at PMRF. Overall goal is to provide statistical methodology for density estimation using bottom mounted fixed phones. While PMRF effort is ongoing, below is a preliminary assessment from one of the authors.

The Ecology and Acoustic Behavior of Wintering Minke Whales in the Hawaiian and Pacific Islands

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LONG-TERM GOALS

This effort is in support of a long-term goal for better knowledge of marine mammal species densities at U.S. Navy instrumented ranges. By knowing the seasonal densities of various species at a range facility (baseline), one can better understand significance of changes observed from activities such as mid frequency active sonar at that facility.

OBJECTIVES

This effort focuses on Central North Pacific minke whale (*Balaenoptera acutorostrata*), herein referred to as minke whale, vocal behavior while wintering in the Hawaiian Islands observed using bottom hydrophones. The effort is in partnership with the ONR effort with the same title (Norris et al 2009) being headed by Tom Norris of BioWaves leading the field effort and includes participation from SSC PAC (Martin-this effort), University of St Andrews (Janik and Thomas), and the University of Hawaii (Oswald and Nosal).

This specific effort scientific and technical objectives are: 1) Monitor multiple hydrophones to provide near real-time location information for minke whales to an at-sea field team aboard the *R/V Dariabar* surface vessel; and 2) Conduct analysis of Pacific Missile Range Facility (PMRF) hydrophone data for minke whale acoustics, including signal characteristics, detection, classification, association, localization and density estimation using minke whale boing vocalizations.

APPROACH

The approach is to support the fieldwork by on-site participation at PMRF and conduct subsequent laboratory analysis. The study area includes the Barking Sands Underwater Range Expansion (BSURE) portion of the PMRF facilities. Seventeen bottom-mounted hydrophones (bandwidth ~100Hz to 18KHz) at BSURE (Figure 1) are being utilized for the minke whale study. No organic capability currently exists at PMRF to utilize passive acoustics to detect, classify and localize minke whales. To perform near real-time detection and localization of minke whale boing vocalizations utilizing the hydrophone data requires experienced personnel with appropriate tools. This effort leverages the Density Estimation of Cetaceans using Acoustic Fixed sensors (DECAF) project being led by Dr. Len Thomas with several co-pi's (Dr. D. Mellinger, Dr. P.Tyack, D. Moretti and S. Martin). DECAF is applying acoustic density estimation techniques to three species of marine mammals on U.S. Navy instrumented ranges as test cases: beaked whales at the Atlantic Undersea Test and Evaluation Center (AUTEC), sperm whales at AUTEC, and minke whales at PMRF.

Post fieldwork analysis involves manual acoustic data analysis using Adobe Audition®, a custom tool for review of recorded multiplexed data, and Matlab®. Techniques being developed as part of the DECAF effort for minke whale boing density estimation are being utilized and modified to support this effort. Similarly, findings from this effort are feeding the DECAF case study effort with new information (e.g. the boing frequency feature discovered in this effort helps the DECAF effort associate boings to

individuals as discussed later). To detect minke whale boings we are utilizing the strongest component of the boing as observed on PMRF bottom hydrophones. This strongest component is termed the dominant signal component (DSC) and resides in the frequency range between 1350Hz and 1440Hz. Wenz (1964) coined the term "boing" and described the major energy of the Hawaii region boing as being between 1.3kHz and 1.4kHz. A spatially explicit capture recapture technique (SECR) is currently being applied in the DECAF effort for minke whale boing vocalization density estimation (Marques et al 2009). A piece of information still needed for minke whale density estimation is the average boing cue production rate, for which hopefully, this effort can help provide initial information. Acoustic density estimation derived using PMRF hydrophones will be compared to acoustic density estimation utilizing towed hydrophones (Norris effort) allowing comparison of the two different acoustic modality density estimations.

2009 WORK COMPLETED

The field tests in March and April 2009 were fully supported by on-site effort at PMRF. Recordings of the seventeen PMRF BSURE hydrophones were made for the days that the *R/V Dariabar* was on the PMRF range. Detailed manual analysis of selected data, corresponding to the day of a visual sighting on 27 April 2009, has been completed. Automation of analysis techniques is in progress.

RESULTS

A major accomplishment in FY09 was the development of a process for providing near real-time location cueing for minke whales present on the PMRF range to a field team aboard the *R/V Dariabar*. While similar cueing of surface craft to marine mammal locations has occurred at the two other U.S. Navy instrumented ranges (AUTEC and the Southern California Off-shore Range), an automated real time system (the Naval Undersea Warfare Center developed Monitoring Marine Mammals on Navy Ranges) and multiple expert operators are utilized (Moretti et al 2008). PMRF does not currently have a similar system installed. The method developed for localizing marine mammals at PMRF involves use of a custom multiple channel review program (previously developed by SPAWAR Systems Center Pacific) to manually detect boings, associate boings across multiple hydrophones and provide reasonably accurate times of arrival at at least four hydrophones (Martin et al 2009). These times of arrival are then utilized to determine animal location using a hyperbolic localization routine (Vincent 2001).

A significant outcome of the 2009 field work was that the location cues provided by the shore based PMRF effort was a major contributor to the subsequent visual sighting of a minke whale by the field team aboard the *R/V Dariabar* at 14:00 HST on 27 April 2009. The first VHF radio call with location information of a minke whale was at 10:30 HST while the *R/V Dariabar* was 23km away from the contact. Several additional localizations of this contact were radioed to the *Dariabar* over the ensuing 3 hours while the *R/V Dariabar* transited to the location. At 14:00 HST personnel on the *Dariabar* sighted a minke whale in the area of the last localizations provided from shore. This is a significant accomplishment given the difficulties, and rarity, of sightings of minke whales in Hawaiian waters. Figure 2 provides a Google Earth® map view of a portion of the BSURE range with a few *R/V Dariabar* locations along with a subset of minke localizations as determined by the PMRF hydrophones. Another significant accomplishment is what was believed to be an individual minke whale was acoustically tracked for 5 hours and 50 minutes. Collaboration with E. Nosal confirmed the post exercise localizations derived utilizing manually determined arrival times were is good agreement (within a few hundred meters) with model-based localizations utilizing these arrival times.

A significant technical achievement involves new information on the Central North Pacific minke whale boing characteristics as a result of post fieldwork analysis. Specifically, a stable frequency feature of one individual's boings was observed over 5 hours and 50 minutes. This frequency feature, termed the

dominant signal component frequency (DSCF), was found to have a mean value of 1384.4Hz (n=54) with a standard deviation of only 1.55Hz (determined using sub-Hertz resolution analysis for the closest hydrophone only). Even more exciting is that other animals, which were readily detected, appear to exhibit similarly stable DSCFs yet with different frequencies (detailed analysis still underway). This has significant impact on the acoustic study of individual minke whales wintering in Hawaii. The DSCF feature is being utilized by the DECAF effort, although using the lower frequency resolution provided by the DECAF minke whale boing detector. This finding raises questions such as: How universal are the stable DSC frequencies? Can the whales voluntarily control this frequency, or is it possibly anatomically controlled (with implications relative to the baleen whale sound production mechanism)?

Figure 3 illustrates the spectral complexity of a typical strong minke whale boing as recorded on hydrophone # 17 at 13:21:58 HST on 27 April 2009. Three strong groupings of the amplitude modulation sideband products (alternatively termed pulse repetition rate harmonic bands) are readily observed clustered around 1.4kHz, 4.5kHz and 8kHz while weaker components are seen, including some over 11kHz. The horizontal range of the animal from this hydrophone was calculated as 6.8km using time difference of arrival techniques. The DECAF developed minke whale boing automatic detector has successfully detected 54 boings from this (suspected) sighted individual from when the recorder was turned on that morning (07:49 HST) until when the minke went quiet at 13:44 HST. Calculation of the inter-boing-interval requires one to have good confidence the calls are from the same individual animal. For this analysis determination was made via the fact that successive calls were of similar energy levels, with similar broadband energy patterns over multiple hydrophones and manual time of arrival based localization of boings from 11:43 to 13:44 HST. The mean inter-boing-interval over the entire 5 hour 55 minute period was 366.746 seconds (n=56) with a standard deviation of 109.3 seconds. This mean interval is in agreement with the six minutes mean reported previously for Hawaiian minke whales (Thompson and Friedl 1982). However, since the amount of time the individual remained quiet has yet to be determined (it has not been reacquired after going silent in recorded data) a meaningful long-term average boing rate for performing acoustic density estimation is still unknown.

Figure 4 provides a high-resolution spectrum (128K pt FFTs, SR=96kHz, 50% overlap, bin width of 0.73Hz, over 2.73 seconds of data) for the signal shown in figure 3. The left pane shows the overall magnitude to over 12kHz. The multiple amplitude modulated sideband products are readily seen (described by Watkins as burst-pulse modulation harmonic bands). The right pane shows a zoom of the DSC component observed at 1384 Hz along with one upper and one lower sideband spaced at the pulse repetition rate of 115 Hz. The vast majority of minke whale boings DSC's observed in data from the PMRF hydrophones resides in the frequency band from 1350 Hz to 1440 Hz. This type of high-resolution spectral analysis was utilized in concert with the DECAF minke boing detector to provide a higher resolution frequency feature (0.73Hz vice the DECAF detectors 5.8 Hz resolution) along with the relative amplitude of the DSC for further investigation.

Automated analysis, using the higher resolution DSCF and relative amplitude features, has just recently been performed for 6 hours 40 minutes of data (07:49 - 14:29 HST) for all 17 hydrophones on 27 April 2009. The DECAF boing detector is capable of detecting very low signal to noise ratio boings (Morrissey et al 2009), and detects 6,075 boings on the 17 phones over this period. This count includes false positives and omits misses, and is felt unmanageable. The high-resolution DSC frequency and relative amplitude features aid in this area. First, by applying amplitude thresholding (>50dB) to reject weaker boings, lowers the total number of detections by 20% to 4,878. Raising the amplitude threshold can be done, however at the expense of detecting the signals on multiple hydrophones which is an important feature for associating boings via the spatial pattern of detections over time. A histogram of the 4,878 amplitude thresholded detection's DSCFs between 1350Hz and 1440 Hz is shown in Figure 5. Three local

maxima are clearly seen. The central maximum is at 1384Hz which corresponds to the individual tracked for almost 6 hours and believed to be the individual sighted at 14:00 HST. Two other peaks are seen, one at 1368Hz, and the strongest and widest peak at 1406 Hz (preliminary analysis indicates this strongest DSC frequency peak is the result of two, or more, individual minke whales). One can band pass filter the DSC frequencies and obtain reasonable plots of detections for the 17 phones (vertical axis) vs. time for individuals. Figure 6 shows a 15-minute sample plot of all hydrophones amplitude thresholded detections (top) vs. time while the lower plot shows the DSC frequency filtered (1381.5H-1386.5 Hz) detections. The utility of the DSC frequency filtering is clearly evident and could be utilized for automatic localization, however the current auto detector start time uncertainty is too large and more work needs completed in this area of automation. Other individuals appear to also have fairly constant, yet different, DSC frequencies during this time (e.g. 1368 Hz, 1402.5 Hz, and 1407.5 Hz center frequencies).

Multipath is occasionally observed in hydrophone data and less frequently detected by the autodetector. Figure 7 shows an Adobe Audition® spectrogram (1200Hz to 1500Hz) for twenty seconds of data from hydrophone # 14 at 13:44:20 HST on 27 April 2009. Two boings can be seen; one near the start of the spectrogram and one near the end. One sees the dominant signal components (DSC) between the two added white horizontal lines along with both upper and lower 115Hz PRR sidebands. It is readily discerned in this figure that the first boing has a higher DSC frequency than the second boing. The second boing actually has a DSC frequency of 1384 Hz and is believed to be from the sighted individual. Time differences of arrival techniques utilizing the five closest hydrophones times of arrival (manually determined), locate this individual 23.9km from this hydrophone at this time. Bottom-surface multipath is seen in both boings, the first delayed ~ 1.8 seconds from its first arrival and the second delayed ~2.3 seconds from its first arrival. A ray trace program was utilized to model this situation inputting modeled values (XBT data to 750m from 27 April 2009 with historic sound speed for deeper depths courtesy of Nosal, animal depth of 50m, bottom depth 4550 m, phone depth 4360m, horizontal distance 23.9km to this phone). The bottom depth and sensor depth utilized simulate a sloping bottom for the flat bottom assumption in the ray trace program. Figure 8 illustrates the ray trace output with five eigenrays (direct, surface, bottom, surface-bottom, and bottom-surface paths). Due to the sloping bottom, the bottom and surface-bottom paths show incorrect timing. The modeled direct path distance and arrival time are 24,303.1m @ 16.1683 sec while the bottom-surface path is at 27.409.6m @ 18.2643 sec. The modeled multipath delay for this situation is therefore 2.096 seconds, which is in general agreement with the observed ~2.3 seconds observed in spectrogram data (Figure 7) and first order calculations assuming isovelocity water. The multipath presence is quite interesting as it has implication for single sensors deployed on the seafloor which are much more prevalent in the research community vice the large arrays of hydrophones on U.S. Navy instrumented ranges.

IMPACT/APPLICATIONS

The ability to utilize U.S. Navy range hydrophones at PMRF in Hawaii to cue bio-acoustic field research to minke whale locations has been demonstrated. The discovery of the stability of a detailed spectral component of the complex boing vocalization (the DSCF) contributes new information on minke whale (boing) acoustics and will be investigated further. Presence of bottom-surface multipath is of interest to potential deployment of short to long-term acoustic recorders.

Acoustic density estimation techniques for minke whale boings are currently in development (DECAF), which will enable longer-term investigation of minke density on PMRF by utilizing recorded data from 2002 through present.

TRANSITIONS

The minke whales boing's frequency is being utilized in the DECAF minke test case acoustic density analysis. Work effort will be documented via publication in a peer-reviewed journal.

RELATED PROJECTS

Density Estimation for Cetaceans using Acoustic Fixed sensors (DECAF) is closely related to this effort. Dr. Len Thomas leads the effort at developing, and demonstrating, acoustic density estimation methodology for marine mammals using bottom mounted sensors. Martin is one of the co-investigators on the effort and overseeing the test case for minke whales using acoustic data collected from PMRF in 2006 and 2007. Web site: http://www.creem.st-and.ac.uk/decaf/

An ONR effort with the same title is being led by Thomas Norris (BioWaves). That effort is directed at the at sea field work and towed hydrophone acoustic data.

Pacific Fleet also funds Martin to obtain acoustic data collections for 31 PMRF hydrophones (which includes the BSURE phones) two days per month throughout FY09 with several days of analysis effort included.

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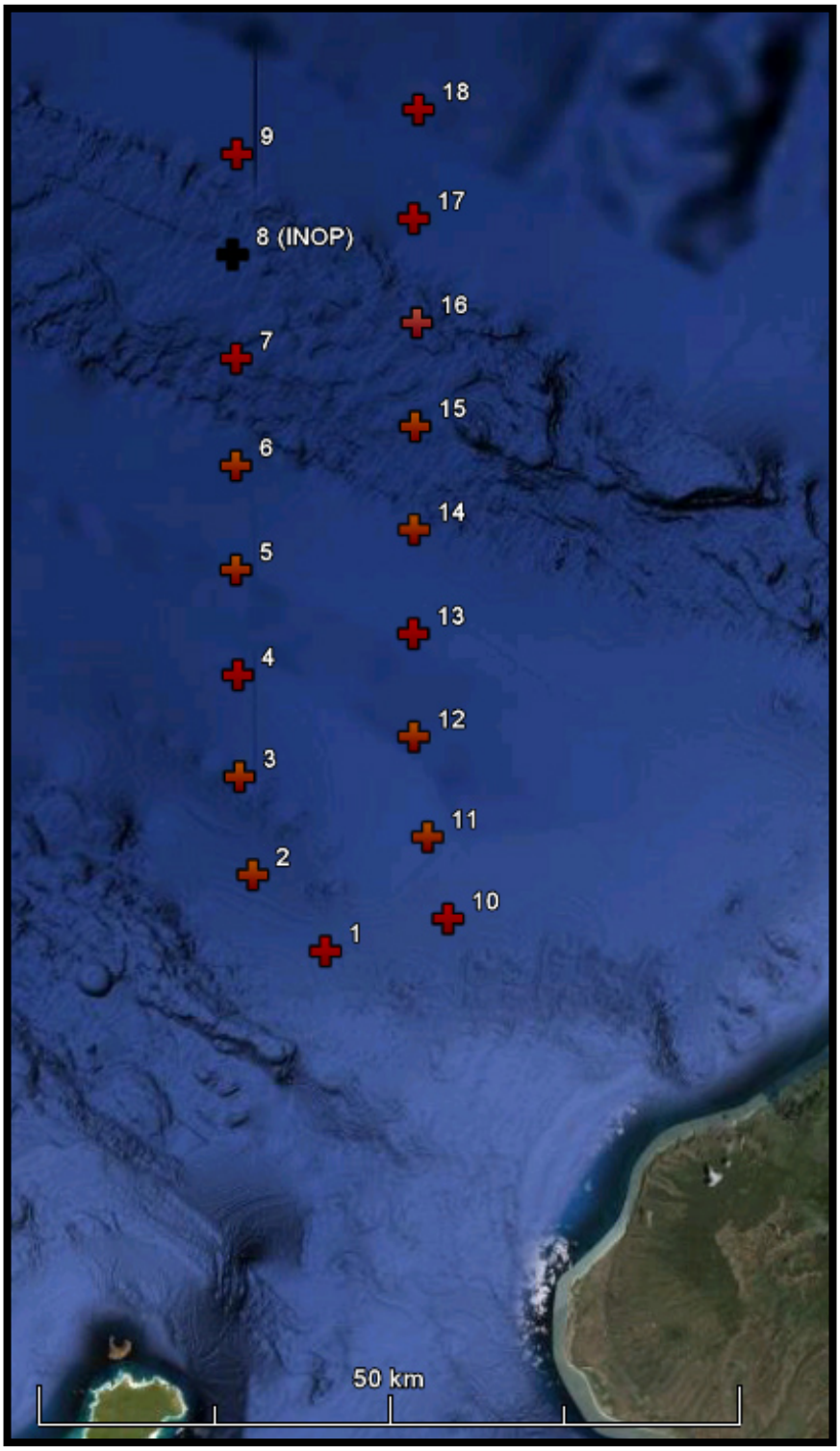


Figure 1 – Study area showing approximate locations of hydrophones at the Pacific Missile Range Facility Barking Sands Underwater Range Expansion area. Water depths range from 1800m to over 4600m. Western Kauai seen at lower right, northern Niihau at lower left.

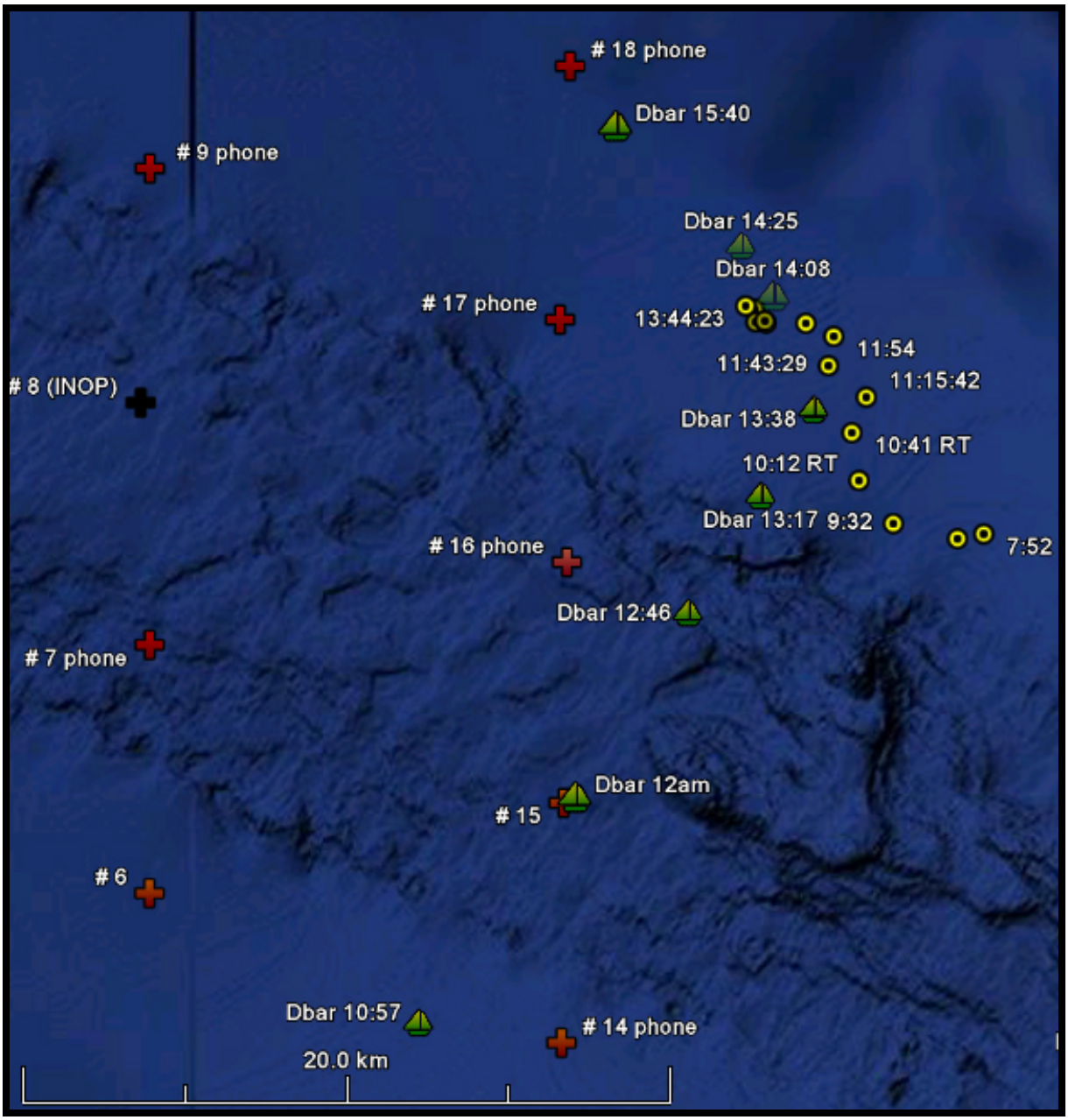


Figure 2 – Overview of 27April 2009 minke whale visual sighting at 14:00 HST by the crew of the R/V Dariabar. Red icons are PMRF hydrophones, green sailboat icons are the R/V Dariabar positions and the yellow dots indicate a subset of minke whale locations determined using PMRF hydrophones. Hawaiian standard times indicated in white next to R/V Dariabar and minke whale locations.

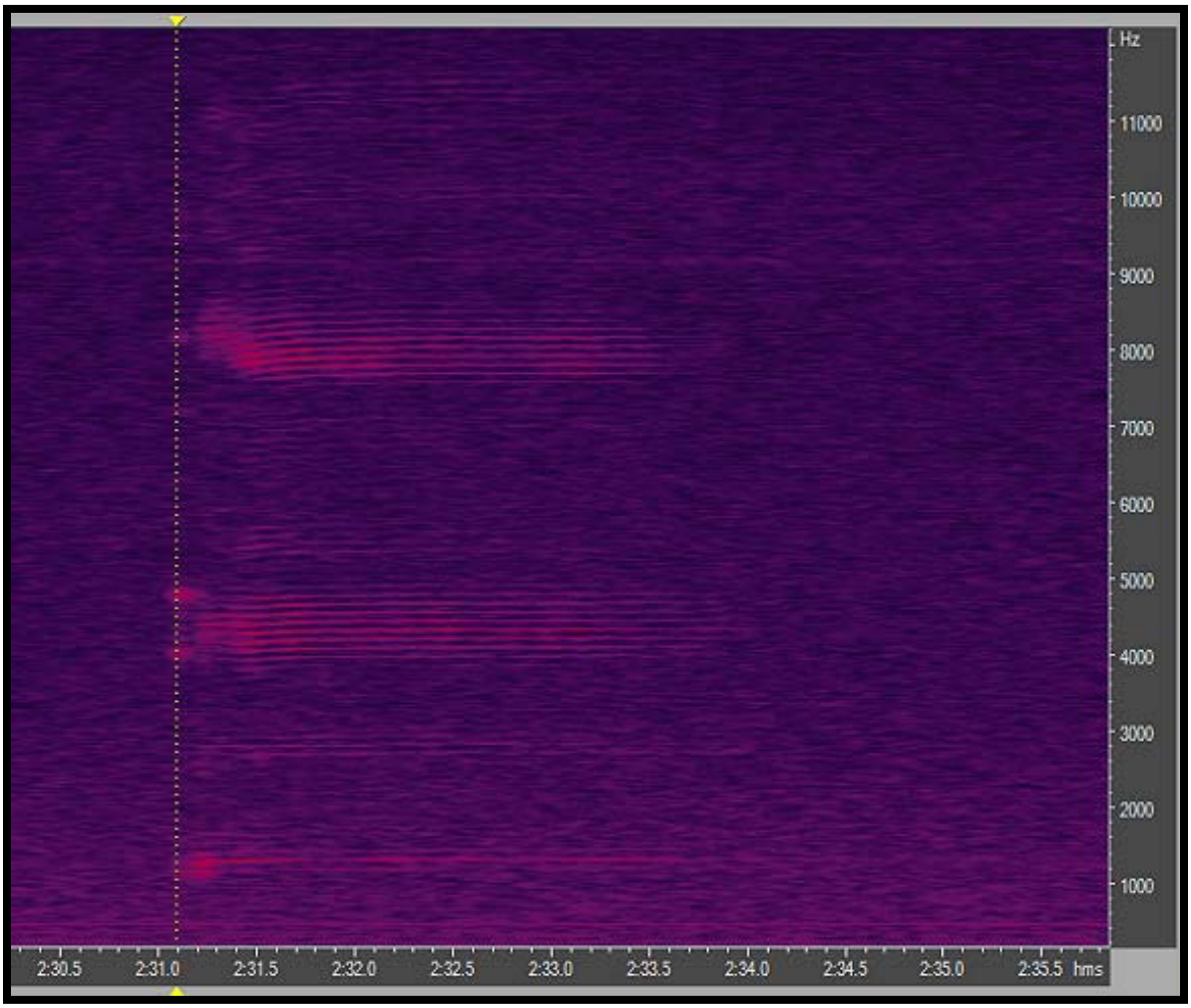


Figure 3 – Spectrogram (DC to 12.2kHz) for a boing received on hydrophone #17 at 13:21:58 HST. The figure shows the spectral complexity of the boing. The horizontal range of the animal from hydrophone # 17 is calculated using arrival time differences to be 6.8km. The three strongest groupings of boing amplitude modulation products (sidebands) are seen at 1.4kHz, 4.5kHz and 8.0kHz. Zooming into this signal allowed 45 separate boing sideband products to be observed.

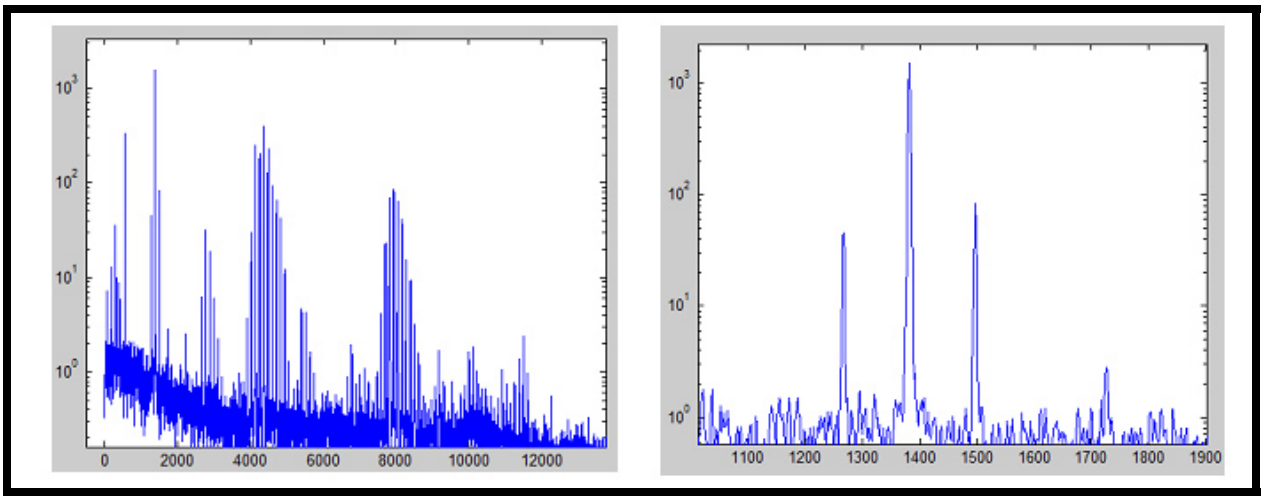
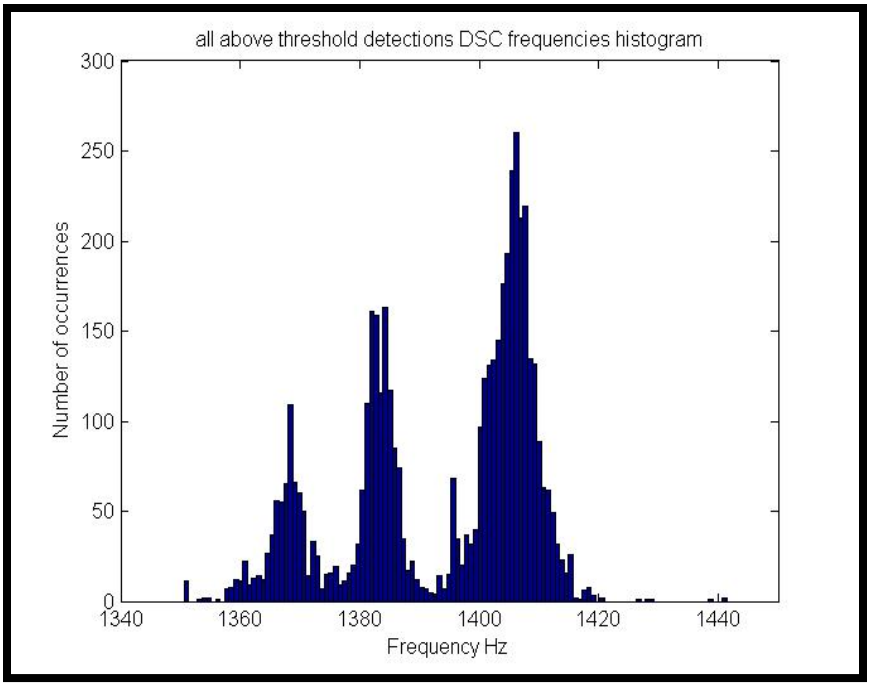


Figure 4 – High resolution spectral view of the same minke boing vocalization shown in figure 2. 128Kpt FFT's averaged over the duration of the boing (50% overlap) of 96KHz sampled data (0.73 Hz bin width). Vertical axis is relative magnitude(log scale). Left – frequency span from 0 Hz to 13 KHz, strongest component is seen to be the 1.384KHz line (termed dominant signal component - DSC). Lines under 1000 Hz are all 60 Hz power related, no discernable line at the pulse repetition rate of 115Hz. Right – enlargement of the 1KHz to 2Khz spectral region showing the DSC and the first 115 Hz upper, and lower sidebands of the DSC.

Figure 5 – Histogram of automatically detected DSC frequencies when relative amplitude > 50dB for 6 hrs and 40



minutes of data from 17 BSURE hydrophones 07:49 to 14:29 HST on 27 April 2009. Total number of detections 4,878. The majority of the detections (74%) are from four center frequencies (1368, 1484, 1402.5 and 1407.5Hz) with spans of +/-2.5Hz.

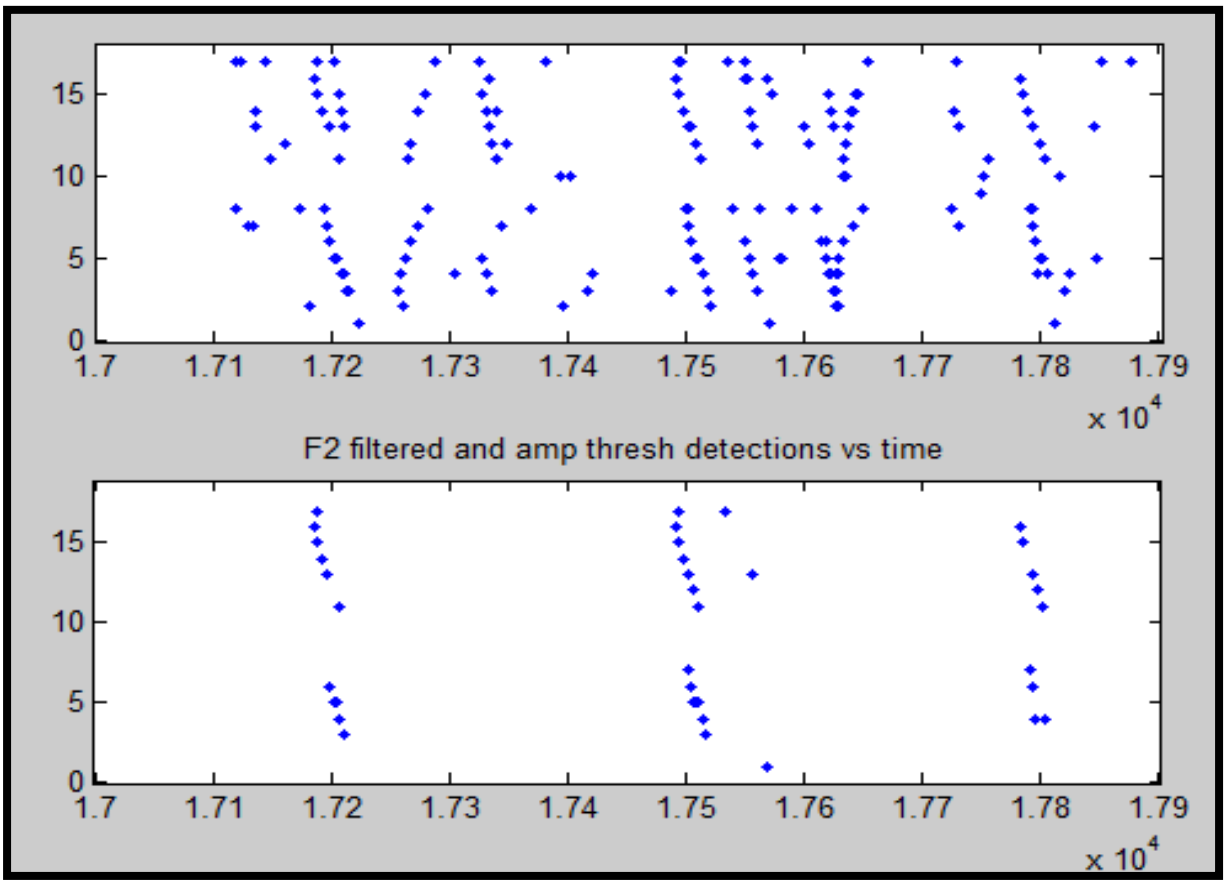


Figure 6 – Fifteen minutes of auto detection data plotted for hydrophone number (vertical axis) vs. time in seconds (horizontal axis). Upper plot shows all detections > 50dB relative amplitude. Lower plot shows only detections with dominant signal component between 1381.5Hz to 1386.5 Hz. Three boings are clearly seen at times 1.72, 1.75 and 1.78 x10^4 seconds. As can be seen, up to a dozen of the 17 hydrophones can detect a single boing, the curved pattern seen below is a result of the sound propagating throughout the range over tens of seconds.

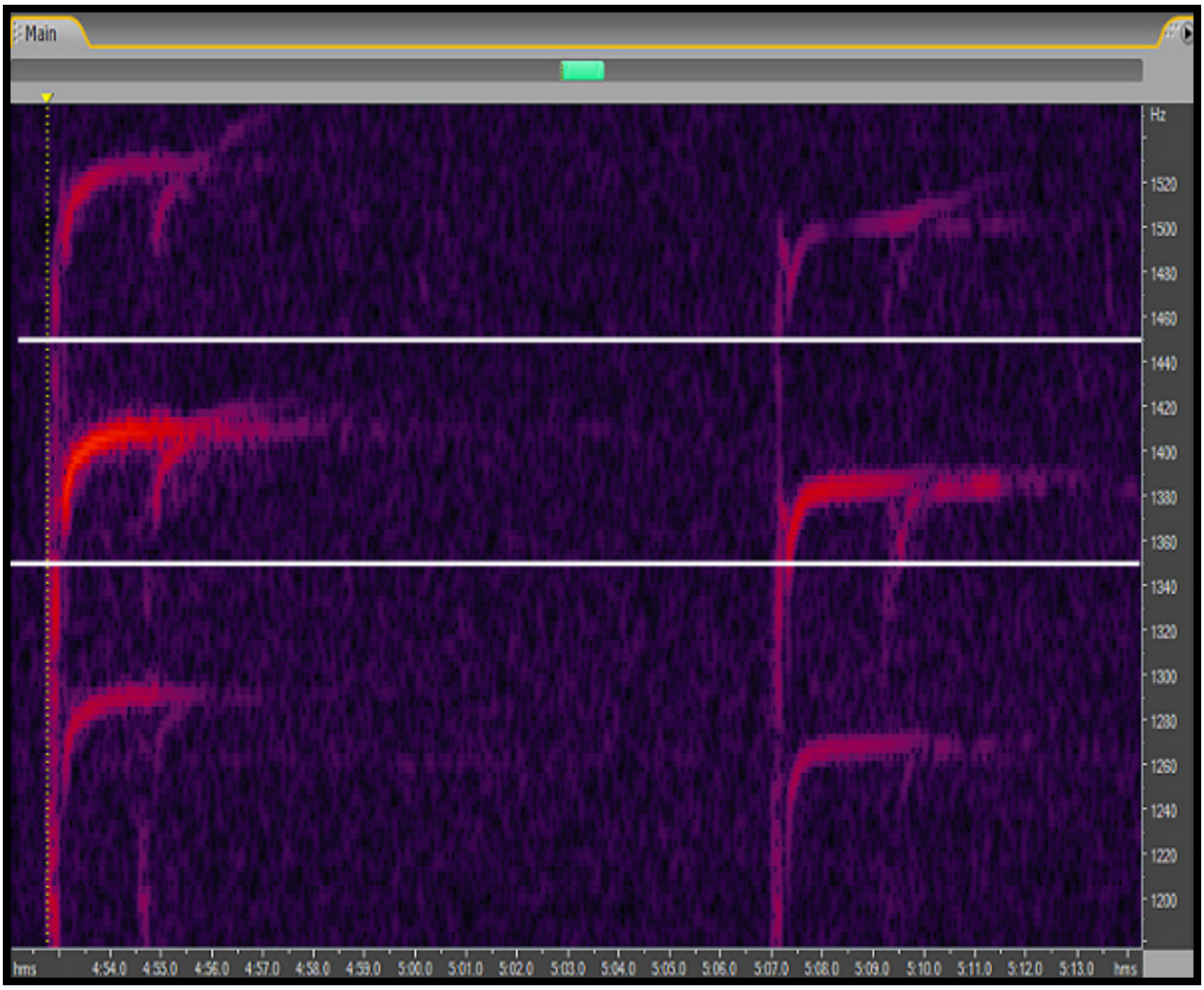


Figure 7 –Twenty second spectrogram (1180Hz to 1550Hz) of two boings received on hydrophone #14 at 13:44 HST on 27April 2009. The two horizontal white lines indicate the band of 1350Hz to 1450Hz. The first boing on the left is a relatively strong signal from a Minke whale in the southern end of the range, with a dominant signal component frequency, (DSCF) of ~ 1410 Hz. The second signal to the right is the last boing detected at 13:44:20 from the sighted individual, which exhibits the 1384Hz DSCF. Upper and lower sidebands from the 115Hz pulse repetition rate are also clearly seen for both boings. Each boing exhibits a time delayed multipath, believed to be bottom-surface multipath arrivals delayed by ~ 1.8 seconds for the first boing, and ~2.3 seconds for the seconds boing. The short multipath delays are indicative of long propagation ranges (>20Km).

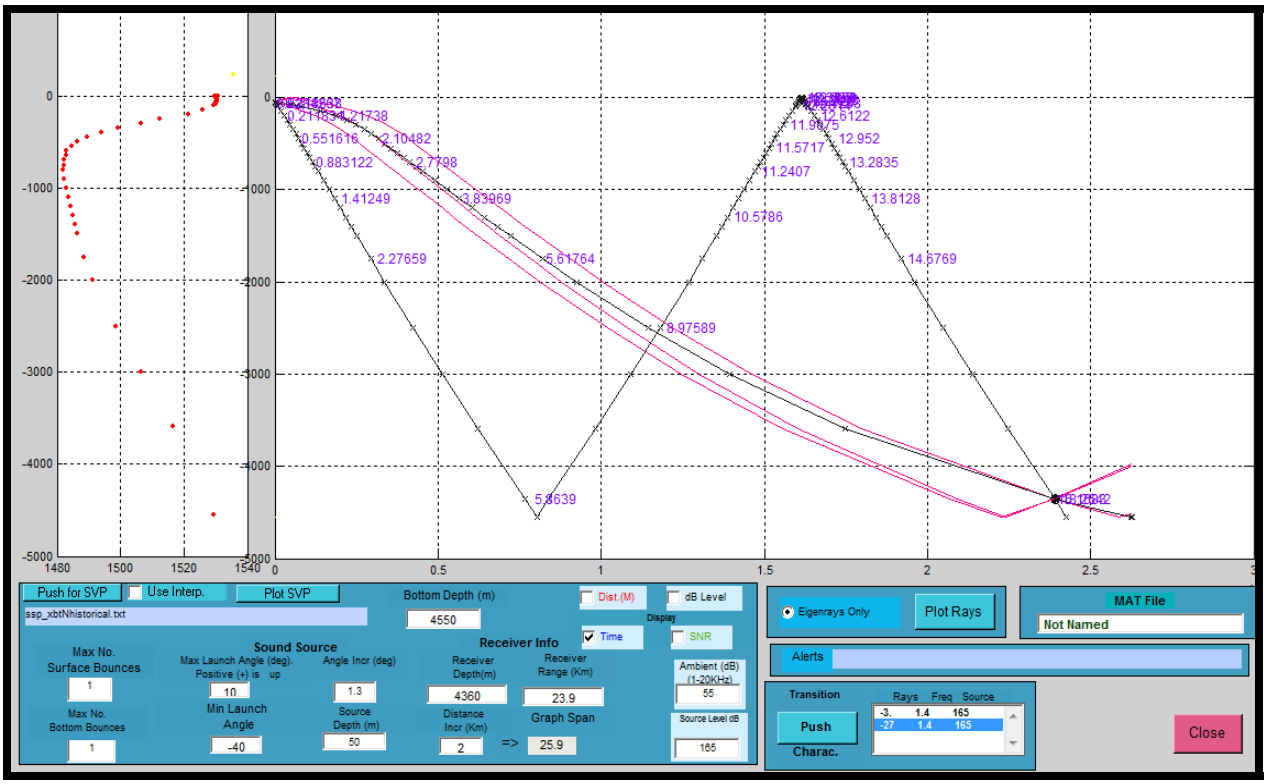


Figure 8 – Ray trace program results for modeled animal depth of 50m, bottom depth of 4550 m, hydrophone depth of 4360m, horizontal range 23.9km, sound speed 0-700m from XBT data 27 April 2009 combined with historical deeper data (courtesy Nosal). Five eigenrays found (direct, surface, bottom, surface-bottom and bottom-surface). The delay for the direct to bottom-surface path for this case is 2.1 seconds which is in general agreement with the ~2.3 seconds observed in spectrogram data (figure 7).

Part III- HRC Adaptive Management Recommendations

Adaptive management is an iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems. Adaptive management helps science managers maintain flexibility in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction will improve understanding of ecological systems to achieve management objectives; and is about taking action to improve progress towards desired outcomes.

In March 2009, CNO N45 convened government and academic researchers to review the Navy's range complex monitoring plans. This diverse group of experts reviewed the methods that currently exist for monitoring, methods expected to be available in five years and the Navy's current plans. The team reinforced that the current methods being used by the Navy for monitoring were robust and strongly recommended that Navy continue to use a diversity of methods simultaneously. For the HRC range complex monitoring, as well as monitoring conducted in other range complexes, the Navy was successful in using a diversity of field methods to meet gather visual and acoustic data towards answering the questions posed by Navy and NMFS.

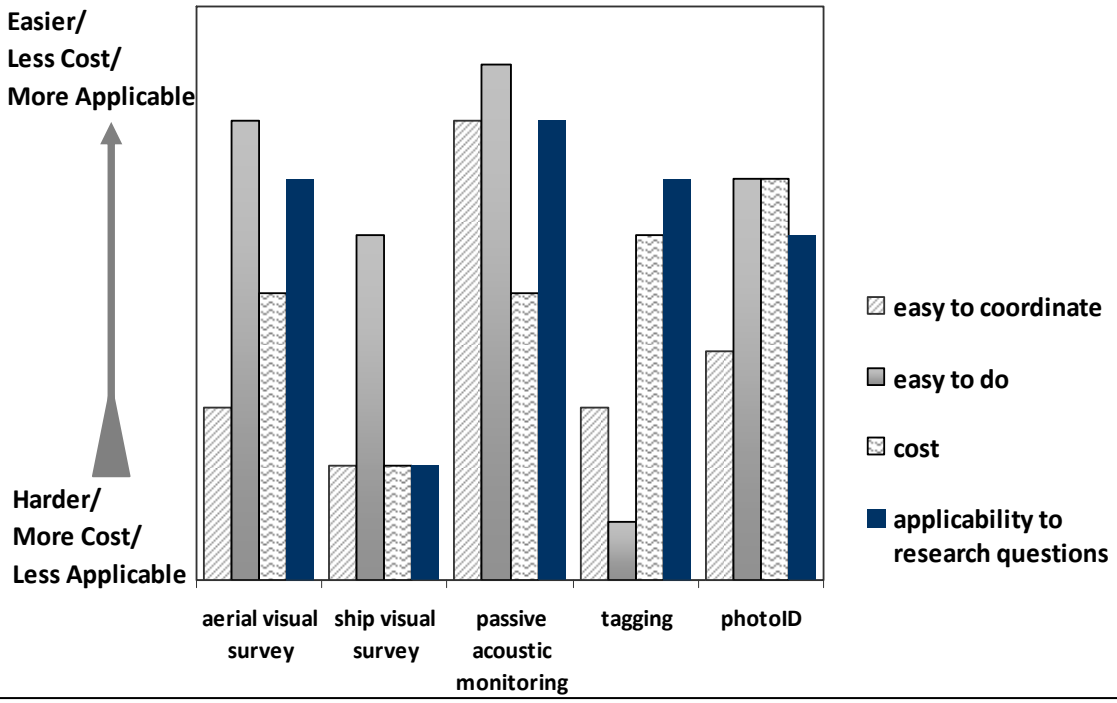
Significant progress was made during range complex compliance monitoring within the Hawaii Range Complex this year. This year's focus was expansion beyond monitoring techniques that are proven in the HRC, while targeting required metrics. Scheduling monitoring that involves civilian aircraft and ships operating concurrently with multiple Navy aircraft and ships in the same area required extensive pre-survey coordination between multiple Navy commands. The U.S. Pacific Fleet operational community (N7, N3 and MDSU) provided critical interface and coordination which was instrumental in using novel field methods to allow for researchers to conduct monitoring in close-proximity to Navy assets. The U.S. Pacific Fleet operational community also provided berthing and vessels (MDSU) for MMOs on four types of surface vessels.

Cancellations or major date shifts in Navy training events based on logistics, fiscal, or operational needs were challenging to overcome. These kind of changes are difficult to predict and more importantly, more difficult to reschedule from a monitoring prospective when contracts have been awarded, survey equipment has been purchased, rented or relocated; personnel availability and transport arranged; and fixed date contracts put into place. Several planned Navy training events scheduled for monitoring had to be re-scheduled to cover the change in monitoring design.

Specific challenges faced were 1) further research showed that no high-ground or tower exist near explosive events for shore-based observing; 2) most underwater detonations/explosive events occur on an established range adjacent to the Honolulu International Airport, requiring extensive coordination with Federal Aviation Authority; 3) low densities of animals precluded large sample sizes; 4) a metrics of hours was difficult to predict vice using events as the metric for explosive events.

Figure II-11 shows a highly subject preliminary assessment of various monitoring techniques from the Compliance and R&D programs in terms of how effective they may be in the HRC. By "subjective", the Navy refers to a review across a number of factors made by U.S. Pacific Fleet environmental planning staff based on lessons learned, data obtained, and associated coordination issues that arose during the monitoring described in this report. This is an early preliminary assessment in that data analysis,

especially of collected passive acoustic monitoring data is still ongoing. The kind of feedback obtained by this form of internal self-assessment, however, is useful in allowing the Navy to plan future range complex monitoring, as part of the Adaptive Management Process.



Definition of Subjective Categories

"**Easy to coordinate**" = ease of being able to gain HRC access especially in associate with MTEs

"**Easy to do**" = ease of performing once on range; also includes standardization of technique to SOCAL Range Complex

"**Cost**"= costs associated with a particular technique; includes costs associated pre-event preparation/purchasing, field work, and post-field effort data analysis

"**Applicability to research questions**"= Will technique provide the enough scientific information to address the Navy-NMFS monitoring objectives over time; to some degree also reflective of value of a given technique given the three categories above

Figure I-6. Subjective assessment of techniques for adaptive management review of 2009 HRC monitoring.

PROPOSED 2010 MONITORING COMMITMENTS

In view of lessons learned during implementation of the 2009 HRC Monitoring Plan (DoN 2009a), and as part of the Navy's adaptive management review for the Hawaii Range Complex, a modification of the 2009 Plan is recommended and shown in **Table II-1**0.

The main rational for restructuring the monitoring shown in **Table II-10** is to:

- simplify the presentation of goals,
- provide more flexibility in types of events monitored given the often rapid change in Navy training schedules,
- align the technique with the best promise of more accurately addressing the Monitoring Plan objectives, and
- demonstrate the value of leverage data collection efforts from the HRC specific on-going ONR R&D program which is already concurrently addressing some portions of the information needed in support of the monitoring goals.

Original projection of 2010 monitoring needs discussed with NMFS in summer of 2008 and finalized in the 2009 HRC Monitoring Plan is laid out in Table 10. Given the lessons learned and data presented from 2009 monitoring, and leveraging from parallel N45 and ONR R&D program, modification of the 2010 U.S. Pacific Fleet funded portion of the Navy's overall monitoring in the Hawaii Range Complex is sought to align monitoring with the best science technique available.

Specific revisions for elements of the proposed 2010 monitoring in **Table II-10** include:

Visual: Recommended 2010 monitoring shows a shift towards combining all visual survey hours (aerial and vessel) into one overall category of "total visual survey hours" to allow for better flexibility when scheduling visual monitoring throughout the study year. While aerial surveys were more productive in terms of value and proximity to pre-, during, and post-training events, flexibility to select from future aerial or vessel survey is desired so that as future training events are identified, the best technique can be applied to maximize data collection. Factors such as the relatively low Hawaii marine mammal densities leading to lower encounter rates and risks associated (e.g. safety) with aerial surveys will also factor into which method is chosen for each survey conducted in the HRC.

The commitment to conduct aerial surveys during near shore explosive events was removed from original FY10 commitments based upon practical experience in FY09. Specifically, most of the near-shore explosive events occur at Pu`uloa Training Range, which is located adjacent to the flight path of the Honolulu International Airport. Flight path restrictions not only compromised monitoring survey design, but also presented safety considerations.

Additionally, operational data that became available after the HRC monitoring plan was completed in 2008 shows that there are no near-shore explosive events with sufficient "high ground" to conduct shore-based monitoring. Therefore, this earlier goal has also been removed for 2010.

Marine Mammal Observers (MMOs): The only change to this commitment is to change from a metric of hours to a metric of events. This is to account for the variable time duration of ASW and explosive

events as experienced in FY09. MMOs will continue to be used for gathering species and behavioral data as well as implementation of the Lookout Effectiveness study currently under development by Navy, University of St. Andrews and NMFS Science Centers.

Marine Mammal Tagging: Tagging commitments did not change except to add that the 15 individuals tagged is a goal instead of a firm number.

PAM: Four HARPs will be deployed within the HRC Range Complex in FY10. CPF will also continue to fund SPAWAR to gather data at least two days per month using the bottom-mounted hydrophones at the Pacific Missile Range Facility. Additionally, CPF will coordinate with autonomous devices deployed under the ONR/N45 R&D program which has additional devices deployed within the Hawaii Range Complex. The HRC monitoring plan recommendation was to deploy 10 new devices, however, this was prior to receiving information on the numerous Navy-funded devices that are already deployed in the HRC.

Table I-10. Navy's final proposed FY10 monitoring plan for the Hawaii Range Complex.

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 (ULT) and/or explosive events.	Adaptive Management Review (AMR) for FY11
Marine Mammal Observers (MMO) STUDIES 1,2,3, 4, 5	80 hours aboard Navy vessels during MTE, ULT, and/or explosive events	
Tagging STUDIES 1,2, 3	Tag a goal of 15 individual marine mammals	
Passive Acoustics Monitoring (PAM) STUDIES 1,2, 3	Install four HARPs; collaborate with data collection from other N45/ONR R&D funded autonomous PAM devices (goal of 10 devices total). Analyze PIFSC acoustic data collected in 2009.	
Mitigation Effectiveness STUDY 5	Lookout effectiveness study by MMOs on Navy surface vessels during 3 ASW events and 6 explosive events	

Total FY10 commitment:

120-160 hours visual surveys; 80 hours Marine Mammal Observers; 15 tagged marine mammals; begin data collection from four Fleet-funded HARPs; conduct other Fleet-funded opportunistic PAM if available; collaborate with ongoing N45/ONR funded PAM.

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

Study 2= If marine mammals and sea turtles are exposed to sonar, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

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

Study 4= What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

Study 5= Is Navy's suite of mitigation measures for sonar and explosives, and major exercise measures agreed to by Navy through permitting effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles

SECTION II- SOUTHERN CALIFORNIA RANGE COMPLEX

The SOCAL Range Complex consists of 120,000 nm^2 of sea area from approximately Dana Point California to San Diego extending 620 nm southwest into the Pacific Ocean, and 42 nm^2 of land encompassing San Clemente Island (**Figure II-1**). Various subcomponents of the range complex are more fully described in the Final SOCAL Range Complex OEIS/EIS (DoN 2008b). Of note and in regards to in-water unit-level training and major training event (MTE) using sonar and explosives, a much more limited subset of the range complex is used.

Collaborative Research Objectives In SOCAL

As discussed in the Navy's SOCAL Monitoring Plan (DoN 2009a), there are efforts within SOCAL funded by U.S Pacific Fleet, part of the SOCAL compliance monitoring, and by the Environmental Readiness Division of the Chief of Naval Operations (CNO N45). There are also various projects either funded by or conducted by the Office of Naval Research (ONR), and the Naval Postgraduate School (NPS) in Monterey, CA. Some of the results and major milestones from the Navy's Research and Development (R&D) monitoring (CNO N45 and ONR funded efforts) are presented in Part II of this Section.

On 10 December 2008, an informal SOCAL monitoring meeting was held at Scripps Institute of Oceanography (SIO), La Jolla, CA. Approximately 26 people representing various Navy commands and Navy scientists met at SIO for the one-day conference. Navy representatives included policy, operators, range control, and research scientists. Regional scientists attending included senior researchers from SIO, NMFS' Southwest Fisheries Science Center (SWFSC), and other marine mammal scientists. The conference was a two-part meeting with general presentations by various individuals in the morning, followed by an afternoon working group to discuss an integrated way forward. Key presentations and consensus points from the 10 December conference are listed in the text box. More information on SOCAL marine mammal programs and associated technology use by major partners of the Navy's R&D program is available online at:

Naval Postgraduate School http://www.nps.edu

Marine Mammal Acoustics Group, Marine Physical Laboratory, Scripps Institute of Oceanography, University of California San Diego http://cetus.ucsd.edu/

Cascadia Research Collective, Olympia Washington http://www.cascadiaresearch.org/

To enhance collaboration with the R&D program in SOCAL, some elements of the Fleet funded Compliance Monitoring as discussed in the SOCAL Monitoring Plan were scheduled to occur concurrently with R&D monitoring, and in some cases joint Fleet and R&D funding was used for a particular survey. Integration of these multiple programs is still ongoing and planned for successive years, and will be discussed in the Adaptive Management section of this report.

In addition, to more appropriately answer the study questions listed in the introduction and SOCAL Monitoring Plan (DoN 2009b), recommendations will be made on how to use the most appropriate monitoring program element from either program in subsequent year Range Complex monitoring to provide the scientifically valid data needed to address the key Navy-NMFS study questions.

Presentation Titles From 10 December 2008 SOCAL Monitoring Conference

U.S. Pacific Fleet - **SOCAL Monitoring Plan overview**

Naval Undersea Warfare Center (NUWC) - **M3R at SOAR**; Synopsis of major work at SOAR and AUTEC regarding passive acoustic monitoring, tagging, species verification with and without active sonar. Overview of recently submitted 3-year plan

Naval Post Graduate School (NPS)- **Naval Post Graduate School SOCAL/SCORE Activities; SCORE recordings, their analysis and acoustic modeling plans; Automated Identification System (AIS) data collection for merchant ships at SCORE**

Space and Naval Warfare Systems Center (SPAWAR)- **Density estimation cetacean for cetaceans from passive acoustics (DECAF); Environmental Research Conducted at the Navy Marine Mammal Program; ESRI tools and software to do focal follows during ship surveys**

Scripps Institute of Oceanography (SIO)- **Acoustic Monitoring in the SOCAL Range Complex**

Southwest Fisheries Science Center (SWFWS)- **Vessel and Aerial Surveys in the SOCAL Area**

Cascadia Research Collective (CRC)- **Research Methods – Small Boat, Photo ID, Tagging, CALCOFI; Tagging, photo ID and other work at SCORE**

Marine Mammal Research Consultants (MMRC)- **Aerial Surveys and Marine Mammal Monitoring 2008: SOCAL**

Bio-Waves- **Passive Acoustic Surveys, Monitoring and Tracking**

Consensus Points From 10 December 2008 SOCAL Monitoring Conference

• It makes obvious sense to try to align both U.S. Pacific Fleet SOCAL Monitoring Plan and N45 R&D Program specific to SOCAL, although this is also a long-term objective of all Navy range complex monitoring based on policy direction from CNO N45.

• Baseline observation of marine mammal behavior must be obtained without Navy operations present to allow meaningful comparisons to observations taken during Navy operations.

• U.S. Pacific Fleet, N45, and individual researchers will compare AND align research/monitoring schedules in January 2009. Using inputs from Navy planning, previous N45 monitoring plan, and U.S. Pacific Fleet SOCAL Monitoring Plan recommendations, a single SOCAL "Marine Mammal Monitoring Matrix" will be drafted.

• U.S. Pacific Fleet Environmental will work with N45 (and individual researchers) to obtain the appropriate permissions for monitoring, including any required command briefings.

• During the first Adaptive Management period prior to FY10 monitor, conduct a review of data obtained to date to see how results may or may not adequately address overall program goals. In addition to data, economic, logistic, practicality, and safety should also be part of this adaptive management review. SWFSC strongly recommends re-evaluation of aerial surveys in view of safety concerns, although other researchers do point out how aerial surveys can be re-focused into direct monitoring of animal behavior vice traditional offshore presence/absents surveys.

• Data results and collaborative sharing for any combined monitoring must be available by 01 August 09, or as soon as possible prior to 30 August for any July 2009 monitoring. This is to support the annual report preparation for SOCAL monitoring required for submission to NMFS OPR by 01 October 2009. (Note: formal submissions are not necessarily required, but U.S. Pacific Fleet will need print quality graphics, data tables, basic method write-ups, and any text caveats to preliminary research interpretation. Proper citation to original contributing author/organization will be made in any Navy monitoring report).

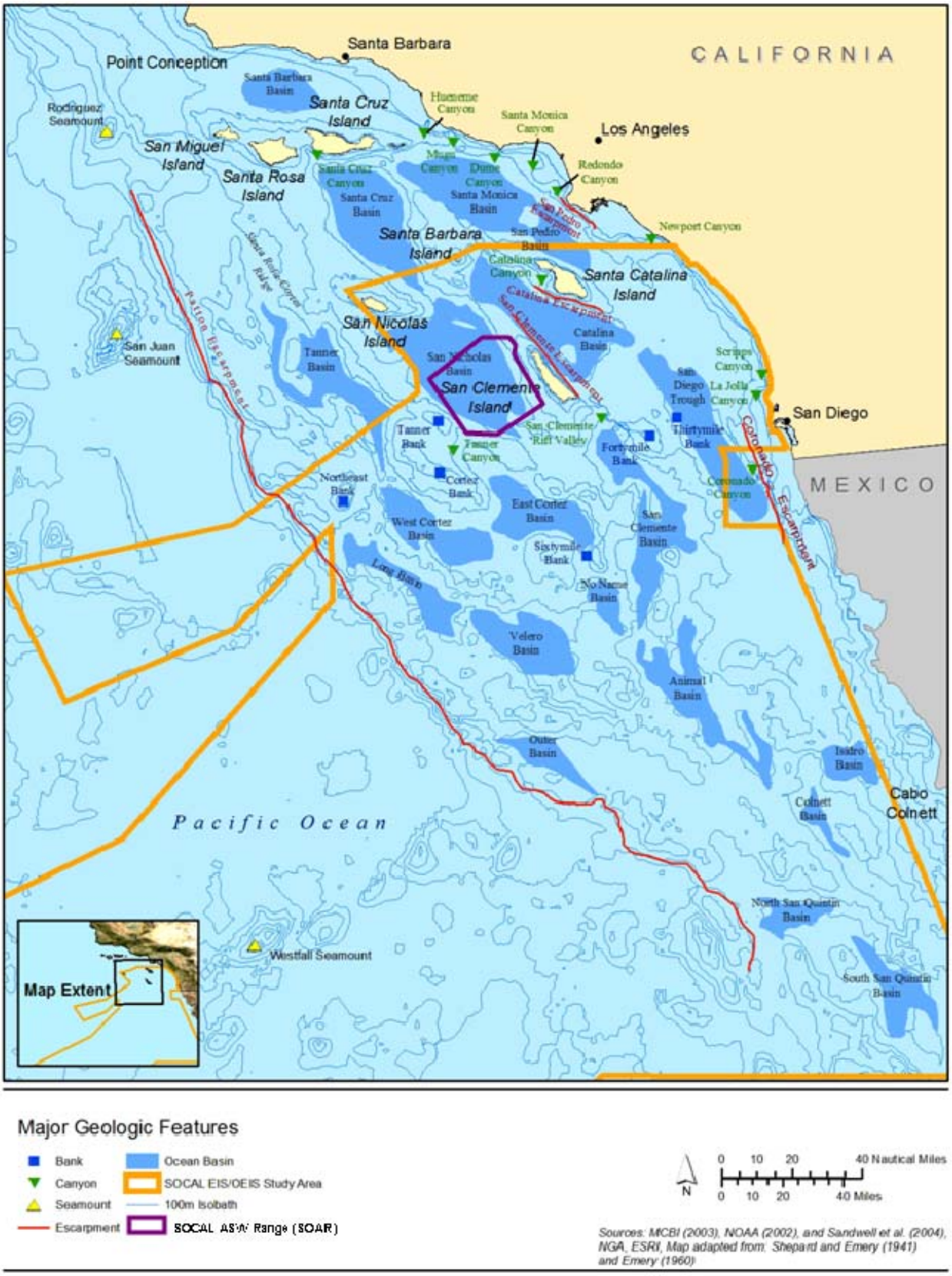


Figure II-1. Southern California Range Complex and regional offshore underwater features.

Part I- SOCAL Range Complex Monitoring Plan Accomplishment

To assess the accomplishments of the FY09 SOCAL Range Complex Monitoring Plan, discussions of the pertinent study questions and associated monitoring goals, review of Navy major training events in SOCAL this year, and results from specific monitoring techniques outlined in the Monitoring Plan and implemented this year are presented below.

SOCAL STUDY QUESTIONS OVERVIEW

The intent of the SOCAL Monitoring Plan (DoN 2009b) was to use a set of study questions that would help frame the monitoring in terms that could assist in answering over the long term program objectives posed by NMFS (*see* Introduction).

Table II-1 from the final SOCAL Monitoring Plan shows the FY09 monitoring objectives as initially agreed upon by the NMFS and Navy. Significant effort in the SOCAL Monitoring Plan was given to monitoring, whenever possible, during major training events (MTE) due to the higher tempo of exercise events and numbers of various platforms in use. Certain survey elements such as aircraft and ship visual surveys were conducted around MTEs (before, during, or after) whenever possible. Longer term deployed passive acoustic sensors such as high-frequency acoustic recording packages (HARP) could be deployed for periods of up to three months before needing to be retrieved for data download. Finally, the Navy's permanently bottom-mounted hydrophone array west of San Clement Island began full-time marine mammal passive acoustic vocalization data collection starting in February of 2009.

Table II-1. SOCAL Range Complex marine mammal monitoring expectations under the NMFS LOA.

STUDY 1,3, 4 (exposures and behavioral responses)		
Aerial Surveys	Portions of major exercises, intermediate level exercises, or Unit Level Training (ULT) events using mid-frequency active sonar (MFAS), and offshore detonation events	Adaptive Management Review (AMR) for FY10
Marine Mammal Observers (MMO)	Opportunistic; minimum intermediate level or ULT MFAS exercises	
Vessel surveys (study 3, 4 only)	Portions of major or intermediate level MFAS exercises and offshore detonation events	
Marine Mammal Tagging (study 1, 3)	Award monitoring contract, develop SOP (Studies 1,2,3)	
STUDY 2 (geographic redistribution)		
Aerial Surveys Before And After Training	Award monitoring contract, develop SOP, obtain permits; Portions of major, intermediate level, or ULT MFAS exercises	AMR
Passive Acoustics Monitoring (PAM)	Award monitoring contract, develop SOP, obtain permits; Order devices and determine best location; integrate SOAR M3R classification data for beaked whales (BW)	
Marine Mammal Tagging	Award monitoring contract, develop SOP, obtain permits	
STUDY 5 (mitigation effectiveness)		
MMO/ Lookout Comparison	Opportunistic as staff and SOP developed; minimum intermediate or ULT	AMR
Aerial Surveys Before And After Training	Portions of major or intermediate MFAS exercises	
TOTAL FY 09 Commitment as outlined in DoN 2009a, NMFS 2009b: 120 hours aerial survey; 60 hours vessel survey; 36 hours Marine Mammal Observers; PAM: integrate existing PAM		

For any assessment of the NMFS-Navy study questions specific to SOCAL (from the Introduction and in **Table II-1**), an understanding of the underlying importance of U.S. West Coast oceanographic and climatic conditions on regional marine mammal occurrence is needed. Variation in oceanographic and climatic conditions within Southern California has a dramatic influence on marine mammal distribution, species assemblages likely to be present, foraging, and breeding success. This is especially important in trying to interpret monitoring results specific to discussions of geographic redistribution, or behavioral context of a potential response or lack of response to an activity. For instance, variation in a species distribution between monitoring surveys, or over time, may be in response to natural response to normal seasonal oceanographic shifts, as well as longer-term climatic events (ex., El Niño, La Niño).

As discussed in the SOCAL EIS/OEIS (DoN 2008b), the marine waters of Southern California represent a transitional area between subarctic, central, and equatorial water masses. Within any given year there is typically a cooler water period more dominated by subarctic water (approximately Nov-Apr) and a warmer water period more dominated by central and equatorial water (approximately May-Oct). These dates are approximate within any given year, due to natural variation in ocean water temperatures, and influences from larger-scale processes discussed below.

Long-term climatic influences in the region include El Niño-Southern Oscillation (commonly referred to simply as El Niño), Pacific Decadal Oscillation, and global warming. The recurring El Niño pattern is one of the strongest in the ocean-atmosphere system. El Niño is defined by relaxation of the trade winds in the central and western Pacific, which can set off a chain reaction of oceanographic changes in the eastern Pacific Ocean. Off the coast of California, El Niño events are characterized by increases in ocean temperature and sea level, enhanced onshore and northward flow, and reduced coastal upwelling of deep, cold, nutrient-rich water. During this period, plankton abundance decreases, resulting in a decrease in survivorship and reproductive success of planktivorous invertebrates and fishes. Marine mammals and seabirds, which feed on these organisms, experience widespread starvation, decreased reproductive success, and may adjust their distributions in an attempt to compensate.

Every 20 to 30 years, the surface waters of the central and northern Pacific Ocean, from 20 degrees north toward the pole, shift several degrees from their mean temperature. Such shifts in mean surface water temperature, known as the Pacific Decadal Oscillation, have been detected five times during the past century, with the most recent shift having occurred in 1998. This oscillation affects production in the eastern Pacific Ocean and, consequently, affects organism abundance and distribution throughout the marine food chain. Ocean waters off the coast of California have warmed considerably over the last 40 years. It is not clear if this warming is a consequence of an interdecadal climate shift, or global warming. In response to this phenomena, along with the two discussed above, some marine species have shifted their geographic ranges northward, altering the composition of local assemblages of biota. For instance, over the past couple of decades, large-scale population assessment surveys conducted by the NMFS SWFSC provide evidence for blue whales shifting foraging grounds outside of the California-Oregon-Washington study area (Barlow and Forney 2007; Barlow et al. 2008). This shift in blue whale distribution may be associated with the overall declining trend in zooplankton displacement volumes off California since the 1990s (Goericke et al. 2007; McClatchie et al. 2008). However, NMFS surveys are conducted every 3 to 5 years primarily in summer and fall, and as such do not capture seasonal variability between years.

In terms of the SOCAL Monitoring Plan, **Figure II-2** shows data from the National Weather Service Climate Prediction Service for warm and cold ocean temperature episodes as a predictor of El Niño and La Niño oceanographic conditions within SOCAL from 1950 through July 2009. For the period covered by

this monitoring report, SOCAL experienced a slightly cooler ocean water period, but not significant enough of a cooling episode to be classified as a La Niño.

Figure II-2. Warm and cold ocean temperature episodes base on Oceanic Niño index as a predictor of El Niño and La Niño oceanographic conditions within SOCAL.

(dashed box over represents period (2008-2009) over which Navy funded marine mammal monitoring listed in this report occurred)

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1950	-1.7	-1.5	-1.3	-1.4	-1.3	-1.1	-0.8	-0.8	-0.8	-0.9	-0.9	-1.0
1951	-1.0	-0.9	-0.6	-0.3	-0.2	0.2	0.4	0.7	0.7	0.8	0.7	0.6
1952	0.3	0.1	0.1	0.2	0.1	-0.1	-0.3	-0.3	-0.2	-0.2	-0.1	0.0
1953	0.2	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
1954	0.5	0.3	-0.1	-0.5	-0.7	-0.7	-0.8	-1.0	-1.2	-1.1	-1.1	-1.1
1955	-1.0	-0.9	-0.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.4	-1.8	-2.0	-1.9
1956	-1.3	-0.9	-0.7	-0.6	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9	-0.9	-0.8
1957	-0.5	-0.1	0.3	0.6	0.7	0.8	0.8	0.8	0.9	1.0	1.0	1.0
1958	1.7	1.5	1.2	0.8	0.6	0.5	0.3	0.1	0.0	0.0	0.2	0.4
1959	0.4	0.5	0.4	0.2	0.0	-0.2	-0.4	-0.5	-0.4	-0.3	-0.2	-0.2
1960	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1	0.0	-0.1	-0.2	-0.2	-0.2
1961	-0.2	-0.2	-0.2	-0.1	0.1	0.2	0.0	-0.3	-0.6	-0.6	-0.5	-0.4
1962	-0.4	-0.4	-0.4	-0.5	-0.4	-0.4	-0.3	-0.3	-0.5	-0.6	-0.7	-0.7
1963	-0.6	-0.3	0.0	0.1	0.1	0.3	0.6	0.8	0.8	0.9	1.0	1.0
1964	0.8	0.4	-0.1	-0.5	-0.8	-0.8	-0.9	-1.0	-1.1	-1.2	-1.2	-1.0
1965	-0.8	-0.4	-0.2	0.0	0.3	0.6	0.8	1.0	1.2	1.3	1.3	1.3
1966	1.2	1.0	0.8	0.5	0.2	0.2	0.2	0.0	-0.2	-0.2	-0.3	-0.3
1967	-0.4	-0.4	-0.6	-0.5	-0.3	0.0	0.0	-0.2	-0.4	-0.5	-0.4	-0.5
1968	-0.7	-0.9	-0.8	-0.7	-0.3	0.0	0.3	0.4	0.3	0.4	0.7	0.9
1969	1.0	1.0	0.9	0.7	0.6	0.5	0.4	0.4	0.6	0.7	0.8	0.7
1970	0.5	0.3	0.2	0.1	0.0	-0.3	-0.6	-0.8	-0.9	-0.8	-0.9	-1.1
1971	-1.3	-1.3	-1.1	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8	-0.9	-1.0	-0.9
1972	-0.7	-0.4	0.0	0.2	0.5	0.8	1.0	1.1	1.2	1.3	1.4	1.4
1973	1.3	1.1	0.5	-0.1	-0.6	-0.9	-1.1	-1.3	-1.4	-1.7	-2.0	-2.1
1974	-1.9	-1.7	-1.3	-1.1	-0.9	-0.8	-0.6	-0.5	-0.5	-0.7	-0.9	-0.7
1975	-0.6	-0.6	-0.7	-0.8	-0.9	-1.1	-1.2	-1.3	-1.5	-1.6	-1.7	-1.7
1976	-1.6	-1.2	-0.8	-0.6	-0.5	-0.2	0.1	0.3	0.5	0.7	0.8	0.7
1977	0.6	0.5	0.2	0.2	0.2	0.4	0.4	0.4	0.5	0.6	0.7	0.7
1978	0.7	0.4	0.0	-0.3	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.1
1979	-0.1	0.0	0.1	0.1	0.1	-0.1	0.0	0.1	0.3	0.4	0.5	0.5
1980	0.5	0.3	0.2	0.2	0.3	0.3	0.2	0.0	-0.1	-0.1	0.0	-0.1
1981	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3	-0.4	-0.4	-0.3	-0.2	-0.1	-0.1
1982	0.0	0.1	0.1	0.3	0.6	0.7	0.7	0.8	0.8	0.8	0.8	0.8
1983	0.8	0.8	0.8	0.8	0.8	0.6	0.2	-0.2	-0.6	-0.8	-0.9	-0.7
1984	-0.4	-0.2	-0.2	-0.3	-0.5	-0.4	-0.3	-0.2	-0.3	-0.6	-0.9	-1.1
1985	-0.9	-0.8	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5	-0.5	-0.4	-0.3	-0.4
1986	-0.5	-0.4	-0.2	-0.2	-0.1	0.0	0.3	0.5	0.7	0.9	1.1	1.2
1987	1.2	1.2	1.2	1.0	0.8	0.6	0.4	0.3	0.3	0.3	0.3	0.3
1988	0.7	0.5	0.1	-0.2	-0.7	-1.2	-1.3	-1.2	-1.3	-1.6	-1.9	-1.9
1989	-1.7	-1.5	-1.1	-0.8	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	-0.1
1990	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
1991	0.4	0.3	0.3	0.4	0.6	0.8	1.0	0.8	0.8	1.0	1.1	1.1
1992	1.1	1.1	1.0	0.8	0.6	0.3	0.5	0.2	0.0	-0.1	0.0	0.2
1993	0.3	0.4	0.6	0.7	0.8	0.7	0.4	0.4	0.4	0.4	0.3	0.2
1994	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.9	1.1	1.2
1995	1.2	0.8	0.7	0.4	0.3	0.2	0.0	-0.2	-0.5	-0.6	-0.7	-0.7
1996	-0.7	-0.7	-0.5	-0.3	-0.1	-0.1	0.0	-0.1	-0.1	-0.2	-0.3	-0.4
1997	-0.4	-0.3	0.0	0.4	0.8	1.1	1.3	1.4	1.5	1.6	1.6	1.6
1998	1.5	1.3	1.0	0.7	0.5	0.0	-0.5	-0.8	-1.0	-1.1	-1.3	-1.4
1999	-1.4	-1.2	-0.9	-0.8	-0.8	-0.8	-0.9	-0.9	-1.0	-1.1	-1.3	-1.6
2000	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0.0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.9	1.0	1.1	1.2	1.2	1.2	1.2
2003	1.1	0.8	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.8	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.8	0.9	0.9
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1.0	-1.1	-1.3
2008	-1.4	-1.4	-1.0	-0.8	-0.6	-0.4	-0.1	0.0	0.0	0.0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6						
Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ

DESCRIPTION: Warm (red) and cold (blue) episodes based on a threshold of +/- 0.5°C for the Oceanic Niño Index (ONI) [3 month running mean of ERSST.v3b SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)], based on the 1971-2000 base period. For historical purposes cold and warm episodes (blue and red colored numbers) are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

From: *National Weather Service Climate Prediction Center*

http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

warm period scale

+0.5 to 0.7°C (+0.9 to 1.3°F)

+0.8 to 1.0°C (+1.4 to 1.8°F)

≥ +1.1°C (≥ +2.0°F)

cold period scale

-0.5 to -0.7°C (-0.9 to -1.3°F)

-0.8 to 1.0°C (-1.4 to 1.8°F)

≥ -1.1°C (≥ -2.0°F)

SOCAL MAJOR TRAINING EXERCISE SUMMARY

Given the focus on monitoring around Navy at-sea training events, a list of MTEs that occurred in SOCAL between August 2008 and August 2009 is provided in **Table II-2**. Marine mammal sightings during MTEs are a form of compliance monitoring and represent a substantial number of sightings. For SOCAL, NMFS designated MTEs include Ship Anti-Submarine Warfare Readiness and Evaluation Measuring (SHAREM), Sustainment Exercises (SUSTEX), Integrated ASW Course Phase II (IAC2), Composite Training Unit Exercises (COMPTUEX), and Joint Task Forces Exercises (JTFEX).

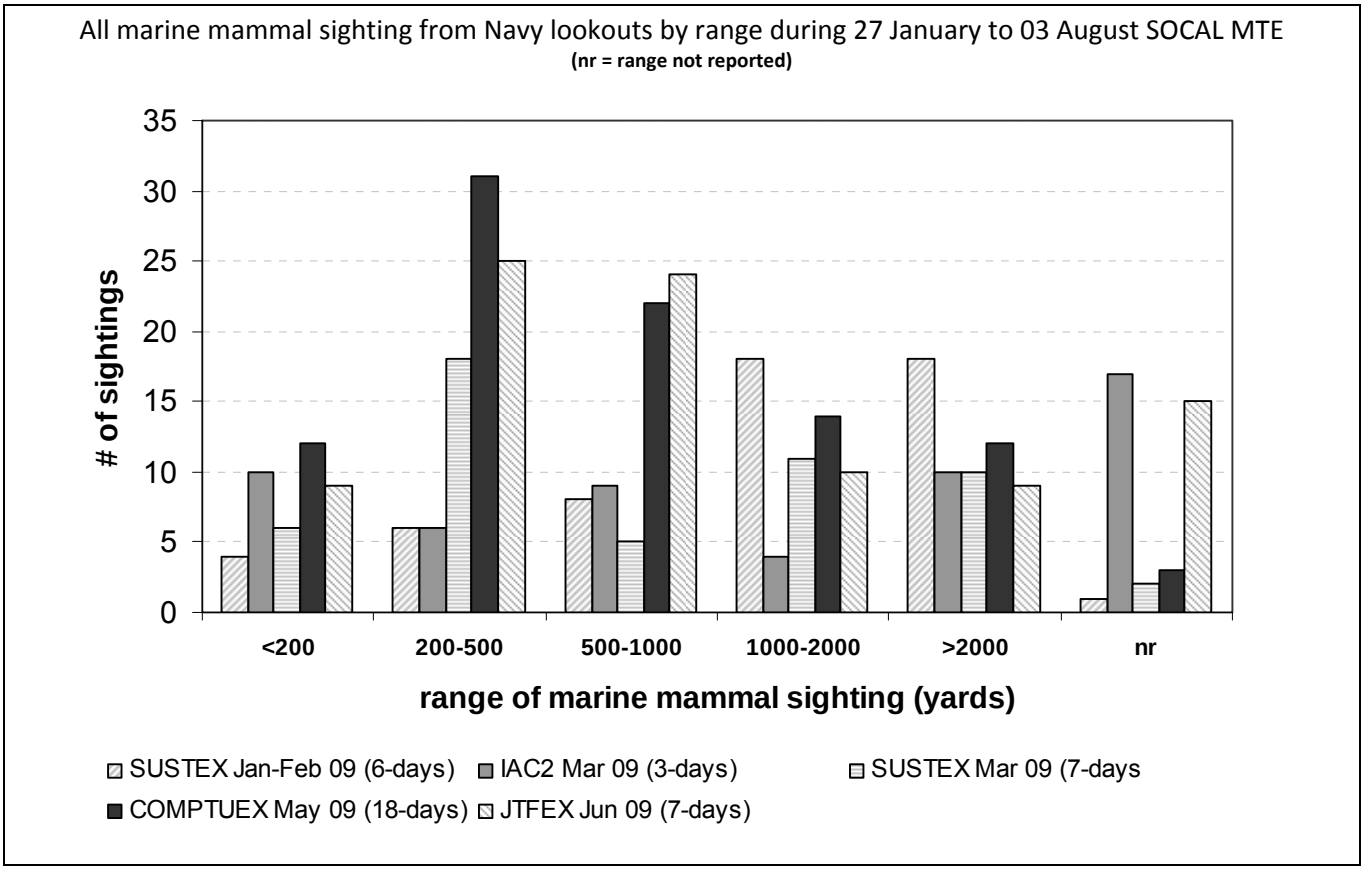
There were a total of 11 MTEs within the SOCAL Range Complex between 01 August 2008 and 03 August 2009. Of the 11, there were six MTEs between the end of January to 01 August 2009. All told, there were only 114 non-consecutive cumulative days involving MTEs within SOCAL out of the approximately 368 days between 01 August 2008 to 03 August 2009, and only 59 days of non-consecutive cumulative MTE out of approximately 192 days between 24 January 2009 and 03 August 2009.

During transits and training events within all 11 MTEs, Navy lookouts reported 546 marine mammal sightings for an estimated 5,312 marine mammals. Marine mammal sightings occurred at variable ranges by type of MTE (**Tables II-2, II-3, and II-4**). There were no obvious indication or report that any marine mammal observed by Navy lookouts behaved in a manner not associated with normal movement, or foraging.

Table II-2. SOCAL Major Training Events (MTE) between 01 August 2008 to 03 August 2009.

MTE Type	Dates	# Of Days	# Of Marine Mammal Sightings	# Of Marine Mammals
COMPTUEX	16 October- 04 November 2008	19	38	896
COMPTUEX	29 October – 14 November 2008	16	96	1,321
JTFEX	09-15 November 2008	8	24	144
JTFEX	01-12 December 2008	12	30	268
JTFEX	24-31 January 2009 [1]	8	-	-
SUSTEX	27 January – 01 February 2009	6	58	297
IAC2	10-12 March 2009	3	60	490
SUSTEX	13-19 March 2009 [2]	7	52	823
COMPTUEX	11-22 May 2009	12	95	700
JTFEX	29 May-05 Jun 2009	8	93	373
COMPTUEX	20 Jul-03 Aug 2009 [1,3]	15	-	-
	Totals:	114 days	546 sightings	5,312 marine mammals

[1] no marine mammal sighting information collected
[2] this exercise ran from 13-26 March, but no ASW from 20-26 March
[3] no anti-submarine warfare training planned and no sonar training conducted during this MTE



One way to use Navy lookout data to address NMFS' Study question "Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?", is to examine marine mammal sighting data from Navy MTEs and predict likely exposure.

The three categories of mitigation measures (Personnel Training, Lookout and Watchstander Responsibilities, and Operating Procedures) outlined in the SOCAL EIS/OEIS and approved by NMFS (DoN 2008b, NMFS 2009b) were effective in detecting and appropriately mitigating exposures of marine mammals to mid-frequency sonar. Fleet commanders and ship watch teams continue to improve individual awareness and enhance reporting practices. This improvement can be attributed to the various pre-exercise conferences, mandatory marine species awareness training, and making adjustments based upon the lessons learned. The safety zones were adhered to, and vessels and aircraft applied mitigation measures when marine mammals are visually observed within the requisite zone.

Ranges associated with potential criteria levels of PTS and TTS (215 and 195 dB re 1 μPa^2-s) are much shorter than 200 yards. During SOCAL MTEs from Jan 09 to Jun 09, there were a total of 15 sightings of 167 marine mammals sighted at ranges less than 200 yards in which MFAS was initially being used prior to mitigation being applied (**Table II-3**).

Table II-3. Breakdown by ranges of less than 200 yards of marine mammal sightings concurrent with MFAS use from January to August 2009 in the SOCAL Range Complex.

Range of sighting <200 yards from Navy MFAS ship and number of marine mammals
160 dolphins
5 whales
2 pinnipeds
167 total marine mammals

Since there was no planned MTE sonar in July, effective dates for this data summary are from MTEs between January to June 2009 (see Table II-2)

Table II-4 contains a list of all mitigation events at ranges less than 200 yards during MTEs in SOCAL from January to June 2009. It should be noted that with or without mitigation, given relative motion of ships maneuvering at-sea and independent marine mammal movement, the time any given animal would be exposed to MFAS from surface ships is likely to be limited as shown by the distances calculated in **Table II-3** Column 12.

Table II-4. SOCAL MTEs where sonar was on during detection of marine mammals at ranges less than 200 yards and associated mitigation.

1) MTE	2) Month (2009)	3) Species Sighted	4) # of marine mammals sighted	5) Platform	6) Length of time observed (min)	7) Range at which marine mammal sighted	8) Mitigation [secure (SD); power down (PD); maneuver ship (MAN) [1]]	9) Estimate MAX. exposure PRIOR to mitigation (dB re 1uPa) [2]	10) Number of minutes sonar mitigation applied (min)	11) Estimate exposure AFTER mitigation (dB re 1uPa) [2]	12) DISTANCE ship would have moved given length of mitigation and nominal 10-knot ship speed (yds)	13) IF source in use hull-mounted, true bearing, animal travel	14) Observed behavior
SUS-TEX	Jan	dolphin	10	DDG	1	<200	na [1]	<190 dB	nr	-	-	na	dolphins bowriding
IAC2	Mar	dolphin	18	DDG	10	<200	SD	<190 dB	nr	none	-	dolphins 320 from ship, ship crs 294, dolphins opening	dolphins opening range from ship
IAC2	Mar	dolphin	12	DDG	30	<200	SD	<190 dB	nr	none	-	dolphins 280 from ship, ship crs 294, opening	none reported
C2X	May	whale	1	DDG	3	<200	PD	<190 dB	15	for 15 min	5070	whale 200 from ship, ship crs 350, whale moving away from ship (opening)	blowing
C2X	May	pinniped	1	FFG	1	<200	SD	<180 dB	18	none for 18 min	6084	seal 170 from ship, ship crs 101	none reported
C2X	May	dolphin	8	DDG	15	<200	SD	<190 dB	15	none for 15 min	5070	dolphins 331 from ship, ship crs 331	none reported
C2X	May	pinniped	1	DDG	1	<200	SD	<190 dB	60	none for 60 min	20280	pinniped 060 from ship, ship crs 150, pinniped opening	momentarily observed off port bow
C2X	May	whale	1	DDG	2	<200	SD, MAN	<190 dB	30	none for 30 min	10140	whale 345 from ship, ship crs 345	grey whale surface off starboard bow
C2X	May	whale	1	FFG	3	<200	SD	<180 dB	7	none for 7 min	2366	whale 300 from ship, ship crs 282	none reported
JTFEX	Jun	dolphin	27	CG	3	<200	SD	<190 dB	15	none for 15 min	5070	dolphins 115 from ship, ship crs 205, swimming parallel to ship	none reported
JTFEX	Jun	dolphin	25	DDG	1	<200	SD	<190 dB	10	none for 10 min	3380	dolphins 350 from ship, ship crs 333, dolphins swimming away (opening) from ship	none reported
JTFEX	Jun	whale	1	DDG	1	<200	SD	<190	12	none for 12 min	4056	whale 204 from ship, ship crs 199	blowing surfaced off bow then dove
JTFEX	Jun	whale	1	DDG	5	nr [1]	SD	nr	30	none for 30 min	10140	whale 250 from ship, ship crs 267	blowing
JTFEX	Jun	dolphin	10	DDG	3	<200	SD	<190 dB	15	none for 15 min	5070	dolphins 140 from ship, ship crs 145, dolphins opening from ship	surfaced pod of dolphins
JTFEX	Jun	dolphin	50	DDG	2	<200	SD	<190 dB	3	none for 3 min	1014	dolphins 170 from ship, ship crs 170, dolphins swimming and bowriding	bowriding
notes:													

1) MTE	2) Month (2009)	3) Species Sighted	4) # of marine mammals sighted	5) Platform	6) Length of time observed (min)	7) Range at which marine mammal sighted	8) Mitigation [secure (SD); power down (PD); maneuver ship (MAN) [1]]	9) Estimate MAX. exposure PRIOR to mitigation (dB re 1uPa) [2]	10) Number of minutes sonar mitigation applied (min)	11) Estimate exposure AFTER mitigation (dB re 1uPa) [2]	12) DISTANCE ship would have moved given length of mitigation and nominal 10-knot ship speed (yds)	13) IF source in use hull-mounted, true bearing, animal travel	14) Observed behavior

[1] na= not applicable; mitigation not applicable if dolphins are determined to be bowriding; nr = not reported

[2] Estimated exposure based on 20Log[R] spherical spreading propagation loss for ranges less than 1000 yards and where nominal MFAS source level (SL) assumed to be 235 dB for DDG and 225 for FFG (Urick 1982). Actual operating parameters and oceanographic conditions likely result is lower exposures. This calculations assumes exposure prior to mitigation. Once animal was spotted at the range indicated, applied mitigation would have resulted in much lower to no exposures.

Estimated exposures within 2000 yards can be determined based on standard formulas of how sound propagates in water. Spherical spreading is generally valid within 1000 yards from the sound source, and can be expressed as spreading loss [in decibels (dB) from a source] equals 20logR [with "R" being range from the source in yards (Urick 1982)]. Spherical spreading loss in the first 1000 yards equates to 60 dB of loss. At ranges between 1000 and 2000 yards the sound waves become trapped by the sea surface and bottom and cannot expand vertically. The spreading wave then forms an expanding cylinder. Cylindrical spreading loss in dB between two points can be calculated by using the formula $10\text{Log}R_2/R_1$. Cylindrical spreading loss between 1000 and 2000 yards equates to an additional 3 dB of loss. By the time the sound wave has propagated to 2000 yards the sonar signal strength has decreased by a total of 63 dB. Using the AN/SQS-53 sonar as an example transmitting at 235 dB subtracting the 63 dB of spreading loss equates to an estimated sonar Receive Level (RL) of 172 dB at 2000 yards. The spreading loss formulas are used to make very conservative assumptions about potential exposure. The formula is an estimation of spreading losses only and does not take into account other factors that could increase the total propagation losses such as oceanographic conditions, attenuation losses, scattering losses, and Navy-unique MFAS operating parameters which would result is slightly lower sonar transmit levels. Use of this approach to estimate potential Receive Levels (RL) at any given animal assumes the horizontal range from a visual sighting accounts for an animal across all depths at which an animal travels to predict the maximum, worst case potential exposure. In other words, this estimated worst case exposure is presented independent of the animal's actual depth level, since a) time and depth of current and previous dives cannot be deduced from a limited surface sighting, and b) oceanographic and tactical conditions influence actual sound propagation at different depths. Given relative motion of ships and animals at sea, the time spent with any given exposure from surface ships is likely to be limited.

SOCAL MONITORING ACCOMPLISHMENTS

There were notable monitoring successes and significant lessons learned in trying to implement SOCAL compliance monitoring as specified by the Monitoring Plan, and in leveraging existing marine mammal monitoring programs funded by different Navy offices. For reference during this discussion, **Figure II-1** shows the SOCAL Range Complex and associated key land and bathymetric features within the region discussed in terms of monitoring areas.

In general, the majority of monitoring effort was attempted within and adjacent to the San Nicolas Basin, an area west of San Clemente Island that also has a Navy permanently instrumented underwater passive acoustic tracking range. The reason for a primary focus on this area was to leverage multiple survey and monitoring techniques used by both the U.S. Pacific Fleet compliance monitoring and N45 R&D monitoring within a key training area. Other areas selected for monitoring included the Catalina Basin and San Diego trough (and surrounding underwater ridges and knolls) between San Clemente Island and the California coastline, and the San Clemente Basin (and surrounding underwater ridges and knolls) south of San Clemente Island (**Figure II-1**)

The two text boxes on the following pages highlight some of the major cumulative accomplishments for marine mammal monitoring within the SOCAL Range Complex from August 2008 to 01 August 2009. **Tables II-5** and **II-6** summarize the level of Navy-funded monitoring effort and specific accomplishments. **Table II-5** presents the level of effort for monitoring in terms of the goals set forth in the SOCAL Monitoring Plan. In addition, the value added leveraging from the Navy's R&D program conducted within SOCAL is also shown. Detailed level of effort and specific metrics (hours of effort, length of cruise, number of sightings, etc.) are provided in **Table II-6**.

Some survey data is still being analyzed and some of the value reported in Tables II-5 and 6 will increase when final summaries are completed. As of this report date, key statistics include:

- 19,700 nm of visual survey effort
- 1,533 marine mammal sightings of groups or individuals
- 78,635 estimated number of marine mammals sighted
- >10,000 hours of passive acoustic echolocation and vocalization data collected
- 8,148 digital photos and 227 minutes of digital video taken
- 54 tissue biopsies collected
- 12 satellite tracking tags attached to individual marine mammals, including two Cuvier's beaked whale

Major accomplishments from the U.S. Pacific Fleet's FY 2009 compliance monitoring in SOCAL include:

- Aerial Visual Survey (Compliance Monitoring)
  - The significant distance surveyed and quantity of marine mammal sightings obtained during the Oct-Nov 2008 and June-July 2009 SOCAL aerial surveys represent the most up-to-date and comprehensive visual surveys for marine mammals in the SOCAL/SOAR vicinity since the SWFSC aerial surveys in 1998-99 (Carretta et al. 2000);
    - Completed 114 hours (over 24 cumulative days) out of 120 hours scheduled for aerial visual surveys;
    - 11,219 nm of ocean surveyed;
    - 701 sightings of individuals or groups for an estimated total of 50,527 marine mammals;
    - 5,730 digital photo imagines of marine mammals were taken;
    - 227 minutes digital video of marine mammals were taken;
  - Unique extended focal follows by airplane were performed for blue, fin, and humpback whales, and Risso's dolphins, and small (<~50) groups of bottlenose dolphins, common dolphins, and Pacific white-sided dolphins (focal groups explained in aerial survey discussion).
    - 93 focal groups circled for 5-9 min;
    - 27 extended focal groups circled for >10 min (species included blue whales, bottlenose dolphins, common dolphins spp., fin whales, humpback whales, and Risso's dolphins)
    - Longest duration focal follow: fin whale group for 60 min.
  - Seven systematic assessments of marine mammal reactions to aircraft at various altitudes (one blue whale, one fin whale, two common dolphin spp., and three Risso's dolphins)
- Vessel Visual Survey (Compliance Monitoring)
  - Completed 70 hours of a ship board visual survey over eight days. This represents an additional 10 hours of effort over the FY09 planned amount of 60 hours;
  - 539 nm of ocean surveyed;
  - 153 sightings of individuals or groups for an estimated 2,321 marine mammals;
  - 36 passive acoustic detections by species made during concurrent PAM from towed array.
- Passive Acoustic Monitoring (Compliance Monitoring)
  - Deployment in January 2009 of two new high-frequency acoustic recording packages (HARP) in areas of interest within SOCAL and funding for analysis provided to Scripps Institute of Oceanography;
    - >108 days and >2,500 hours of passive acoustic date from marine mammal vocalizations before, during, after, and between Navy training events were recorded.

Major accomplishments from the CNO N45's August 2008 to August 2009 R&D monitoring in SOCAL include:

- Vessel\Boat Visual Surveys ***** (R&D Monitoring)-
  - Completed 1,040 hours of boat and small craft (RHIB) visual survey effort;
  - 7,636 nm of ocean surveyed;
  - 30-day deployment of stationary FLoating Instrument Platform (FLIP) for visual and PAM adjacent to Navy instrumented range (SOAR)
  - 679 sightings of individuals or groups for an estimated total of 25,787 marine mammals;
  - 2,418 digital photo images of marine mammals taken;
  - 54 tissue samples (biopsies) collected

  **** not all summary statistics have been tabulated for 2009 as of this report date***

- Passive Acoustic Monitoring (R&D Monitoring)
  - Continued data collection from 10 additional HARPs, some having been deployed in SOCAL since 1999
  - Over >10,000 hours of passive acoustic marine mammal vocalization data recorded from HARPS; analysis ongoing
  - Two field validation experiments with the Navy's Marine Mammal Monitoring on Navy Ranges (M3R); continuous passive acoustic data collection in support of M3R program begun in February 2009 on the Navy's instrumented underwater range west of San Clemente Island;
  - 118 passive sonobuoys deployed on SOCAL cruises associated with the California Cooperative Oceanic Fisheries Investigation (CalCOFI) program
- Tagging (R&D Monitoring)
  - 12 satellite tracking tags were attached to four different species for varying amounts of time (eight fin whales, two Cuvier's beaked whales, one Risso's dolphin, and one bottlenose dolphin). Tagging of Cuvier's beaked whales, Risso's dolphin, and bottlenose dolphin represent the first every tagging of these species in SOCAL;

Table II-5. U.S. Navy funded marine mammal monitoring from August 2008 to August 2009 in terms of SOCAL Range Complex Monitoring Plan compliance.

Study Type And Goal	U.S. Navy EIS/LOA Compliance monitoring	MTE?	U.S. Navy R&D funded monitoring	MTE?
Aerial Surveys (AS) **(studies 1,2,3,4,5)** **120 hrs**	1) **27 hours 17-21 Oct 2008** over 2,380 nm 2) **23 hours 15-18 Nov 2008** over 2,140 nm 3) **30 hours 05-11 Jun 2009** over 2,943 nm 4) **34 hours 20-28 Jul 2009** over 3,389 nm	During COMPTUEX After JTFEX After JTFEX During COMPTUEX [1]	-	-
Marine Mammal Observers (MMO) **(studies 2, 5) 36 hrs**	*See text*		-	-
Vessel surveys (VS) **(studies 3, 4)** **60 hrs**	1) **70 hours** 21-28 July 2009 over 845 nm	Non-sonar COMPTUEX	1) **228+ hours** 2-10 Aug 2008 over 734 nm (CRC RHIB, SIO RHIB, R/V Sproul) 2) **240 hour**s 13 Oct-12 Nov 08 (FLIP) 3) **267+ hours** 17-30 Oct 2008 over 1,073 nm (CRC RHIB, SIO RHIB, R/V Sproul) 4) **27 hours** 9-14 Mar 2009 over * nm (R/V Sproul) 6) * **hours** 15-20 May 2009 over * nm (R/V Sproul) 7) **81 hours** 18-26 July 2009 over 777 nm (CRC RHIB) 8) **70 hours** 20-28 July 2009 over 682 nm (SIO/SWFSC RHIB)	No exercise ongoing During COMPTUEX During IAC2 and SUSTEX During IAC2 and SUSTEX During COMPTUEX During COMPTUEX [1] During COMPTUEX [1]
Marine Mammal Tagging (MMT) **(studies 1, 2, 3)**	-	-	1) **4** tags deployed (Aug, Oct 2008) (1 Cuvier's beaked whale, 3 fin whales [2]) 2) **8** tags deployed (15-30 July 2009) on four species (5 fin whales, 1 adult male Cuvier's beaked whale, 1 bottlenose dolphin [2], 1 Risso's dolphin [2])	During COMPTUEX During COMPTUEX
Passive Acoustics Monitoring (PAM) **(study 2)** **Integrate existing**	1) **2** new U.S. Pacific Fleet funded High-frequency acoustic recording packages (HARP) deployed Jan 2009 [3]; over 108 days and 2,604 hours PAM recorded, analysis ongoing	During 5 MTEs	1) **10 HARPS**. * hours acoustic data recorded 2) **2 M3R field validations**. * hours passive acoustic data recorded 3) **1 FLIP deployment**. * hours passive acoustic data recorded 3) **Towed arrays and Sonobuoys** (CalCOFI , see below). 526 hours recorded	During 5 MTEs During 5 MTEs During 5 MTEs
CalCOFI	-	-	1) total hours of marine mammal VS 93 hours 14-30 Aug 2008 86 hours 14-29 Oct 2008 76 hours 08-23 Jan 2009 83 hours 08-23 Mar 2009 * hours 14 Jul- 05 Aug 2009 2) 118 sonobuoys deployed (passive AN-SSQ-57B)	During: COMPTUEX No IAC2 and SUSTEX No Non-sonar COMPTUEX During 3 MTEs (above)
TOTALS	114 hours AS 701 sightings of 50,527 marine mammals, 11,219 nm of effort, 5,730 digital photos taken 70 hours VS 153 sightings of 2,321 marine mammals) 2 PAM devices deployed 2,604 hours passive acoustic data collected		1,040 hours VS 679 sightings of 25,787 marine mammals over 7,636 nm of effort 2,418 digital Photo/ID images taken; 54 biopsies taken 526 hours passive acoustic data recorded (towed array and sonobuoys only) 12 tags attached	

Notes: * not all summary statistics have been tabulated for 2009 as of this report date

[1] NO anti-submarine warfare planner or sonar used during this MTE; monitoring was planned and contracted prior to Navy change to MTE composition

[2] First ever SOCAL tag deployments on these species (Cuvier's beaked whale, Risso's dolphin, bottlenose dolphin)

[3] PAM: HARPS- 2 bottom deployed Jan 2009, one within SOCAL Range Complex (East Cortes Basin), one outside of complex boundaries (Santa Cruz Basin) as a control. 10 other HARPs deployed both within and outside of SOCAL Complex. Some HARPs continuously deployed since 1999; M3R- near continuous field recording of marine mammal vocalizations on SOAR from Mar-Aug 2009. Two field validation of beaked whale detector concurrent with small boat visual sighting s and other marine mammal detections 2-10 Aug 2008 and 15-30 Jul 2009

Table II-6. Cumulative total of effort and accomplishments from Navy funded monitoring in SOCAL from August 2008 to August 2009.

N= CNO N45, P= U.S. Pacific Fleet, NPG= Naval Postgraduate School; S= Scripps Institute of Oceanography, C= Cascadia Research Collective, M= Marine Mammal Research Consultants

Navy funding	Performing Organization	Survey Dates or Window	Participating Vessels	# Days (days)	Total Survey Time (hrs)	Total Survey Distance (nm)	# Groups	# Individuals	# Species visually sighted	Digital Photo/ IDs (#)	Digital video taken (min)	Biopsies (#)	Satellite Tags (# tags)	# Passive recordings (#)	Total passive recording (hrs)	# Acoustic detection (#)	# Species acoustically detected (#)	# Passive sonobuoys (# buoys)
N	S,C	2-10 Aug 08	2 CRC RHIBs, 1 SIO RHIB, Sproul [1, 3]	31	229	734	147	5,698	10	36	-	11	2	*	*	*	*	*
N	S,C	14-30 Aug 08	CalCOFI	17	93	895	58	1,007	8	227	-	-	-	65	139	51	8	31
N	S,C	14-29 Oct 08	CalCOFI	17	86	727	36	732	6	81	-	-	-	61	126	67	8	29
N	C	17-30 Oct 08	1 CRC RHIB, 1 SIO RHIB, Sproul [2, 3]	28	267	1,073	61	4,771	13	54	-	10	2	*	*	*	*	*
N	S	13 Oct-12 Nov 08	FLIP	30	*	-	*	*	*	*	-	-	-	*	*	*	*	*
N	S,C	8-23 Jan 09	CalCOFI	16	76	694	72	984	11	381	-	-	-	59	128	42	8	30
N	S	9-14 Mar 09	R/V Sproul	6	*	*	*	*	*	*	-	-	-	*	*	*	*	-
N	S,C	7-23 Mar 09	CalCOFI	17	83	768	29	440	7	223	-	-	-	59	133	29	6	28
N	S	15-20 May 09	R/V Sproul	6	*	*	*	*	*	*	-	-	-	*	*	*	*	*
N	C	18-26 July 09	1 CRC RHIB [4]	9	81	777	76	3,282	10	228	-	8	8	-	-	-	-	-
N	S	20-28 Jul 09	1 SIO RHIB	8	70	682	42	3,250		1,175	-	25		33	*	-	-	-
N	S	14 Jul-05 Aug 09	CalCOFI	25	*	1,006	110	2,050	*	*	-		-	*	*	*	*	*
P	M	17-21 Oct 08	Partenavia P-68-C	5	27	2,380	115	12,587	10	2,330	95	-	-	-	-	-	-	-
P	M	15-18 Nov 08	Partenavia P-68-C	4	23	2,140	185	5,732	8	-	-	-	-	-	-	-	-	-
P	M	5-11 June 09	Partenavia P-68-C	6	30	3,192	161	9,489	11	1,099	83	-	-	-	-	-	-	-
P	M	20-29 July 09	Partenavia P-68-C	9	34	3,507	240	22,719	10	2,301	49	-	-	-	-	-	-	-
P,N	S,C	21-28 July 09	R/V Sproul [4]	8	70	845	153	2,321	10	13	-	-	-	*	*	36	*	-
NPG	NPG	24-28 July 09	R/V New Horizon [5]	5	56	280	48	3,573	8	*	-	-	-	*	*	*	*	-
				247	**1,224**	**19,700**	**1,533**	**78,635**		**8,148**	**227**	**54**	**12**	**277**	**526**	**225**		**118**

* = data not available as of this report date

1 Does not include effort hours for SIO RHIB; does not include survey distance for Sproul, SIO RHIB

2 Does not include survey distance for SIO RHIB

3 PhotoID # is the actual number of fin whales and beaked whales identified, IDs of bottlenose and Risso's are not processed as of 01 August 09 and not included in this total

4 Estimated number of IDs, including fin whales, Cuvier's beaked whales, bottlenose and Risso's dolphins

5 Does NOT yet include photoID of fin whale for R/V Horizon/NPG July effort

RANGE COMPLEX AERIAL VISUAL SURVEYS

FY09 Monitoring Plan Objectives: (120 hours) Portions of major exercises, intermediate level exercises, or Unit Level Training (ULT) events using mid-frequency active sonar (MFAS), and offshore detonation events [STUDY 1,3, 4 exposures and behavioral responses]; Portions of major or intermediate MFAS exercises [STUDY 5 mitigation effectiveness]

Monitoring Plan Accomplishment: Given the limited number of offshore in-water explosive events in SOCAL this year (DoN 2009b) combined with variable unspecified locations at sea and typical short duration (<1-4 hours) of the events, aerial monitoring for explosive events were not conducted. The focus of 2009 aerial monitoring, therefore, was to associate monitoring effort specifically with MTEs. Approximately 114 hours of aerial visual survey effort was performed out of 120 hours planned and scheduled. The difference accounts for lost flight time when the aircraft could not perform visual survey due to inclement weather, which for SOCAL consisted mostly of low-lying (<1,000 ft) clouds and fog. Note, the Navy is not intending to make up the approximately six hours lost to weather in 2010. These surveys were planned and funded to support a 120 hour aerial effort, and the plane and survey crew were on station and available during the July period, but unable to fly. The quality and quantity of data obtained from the accomplished aerial survey hours supports the assertion that aerial monitoring provided valuable data for the SOCAL Range Complex in terms of the SOCAL Monitoring Plan.

Summary: Visual surveys of marine animals can provide detailed information about behavior, distribution, and abundance of marine mammals and sea turtles. Baseline measurements and data for comparison can be obtained before, during, and after training exercises. Aerial surveys also offer an excellent opportunity for detailed behavioral focal observations using established protocol, allow for observation of marine mammals below the surface (0-30+ feet depending on water clarity), and were able to cover a given search area in a shorter time.

For SOCAL Compliance Monitoring, four aerial surveys were conducted within the SOCAL Range Complex between October 2008 and August 2008 (**Table II-7)**. The detailed report for the 17-21 October 2008 and 15-18 November 2008 surveys contains a complete description of methodologies used during all SOCAL aerial surveys (Smultea et al. 2009) (see **Appendix G**).

Partenavia P-68-C fixed wing, twin-engine aircraft used during SOCAL aerial surveys (Oct 08)

Surveys were conducted with a Partenavia P68-C flying at 100 knots groundspeed and 1,000 feet altitude during transects, and 1,200-1,500 ft altitude and 0.2-0.5nm radial distance during focal follows. Observations involved a pilot and three professionally trained marine mammal biologists. One biologist was the data recorder/video and still camera operator and the other two were observers (one of whom was a recorder during focal sessions). Line-transect surveys followed standard methodology flying a grid pattern perpendicular to coastal and major bathymetric features. Behavioral observation methods generally followed protocols previously implemented from small fixed-wing aircraft to monitor baseline distribution, behavior and reactions of cetaceans to various anthropogenic stimuli, including past Navy

MTEs. Behavioral state, heading and spacing between individuals (in body lengths) were recorded when a group was first sighted. This was typically followed by circling of the sighting to (1) photo-verify species, estimate group size/calf presence and collect behavioral variables using scan sampling, and/or (2) conduct an extended focal follow involving continuous and/or scan sampling and video recording. Extended focal follows were conducted by circling at an altitude and radius (see above) greater than "Snell's cone," where submerged animals are not expected to be able to hear and thus, not react to the aircraft based on past studies and physical acoustics.

Figure II-3 highlights some of the range of visual conditions ranging from excellent to poor experienced during the SOCAL aerial surveys (Oct-Nov 08 clear Santa Ana conditions and July 09 periodic low clouds and fog).

Table II-7. Aerial survey results in the SOCAL Range Complex from October 2008 to July 2009.

Survey Date	Time Flown (hrs)	Distance Flown (nm)	MTE?	Approximate SOCAL Areas Surveyed (see Figures II-1 and II-9 for more detail)	# Of Indiv. Or Grp. Sightings	Total # Of Marine Mammals Sighted	Notes
17-21 Oct 2008	27	2,380	During COMP-TUEX	Catalina Basin and San Diego Trough (east of San Clemente Island-SCI); San Nicolas Basin (west of SCI)	115	12,587	From both OCT and NOV surveys: 2,330 digital photos taken ; 95 min. digital video taken; observation of 42 unique focal follows (from 5 to 60 min) of fin, humpback and blue whales, Risso's dolphins, and small (<~50) groups of bottlenose, common, and Pacific white-sided dolphins
15-18 Nov 008	23	2,140	After JTFEX	Around SCI; Catalina Basin and San Diego Trough (east of San Clemente Island); San Nicolas Basin (west of San Clemente Island); San Clemente Basin (south of SCI)	185	5,732	
5-11 Jun 2009	30	3,192	After JTFEX	Around SCI; Catalina Basin and San Diego Trough (east of San Clemente Island); San Nicolas Basin (west of San Clemente Island)	161	9,489	1,099 digital photos taken; 83 min digital video taken; observation of 31 unique focal follows (from 5 to 48 min)
20-28 Jul 2009	34	3,507	During non-sonar COMP-TUEX	Catalina Basin and San Diego Trough (east of San Clemente Island); San Nicolas Basin (west of San Clemente Island)	240	22,719	2,301 digital photos taken; >49 min digital video taken; observation of 45 unique focal follows (from 5 to 38 min)
Totals:	**114**	**11,219**			**701**	**50,527**	

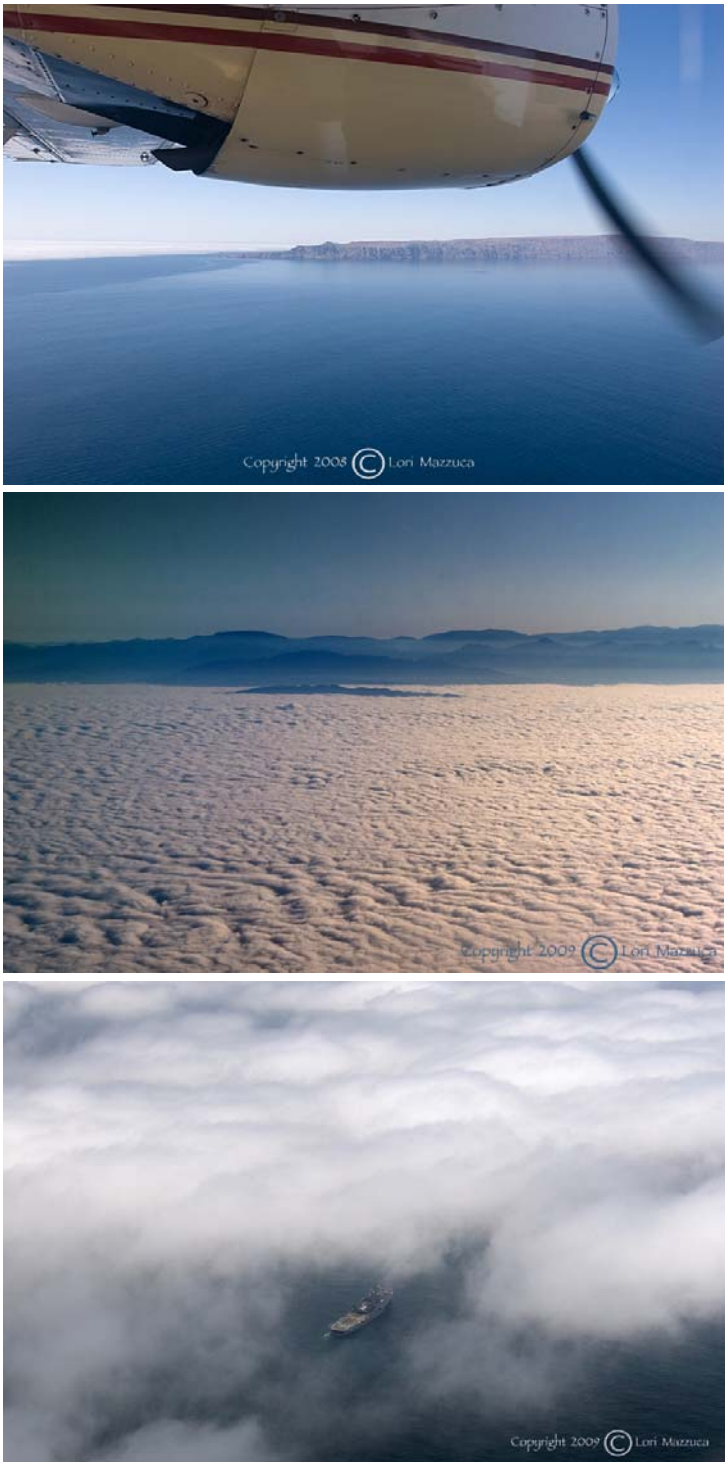


Figure II-3. SOCAL weather conditions experienced during aerial surveys in Oct08 and Jul09.

(top) calm conditions (Oct 08) during SOCAL Santa Ana weather, (middle) offshore low clouds and fog that hindered visual search (Jul 09), and (bottom) low clouds with patchy breaks and Navy ship seen below (Jul 09) in clouds

17-21 OCTOBER 2008 AND 15-18 NOVEMBER 2008 AERIAL SURVEYS RESULTS

During an concurrent MTE from 17-21 Oct 08, approximately 27 hours of survey was conducted over 2,380 nm of tracklines (**Figure II-4)**. A total of 115 marine mammal sightings were reported for an estimated 12,587 individuals. Species identified included: three whale species (blue, fin, and Bryde's), four dolphin species (bottlenose, short- and long-beaked common, and Risso's), and two pinniped species (California sea lion, and harbor seal). Overall, the common dolphin was the most frequently identified cetacean species and genus in terms of both number of groups and individuals (81% of total individuals)(**Table II-8**).

Following a MTE from 15-18 Nov 2008, approximately 23 hours of survey was conducted over 2,140 nm of tracklines. A total of 185 marine mammal sightings were reported for an estimated 5,732 individuals. Species identified included: two whale species (fin and humpback), three dolphin species (common, Pacific white-sided, and Risso's), and three pinniped species (California sea lion, harbor seal, and northern elephant seal). Overall, the common dolphin was the most frequently identified cetacean in terms of both number of groups and individuals (66% of total individuals) (**Table II-8**).

Figure II-5 shows example key marine mammal photographs and approximate sighting location during either the Oct or Nov aerial survey.

Sighting Rates- Overall, sighting rates for individual marine mammals were higher during the MTE period in Oct (2.71 indiv/km) vs. after the MTE in Nov (1.85) based on all sightings made during systematic and random effort (excluding circumnavigation of San Clemente Island in Nov); however, the actual SOAR MTE area was not surveyed in Oct given airspace conflicts. Conversely, overall sighting rates for groups was lower in Oct (0.029 groups/km) vs. Nov (0.047 groups/km). Based on known species or genus, sighting rates were highest for common dolphins in both Oct and Nov. The combined sighting rate for all common dolphins in Oct (2.4 indiv/km, n = 30 groups) was nearly double that of Nov (1.3 indiv/km, n = 32 groups). However, the sighting rate for confirmed short-beaked common dolphins was similar for Oct and Nov (0.65 vs. 0.53 indiv/km, respectively). The number of sightings and thus sighting rates were considerably smaller for the remaining species (**Appendix G**). Risso's dolphins had the second highest sighting rate in Oct (0.15 indiv/km, n =18 groups), but this rate dropped considerably during Nov when only one group was seen (**Appendix G**). Sightings rates for all whales (including unidentified whales) were under ~0.01 individuals/km, and this rate was higher during Nov than Oct; however, the sample size was small (n = 29 whale groups). No Pacific white-sided dolphins were seen during Oct while the sighting rate was 0.01 indiv/km (n = 12 groups) in Nov.

Distribution- Overall, there was little overlap in survey areas between Oct and Nov given airspace conflicts. In Oct, whales tended to be associated with the edges of bathymetric reliefs such as the edges of the Catalina Basin, though the sample size was small (n = 8). In Nov, whales (mostly baleen whales) were sighted through much of SOAR but appeared to concentrate between southwest San Clemente Island and Tanner Bank to the west. In Nov, another small concentration of whale sightings occurred 11 nm northwest of San Diego directly west of the airport where the survey aircraft crossed nearly daily during transits to survey areas. This area encompassed the La Jolla and Scripps canyons; in contrast, only one whale was seen here in Oct. In Oct, dolphin sightings (primarily common and Risso's dolphins) were associated with the edges of bathymetric reliefs such as the Santa Catalina and Coronado escarpments, the coastal La Jolla and Scripps canyons, and underwater bank drop-offs. Their distribution generally encompassed a northwest-oriented band stretching between San Diego and Santa Catalina Island where the aircraft typically transited from the airport to the small survey grid south of Santa Catalina Island

(**Appendix G**). In Nov, dolphins were again concentrated along underwater drop-offs within the areas surveyed, including along the edges of San Nicholas Basin in SOAR, the drop-off east of Tanner Bank in west SOAR, and the Coronado Escarpment. Very few dolphins were seen during Nov transects in the south portion of the survey area over the San Clemente Rift Valley and the East Cortez Basin. Pacific white-sided dolphins (seen only in Nov) were sighted most frequently off the southwest edge of San Clemente Island over steep bathymetric drops. Pinnipeds were distributed primarily near and between San Clemente Island and Santa Catalina Island both in Oct and Nov, with smaller numbers seen in offshore waters. During the circumnavigation of San Diego on two days in Nov, most pinniped sightings occurred along the northwest and northeast San Clemente Island shoreline, particularly the central west shoreline.

Behavior- Four species or genus had sample sizes considered large enough (n ≥ 8) to warrant summarizing initially observed behavior state, heading, and mean dispersal between individuals: fin whales (n = 12), common dolphins (n = 62), Risso's dolphins (n = 19), and Pacific white-sided dolphins (n = 12). In both Oct and Nov fin whales were nearly always initially observed traveling (**Appendix G**), with just one group engaged in surface-active travel, in Oct. All fin whale groups were first seen headed 46-315º magnetic; none were first seen headed generally north or south. Seven of eight fin whale groups with ≥2 individuals were initially observed ≤6 body lengths apart. The largest mean dispersal distance of >15 body lengths occurred during Nov. In both Oct and Nov for combined common dolphin sightings, most groups were initially observed surface-active milling, surface-active traveling, or traveling; resting/logging was never observed among this genus. The most frequently first-observed heading for common dolphins was bimodal in the opposite directions of northeast/east and southeast/west. Inter-individual dispersal tended to be ≤3 body lengths, particularly in Nov. Most (84%) of the total 19 Risso's dolphins groups with recorded behavioral states were traveling when first seen, with only one group heading recorded in Nov. Risso's were only occasionally first observed milling or surface-active traveling. The most frequently observed headings among Risso's were northeast/east, southwest/west, and northwest/north. Overall, and for Nov, mean distance between individual Risso's tended to be ≤3 body lengths. This distance was considerably higher (10.5 body lengths) for the one Risso's group seen in Oct. Pacific white-sided dolphins were seen only during Nov (n = 12). When first observed, their behavior state tended to be travel. Mean inter-individual dispersal was usually ≤3 body lengths. Heading data were too few (n = 2 group headings) to summarize.

Focal Follows- Most (≥50%) of the 291 cetacean sightings were circled at least several times by the aircraft to photo-verify species and make group-size estimates as needed/feasible. For exploratory analyses and feasibility assessment, any group followed for ≥5 min was considered a "focal follow". Sightings that were followed ≥10 min were considered "extended focal follows" where video was usually taken in addition to photographs. For extended follows, altitude was increased to 1,200-1,500 ft and radial distance maintained as possible at 0.5-1.0 km. Most extended focal follows involved common dolphins (n = 16), followed by fin whales (n = 11) then Risso's dolphins (n = 5). A total of 42 focal follows (including extended follows) ranging in duration from 5-60 min were conducted: 22 in Oct and 20 in Nov (**Appendix G**). The overall mean focal follow duration was 11.9 min, with a mean of 9.8 min in Oct and 13.6 min in Nov. A total of 12 extended focal follows occurred: 5 in Oct and 7 in Nov. The longest extended focal follows occurred with a group of humpbacks on 16 Nov (30 min) and a group of fin whales on 17 Nov (60 min). The latter encounters included unusually long observations and video of whales below the water surface during calm Beaufort 1 conditions. Continuous sampling including video considered suitable to calculate respiration and dive times was conducted on two fin whale and two humpback whale groups. However, it was difficult to maintain consistent continuous uninterrupted

views of individuals during strong glare conditions. Detailed analyses of focal follow behavioral data (e.g., potential changes in orientation, respiration and dive times, etc.) were not conducted given the inability to know MFAS transmission times, the small sample sizes, budget limitations, and goals of the survey. Rather, these aerial surveys were considered exploratory feasibility studies to assess whether such data could be collected and on which species, etc. Future detailed analyses of this kind may be undertaken in the future and combined with results herein to provide a larger sample size.

Unusual Observations- Per the aerial survey objectives, one goal of the aerial surveys was to identify any unusually behaving, injured, stressed, stranded, near-stranded, or dead marine mammals or sea turtles during or after the Oct MTE. As little is known about what constitutes "normal" vs. "unusual" behavior among most cetaceans in the study area, particularly in the field, the ability to make this assessment is ambiguous at best. Other than a dead floating blue whale carcass and two dead California sea lion sightings discussed in **Appendix G**), there were no observations of any animals or behavior that appeared distinctly "unusual" and potentially related to exposure to MFAS. There is no information that Navy training events contributed to these mortalities. As discussed in the SOCAL Final Environmental Impact Statement (FEIS) (DoN 2008b), there are a number of natural mortality sources for marine mammals that are part of the normal population dynamics for common SOCAL species. Ship strikes are also a documented cause of whale deaths off southern California, including blue whales (Jensen and Silber 2004; DoN 2008b; Wilkin et al. 2009).

The observations reported from the October and November aerial survey effort are necessarily limited only to those animals seen. Most of those observations were brief in duration, restricting the ability to make a more informed assessment. One unusual observation was made of a humpback whale creating what appeared to be an underwater bubble cloud while with another humpback on Nov 16. This was considered unusual because it had not previously been seen by the observers with humpbacks off California. However, underwater bubble blowing is a common behavior among feeding humpbacks and humpbacks on the wintering grounds, and humpbacks are known to feed in the general survey region.

Highlights Of The SOCAL October-November 2008 Aerial Survey Monitoring

- The Oct and Nov 2008 aerial survey results show that many marine mammals were seen near the active SOAR area in the SOCAL during the Oct MTE as well as in and near SOAR within 1-5 days after the MTE ended (correlating with the Nov survey days). During Oct, the sighting rate for all marine mammals was 2.71 vs. 1.85 MM/km in Nov (per systematic/random effort excluding Nov San Clemente Island circumnavigation); however, the actual SOAR MTE area was not surveyed in Oct given airspace conflicts.
- Though sample sizes were small, relative sighting rates differed notably for several species in Oct vs. Nov. Differences may be due to sampling error or to the transition from "warm-water" to "cold-water" seasons and species in Oct and Nov as reported by Carretta et al. (2000) for the SOAR region (see later section Past Cetacean Studies in and Near SOAR). For example, three humpback groups were seen in Nov vs. none in Oct. The sighting rate for common dolphins in Oct (during MTE) was nearly double that of Nov (after MTE). In Oct, 18 Risso's dolphin groups were seen vs. 1 in Nov. No Pacific white-sided dolphins were seen in Oct and 8 groups were seen in Nov. In addition, the sighting rate for California sea lions was higher in Nov than Oct attributed to two days of Nov San Clemente Island shoreline surveys where this species aggregates.
- Three sightings of floating carcasses were located and photo-documented. This included shoreline surveys around San Clemente Island on 2 days when a dead California sea lion was photo-verified on both days. A dead blue whale was sighted ~6 km away and photo- and video-documented.

This illustrates the utility and important contribution of aerial surveys for identifying dead, injured, stranded and near-stranded marine mammals.

- There was little overlap in survey areas between Oct and Nov given airspace conflicts. Thus, it is not possible to make direct comparisons between Oct and Nov marine mammal distributions relative to MFAS periods. However, some general trends were observed. In both Oct and Nov, whales and dolphins tended to concentrate along edges of bathymetric reliefs. Cetaceans were distributed through much of SOAR in the post-MTE period, particularly off the southwest edge of San Clemente Island characterized by steep bathymetric relief, especially Pacific-white-sided dolphins. In Nov, whales (mostly baleen whales) were sighted through much of SOAR but appeared to concentrate between southwest San Clemente Island and Tanner Bank to the west. In both months, cetaceans were frequently seen ~20 km northwest of San Diego directly west of the San Diego coastline where the survey aircraft crossed nearly daily during transits to survey areas. Pinnipeds were seen predominantly along and between the San Clemente Island and Santa Catalina coastlines.
- Basic quantifiable behavioral data (behavior state, heading, inter-individual dispersal distance) were collected from most cetacean sightings. These variables can be useful indices of disturbance per previous studies (see **Appendix G**). Based on limited sample sizes, trends in exploratory analyses indicate that these behavior variables were similar in Oct and/or Nov within four cetacean species: fin whale, common dolphin, Risso's dolphin, and Pacific white-sided dolphin. However, common dolphins appeared to head predominantly northeast/east and southwest/west in both Oct and Nov.
- Mean group size of common dolphins shifted notably with considerably larger groups in Oct (397 indiv/group, n = 30) vs. Nov (89 indiv/group, n = 32). Carretta et al. (2000) reported a similar downward trend in group size during warm- vs. cold-water seasons. These patterns may be related to regional differences in survey areas in Oct and Nov, seasonal oceanographic changes, prey movement, or other natural life-history or environmental conditions. Further study and larger samples sizes are needed to evaluate whether these differences are significant in terms of natural variation or may potentially be influenced by MTE events.
- Focal follows as documented by photographs or video demonstrated that all species observed could be tracked below the water surface from the aircraft, some for longer periods than others dependent on Bf conditions, body coloration, behavior state, etc. This addressed one of the project hypotheses and predictions. It also addressed goals of the SOCAL Marine Mammal Monitoring Program (DoN 2009b).
- Data were collected using previously established protocol as a guideline, tailored for the region and species of interest. The resulting protocol was recently used during similar aerial surveys for Navy monitoring off San Diego and Hawaii in June 2009 (Smultea et al. 2009b). Assessing "the efficacy and practicality of monitoring" techniques in this manner meets goals of the range complex monitoring plans (DoN 2009a, 2009b). This aerial survey effort contributes to the ultimate goal of developing, establishing and ensuring standardized data-collection techniques that facilitate comparison between and among different data from future SOCAL and other Navy range monitoring efforts, a goal of the range complex monitoring plans and the Navy-wide Integrated Comprehensive Monitoring Program (ICMP)(DoN 2009b).
- Sample sizes of some species (mainly common dolphins) may be sufficiently large in SOCAL to estimate density and abundance of animals, including relative to MTE activities, particularly if combined with future survey data in this area. Related exploratory analyses to assess density and abundance are planned to be conducted.
- Extended focal follows of fin, humpback and blue whales, Risso's dolphins, and small (<~50) groups of common dolphins, Pacific white-sided dolphins, and bottlenose dolphins can successfully be

conducted from an aircraft circling at 1,200-1,500 ft similar to previous studies, including videotaping (**Appendix G**). These parameters have been shown to minimize and avoid the potential for focal cetaceans to be disturbed by the aircraft (see Introduction and Snell's cone discussion, **Appendix G)**. This protocol should be followed unless it can be demonstrated that particular species do not exhibit detectable reactions to the aircraft at closer distances. To our knowledge, focal follows of most cetaceans encountered, involving circling of a group from an aircraft and systematic collection of behavioral data, had not been previously conducted, with the exception of humpback and bottlenose dolphins in other regions outside of SOCAL. Survey results successfully demonstrated that extended focal sessions can be conducted on priority ESA-listed and "surrogate" deep-diving species (DoN 2009b) such as the Risso's dolphin. Behavioral observations made during focal follows in Oct and Nov are also scientifically unique and noteworthy for Southern California waters, and further demonstrate the feasibility of this methodology for these and other marine mammal species.

- Effort was successfully performed without interfering with at-sea Navy training involving multiple Navy assets. However, extensive multi-command pre-survey coordination is required in order to obtain permission for airspace access. At least for the SOCAL 2008 MTEs, areas where the observer aircraft could fly during a MTE without potential airspace conflict were limited, sometimes to relatively small areas, and accessible areas changed on short notice. Although not experienced during the Oct and Nov MTEs, there may be future MTEs where, due to Navy needs, MTE schedules change (move to different dates, get cancelled, etc.) quicker than aerial survey contracting can accommodate. Effective communications between experienced aircraft pilots familiar with Navy air space procedures, and the Navy air tower allowed observers to maximize the periods they could fly safely. In addition, the aircraft observer team operated on standby as practicable, and could adapt to short-notice changes in airspace schedules.
- Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for future planned Navy activities identified in the SOCAL EIS/OEIS and monitoring plan (DoN 2008, 2009b). As such, the survey contributes to the "overall knowledgebase of marine species", a goal of the SOCAL monitoring (DoN 2009b).
- This survey helped to identify both limitations of and recommendations for future SOCAL and other monitoring-related effort. Information gathered can be used to continue developing effective monitoring approaches and to gather behavioral data on the potential effects or lack of effects of Navy activities on marine resources as required under the SOCAL monitoring plan.

Table II-8. Summary of marine mammal sightings by species during the October and November 2008 aerial monitoring surveys in the SOCAL Range Complex.

Species	17-21 OCTOBER - *During* MTE				15-18 NOVEMBER- *After* MTE			
	# of Groups	# of MM	Mean Grp Size	Sighting Rate (# Indiv. /km)	# of Groups	# of MM	Mean Grp Size	Sighting Rate (# Indiv. /km)
Blue whale	1	2	2.0	<0.01	-	-	-	-
Blue whale (carcass)					1	1	1.0	<0.01
Fin Whale	6	10	1.7	<0.01	5	12	2.4	<0.01
Fin or Sei whale	-	-	-	-	1	1	1.0	<0.01
Bryde's whale	1	1	1.0	<0.01	-	-	-	-
Humpback whale	-	-	-	-	3	7	2.3	<0.01
Unidentified baleen whale	-	-	-	-	1	1	1.0	<0.01
Unidentified large whale	-	-	-	-	8	8	1.0	<0.01
Unidentified medium whale	-	-	-	-	1	2	2.0	<0.01
Bottlenose dolphin	5	34	6.8	0.01	-	-	-	-
Common dolphin sp.	22	8,731	396.9	1.73	27	2,395	88.7	0.57
Long-beaked common dolphin	2	80	40.0	0.02	-	-	-	-
Short-beaked common dolphin	5	1,395	279.0	0.65	5	1,380	276.0	0.53
Possible. common dolphin sp.	1	30	30.0	0.01	-	-	-	-
Pacific white-sided dolphin	-	-	-	-	12	498	41.5	0.01
Risso's dolphin	18	553	30.7	0.15	1	50	50.0	0.02
Unidentified dolphin	10	362	36.2	0.10	13	338	26.0	0.13
California sea lion	37	126	3.4	0.03	53	132	2.5	0.03
California sea lion (carcass)	-	-	-	-	2	2	1.0	<0.01
Harbor seal	1	1	1.0	<0.01	9	15	1.7	<0.01
Northern elephant seal	-	-	-	-	1	1	1.0	<0.01
Unidentified sea lion	-	-	-	-	1	7	7.0	<0.01
Unidentified pinniped	3	3	1.0	<0.01	23	26	1.1	<0.01
Unidentified marine mammal	-	-	-	-	6	26	4.3	0.01
Unidentified small marine mammal	-	-	-	-	6	8	1.3	<0.01
Common dolphin sp. & bottlenose dolphin	2	1,257	637.5	0.35	-	-	-	-
Common dolphin sp. & CA sea lion	-	-	-	-	1	26	26.0	0.01
Common dolphin sp. & Pacific white-sided dolphin	-	-	-	-	1	300	300.0	0.12
Short-beaked common & Pacific white-sided dolphin	-	-	-	-	1	400	400.0	0.15
Short-beaked common dolphin & CA sea lion	-	-	-	-	1	60	60.0	0.02
Pacific white-sided dolphin & CA sea lion	-	-	-	-	1	22	22.0	0.01
Unidentified dolphin & CA sea lion	-	-	-	-	1	14	14.0	0.01
Totals:	**115**	**12,587**			**185**	**5,732**		

Data from Smultea et al. 2009 Appendix G)

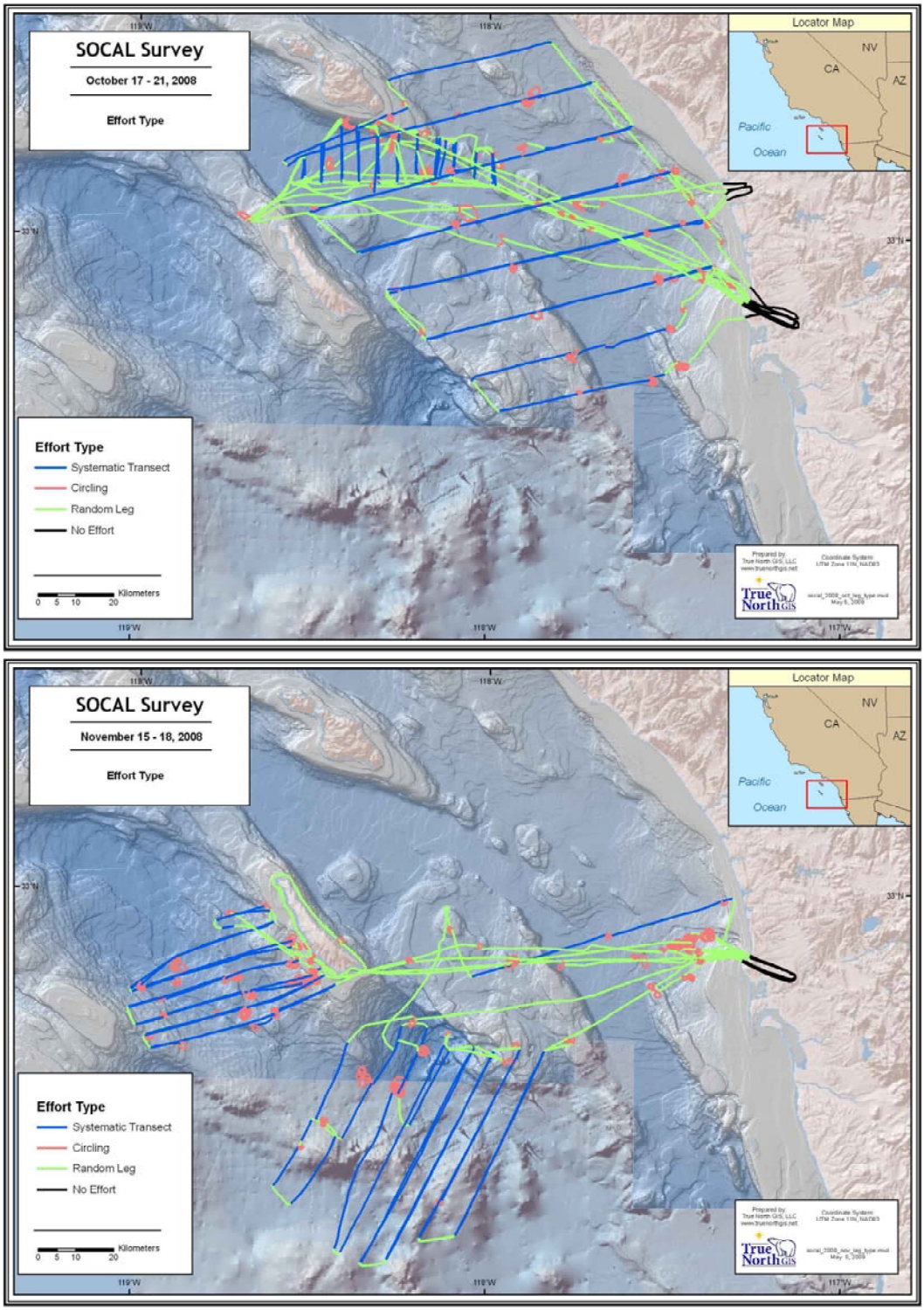


Figure II-4. Aerial survey track lines and observation effort in SOCAL during a Major Training Event (MTE) (15-21 Oct 2008 - top panel), and after a MTE (15-18 Nov - bottom panel).

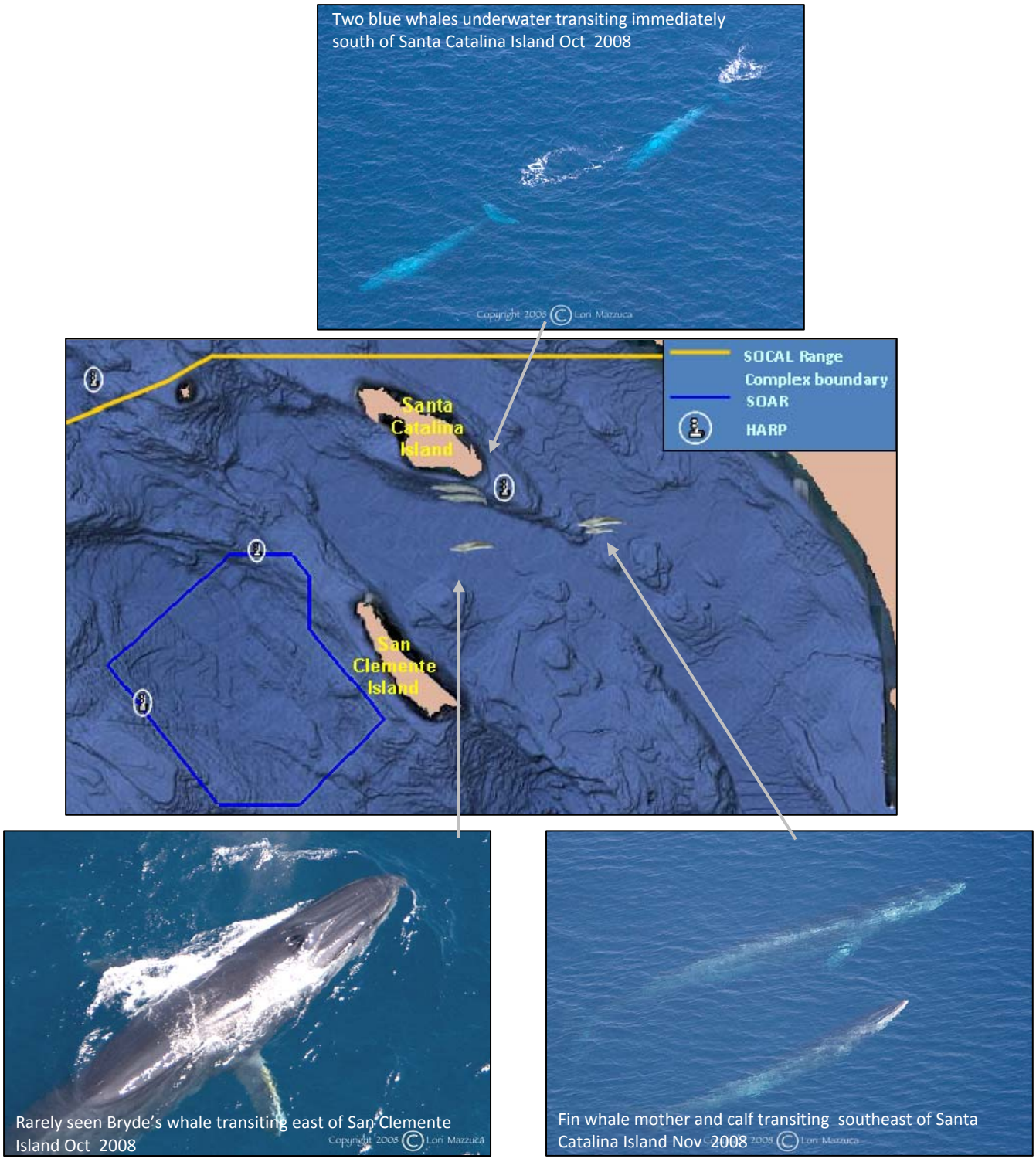


Figure II-5. Marine mammal photographs and approximate locations of sighting during Oct and Nov aerial surveys.

5-11 JUNE 2009 AND 20-29 JULY 2009 AERIAL SURVEYS RESULTS

Following a MTE from 5-11 Jun 09, approximately 30 hours of survey was conducted over 3,192 nm of tracklines (**Figure II-6**). A total of 161 marine mammal sightings were reported for an estimated 9,489 individuals. Species identified included: three whale species (blue, fin, and humpback), four dolphin species (bottlenose, common, Northern right whale, and Risso's), and two pinniped species (California sea lion, and harbor seal) (**Table II-9**).

There were 24 focal groups circled (5-9 min each), seven extended focal group circled (>10 min) with the longest extended focal follow being 48 min with a fin whale. In addition, there were three systematic assessments of reactions by marine mammals to presence of an aircraft at various altitudes (one blue whale, 1 fin whale, 1 Risso's dolphin).

From 20-29 Jul 09, approximately 34 hours of survey was conducted over 3,389 nm of tracklines during a SOCAL MTE that had no ASW or sonar planned (**Figure II-7)**. Note, the Jul aerial survey had been planned earlier in 2009 prior to the decision by the Navy to delete MFAS use from the July MTE. The decision to not use MFAS was a Navy decision based on operational and logistic needs for this particular exercise. Given deployment and contracting plans already in place, as well as a reporting deadline of effort through 01 August 2009, the aerial survey was allowed to proceed and structured to work in conjunction with other Navy monitoring efforts. Focus of the Jul aerial survey, therefore, was a collaborative endeavor designed to work cooperatively with planned R&D funded monitoring also scheduled for Jul in the same area. For instance, from July 25-26, west of San Clemente Island, aerial and vessel (R/V Sproul performed by SIO) line-transect surveys for marine mammals were successfully conducted simultaneously to passive acoustic monitoring studies by Naval Undersea Warfare Center's (NUWC) Marine Mammal Monitoring on Navy Range Program (M3R) and Scripps Institute of Oceanography (SIO) researchers (visual, towed passive, and bottom-mounted HARPs), and tagging and photo-identification surveys by Cascadia Research Collective (CRC). Analyses are underway to compare results between the various platforms. Complimentary data will be synthesized to provide a 3-D snapshot of marine mammal behavior, occurrence and distribution in this area. Visual data will also be used to ground-truth acoustic detections. The collaborative nature of these studies facilitates maximization of data collection and synthesis relative to SOCAL Monitoring Plan (DoN 2009b) goals. Data analysis from the combined techniques is ongoing at the time of this report, although some preliminary details from the R&D-funded Jul survey efforts are shown in **Table II-6** and in Part II.

A total of 240 marine mammal sightings were made during the 20-29 Jul aerial survey for an estimated 22,719 individuals. Species identified included: three whale species (blue, fin, and minke), one beaked whale species (Cuvier's), four dolphin species (bottlenose, common, Pacific white-sided, and Risso's), and two pinniped species (California sea lion, and harbor seal) (**Table II-9**). The July survey was the only aerial survey where Cuvier's beaked whales were observed. **Figure II-8** presents some of the photography results from the July aerial survey.

There were 37 focal groups circled (5-9 min each), eight extended focal group circled (>10 min) with the longest extended focal follow being 38 min with a pod of long-beaked common dolphins. In addition, there were four systematic assessments of reactions by marine mammal to presence of an aircraft at various altitudes (two common dolphins spp. and two Risso's dolphins).

HIGHLIGHTS OF THE SOCAL JUNE-JULY 2009 AERIAL SURVEY MONITORING

Overall, results support the utility of aerial surveys to:

(1) collect quantifiable behavioral data known to be indices of stress or disturbance,
(2) conduct focal follows of priority cetacean species including video-documentation of underwater behavior,
(3) provide the advantage of surveying SOAR in one day, providing a "snapshot" of marine mammal numbers, presence, distribution and behavior before, during and after MTEs;
(4) provide a platform from which the behavior and potential reactions of cetaceans to MTEs may be studied without confounding results (vs. from vessels), and
(5) locate and identify dead floating and stranded animals.

Specific result highlights are listed below.

- The aerial survey grids west and east of San Clemente Island were each fully surveyed within one day on several different days. This demonstrates the unique ability of the aerial surveys to obtain a "snapshot" of the numbers, occurrence, distribution, species diversity, behavior, and disposition of marine mammals in these high-priority areas within a short (<1 day) time. This ability is useful in providing information for the area before, during and after MTEs.
- A fin whale entangled in ~100 m of fishing rope and a buoy was observed east of San Clemente Island in June. The sighting was immediately communicated to a passing US Coast Guard helicopter and to regional Navy Environmental Planners. The Navy contacted NMFS Southwest Division. In addition, two dead probable California sea lions were observed in July: one east and one west of San Clemente Island in the middle of the basins. These sightings show that the aircraft is an effective way to quickly identify dead and injured/stranded marine mammals. This was similarly demonstrated in Oct and Nov aerial surveys off SOCAL when a dead blue whale and two sightings of a dead California sea lion were made (see Smultea et al. 2009, **Appendix H**).
- Sample sizes of species sightings collected during June and July 2009, especially if combined with aerial surveys conducted in Oct-Nov 2008, are sufficiently large (>60-80) to calculate reasonable density and abundance estimates for some species (e.g., common and Risso's dolphins, possibly blue and fin whales). These data can be used to estimate populations in the area, including before, during, and/or after MTEs.
- Marine mammals were seen in and near the active area west of San Clemente Island during June as well as in and near this area after the MTE in July.
- Seven systematic assessments of the potential effect of our aircraft circling at different altitudes and ~0.5 nm lateral distance on Risso's and common dolphins and fin and blue whales were undertaken. Preliminary analyses indicate that flying at altitudes of ~1,500 ft and in some cases ~1,000 ft and lateral distance ~0.5 nm did not result in obvious changes in behavior, heading, or dispersal. One blue whale continued lunge feeding throughout the ~40-min observation period. This provides support that the aircraft can be used to assess cetacean behavior without affecting that behavior at these altitudes and distances. These are the first systematic assessments of this type conducted on delphinids, and blue and fin whales to our knowledge.
- Blue whales were seen more frequently in June while fin whales were seen more frequently in July. In both June and July, blue whales concentrated along the coastal shelf break. In contrast, fin whales were more widely distributed with highest numbers in the basin between San Clemente Island

and Tanner Bank. In July, fin whales were seen more frequently in the NW section of this basin vs. in the central basin in June.

- Overall, Risso's dolphins were the most frequently sighted species followed by common dolphins. In contrast, in Oct-Nov, common dolphins were by far the most frequently seen species. Risso's dolphins were common in both June and July while common dolphins were more frequently seen in July. In June, Risso's dolphins were distributed widely in offshore waters, with a concentration along the steep drop-off on the east side of San Clemente Island. In contrast, common dolphins occurred primarily in near-shore slope waters. In July, Risso's were more clustered along coastal slope waters similarly to common dolphins. Both species tended to be associated with high-relief bathymetric features as was found in Oct-Nov surveys (Smultea et al. 2009, **Appendix H**). Relatively few sightings of either species occurred in waters west of San Clemente Island, particularly in July.
- Humpback whales (n = 2 groups) and northern right whale dolphins (n = 3) were seen only in June while the Pacific white-sided dolphin, minke whale, and Cuvier's beaked whale (n = 1 each) were seen only in July. One group of four Cuvier's beaked whales was detected in July (west of San Clemente Island).
- In June, California sea lions were frequently seen along the coast of San Clemente Island during the 2 circumnavigations of San Clemente Island with few seen at sea. In contrast, California sea lions were frequently seen at sea in July.
- Mean group size, behavior state, heading, and dispersal distance were similar in June and July within the four cetacean species examined: blue whale, fin whale, common dolphin, and Risso's dolphin. However, common dolphins appeared to head predominantly northeast/east and southwest/west in both June and July, similar to data from Oct and Nov (Smultea et al. 2009, **Appendix H**). Risso's tended to head most frequently to the west in June and July.
- Focal follows further documented with photographs and video that all species observed could be tracked below the water surface from the aircraft, some for longer periods than others dependent on Bf conditions, body coloration, behavior state, etc. This addressed one of the project hypotheses and predictions. It also addressed goals of the SOCAL Monitoring Plan (DoN 2009b).
- Our work contributes to the ultimate goal of developing, establishing and ensuring standardized data collection techniques that facilitate comparison between and among different data from future SOCAL and other Navy range monitoring efforts, a goal of the Monitoring Plan and the Navy-wide Integrated Comprehensive Monitoring Program (ICMP) (DoN 2009: p. 3).
- This effort was successfully performed for the third and fourth times without interfering with at-sea Navy training involving multiple Navy assets. However, extensive multi-command pre-survey coordination is required in order to obtain permission for airspace access.
- Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for future planned Navy activities identified in the SOCAL Monitoring Plan (DoN 2009b). As such, the survey contributes to the "overall knowledgebase of marine species", a goal of the SOCAL Monitoring Plan.

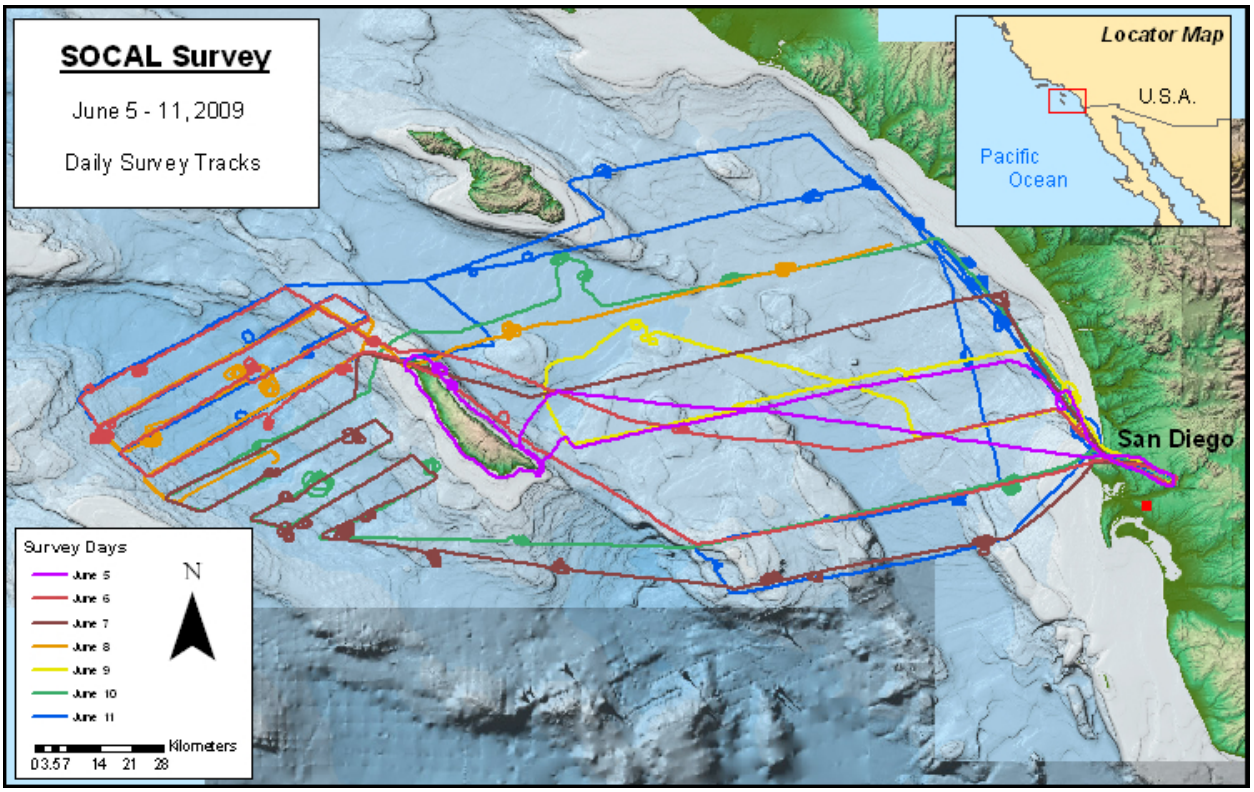


Figure II-6. Daily aerial survey track lines in SOCAL 5-11 June 2009 after a Major Training Event.

Table II-9. Summary of marine mammal sightings by species during the June and July 2009 aerial monitoring survey in the SOCAL Range Complex.

Species	5-11 JUNE - *After* MTE			20-29 JULY- *During* MTE		
	# of Groups	# of MM	Mean Group Size	# of Groups	# of MM	Mean Group Size
blue whale	9	11	1.22	20	26	1.3
fin whale	23	34	1.48	6	7	1.17
probable fin	1	2	2	0	0	0
fin/sei	0	0	0	1	4	4
fin/sei/Bryde's	0	0	0	1	1	1
humpback whale	2	2	1	0	0	0
minke whale	0	0	0	1	1	1
unidentified Balaenoptera	13	14	1.08	3	3	1
unidentified medium sized whale	0	0	0	1	1	1
Cuvier's beaked whale	0	0	0	1	4	4
bottlenose dolphin	1	11	11	1	15	15
Common dolphin spp.	16	4,752	297	47	12,020	255.74
long beaked common dolphin	1	400	400	5	1,057	211.4
short-beaked common dolphin	0	0	0	5	1,355	271
short beaked common & California sea lions	0	0	0	1	230	230
unidentified dolphin, common dolphin spp. or bottlenose	0	0	0	1	9	9
probable common dolphin	3	475	158.33	3	1,260	420
Pacific white sided dolphins	0	0	0	1	35	35
Risso's dolphin	40	701	17.53	53	779	14.7
unidentified dolphin, possible Risso's	0	0	0	1	300	300
unknown dolphin	16	1,503	93.94	51	5,554	108.9
northern right whale dolphin	3	1,500	500	0	0	0
California sea lion	23	69	3	26	33	1.27
harbor seal	1	1	1	1	1	1
unidentified sea lion	0	0	0	1	1	1
unidentified pinniped, probable ca sea lion	0	0	0	1	1	1
unknown pinniped	6	9	1.5	3	6	2
pinniped carcass	0	0	0	2	2	1
unknown marine mammal	1	3	3	1	1	1
unknown small marine mammal	1	1	1	2	13	6.5
unknown whale	1	1	1	0	0	0
Totals:	**161**	**9,489**		**240**	**22,719**	

Data from Smultea et al. 2009 (Appendix H)

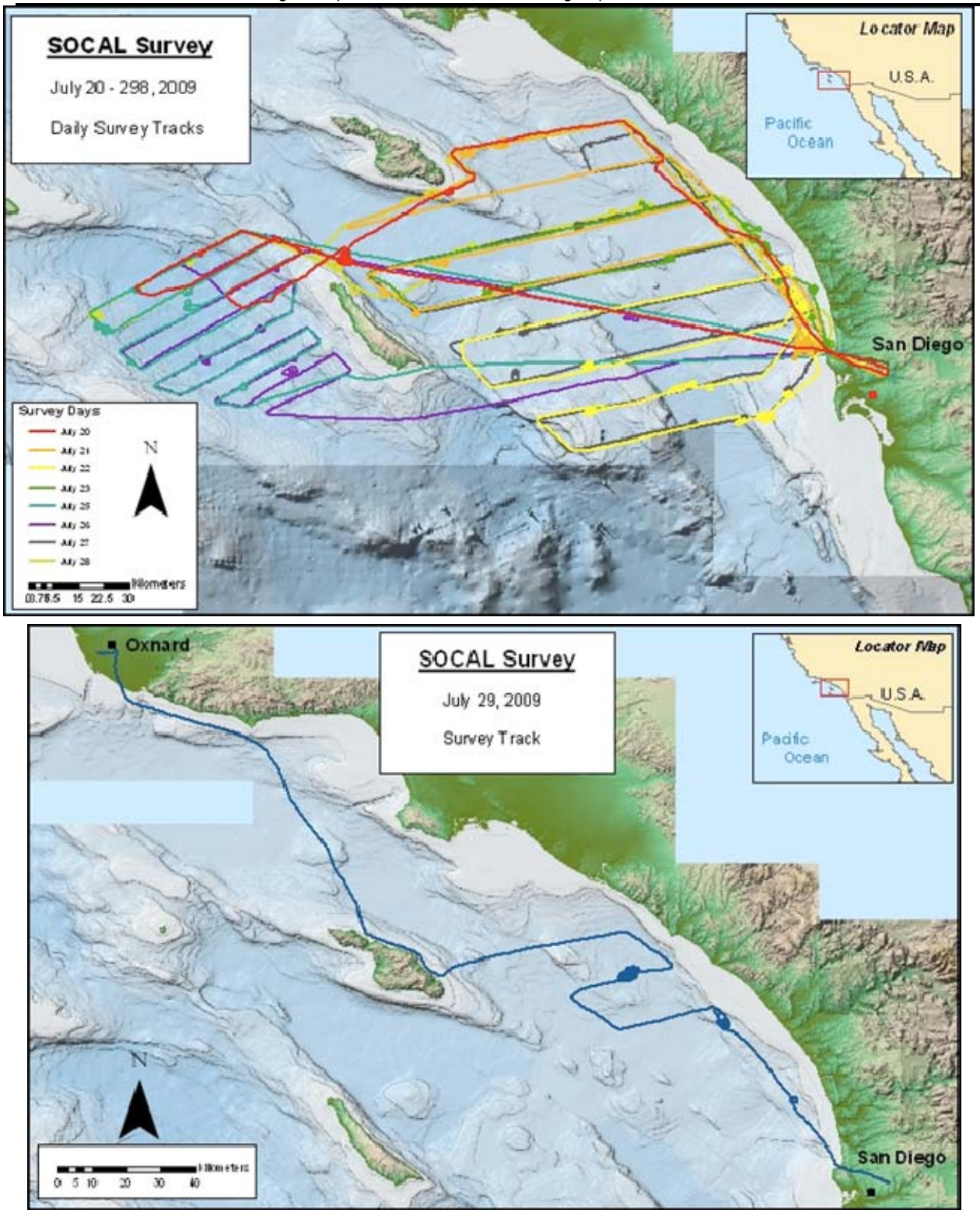


Figure II-7. Aerial survey track lines in SOCAL 20-28 July 2009 during a Major Training Event (top panel), and final return leg 29 July (bottom panel) .

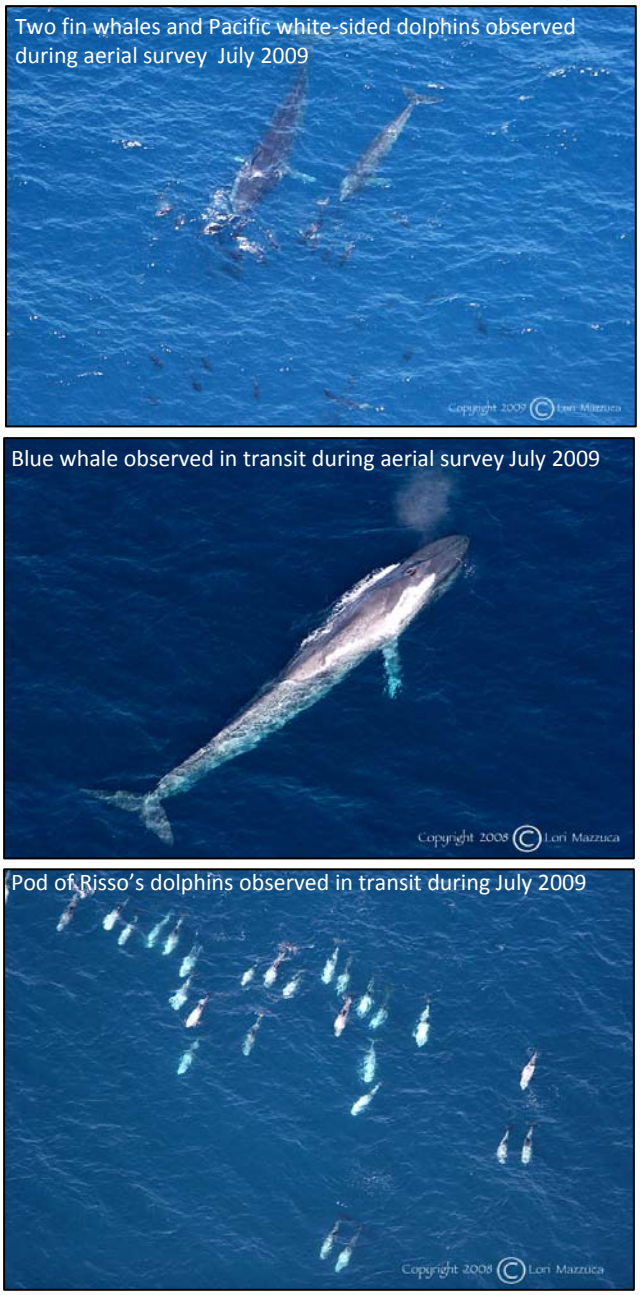


Figure II-8. Marine mammal photographs during the July 09 SOCAL aerial survey.

RANGE COMPLEX MARINE MAMMAL OBSERVERS (MMO)

FY09 Monitoring Plan Objectives: (36 hours) Opportunistic ; minimum intermediate level or ULT MFAS exercises [STUDY 1,3, 4 exposures and behavioral responses]; Opportunistic as staff and SOP developed; minimum intermediate or ULT [STUDY 5 mitigation effectiveness].

Monitoring Plan Accomplishment: Due to extensive MTE participation and ship schedule conflicts, appropriate platforms for MMO in SOCAL were not indentified prior to 01 August 09. Planning is underway for assigning MMOs to Navy ships from September 09 through 01 August 2010. The hours of observations, will be added to FY10, pending FY10 SOCAL Monitoring Plan adaptive management review and subsequent discussions with NMFS. HRC, with lighter operational schedules, has been more successful in obtaining ship space for MMOs, and discussions of those results are contained in Section I. Finally, U.S. Fleet Forces Command, U.S. Pacific Fleet, Naval Undersea Warfare Center, Newport Rhode Island and NAVFAC Atlantic are working with subject matter experts from Centre for Research into Ecological and Environmental Modeling (CREEM), University of St. Andrews and NMFS science centers to design a more comprehensive lookout/MMO comparison study. The study design will be completed in 2009 and implemented in 2010.

RANGE COMPLEX VESSEL (SHIP OR BOAT) VISUAL SURVEYS

FY09 Monitoring Plan Objectives: (60 hours) Portions of major or intermediate level MFAS exercises and offshore detonation events [STUDY 1,3, 4 exposures and behavioral responses].

Monitoring Plan Accomplishment: Approximately 70 hours of vessel visual survey effort was performed out of 60 hours planned (+10 hours). Given the limited number of offshore in-water explosive events in SOCAL this year (DoN 2009c) combined with variable unspecified locations at sea and typical short duration (<1-4 hours) of the events, vessel monitoring for these were not conducted. The focus of vessel monitoring, therefore, were in association with MTEs. The majority of vessel (ship and boat from both Compliance and R&D programs) occurred during SOCAL MTEs as per the SOCAL Monitoring Plan Objectives.

SIO Research Vessel (R/V) Robert Gordon Sproul

Summary:

A joint-Navy funded vessel cruise was conducted west of San Clemente Island from 21-28 July 2009 during a SOCAL Range Complex MTE. Funding from the U.S. Pacific Fleet compliance Monitoring Program and N45 R&D Program was used to support the cruise conducted with SIO's R/V Robert Gordon Sproul. Over 70 hours of survey effort was conducted covering 539 nm. There were 153 marine mammal sightings for an estimated 2,321 individuals. In addition, there were 36 passive acoustic detections of marine mammals, with species identified to data as bottlenose dolphins, short-beaked common dolphins, and Pacific white-sided dolphins.

SOCAL 34 Preliminary Cruise Report- R/V Sproul, July 21-28, 2009

By John Hildebrand
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Executive Summary

During July 21-28, 2009 the R/V Sproul conducted a simultaneous visual and acoustic survey for marine mammals in the Southern California Range Complex (SOCAL) area. A total of 70 hours were spent on-effort covering 539 nm of trackline. Within this effort, 47 hours (306 nm) were devoted to transect lines at the SOAR hydrophone range, which will be compared to passive acoustic monitoring data of range hydrophones and aerial survey data, collected at the same time. A total of 153 marine mammal sightings and 36 acoustic detections were recorded. Additional work conducted during this cruise included servicing High-frequency Acoustic Recording Packages, and conducting an acoustic propagation test at Tanner Bank in support of the Shallow Water Tracking Range development.

Introduction

SOCAL 34 was a shipboard cruise on the R/V Sproul to conduct a simultaneous acoustic and visual survey for marine mammals in the Southern California Range Complex (SOCAL) area (Figure SOCAL34-1). The focus of this cruise was in the instrumented SOAR range, located to the west of San Clemente Island. The R/V Sproul departed San Diego at 8:00 am on 21 July, 2009 and returned to port at 5:30 am on July 28, 2009. Cruise participants are listed in SOCAL34- 1.

The primary mission of SOCAL34 was to conduct a visual and acoustic towed-array survey of the SOAR range, coincident with monitoring of the range's permanent hydrophones using the Marine Mammal Monitoring on Navy Undersea Ranges (M3R) system of the Naval Undersea Warfare Center (NUWC Dave Moretti) and an aerial survey performed by Marine Mammal Research Consultants (MMRC Joe Mobley). A total of 70 hours of visual and acoustic survey effort were conducted by the R/V Sproul, with 47 hours of effort devoted to transect lines located within the area of the SOAR range.

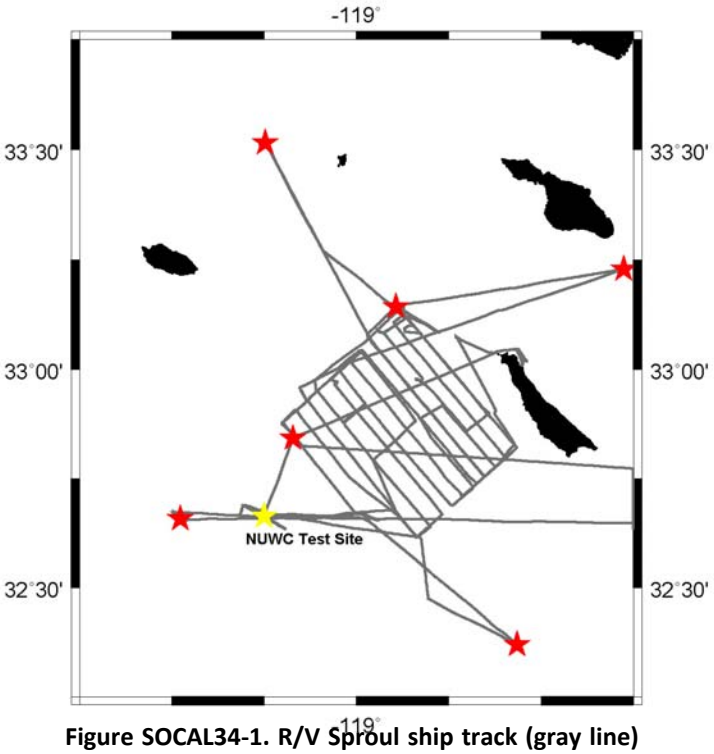


Figure SOCAL34-1. R/V Sproul ship track (gray line) for June 21-28, 2009, with HARP locations (red stars), and non-monitoring related sound propagation test site (yellow star).

High-frequency Autonomous Recording Packages (HARPs) designed for continuous recording of marine mammals vocalizations were recovered, refurbished and redeployed. A one-day effort to study sound propagation in the Tanner-Cortez Banks region was conducted for NUWC. Figure SOCAL34-1 shows the SOCAL region, ship trackline, HARP locations, and the site of the NUWC sound propagation study.

Methods

During daylight hours, visual and acoustic surveys were conducted by the R/V Sproul. The visual and acoustic surveys were conducted independently, so that each would yield independent marine mammal detections. After animals had passed down the side of the vessel the visual observers relayed their sighting information to the acoustic observers, but in no case were the visual observations used to queue the acoustic detections nor the acoustic detections used to queue the visual observers. The survey was conducted during transit between stations, as well as along a set of transects that were designed to cover the SOAR hydrophone array area, so that shipboard observations could be compared with detections from the M3R system and from an aerial survey. These transect lines are shown in Figure SOCAL34-2, with letters designating each line. The lines are about 20 nm long and run northwest-to-southeast, at about 2 nm spacing. Table SOCAL34-2 gives daily survey effort in hours and distance.

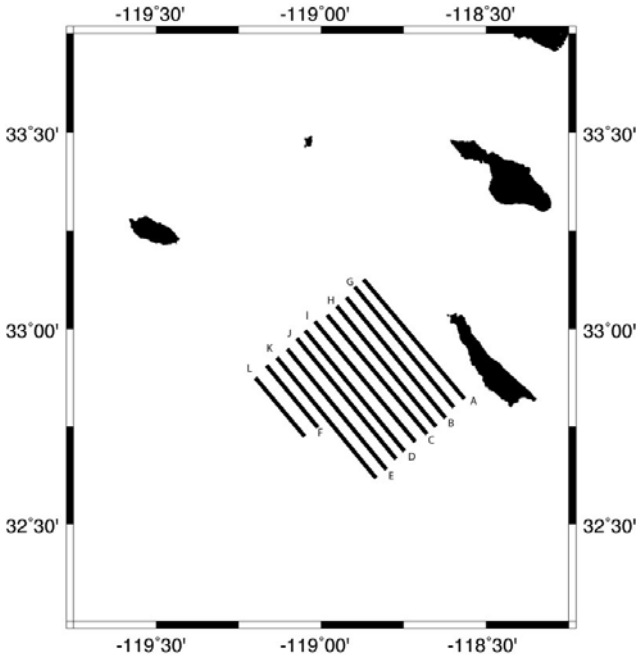


Figure SOCAL34-2. Location of the transect lines covering the area of the SOAR hydrophone arrays.

Table SOCAL34-1: Cruise participants

Name	Organization	Role
John Hildebrand	SIO	Chief Scientist
Ethan Roth	SIO	HARP Engineer
Brent Hurley	SIO	HARP Engineer
Josh Jones	SIO	Towed Array
Hannah Bassett	SIO	Towed Array
Anne Douglas	Cascadia Research	Visual Survey Lead
Chris Cutler	Cascadia Research	Visual Survey Observer
Kelly Cunningham	Cascadia Research	Visual Survey Intern
Corina Leahy	Cascadia Research	Visual Survey Intern
James Kendera	NUWC	Seagoing Technician
Ian Sabo	NUWC	Seagoing Technician
Gus Aprans	SIO	Resident Technician

Visual observations

The visual survey effort was undertaken by the Cascadia Research Collective (Anne Douglas lead observer). At least one experienced marine mammal observer, and one student intern were responsible for maintaining visual observations during day light hours. Observers were posted on both sides of the bridge of the Sproul, approximately 25 feet above the water line of the ship. Port and starboard observers searched out to the horizon from directly ahead of the vessel to 90° of the bow on their respective sides of the vessel. Observations were conducted using 7 X 50 handheld binoculars and naked eye. Image stabilizing 20X binoculars were available for identification of distant animals. The visual watch was rotated between four team members, with two observers on watch, one assigned to data recording, and one resting at any given time. The observers broke effort halfway along all transit lines so there was not a chance of searching into the upcoming survey line.

Towed Hydrophone Array

A six element towed hydrophone array was deployed from the R/V Sproul to conduct an acoustic survey for marine mammal sounds. The array was sampled at 500 kHz, and had an effective bandwidth of 2 – 200 kHz. One pair of array hydrophone elements was monitored at all times, and sound recordings were collected at times when marine mammal sounds were detected on a real-time spectrogram display. The time difference of arrival of sounds at the two hydrophones allowed calculation of bearing angle to the sound source in real-time. Most of the survey was conducted at a ship speed of 8 knots. The towed array was deployed on a 300 m long wire, and at the 8 knot tow speed it was held at a constant depth of about 17 m. During periods of slower tow speed (1 – 5 knots) the array was found to tow at significantly deeper depths (up to 100 m for sustained periods at 1 knot).

High-frequency Autonomous Recording Packages

HARPs were deployed during SOCAL34 to continue efforts to listen for the presence of marine mammals in the SOCAL area (*see Part II in this Section*). The position and depth of each HARP is listed in Table 4. The HARPs record with a sampling rate of 200 kHz. These instruments rest on the seafloor with a hydrophone suspended approximately 10 meters above the instrument. They can record 2 Tbytes of data and have a deployment life of 2 months with continuous data recording. A transponder is built into each unit, allowing communication between the HARP and the ship. The transponder provides the capability to determine the position of the instrument, as well as to enable the acoustic release mechanism, allowing the instrument to be retrieved at a later date.

Results

Visual observations

A total of 153 visual sightings were recorded by the R/V Sproul during 70 hours of survey effort. These were divided between 105 cetaceans and 48 pinnipeds. The most common cetacean species sighted was the fin whale (22) followed by the short-beaked common dolphin (16). The most common pinniped sighted was the California sea lion (38).

Table SOCAL34-4 gives a summary of sightings by species and numbers of individuals, and the cetacean sightings are plotted along the shipboard trackline in Figure SOCAL34-3.

Acoustic Detections

Owing to the recording bandwidth of the towed array (2-200 kHz), only odontocetes (toothed whales) were included in the acoustic detections. A total of 36 acoustic detections were recorded during 70 hours of survey effort. The identification of all detections by species has not been completed, although it is known that at least three species are represented in these data: short-beaked common dolphin, bottlenose dolphin, and Pacific white-sided dolphin. Figure SOCAL34-3 indicates the position of acoustic detections along the shipboard trackline.

Table SOCAL34-2: Survey effort during SOCAL34.

Date	Start Time	End Time	Hours on Effort	Hours on Transect	Distance on Effort (nm)	Distance on Transect (nm)	Comments
21-Jul-2009	9:13	18:57	9.73	0.00	42.39	0.00	Transit to Tanner Bank
22-Jul-2009	7:18	18:43	7.88	0.00	35.05	0.00	South of Tanner Bank.
23-Jul-2009	7:26	17:54	8.25	8.13	82.02	45.97	SOAR Survey lines B,C,D,E
24-Jul-2009	7:32	19:52	10.97	8.70	92.09	69.24	SOAR Survey lines C,D,E,F,L
25-Jul-2009	7:09	19:19	11.43	10.22	93.23	68.85	SOAR Survey lines A,B,G,H
26-Jul-2009	7:12	19:30	11.30	10.62	99.77	72.39	SOAR Survey lines H,I,J,K
27-Jul-2009	7:08	18:40	10.75	9.25	94.31	49.79	SOAR Survey lines A,C,L
		Total	70.32	46.91	538.85	306.23	

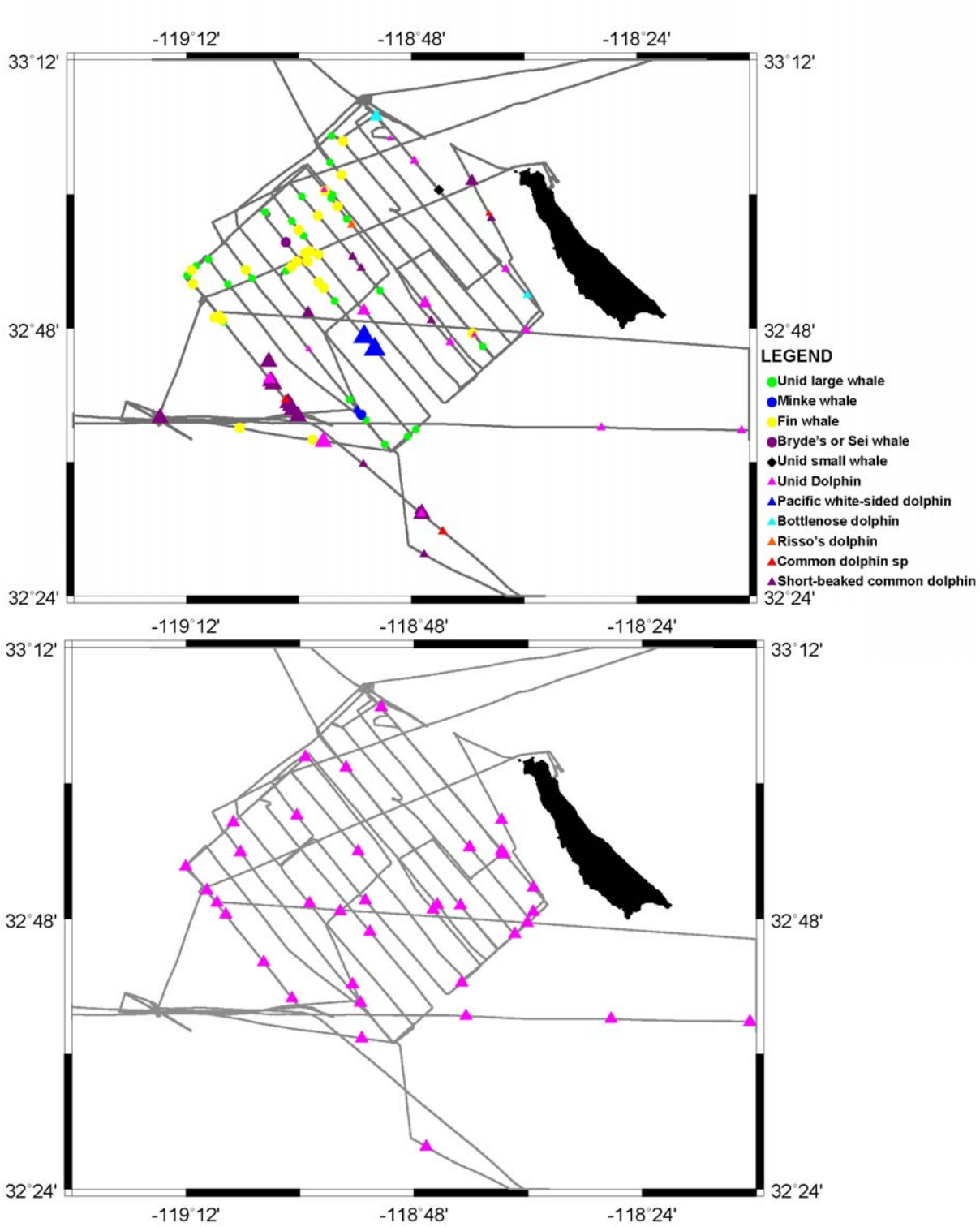


Figure SOCAL34- 3. (top panel) Visual cetacean sightings during SOCAL34. The species is denoted by the color of the symbol and the group size is denoted by the size of the symbol. (bottom panel) Acoustic array odontocete detections during SOCAL34.

Table SOCAL34-3.: Summary of visual sightings during SOCAL34.

	Total Sightings		On Transect		Off Transect	
Species	Sightings	Individuals	Sightings	Individuals	Sightings	Individuals
Elephant Seal	4	4	2	2	2	2
California Sea Lion	38	51	20	24	18	27
Unidentifed Otariid Species	3	4	2	2	1	2
Unidentifed Pinniped Species	3	3	2	2	1	1
Minke Whale	1	1	1	1		
Sei or Bryde's Whale	1	1	1	1		
Fin Whale	22	30	13	18	9	12
Short-beaked Common Dolphin	16	1,144	6	588	10	556
Common Dolphin Species	6	236	1	8	5	228
Risso's Dolphin	2	15	1	9	1	6
Northern Right Whale Dolphin	1	25	1	25		
Pacific White-sided Dolphin	2	236	2	236		
Bottlenose Dolphin	3	67	2	59	1	8
Unidentified Delphinid	20	449	9	97	11	352
Unidentified Small Cetacean	1	20	1	20		
Unidentified Large Cetacean	29	34	21	25	8	9
Unidentified Marine Mammal	1	1	1	1		
Pinniped Total	48	62	26	30	22	32
Cetacean Total	105	2,259	60	1,088	45	1,171
Total	153	2,321	86	1,118	67	1,203

Table SOCAL34-4. Location and water depth of the HARPs deployed during SOCAL34.

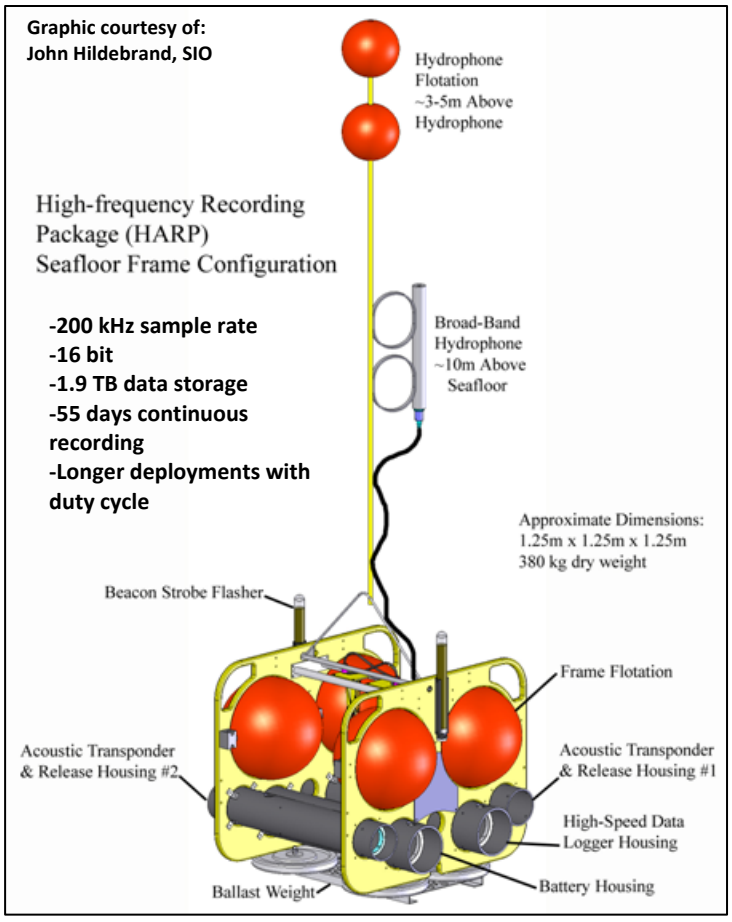
Site	Latitude	Longitude	Depth (m)
Socal34-E	32.65898°N	119.4772°W	1,334 (4,377 ft)
Socal34-G2	33.14265°N	118.8931°W	1,106 (3,629 ft)
Socal34-H	32.84282°N	119.1716°W	992 (3,254 ft)
Socal34-M	33.51545°N	119.2466°W	902 (2,959 ft)
Socal34-N	32.36977°N	118.5648°W	1,287 (4,222 ft)

RANGE COMPLEX PASSIVE ACOUSTIC MONITORING

FY09 Monitoring Plan Objectives: Award monitoring contract, develop standard operating procedures, obtain permits, order devices and determine best location, integrate SOAR M3R classification data for beaked whales [STUDY 2 geographic redistribution]; Note: next year (FY10) SOCAL monitoring goals: Install minimum of two autonomous PAM devices in SOCAL and begin recording; integrate SOAR M3R data.

Monitoring Plan Accomplishment: PAM devices were ordered and purchased. Suitable locations within SOCAL were identified for additional PAM in consultation with Scripps Institute of Oceanography. In advance of FY10 SOCAL Monitoring Plan Objectives, these two HARPs were deployed at the end of January 2009. Review and field testing of M3R is still ongoing under the R&D program vice Range Complex Compliance program. Discussions are ongoing about the best integration process between the two Navy programs (compliance Monitoring Program and R&D).

Summary: This year, as part of the FY09 compliance Monitoring Plan, U.S. Pacific Fleet funded the purchase and early installation of two additional high-frequency acoustic recording packages (HARP) developed by Scripps Institute of Oceanography (SIO) (**Figure II-9**). SIO deployed these two HARPs at the end of during the winter-spring of 2009 which is a full year ahead of the Navy's monitoring obligation which directed a minimum of two passive acoustic devices in FY 2010 (Oct 09 to Sep 10). The HARPs are currently located south of San Clemente Island at the northern edge of the San Clemente Basin, and in the southern end of the Santa Cruz Basin, west of Santa Barbara Island. Both locations represent areas that have not been covered by PAM to significant extent. The southern location south of San Clemente Island represents another area periodically used for certain portions of underwater training events. The northern location is outside of the SOCAL Range Complex.



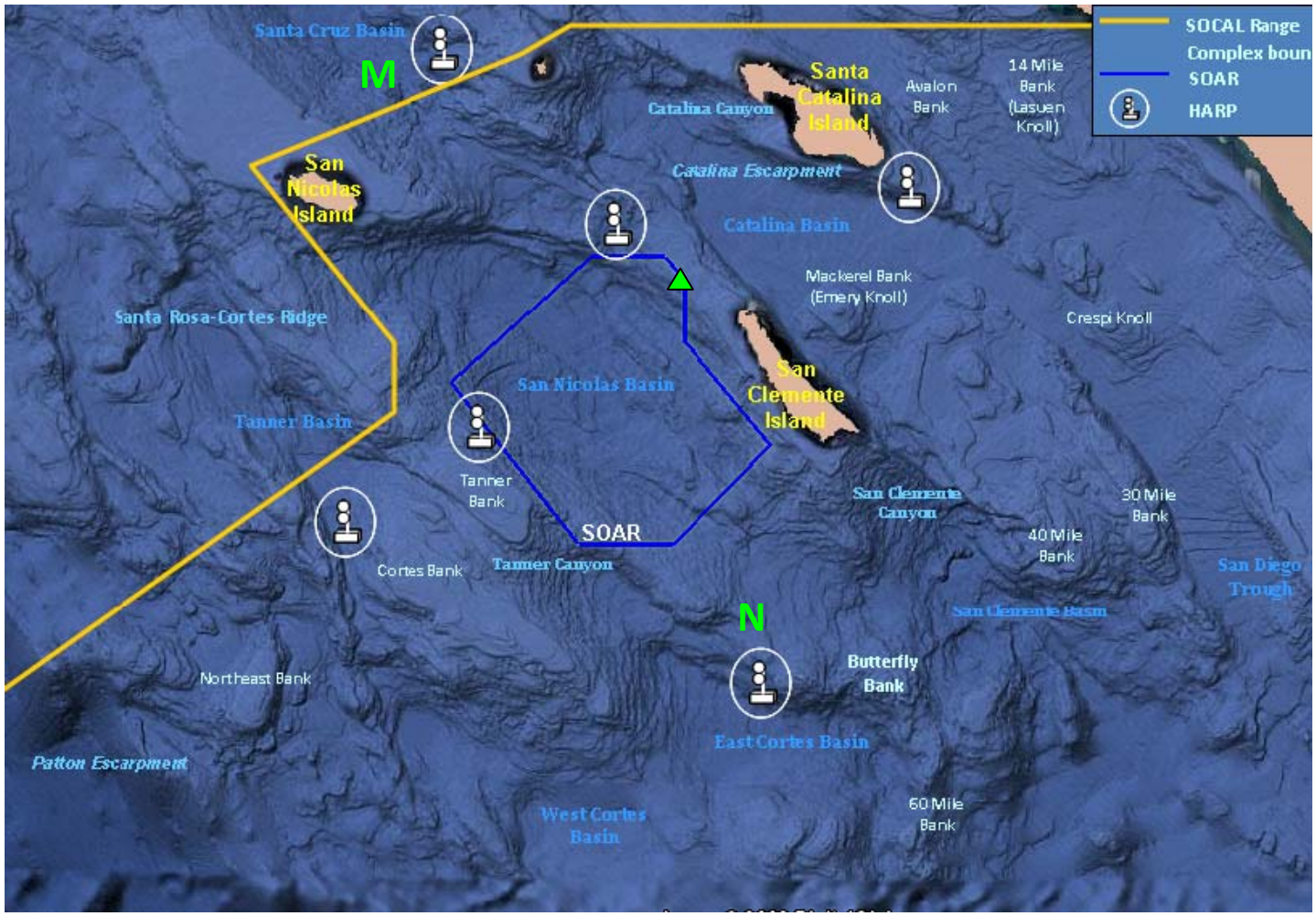


Figure II-9. Locations of FY09 Navy-funded (Research and Development and Compliance programs) bottom-mounted passive high-frequency acoustic recording packages (HARP) within the northern portion of SOCAL Range Complex.

Notes:
-This figure shows only six of a total of 12 HARPs deployed in Southern California.
-HARPS labeled "M" and "N" are two new devices planned for FY10, but under the U.S. Pacific Fleet SOCAL Monitoring Program installed early in FY09. Locations were selected in consultation with Scripps Institute of Oceanography (SIO) and represent the best new locations for study as designated in the FY09 SOCAL Monitoring Plan.
-Green triangle represents approximate position of SIO operated FLoating Instrument Platform (FLIP) deployed from 13 Oct to 12 Nov 2008.

Since deployment, > 2,565 hours of passive acoustic data have been collected from these two Fleet-funded HARPs. Data analysis is ongoing by SIO with FY09 U.S. Pacific Fleet SOCAL monitoring funding provided for a post-graduate student in support of data analysis. At site "M" (see **Figure II-9**), for a 53-day period from 17 May to 08 July 2009, over 1,265 hours of passive recordings were obtained. At site "N" for a 54-day period between 19 May and 12 July 2009, over 1,302 hours of passive recordings were obtained.

Preliminary acoustic monitoring results from the of two U.S. Pacific Fleet funded HARP deployments is presented in **Appendix I**. Detected species include blue whale, California sea lion, beaked whales

(mostly Cuvier's beaked whales), fin whale, humpback whale, killer whale, minke whale, Pacific-white sided dolphin, Risso's dolphin, sperm whale, and unidentified dolphins (likely bottlenose, and long and short-beaked common dolphin). Periods of MFAS as well as commercial and Navy ship traffic were also recorded.

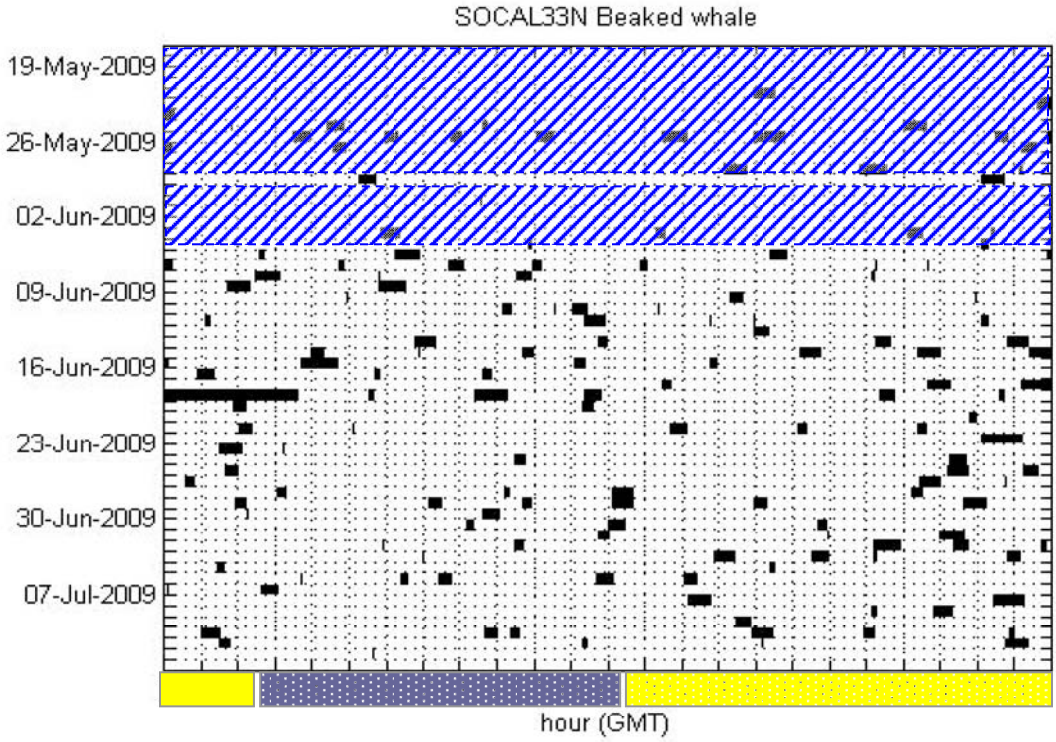


Figure II-10. Plot of beaked whale echolocation detections by time from HARP Site N, south of San Clemente Island between 19 May to 12 July 2009.

(graphic courtesy of John Hildebrand, SIO; yellow box on x-axis indicate approximate local daylight period; gray box local night period; Blue hatched boxes indicate periods of MTEs within the SOCAL Range Complex)

RANGE COMPLEX MARINE MAMMAL TAGGING

FY09 Monitoring Plan Objectives: Award monitoring contract, develop standard operating procedures, obtain permits [STUDY 2 geographic redistribution]

Monitoring Plan Accomplishment: A successful, field-tested tagging program has been ongoing within SOCAL under N45 R&D Program since August 2008. To date, 12 satellite tags have been deployed on four species: bottlenose dolphin, Cuvier's beaked whales, fin whales, and Risso's dolphin. Discussions are ongoing about the best integration process between the two Navy programs (Compliance and R&D). ***[see Section II, Part II "SOCAL Navy Research and Development Accomplishments" for description of July 2009 tagging events in SOCAL]***

Part II- SOCAL Navy Research and Development Accomplishments

From 2008 to 2009, and continuing through 2011, the Navy's R&D program funded and is continuing to fund a multi-component marine mammal research project within the SOCAL Range Complex. This R&D program is managed by the Naval Postgraduate School in Monterey, CA, spearheaded by the Scripps Institute of Oceanography (SIO), and involves marine mammal scientists from SIO, Cascadia Research Collective, and the NMFS' Southwest Fisheries Science Center (SWFSC).

Key components of this project include the Navy's Marine Mammal Monitoring on Navy Ranges (M3R) program, use of ship and small boat based visual and tagging cruises, periodic deployments of the Floating Instrument Platform (FLIP) for visual and passive acoustic monitoring, and passive acoustic monitoring during ship cruises and through deployment of medium term (<3-month) bottom-mounted acoustic recording packages.

Below is a partial list of independently peer-reviewed scientific publications from 2007 to 2008 based on ongoing N45 sponsored R&D monitoring in SOCAL:

CRANFORD, T. W., P. KRYSL, and J. A. HILDEBRAND. 2008. Acoustic pathways revealed: simulated sound transmission and reception in Cuvier's beaked whale (*Ziphius cavirostris*) using the vibro-acoustic toolkit. Bioinspiration and Biomimetics 3 (10pp). DOI: 10.1088/1748-3182/3/1/016001 (Published online).

CRANFORD, T. W., P. KRYSL, and J. A. HILDEBRAND. 2008. Anatomic geometry of sound transmission and reception in Cuvier's beaked whale (*Ziphius cavirostris*). Anatomical Record 291:353-378.

JOHNSTON, D. W., M. MCDONALD, J. POLOVINA, R. DOMOKOS, S. WIGGINS, AND J. HILDEBRAND. 2008. Temporal patterns in the acoustic signals of beaked whales at Cross Seamount. Biology Letters 4(2): 208-211.

KRYSL, P., T. W. CRANFORD, and J. A. HILDEBRAND. 2008. Lagrangian finite element treatment of transient vibration/acoustics of biosolids immersed in fluids. International Journal for Numerical Methods in Engineering 74(5): 754-775.

MADHUSUDHANA, S. K., E. M. OLESON, M. S. SOLDEVILLA, M. A. ROCH, AND J. A. HILDEBRAND. 2008. Frequency based algorithm for robust contour extraction of blue whale B and D calls. OCEANS 2008-MTS/IEEE Kobe Techno-Ocean: 1-8.

MCDONALD, M. A., J. A. HILDEBRAND, S. M. WIGGINS, AND D. ROSS. 2008. A fifty year comparison of ambient ocean noise near San Clemente Island: a bathymetrically complex coastal region off southern California. Journal of the Acoustic Society of America 124(4): 1985-1992.

MCKENNA M. F., J. A. GOLDBOGEN, J. S. LEGER, J. A. HILDEBRAND, T. W. CRANFORD. 2007. Evaluation of postmortem changes in tissue structure in the bottlenose dolphin (*Tursiops truncatus*). Anatomical Record 290(8):1023-1032.

OLESON, E. M., S. M. WIGGINS, AND J. A. HILDEBRAND. 2007. Temporal separation of blue whale call types on a southern California feeding ground. Animal Behaviour 74: 881-894.

ROCH, M. A., M. S. SOLDEVILLA, R. HOENIGMAN, S. M. WIGGINS, AND J. A. HILDEBRAND. 2008. Comparison of machine learning techniques for the classification of echolocation clicks from three species of odontocetes. Canadian Acoustics 36(1):41-47.

SOLDEVILLA, M. S., E. E. HENDERSON, G. S. CAMPBELL, S. M. WIGGINS, J. A. HILDEBRAND, AND M. A. ROCH. 2008. Classification of Risso's and Pacific white-sided dolphins using spectral properties of echolocation clicks. J. Acoust. Soc. Am. 124(1): 609-624.

A summary of monitoring accomplishments between August 2008 and 01 August 2009 from the Navy's R&D program is provided below.

MARINE MAMMAL MONITORING ON NAVY RANGES (M3R)

The Navy already has an existing fixed passive acoustic array at the Southern California Offshore Antisubmarine Warfare Range mounted on the bottom of San Nicholas basin west of San Clemente Island (**Figures II-1 and II-9**). This system was originally designed to record underwater sounds and provide tracking capability for Navy training events. The hydrophones on this fixed system are not currently capable of recording vocalization from all marine mammal species, especially low frequency specialist such as some baleen whales (in particular, blue and fin whales). The existing hydrophones on SOAR are bandwidth limited to 8 – 40 kHz. Planned updates and refurbishment of this passive array are funded and design work in progress which will allow for greater frequency range once newer hydrophones are installed by 2010. After this refurbishment, hydrophone bandwidth will be increased to ~50 Hz – 40 kHz. The Navy's Marine Mammal Monitoring on Navy Ranges (M3R) project within SOAR is currently undergoing field validation and since February 2009, has been recording marine mammal vocalizations continuously. The main objective of the M3R project is to develop a toolset for passive detection, localization, and tracking of marine mammals using existing Navy undersea range infrastructure. While passive acoustic data is currently being continuously collected, this year the full M3R suite was fully implemented and field tested from 15-30 July 2009.

Data analysis from both a previous October 2008 M3R field test, and the July 2009 field test is still ongoing.

SHIP/BOAT VISUAL SURVEYS AND TAGGING

Visual vessel surveys can provide detailed information about behavior, distribution, and abundance of marine mammal within SOCAL by allowing for direct observations and counts of individuals and groups, photography of individual marine mammals for building photo-identification catalogs, collection of tissue samples for genetic analysis in terms of individual and stock compositions, placement of satellite tracking tags, and concurrent passive acoustic recording of vocalizations.

The Navy's R&D program funded visual and tagging surveys within the SOCAL Range Complex between August 2008 and 01 August 2009 (**Table II-12**). Data statistics from some cruises have not been tabulated, so a cumulative summary of hours surveyed, sightings obtained, etc. can not be reported at this time.

The Navy owned and SIO operated FLoating Instrument Platform (FLIP) was deployed from 13 Oct to 12 Nov 2008 northwest of San Clemente Island at the eastern edge of SOAR. Daylight visually observations and continuous passive acoustic monitoring was conducted during a 30 day period encompassing two separate MTEs.

http://www-mpl.ucsd.edu/resources/flip.intro.html

Technological advancements in recent years now provide opportunity for data collection by deploying tags on individual marine mammals for various time periods depending of both animal size and tag type. Between August 2008 and August 2009, under the Navy's R&D Program, 12 tags were deployed on four species of marine mammals including seven fin whales, two Cuvier's beaked whales, one Risso's dolphin, and one bottlenose dolphin. Tagging of Cuvier's beaked whales, Risso's dolphin, and bottlenose dolphin represent the first ever tagging of these species in SOCAL.

Data analysis from this effort is still ongoing.

FLIP as seen from the air during monitoring NW of San Clemente Island Oct-Nov 08

Table II-12. Summary of vessel and boat surveys in SOCAL performed under the Navy's R&D program.

			Number Of:					
R&D cruise	**Survey Length (hrs)**	**Distance Covered (nm)**	**Groups Sighted**	**Mammals Sighted**	**Photo IDs [1]**	**Tissue Samples (Biopsies)**	**Satellite Tags Deployed [2]**	**Passive Acoustic Effort (hrs)**
2-10 Aug 2008 2 CRC RHIBs	229	734	147	5,698	36	11	2	na
2-10 Aug 2008 1 SIO RHIB	*	*	*	*	*	*	na	*
2-10 Aug 2008 R/V Sproul	*	*	*	*	*	na	na	*
13 Oct-12 Nov 2008 FLIP (stationary mooring)	*	na	*	*	*	na	na	*
17-30 Oct 2008 1 CRC RHIB, R/V Sproul	267	1,073	61	4,771	54	10	2	*
17-30 Oct 2008 1 SIO RHIB	*	*	*	*	*	*	na	*
9-14 March 2009 R/V Sproul transit	27	*	*	*	*	na	na	*
15-20 May 2009 R/V Sproul transit	*	*	*	*	*	na	na	*
18-26 July 2009 Cascadia RHIB	81	777	76	3,282	228	8	8	na
20-28 July 2009 SIO/SWFSC RHIB	70	682	42	3,250	1,175	25	na	29
Totals:	674	3,266	326	17,001	1,493	54	12	29

* = not all surveys have been summarized as of this report date

na= not applicable (i.e., doesn't apply to this monitoring technique)

[1] to date, approximately 50 individual Cuvier's beaked whales identified; 150 individual fin whales identified

(SOCAL Cuvier's beaked whales. photos courtesy of Cascadia Research Collective; see also Falcone et al. 2009)

[2] 1 Cuvier's beaked whale, 3 fin whales Aug and Oct 08; 1 bottlenose dolphin, 1 Cuvier's beaked whale, 5 fin whales, 1 Risso's dolphin Jul 09

Cascadia Research Collective RHIB Surveys and Satellite Tagging Within the SOCAL Range Complex August and October 2008- FINAL SUMMARY

By Erin Falcone and Greg Schorr
Cascadia Research Collective – Olympia, WA

The fourth and fifth in a series of collaborative visual-acoustic surveys for marine mammals at the Southern California Offshore Anti-submarine warfare Range (SOAR) near San Clemente Island (SCI) were conducted in August and October 2008. During these surveys, visual observers are vectored to areas of marine mammal vocal detections using the M3R system developed at the AUTEC hydrophone array in the Bahamas and deployed at SOAR. As the array configuration and species diversity at SOAR varies from that at AUTEC, the initial collaborative surveys in the region focused primarily on verifying position and species associated with acoustic detections. By the third survey in October 2007, this technique had been refined considerably, and during favorable conditions experienced observers were reliably vectored within sighting distance of groups of Cuvier's beaked whales. A substantial amount of information was collected on this species during that survey, including data on short term movements, surfacing and vocalization cycles, and group composition. Further, identification photos were collected for approximately 30 unique individuals forming the basis of a catalog for ongoing photo-identification studies. The goal of effort at San Clemente Island in 2008 was to continue collecting baseline sighting data on all marine mammal species encountered in the study area, expand photo-ID data on species of interest (beaked whales, fin and other baleen whales, bottlenose and Risso's dolphins), and deploy medium-duration satellite tags primarily on beaked and fin whales. This report summarizes effort and sightings from all visual survey platforms, and preliminary results of satellite tagging for the year.

Visual surveys were conducted at San Clemente Island from 2-10 August and 17–30 October 2008. Similar to a survey in October 2007, this effort combined visual observations from the R/V Sproul (Scripps Institution of Oceanography, SIO) with those from 2-3 small RHIBS operated by Cascadia Research (N1 and N2) and SIO (the Paula Christine, PC). Cascadia RHIBs launched daily from the Sproul for most survey days in 2008, while the PC was based on San Clemente Island and transited to the range each day, weather permitting. As with previous surveys, a little less than half of effort hours were spent in observer conditions rated as "Fair" or "Poor", indicating that the ability to sight and approach animals was significantly limited by visibility, wind, or swell height.

Table CRC-OCT-1 summarizes all effort at SCORE to date. Although most effort was focused over the instrumented range on the west side of the island, surveys were sometimes shifted to the east side due to weather or range restrictions. On one day in October 2008 surveys were conducted at nearby Santa Catalina Island due to range conflicts. Several hours of survey effort were also spent at Tanner Bank to the west of the array in October 2008.

Tables CRC-OCT-2a and 2b summarize sightings by species in 2008. Sighting rates were generally lower in 2008 than in previous years. This difference is most striking when comparing October 2007 with October 2008. Protocols were similar during these two surveys (two RHIBS and the Sproul focusing on beaked whale detections during calm weather and switching to other species as winds increased) as were the overall proportions of time spent in favorable conditions. The October 2007 survey was considerably shorter than the October 2008 survey (approx. 150 versus 267 effort hours), but the overall sighting rate was more than double (0.75 sightings/hr in 2007, 0.30 sightings/hr in 2008). Species diversity was also low. Risso's dolphins were not sighted at all in October 2008, and bottlenose dolphins were sighted only five times during that survey, with four of these sightings at Catalina Island and the remaining sighting on the east side of San Clemente, not on the instrumented range. Cuvier's beaked whales were sighted regularly in August and October 2008 with the aid of acoustic localizations when wind conditions were less than a Beaufort 3. As in October 2007, observers were able to remain with

groups for periods up to several hours in calm conditions, recording surfacing behavior and movements and collecting photos for individual identification. Another notable difference in October 2008 was that the average group size for Cuvier's beaked whales was smaller than previously recorded. Most group sighted contained three or fewer whales, and these smaller groups were typically less approachable than the groups of 4-7 regularly encountered in earlier survey. Several calves were also observed in 2008, representing our first observations of obviously young individuals in the population. Fin whales were sighted less frequently in August 2008 than in previous surveys, and were virtually absent from the range in October 2008 on all but two days. No fin whales were sighted in the first five days of effort in October 2008, despite broad geographic coverage. A number of fin whales were sighted on 22-23 October, mostly along the northwest border of the array, and no further sightings were made for the remainder of the trip. Analysis of photo identification data from Cuvier's beaked whales and fin whales is currently underway.

Satellite Tagging

Four medium duration satellite tags were deployed at SCORE in 2008: one on a Cuvier's beaked whale and three on fin whales. These small tags, which are attached to the dorsal fin or dorsal ridge area via two barbed darts, are designed to maximize tracking duration and minimize impact on the tagged individual, particularly for smaller odontocetes such as beaked whales, where full implant tags are not currently feasible. They have been deployed previously on seven species of odontocetes in other regions, including Cuvier's and Blainville's beaked whales, sperm whales, killer whales, and pilot whales, providing day-to-day movement data over periods from several weeks to several months. The first tag was deployed on an adult female Cuvier's beaked whale on 3 August 2008, and continued to provide movement data to 24 November 2008 (Figure CRC-OCT-1). Daily movements of this individual were recorded throughout the surge in training activity on the range in October 2008, and may provide an opportunity to look at the movements of this whale in relation to sonar use. The remaining three tags were deployed on fin whales on 8 August, 22 and 23 October 2008 (Figure CRC-OCT-2), representing the first satellite tagging of fin whales with this type of tag, and the first insights into movements of this species in the region. The first two tags transmitted for 34 and 26 days respectively, and the third tag was still transmitting as of 24 November 2008. A preliminary look at the tracks from these four deployments suggest a limited movements by the beaked whale with frequent use of the instrumented range (Figure 1), and very broad regional movements by the fin whales. The number of successful deployments was limited by several factors, including weather, number and behavior of animals encountered, and a decision to focus on beaked whales whenever possible. Weather is the primary obstacle to tagging for all species, given that it impacts both our ability to locate animals (particularly beaked whales), and to make the controlled close approach necessary for deployment. Cuvier's are especially difficult to tag due to their very short surfacing intervals and long intervening dives: there is often two minutes or less to close approach before the end of a surfacing series. Group composition also affected our ability to deploy tags. In general, small groups reacted to the approach of the boat more strongly than larger groups, and even when close approaches were successful, animals often oriented away from the boat precluding a square shot. Despite these challenges we are optimistic that with additional effort in good conditions, we can deploy enough tags to begin to address questions of movement and residency of species within SOAR, and potentially assess some of geospatial impacts of sonar use in the region.

Table CRC-OCT-1. Total effort hours and proportion of effort in "Excellent" or "Good" conditions for all surveys.

Survey Dates	Participating Vessels	Vessel Days	Total Survey Hours	Hours (%) in Excellent or Good Conditions
2-10 Aug 2008	2 CRC RHIBs, 1 SIO RHIB, R/V Sproul	31	228.5	126.4(55)
17-30 Oct 2008	1 CRC RHIB, 1 SIO RHIB, R/V Sproul	28	266.6	160.2(60)
Totals:		59	495	

Table CRC-2a and 2b. Total number of groups sighted, number of groups sighted on and off the range, estimated number of individuals sighted, and average groups sizes for cetacean species encountered at or near SOAR in 2008. Tables exclude sightings of unidentified whales and dolphins.

2A. Sightings 2-10 August 2008

	# groups	# individuals	Ave. grp. Size
blue whale	3	5	1.7
fin whale	47	66	1.4
long-beaked common dolphin	2	90	45
short-beaked common dolphin	29	4,133	142.5
common dolphin, species unknown	9	420	46.7
Risso's dolphin	11	296	26.9
Pacific White-sided dolphin	4	22	5.5
humpback whale	0	0	0
Dall's porpoise	0	0	0
bottlenose dolphin	29	612	21.1
Cuvier's Beaked whale	13	54	4.2
totals:	147	5,698	

2B. Sightings 17-30 October 2008. Table includes sightings from one day at Santa Catalina Island.

	# groups	# individuals	Ave. grp. Size
blue whale	1	1	1.0
fin whale	18	32	1.8
long-beaked common dolphin	3	1,033	344.3
short-beaked common dolphin	14	2,951	210.8
common dolphin, species unknown	6	652	108.7
Risso's dolphin	0	0	0.0
Pacific White-sided dolphin	2	15	7.5
humpback whale	2	3	1.5
Dall's porpoise	1	5	5.0
bottlenose dolphin	5	55	11.0
Cuvier's beaked whale	9	24	3.0
totals:	61	4,771	

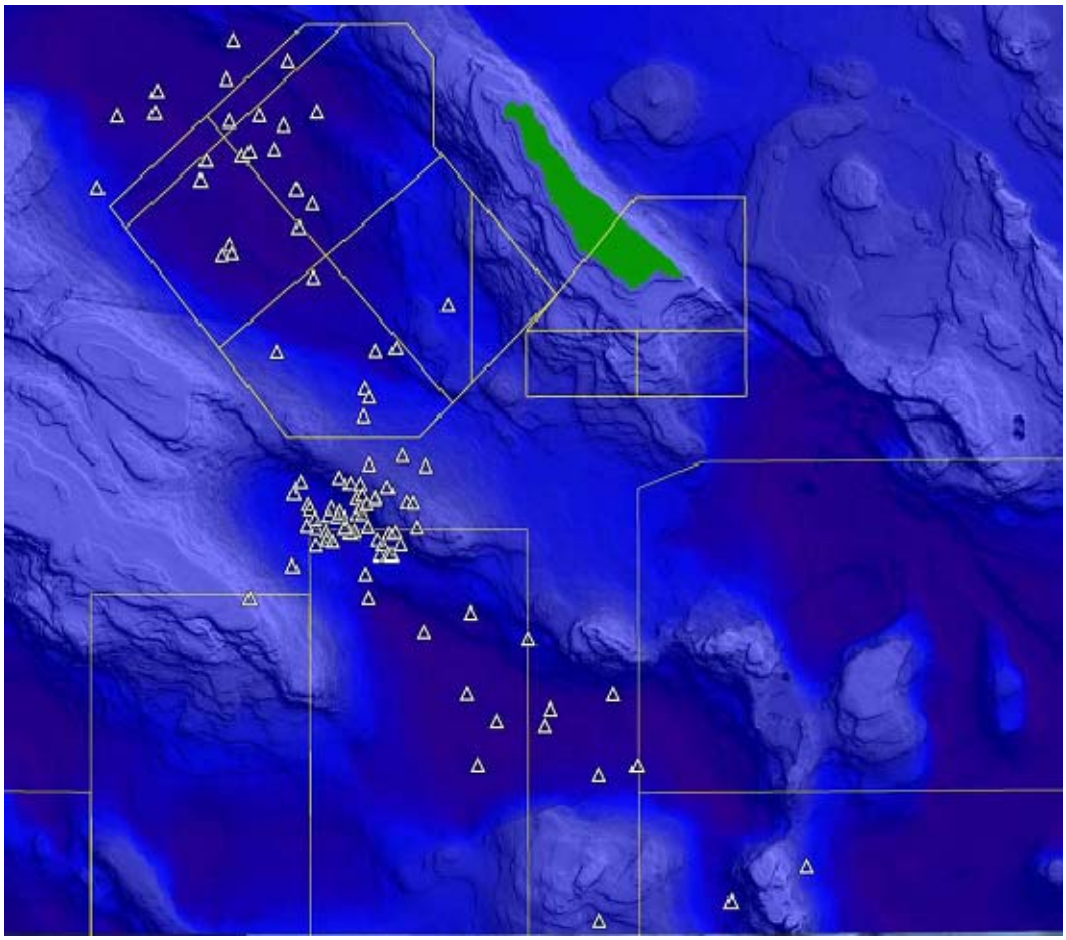


Figure CRC-1. Map showing daily location of a satellite tagged Cuvier's beaked whale over a period of 106 days. The maximum distance moved from the original tagging location is currently 151 km (82 nm) (graphic courtesy of Greg Schorr, Cascadia Research Collective).

Figure CRC-2. Medium duration satellite tag on a fin whale 23 October 2008.
(Photo by and courtesy of Erin Falcone, Cascadia Research Collective)

Cascadia Research Collective RHIB Surveys and Satellite Tagging Within the SOCAL Range Complex 18-26 July 2009- Preliminary trip summary of 27 July 2009

By Erin Falcone and Greg Schorr
Cascadia Research Collective – Olympia, WA

Erin Falcone and Greg Schorr conducted Cascadia Research Collective's first RHIB survey of 2009 at the Southern California Anti-submarine warfare Range (SOAR) west of San Clemente Island in coordination with the Navy's M3R monitoring from 18-26 July 2009. One goal for this year of the study is to implement a more flexible survey approach, where we can better take advantage of suitable weather windows and available range time to facilitate data collection from beaked whales and deploy enough satellite tags to define home ranges, habitat use, and typical movement patterns for multiple range species. This survey ended up being pre-scheduled to coordinate with a line-transect survey by the Sproul and aerial surveys, and so was less weather-dependent than we hope future surveys in 2009-2010 will be. We utilized a single RHIB (Figure CRC-JUL-1), and during times when the range was not available due conflicting operations or poor weather, we shifted operations inshore to adjacent regions of the SOCAL Range Complex, as data from animals in this region will ultimately be essential to defining population structure in naval training areas.

The first peer-reviewed publication from this effort has just been recently published in September 2009 (Falcone et al. 2009).

CRUISE RESULTS

Cascadia's RHIB surveys in July included 81.3 hours of effort covering 777 nm of track lines, with most surveys in the vicinity of San Clemente Island, but also some effort along the mainland coast between Oceanside and Long Beach, along the east side of Santa Catalina Island, and over the basins and banks between San Clemente and the coast. Six of nine days were spent working on the instrumented range. While no range surveys were terminated due to poor weather, conditions were generally not well-suited to sighting beaked whales, with moderate winds and significant swell heights on most days. Despite this, 76 cetacean sightings were recorded from the Cascadia RHIB, including five sightings of Cuvier's beaked whales and one sighting of three unidentified cetaceans likely to be beaked whales (three of these sightings were not directed by acoustic detections). In contrast to previous surveys, where on days with calm winds beaked whale sightings were extended, all but one of these sightings consisted of only a single surfacing series. Table CRC-JUL-1 summarizes our cetacean sightings, photographic IDs, tissue samples collected, and satellite tags deployed during this cruise.

Eight satellite tags were deployed on four different cetacean species: Cuvier's beaked whale (1), bottlenose dolphin (1), Risso's dolphin (1) and fin whale (5). Four of the fin whales were tagged in a single aggregation in the northwestern quadrant of the range and subsequently split up moving in different directions across the range. All tagging was done from a RHIB (Figure CRC-JUL-1) and plots of animal movement shown in Figures CRC-JUL-2 to 4.

Figures CRC-JUL-5 to 7 show the locations of baleen whale, dolphin, and Cuvier's beaked whale sightings during the 18-26 July 2008 RHIB visual survey.

Table CRC-JUL-1. A summary of cetacean sightings at the Southern California Anti-submarine warfare Range and in adjacent regions of the SOCAL Range Complex made by the Cascadia RHIB from 18-26 July 2009.

Species	Groups Sighted	Total Individuals	Avg. Group Size	IDs	Tissue Samples	Sat Tags Deployed
Minke Whale	2	2	1	2		
Blue Whale	8	11	1	11		
Fin Whale	7	19	3	15	1	5
Long-beaked Common Dolphin	12	429	36		1	
Short-beaked Common Dolphin	16	2333	146			
Common Dolphin, Sub-species unknown	5	53	11		1	
Risso's Dolphin	12	267	22	136	3	1
Pacific White-sided Dolphin	1	10	10			
Bottlenose Dolphin	7	144	21	60	2	1
Small Cetacean, Probable beaked whale	1	4	4			
Cuvier's Beaked Whale	5	10	2	4		1
Totals:	76	3,282		228	8	8

Figure CRC-JUL-1. Cascadia RHIB used for tagging operation on and near the U.S. Navy's Southern California Anti-submarine Warfare Range west of San Clemente Island, CA.

In the following maps, the red dots (•) represent the most recent location of each tagged individual as of 13 Aug 2009. Argos locations displayed are not representative of all locations and are not filtered so some points may be added or filtered from the final dataset.

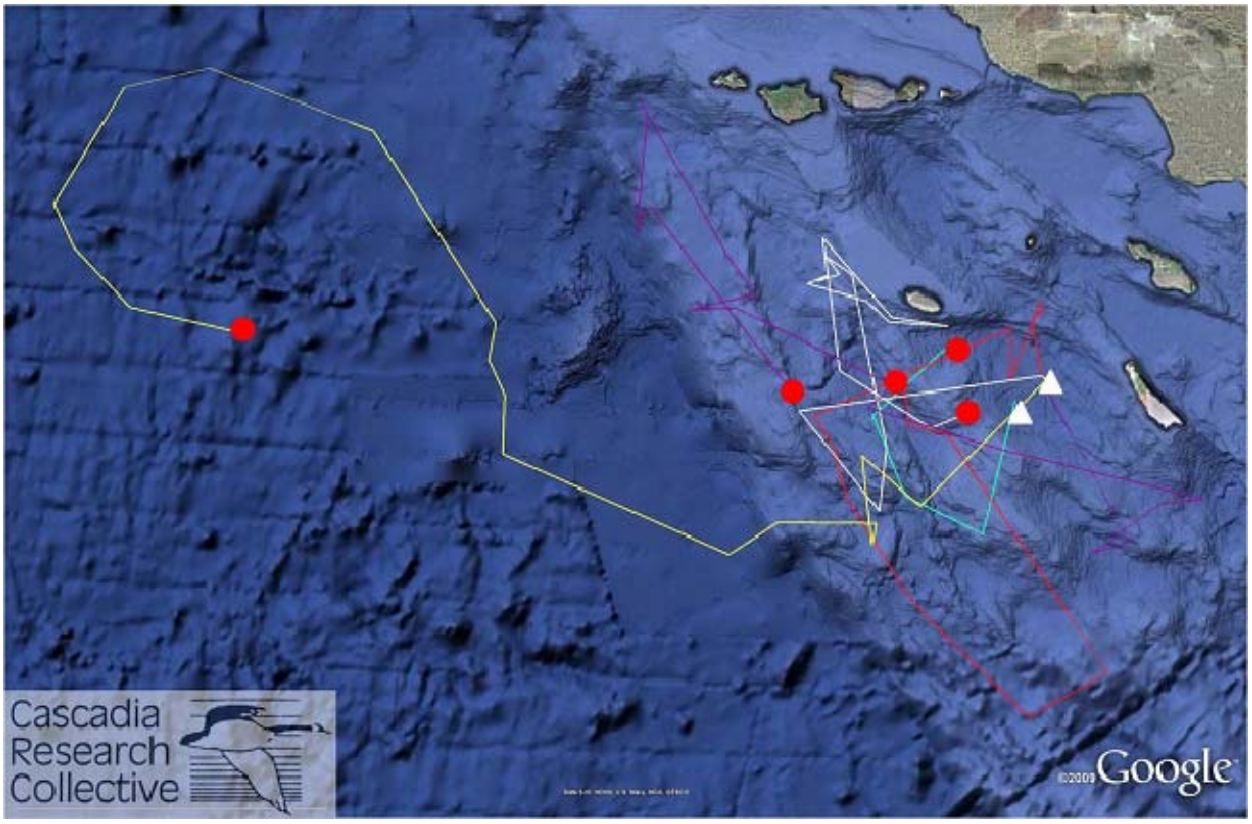


Figure CRC-JUL-2. Movement vectors of five satellite tagged fin whales 25 July through 13 August 2009.

Four individuals were tagged in the same location so the tagging location is represented by a single white triangle.

Created using Google Earth; topographical data courtesy 2009 Digital Globe, U.S. Geological Survey, County of San Bernardino, SIO, NOAA, U.S. Navy, NGA, and GEBCO.

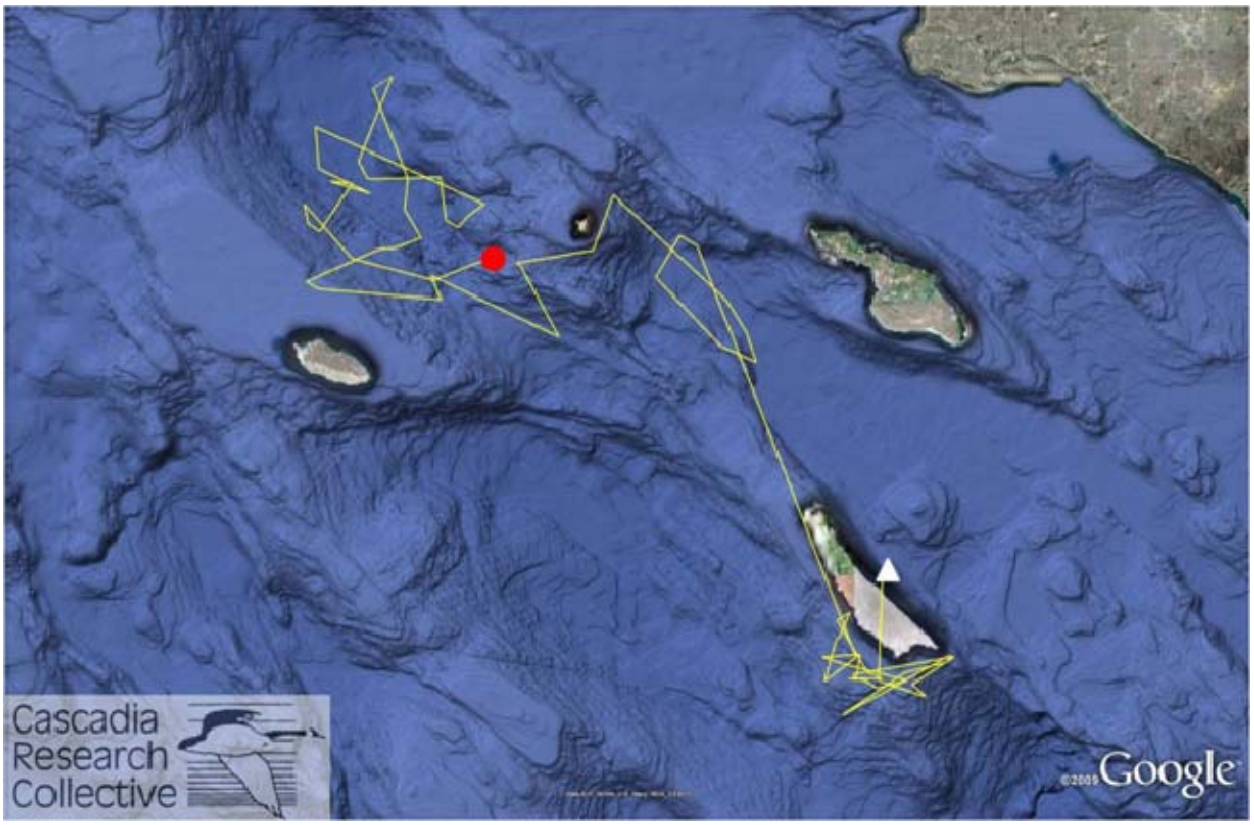


Figure CRC-JUL-3. Movement vectors of a satellite tagged Risso's dolphin 19 July through 2 August 2009.

While the individual spends substantial time in the near-shore environment, it also moves out into the deeper waters of several basins.

Created using Google Earth; topographical data courtesy 2009 Digital Globe, U.S. Geological Survey, County of San Bernardino, SIO, NOAA, U.S. Navy, NGA, and GEBCO.

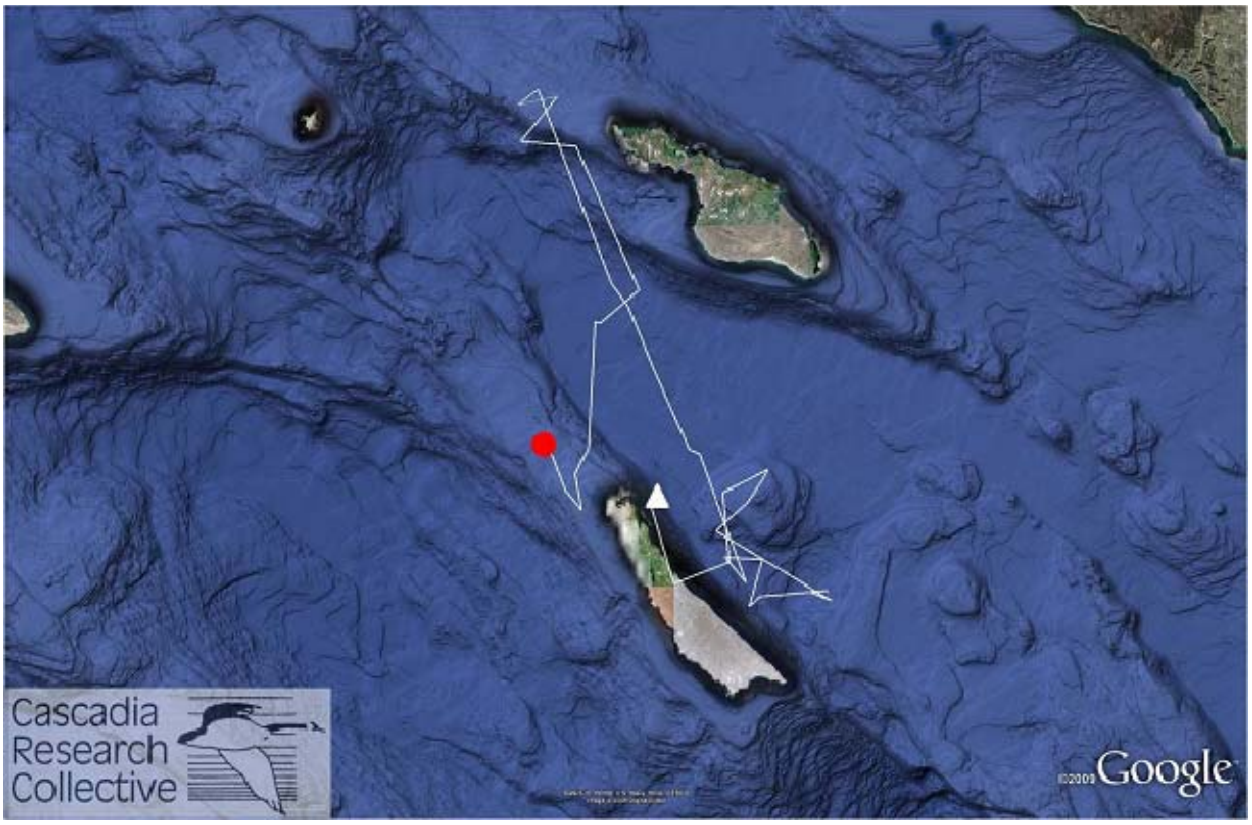


Figure CRC-JUL-4. Movement vectors of a satellite tagged bottlenose dolphin 20 July through 13 August 2009.

Created using Google Earth; topographical data courtesy 2009 Digital Globe, U.S. Geological Survey, County of San Bernardino, SIO, NOAA, U.S. Navy, NGA, and GEBCO.

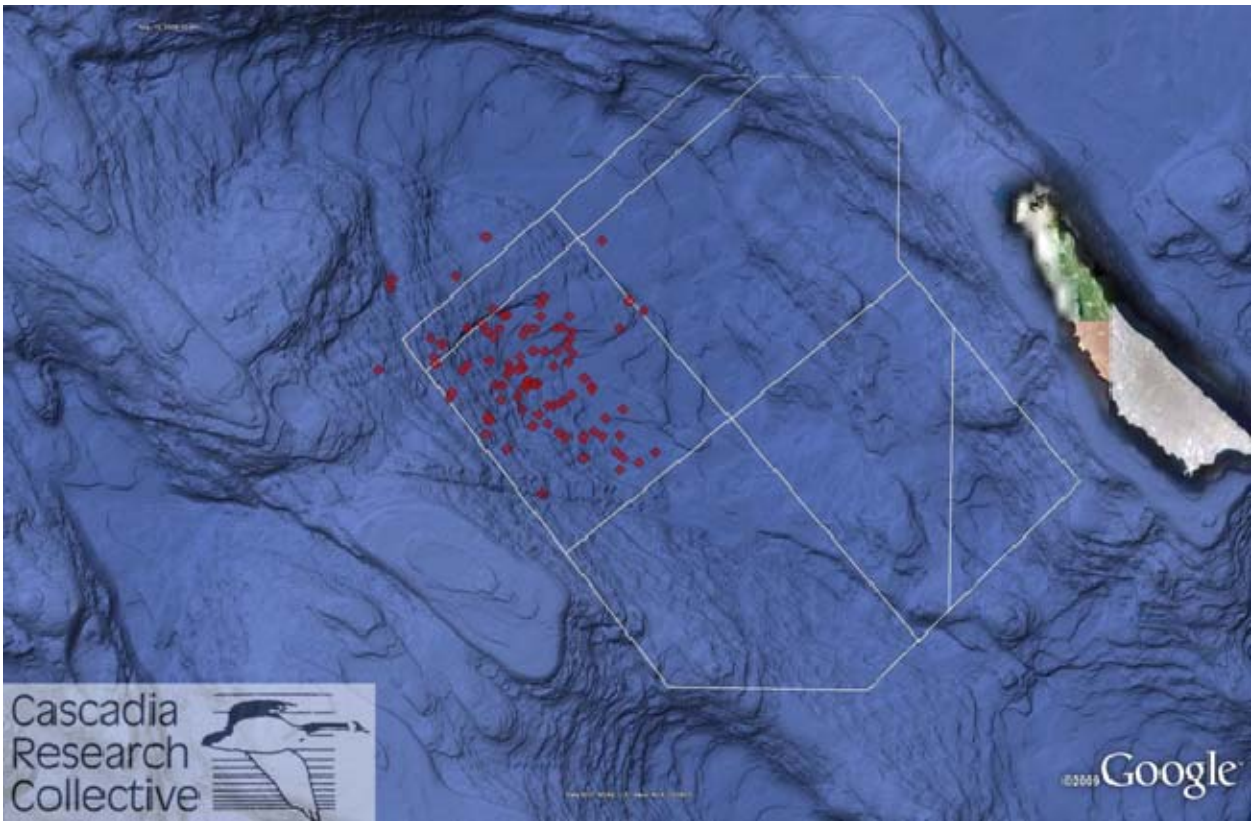


Figure CRC-JUL-5. Argos received locations from the second satellite tagged Cuvier's beaked whale on the SOAR, 20 July through 13 August 2009.

Created using Google Earth; topographical data courtesy 2009 Digital Globe, U.S. Geological Survey, County of San Bernardino, SIO, NOAA, U.S. Navy, NGA, and GEBCO.

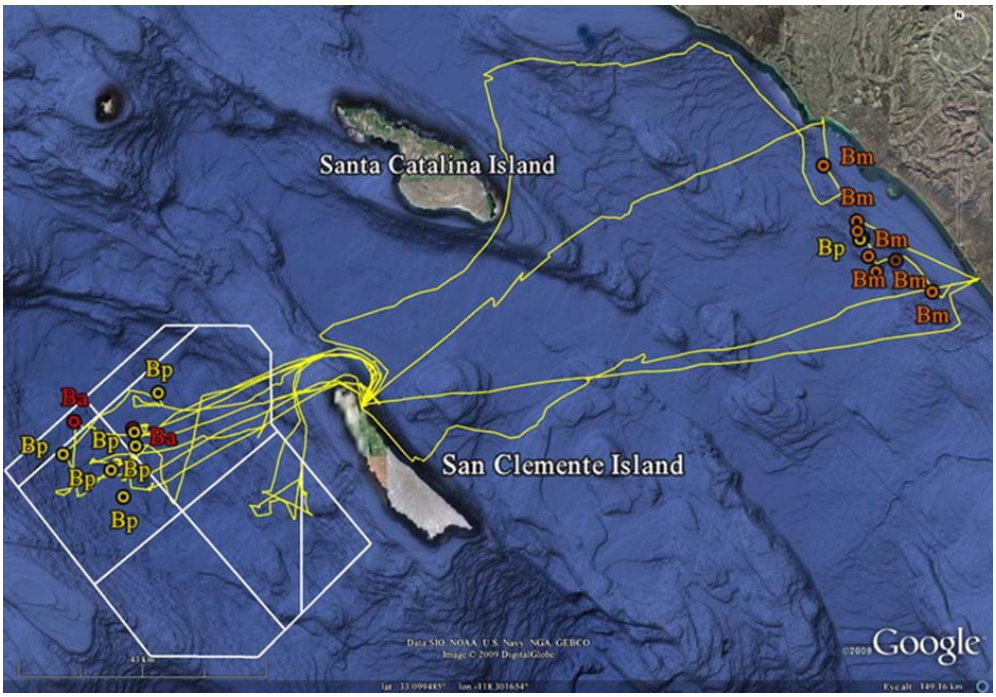


Figure CRC-JUL-6. Baleen whale sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

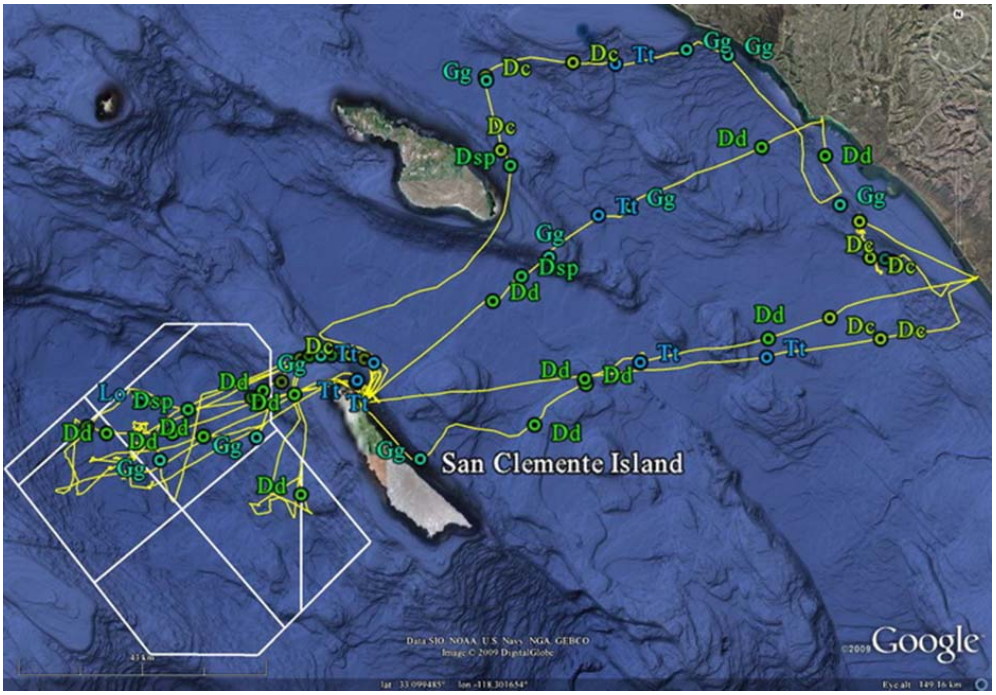


Figure CRC-JUL- 6. Dolphin sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

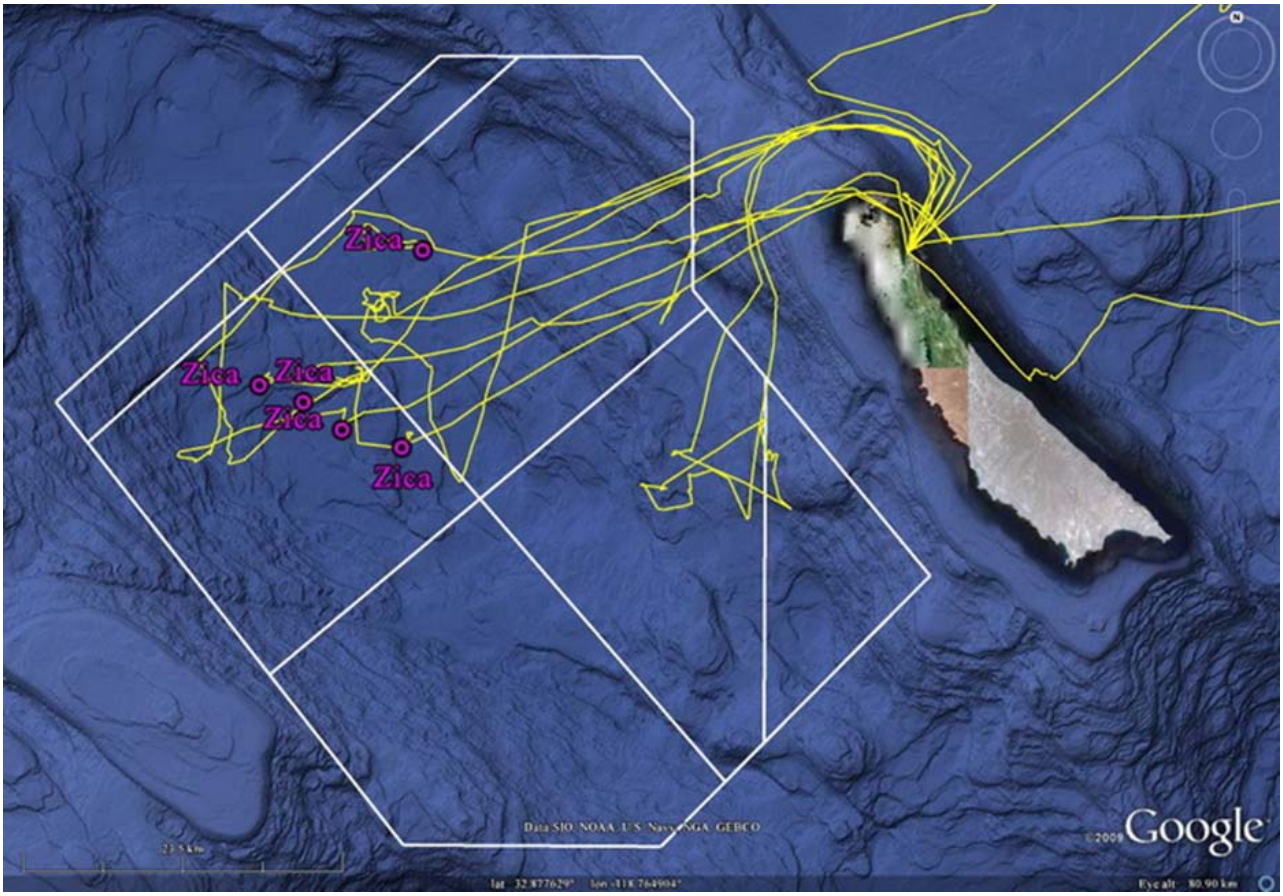


Figure CRC-JUL-7. Cuvier's beaked whale sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

SIO RHIB Marine Mammal Surveys Within The SOCAL Range Complex 20-28 July 2009- Preliminary Trip Summary of 30 July 2009

By Greg Campbell
Scripps Institution of Oceanography - University of California San Diego
and
Dave Weller
Southwest Fisheries Science Center - La Jolla, CA

The Scripps Institution of Oceanography (SIO), in collaboration with the Southwest Fisheries Science Center (SWFSC), conducted the latest in a series of marine mammal RHIB surveys in waters off Southern California at the Southern California Anti-submarine warfare Range (SOAR) and within the Southern California (SOCAL) Range Complex range in coordination with the Navy's M3R acoustic monitoring performed by the Naval Undersea Warfare Center (NUWC) from 20-28 July 2009. The primary objectives of the field effort were to collect photo-identification, biopsy and acoustical data from cetaceans encountered in the waters around San Clemente Island.

Eight surveys totaling 70.5 hours of effort and covering 682 nautical miles yielded sightings of 15 groups of bottlenose dolphins, 10 groups of Risso's dolphins and 16 groups of common dolphins (Figure SIO-RHIB-JUL-1). Photo-identification efforts produced high quality images of distinctive fins from of a large proportion of bottlenose dolphins and Risso's dolphins encountered. Biopsy sampling yielded a total of 25 tissue samples with 18 of 25 acquired from bottlenose dolphins, meeting our goal for testing stress hormone analysis. Acoustical data collection resulted in recordings of whistles, clicks and burst-pulsed calls from the three aforementioned species. Additional details on sighting, photo-identification, biopsy and acoustical data are provided in Table SIO-RHIB-JUL-1.

Photo-identification data collected from bottlenose dolphins at San Clemente Island from 2006-2009 is currently being integrated into an extensive 25-year photographic database from Southern California coastal and offshore sites to provide a regional assessment of residency, movement patterns, distribution and abundance. Risso's dolphin photo-identification data collected at San Clemente Island from 2006-2009 and during recent coastal and Catalina Island surveys is being used in the development of a first-time regional photographic catalog for this species.

Biopsy samples from bottlenose dolphins collected at San Clemente Island in 2008/2009 are currently being incorporated into two analyses: 1) DNA analyses for an evaluation of population structure and relatedness between peripheral groups sampled at both coastal and Catalina Island sites, and 2) Stress hormone analyses to assess relative concentrations of stress hormones as a function of the SCORE range operational status.

Acoustical data collected from delphinids off San Clemente Island from 2006-2009 has been incorporated into a larger database of recordings maintained at SIO. Several current projects are examining these data for species and population specific call structures that are essential for the interpretation of HARP long-term autonomous recordings conducted by SIO.

Recent surveys conducted in the Southern California Bight have allowed for the rapid development of our photographic, biopsy and acoustical databases, however, additional surveys in the SOCAL Range Complex as well as coastal and island sites are needed to develop a comprehensive understanding of cetacean population structures in the region.

Table SIO-RHIB-JUL-1. Summary information on sighting, photo-identification, acoustical and biopsy data collected July 20-28 2009 at San Clemente Island.

Species	Number of Groups	Number of Individuals	Mean Group Size	Number of ID Images	Number of Biopsies	Number of Recordings
Bottlenose Dolphin	15	288	19	747	18	13
Risso's Dolphin	10	87	9	241	1	9
Long-Beaked Common Dolphin	1	24	24	49	3	4
Short Beaked Common Dolphin	8	1357	169	64	3	0
Common Dolphin Species	7	1488	213	74	0	3
Unidentified Delphinid	1	6	6	0	0	0

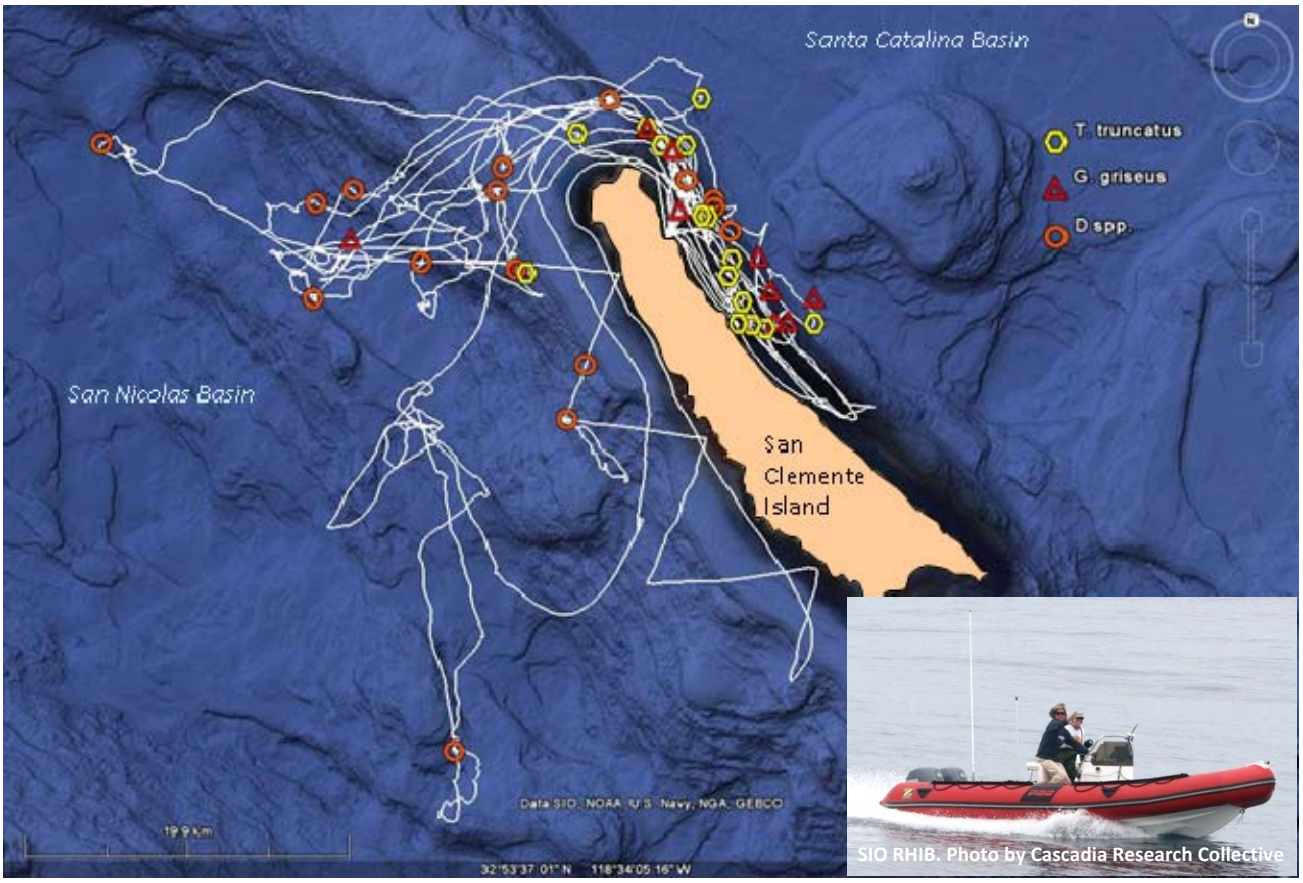


Figure SIO-RHIB-JUL-1. SIO RHIB survey tracks and sighting locations for bottlenose dolphins, Risso's dolphins, and common dolphins (Delphinus spp.) 20-28 July 2009 near San Clemente Island.

CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATION (CALCOFI)

By John Hildebrand
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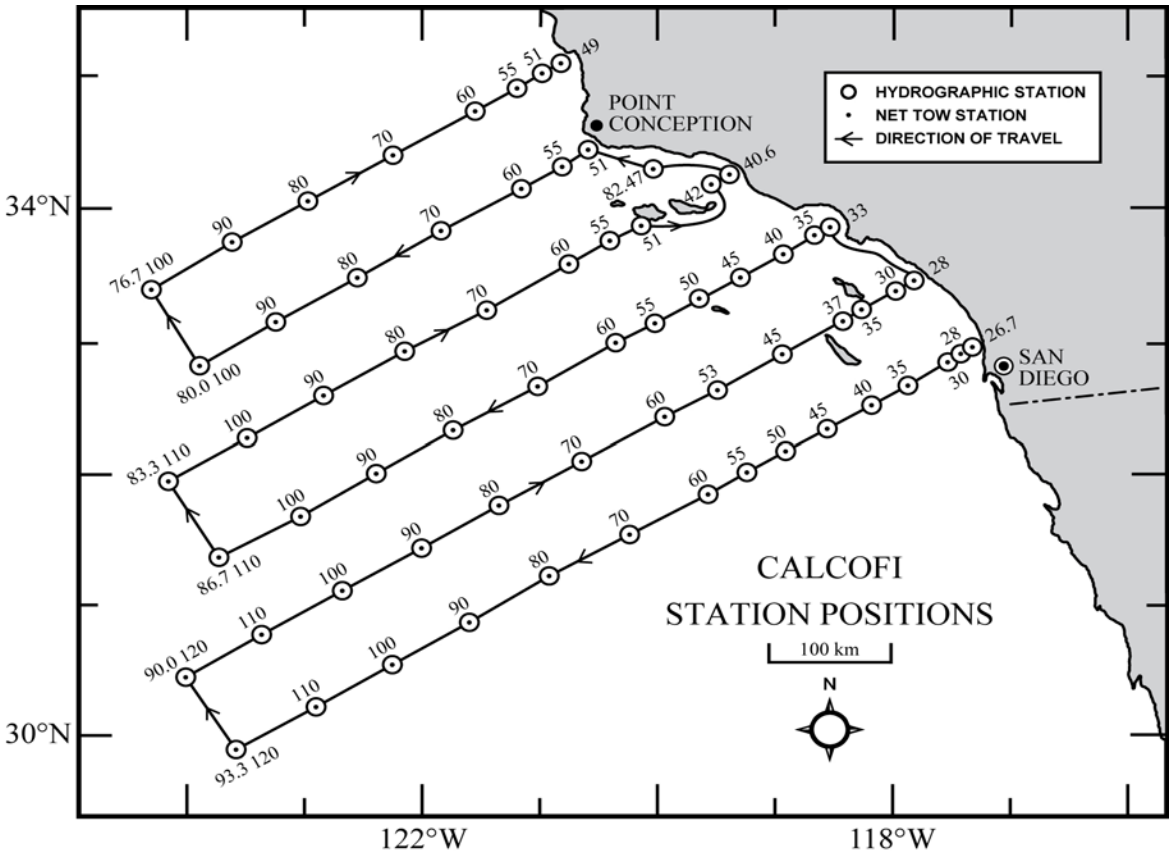
Cetacean survey data from California Cooperative Oceanic Fisheries Investigation (CalCOFI) cruises conducted in southern California has been funded by the Navy R&D program (Marine Mammal Acoustic Monitoring and Habitat Investigation, Southern California Offshore Region). CalCOFI cruises have been conducted consistently on the same transect lines over the past 60 years and provide one of the longest and most extensive time series of physical and biological oceanographic data in the world. Approximately four years ago (2005), Scripps Institution of Oceanography (SIO) was awarded a contract to add visual and acoustic surveys of cetaceans to the CalCOFI cruises. Four seasonal cruises were conducted annually. A towed hydrophone is used to detect vocalizing cetaceans. Sonobuoys are deployed and acoustic signals recorded when the ship stops for oceanographic observations. The goals of the cetacean surveys are to determine the temporal and spatial patterns of cetacean distribution, to compare visual and acoustic survey methods and results, to quantify differences in vocalizations between cetacean species, and to make seasonal estimates of cetacean density and abundance within the study area. The surveys have been successful in achieving broad coverage. The greatest strength of this survey is its broad seasonal and geographic coverage within SOCAL. Sample sizes (numbers of sightings) are comparable or greater than the total number of SWFSC sightings from the same area. The weakness of the CalCOFI surveys are that, due to time constraints, the vessel cannot alter course during the survey to estimate group sizes or always determine species identification. A comparison of visual and acoustic detections has shown that most groups are detected by both methods. CalCOFI cetacean surveys are planned to continue for at least the next two years. To date, no estimates of cetacean density or abundance have been made from the CalCOFI surveys, but both are planned in the future. Plans also exist to model cetacean density as a function of habitat models using these survey data.

Visual monitoring for cetaceans are conducted on quarterly CalCOFI cruises during 2008-2009 using standard line-transect protocol. Visual observers watch during daylight hours when weather permitted while the ship transited between CalCOFI stations (Beaufort sea states 0-5 and visibility greater than 1 nm). A team of two observers searched for cetaceans in a 90° field of view from the bow to abeam of the ship, alternating between 7 x 50 power binoculars and the naked eye. A record of time, position, ship's heading and speed, viewing conditions (including sea state, wind speed and visibility), and observer identification is maintained and updated at regular intervals or whenever conditions changed. Information on all cetacean sightings is logged systematically, including distance and bearing from the ship, species identification and group composition, estimated group size and behavior. In all surveys, 25x power binoculars are used to improve species identification after the sighting of animals using lower power 7x binoculars or no magnification.

Acoustic monitoring for cetaceans during line-transect surveys is conducted using a towed hydrophone array. A 300-m lead wire connects the array to the vessel, and the leading edge of the hydrophone is wrapped with 15 lbs of lead wire to submerge the array. Each pre-amplified element was band-pass filtered from 3 kHz to 100 kHz to decrease high-intensity, low-frequency flow noise and provide protection from signal aliasing at high-frequencies. The multi-channel array data are digitized using a Mark of the Unicorn (MOTU) 896 sound system that recorded the data directly to a computer hard drive using the software program Ishmael. An acoustic technician listened to sounds received from the towed array while visually monitoring a scrolling spectrogram of the incoming sounds on a computer display. Acoustic monitoring during CalCOFI stations is conducted with broadband passive AN-SSQ-57B

sonobuoys. Sonobuoys are expendable hydrophones, sensitive from 20 Hz to 20 kHz, with radio data links for transmission of acoustic data to the ship. Sonobuoys are deployed one nautical mile before each daylight station to a depth of 30m and are recorded for 2-3 hours. The received acoustic signal is digitized with a SoundBlaster SB0300 24-bit external soundcard and recorded directly to computer hard drive using the program "Ishmael". An acoustic technician monitors the sonobuoy signals for cetacean calls using a scrolling spectrogram display. Mysticete calls, sperm whale clicks, and dolphin calls, including whistles, burst pulses, and the low frequency component of their clicks, are recorded with this system. These data provide an expanded database of calls produced by a known, visually-identified species.

Sighting data and summary statistics for five Navy funded marine mammal surveys during CalCOFI cruises are provided in Tables CalCOFI 1 and 2, and Figure CalCOFI-1.

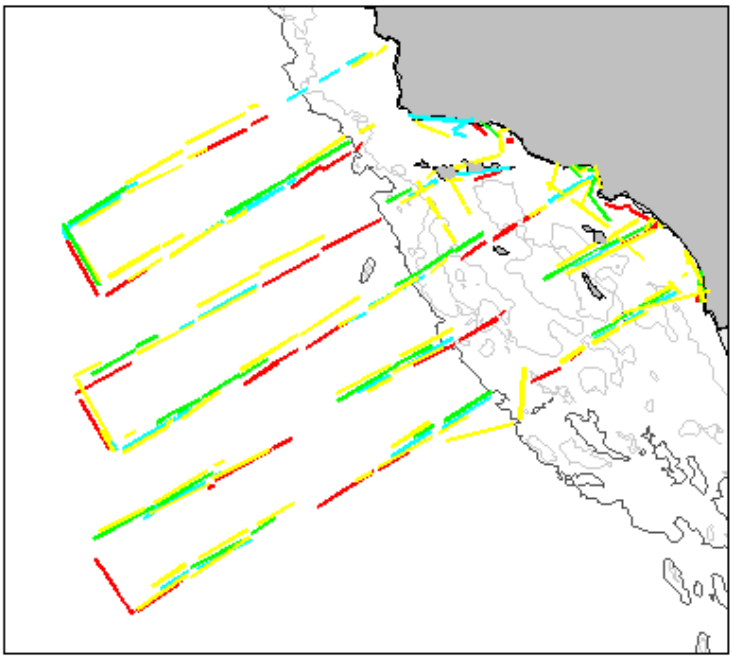


CalCOFI station locations off Southern California (graphic courtesy of CalCOFI program)

Table CalCOFI-1. Summary statistics from five CalCOFI cruises between August 08 and August 09.

CalCOFI Cruise Date	Marine Mammal Survey Effort (hrs)	Total Distance Surveyed (nm)	# of Sightings (#)	# of Marine Mammals (#)	# Digital Photos Taken (#)	# of Passive Acoustic Recordings (#)	Total Hours of PAM (hrs)	# of Acoustic Detections of Species /# of Species	# of Sonobuoys Deployed
14-30 Aug 2008	93	895	58	1,007	227	65	139	51 / 8	31
14-29 Oct 2008	86	727	36	732	81	61	126	67 /8	29
8-23 Jan 2009	76	694	72	984	381	59	128	42 /8	30
8-23 Mar 2009	83	768	29	440	223	59	133	29 /6	28
14 Jul-5 Aug 2009	*	1,006	110	2,050	*	*	*	*	*
Totals:	338	4,090	305	5,213	912	244	526	189	118

* = data not available as of this report date



Marine mammal visual effort trackline on CalCOFI cruises between August 2008 and August 2009 CalCOFI cruises

Table CalCOFI-2. CalCOFI on-effort cetacean sightings, August 2008 to August 2009.

Ns = number of sightings, Ni = number of individuals.

Species	CC0808 (14-30 Aug 2008)		CC0810 (14-29 Oct 2008)		CC0901 (8-23 Jan 2009)		CC0903 (7-23 Mar 2009)		CC0907 (15-30 Jul 2009)	
	N_s	N_i	N_s	N_i	N_s	N_i	N_s	N_i	N_s	N_i
Ba	1	1	1	1	2	2	0	0	0	0
Bbo/Be	0	0	1	1	0	0	0	0	0	0
Bm	3	3	0	0	0	0	0	0	17	21
Bp	10	12	4	5	3	4	3	3	12	14
Dc	1	52	0	0	1	65	2	141	5	351
Dd	8	185	18	402	14	320	3	174	27	1167
Dsp	11	556	4	234	9	196	2	40	14	284
Er	0	0	0	0	7	16	3	4	0	0
Gg	0	0	2	14	1	15	0	0	4	45
Lo	1	32	1	11	0	0	1	2	0	0
Mn	7	13	0	0	6	11	0	0	0	0
Oo	0	0	0	0	2	7	0	0	0	0
Pd	0	0	0	0	10	81	8	44	0	0
Pm	0	0	0	0	1	1	0	0	6	9
Sc	0	0	0	0	0	0	0	0	1	58
Tt	2	22	0	0	4	127	1	2	7	82
UD	5	120	4	62	6	131	3	27	1	1
ULW	9	11	1	2	6	8	3	3	16	18
TOTALS	58	1007	36	732	72	984	29	440	110	2050
Total visual effort	895 nm		727 nm		694 nm		768 nm		1,006 nm	

SPECIES CODE

Ba = *Balaenoptera acutorostrata* (minke whale)
Bbo/Be = *Balaenoptera borealis/edenii* (unid Sei/Bryde's whale)
Bm = *Balaenoptera musculus* (blue whale)
Bp = *Balaenoptera physalus* (fin whale)
Dc = *Delphinus capensis* (long-beaked common dolphin)
Dd = *Delphinus delphis* (long-beaked common dolphin)
Dsp = *Delphinus* spp. (unid common dolphin)
Er = *Eschrichtius robustus* (grey whale)
Gg = *Grampus griseus* (Risso's dolphin)
Lo = *Lagenorhynchus obliquidens* (Pacific white-sided dolphin)
Mn = *Megaptera novaeangliae* (humpback whale)
Oo = *Orcinus orca* (killer whale)
Pd = *Phocoenoides dalli* (Dall's porpoise)
Pm = *Physeter macrocephalus* (sperm whale)
Sc = *Stenella coeruleoalba* (striped dolphin)
Tt = *Tursiops truncatus* (bottlenose dolphin)
UD = unidentified dolphin
ULW = unidentified large whale

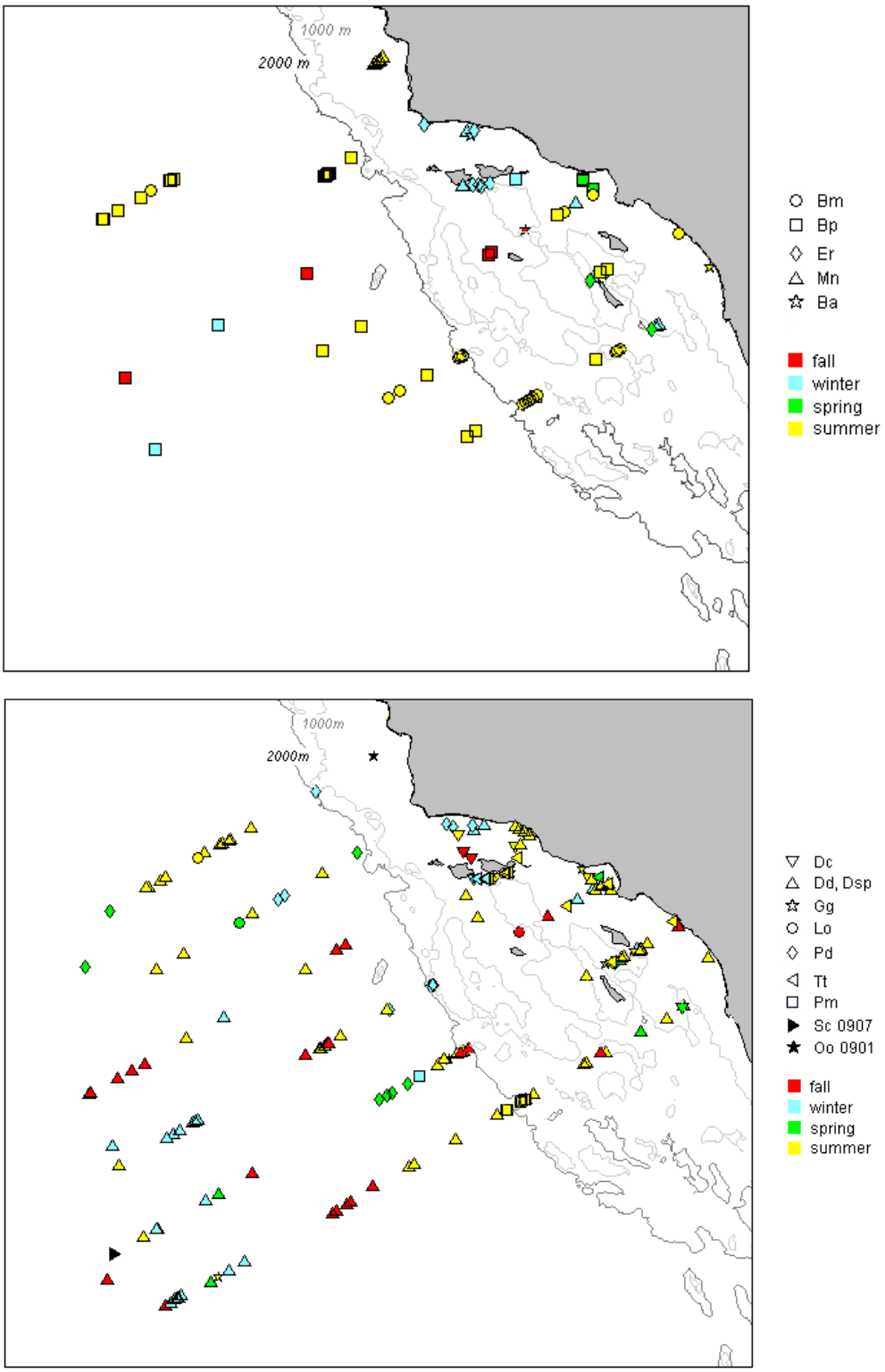


Figure CalCOFI-1. Baleen whale sightings (top) and toothed whale sightings (bottom) during CALCOFI cruises between August 2008 and August 2009.

Naval Postgraduate School

The Naval Postgraduate School at Monterey, California functions on behalf of CNO N45's R&D program, as the program coordinator for marine mammal research in the Pacific. New 2009 publications (http://www.nps.edu/Research/publications/09techrpt.html) describing research through 2008 include:

NPS-OC-09-001 (Oleson, Calambokidis, Falcone, Schorr, Hildebrand) Acoustic and visual monitoring for cetaceans along the outer Washington coast

NPS-OC-09-003 (Stafford) Monitoring Cetaceans in the North Pacific

NPS-OC-09-005 (Ketten, Mountain) Beaked and Baleen Whale Hearing: Modeling Responses to Underwater Noise

NPS-OC-09-006 (Hildebrand) Marine Mammal Acoustic Monitoring and Habitat Investigation, Southern California Offshore Region

NPS-OC-09-007 (Rone, Douglas, Clapham, Martinez, Morse, Calambokidis) Cruise Report for the April 2009 Gulf of Alaska Line-Transect Survey (GOALS) in the Navy Training Exercise Area

Central and Southern California Thesis completed since 1997 by NPG include;

- Hager, C.A., "Modeling the Performance of the Pt. Sur Hydrophone Array in Localizing Blue Whales," MS Thesis, 1997.

- Moore, T.C., "Estimation of the Source Signal Characteristics and Variability of Blue Whale Calls Using a Towed Array," MS Thesis, 1999.

- Kumar, Anurag, "Estimation of Abundance of Blue Whale calls off central California using a seafloor-mounted Hydrophone," MS Thesis, California State University, Fresno, December 2003.

- Garcia, J.F., "Assessing the Performance of Omni-Directional Receivers for Passive Acoustic Detection of Vocalizing Odontocetes: Initial Analysis," MS Thesis, December 2002.

- Daziens, J.M., "Assessing the Performance of Omni-Directional Receivers for Passive Acoustic Detection of Vocalizing Odontocetes," MS Thesis, 2004.

- Pucan, Rommel, "Acoustic Ambient Noise Trends in the North Atlantic and the Mediterranean Sea ," MS Thesis, March 2006. [CLASSIFIED]

- Scheidecker, Elizabeth, " Wavelet applications to Marine Mammal vocalization classification," MS Thesis, September 2005.

- Cesari, Glenn, Pacific Ocean Ambient Noise from Sonobuoys, M.S. Thesis, Naval Postgraduate School, March, 2007. [CLASSIFIED]

• Thompson, Stephanie, Extensible 3D (X3D) graphics for visualizing Marine Mammal reaction to Underwater Sound on the Southern California ASW Range (SOAR), M.S. Thesis, June, 2007.

• Hager, Carl A., "Passive detection and source signal reconstruction of Odontocete vocalizations at the SCORE acoustic range," Ph.D., March 2008.

• Armijo, Cristal, "A Description of the Currents on the Continental Shelf near Eel Point, San Clemente Island, California, from July 10, 2006, to July 23, 1007, " M.S. Thesis, March, 2008

• Cocker, Paul., "Observations of Ocean Ambient Noise (10 Hz to 10 kHz) at the Site of a Former Navy Listening Station to the West of Point Sur, California, from January to July, 2007," M.S. Thesis, June, 2008.

• Jensen, Christian, "A Protocol for Analysis of Marine Mammal Vocalizations from Passive Acoustic Recordings at the Southern California Offshore Range (SCORE)," M.S. Thesis, September, 2008. [CLASSIFIED]

• Mohamed, Jessica, "The Development of a Kernel to Detect Ziphius cavirostris Vocalizations and a Performance Assessment of an Automated Passive Acoustic Detection Scheme," M.S. Thesis, September, 2008.

Between August 2008 and August 2009, NPS focused their SOCAL marine mammal and oceanographic efforts on understanding the acoustic and physical environment within the region from central California through SOCAL. NPG ongoing 2009 efforts include:

(1) looking at the variability of vocalizations recorded by a subset of SOAR hydrophones,

(2) maintaining a moored acoustic recording package at Sur Ridge to help quantify seasonal marine mammal migration into and out of the SOCAL region,

(3) two shallow water moorings on either side of San Nicholas Basin that provide both local flow characteristics as well as cross-basin transport,

(4) development of detection and classification algorithms for marine mammal vocalizations,

(5) ambient acoustic noise studies, and

(6) modeling acoustic propagation in San Nicholas Basin.

NPG did have one marine mammal visual survey in and around the SOAR range during July 2009, current with both the U.S. Pacific Fleet compliance monitoring and N45 R&D monitoring. There were 48 sightings for an estimated 3,573 marine mammals over 56 hours and 280 nm of survey.

Other SOCAL Related Research

SIBR Phase II Project "Marine Mammal Acoustics"

Sonalysts, Inc.[1], in partnership with Dr. Mark McDonald of Whale Acoustics, is continuing work on a Phase 2 Department of Defense Small Business Innovation Research (SBIR) project managed by Naval Air Systems Command (NAVAIR) to analyze beaked whale echolocation as a surrogate for foraging in response to sonar exposure within SOCAL. The goal of the project is to determine beaked whale response to mid-frequency sonar by analyzing potential sonar impacts on the animals' foraging behavior. Existing recordings from passive seafloor recorders include whale echolocation and sonar. The whales' own vocalizations provide an insight into their reactions. So far, through 2009, over 2,000 Cuvier's dives were picked from about 1,200 instrument days of data. This represents about 41 Terabytes of raw data. Sonar impact analysis concentrated on five particular HARP sites in SOCAL containing over 1,600 Cuvier's beaked whale dives and almost 800 hours of opportunistic sonar exposures. Data analysis is still ongoing.

[1] The Government's rights to use, modify, reproduce, release, perform, display, or disclose technical data or computer software marked with this legend are restricted as provided in paragraph (b)(4) of DFARS 252-227-7018, Rights in Noncommercial Technical Data and Computer Software - Small Business Innovative Research (SBIR) Program. Topic Number:N07-024; Contract Number:N68335-07-C-0222; Contractor Name: Sonalysts, Inc.; PO Box 280, Waterford, CT 06385; Expiration of SBIR Data Rights: 9/22/2014

Part III- SOCAL Adaptive Management Recommendations

Adaptive management is an iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems. adaptive management helps science managers maintain flexibility in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction; will improve understanding of ecological systems to achieve management objectives; and is about taking action to improve progress towards desired outcomes.

The Navy's adaptive management of the SOCAL Range Complex Monitoring Plan involves close coordination with NMFS to align marine mammal monitoring with the Plan's overall objectives as stated within earlier sections of the Plan and in the Introduction of this report.

Significant progress was made during Compliance monitoring within the SOCAL Range Complex this year. This first year focus was the preliminary assessment of various monitoring techniques discussed in Part I, as well as coming to grips with the degree of within-Navy and outside-Navy coordination required in order to align monitoring resources and event availability. It should be noted that within the SOCAL Range Complex, scheduling monitoring that involves civilian aircraft and ships operating concurrently with multiple Navy aircraft and ships in the same area required extensive pre-survey coordination between multiple Navy commands. Even with approved deconfliction, emergent changes in Navy training schedules often required last minute revision of planned survey areas, sometimes while the civilian plane or boat was in transit. For instance, during the June and July aerial surveys, the plane was excluded 22 times from a planned survey route while in transit (12 times in June, 10 times in July).

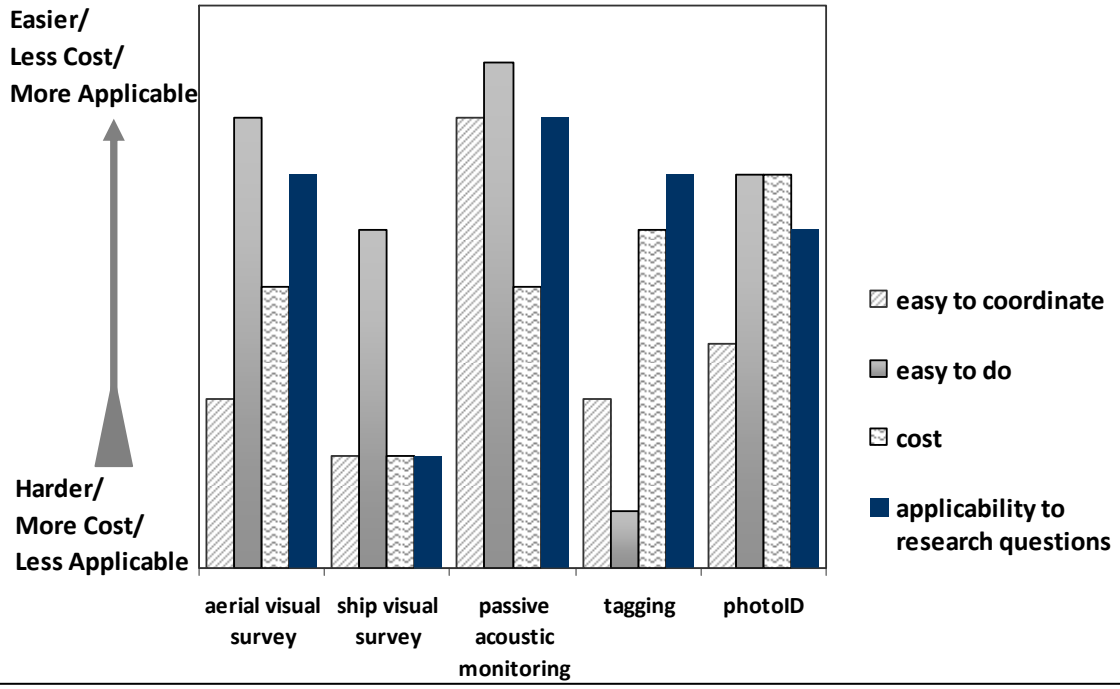
More disruptive were either cancellations or major date shifts in Navy training events based on logistics, fiscal, or operational needs that occurred this year. These kind of changes are difficult to predict and more importantly, more difficult to reschedule from a monitoring prospective when survey equipment has been purchased, rented or relocated; personnel availability and transport arranged; and fixed date contracts put into place. Several planned Navy training events scheduled for monitoring had to either be cancelled, or subject to expensive funding increase to cover the change in monitoring design.

The advance degree of N45's R&D funded monitoring within SOCAL was under appreciated at the time the initial Fleet-funded SOCAL Range Complex Monitoring Plan was originally finalized for submission to the NMFS in mid-2008. Several techniques including deployment of over 10 HARPs located throughout Southern California, development of small boat cetacean tagging procedures and deploying tags on key species, continued refinement of the real-time and near-real time beaked whale detection capabilities of the M3R at SOAR, and associated visual survey efforts in conjunction with the these methods were under evaluated in how close they match the data needs to address the NMFS framed study questions. Integration of certain elements of the N45 R&D program into the Range Complex Compliance Monitoring Program is highly recommended.

Figure II-11 shows a highly subjective preliminary assessment of various monitoring techniques from the Compliance and R&D programs in terms of how effective they may be in the SOCAL Range Complex. By "subjective", the Navy refers to a review across a number of factors made by U.S. Pacific Fleet environmental planning staff based on lessons learned, data obtained, and associated coordination issues that arose during the monitoring described in the HRC-SOCAL Monitoring Report (DoN 2009c).

This is an early preliminary assessment in that data analysis, especially of collected passive acoustic monitoring data is still ongoing. The kind of feedback obtained by this form of internal self-assessment, however, is useful in allowing the Navy to plan future range complex monitoring, as part of the Adaptive Management Process.

Figure II-11. Subjective assessment of techniques for adaptive management review of 2009 SOCAL Range Complex monitoring.



Definition of Subjective Categories

"**Easy to coordinate**" = ease of being able to gain SOCAL Range Complex access especially in associate with MTEs

"**Easy to do**" = ease of performing once on range; also includes standardization of technique to SOCAL Range Complex

"**Cost**"= costs associated with a particular technique; includes costs associated pre-event preparation/purchasing, field work, and post-field effort data analysis

"**Applicability to research questions**"= Will technique provide the enough scientific information to address the Navy-NMFS monitoring objectives over time; to some degree also reflective of value of a given technique given the three categories above

PROPOSED 2010 MONITORING

In view of lessons learned during implementation of the FY09 SOCAL Monitoring Plan, and as part of the Navy's adaptive management review for the SOCAL Range Complex, a Navy recommended modification of the FY09 Plan to reflect the science needed for the revised FY10 SOCAL Monitoring Plan is shown in **Table II-10**.

Note that these tables show a shift towards combining all visual survey hours (aerial and vessel) into one overall category of "total visual survey hours" to allow for flexibility when scheduling throughout the study year.

The main rational for restructuring the monitoring table shown in **Table II-10** is to:

- simplify the presentation of goals,
- provide more flexibility in types of events monitored given the often rapid change in Navy exercise schedules,
- align the technique with the best promise of more accurately addressing the Monitoring Plan objectives, and
- demonstrate the value of leverage data collection efforts from the SOCAL specific on-going N45 R&D program which is already concurrently addressing some portions of the information needed in support of the monitoring goals.

Original projection of 2010 monitoring needs discussed with NMFS in summer of 2008 and finalized in the 2009 SOCAL Monitoring Plan lists 120 hours of aerial survey, 72 hours of vessel survey, 72 hours of MMOs, 2 PAMs, and opportunistic tagging. At that time, the level of effort from the N45 R&D program was not evaluated in terms of its contribution to marine mammal and impact analysis science within the SOCAL Range Complex. Given the lessons learned and data presented from 2009 monitoring (DoN 2009c), and leveraging from parallel N45 R&D program and presentation of effort and results from that program, modification of the 2010 US Pacific Fleet funded portion of the Navy's overall monitoring in the SOCAL Range Complex is sought to align monitoring with the best science technique available.

Specific points of discussion on elements of the proposed 2010 monitoring include:

Visual: Recommended 2010 monitoring reflected in Table 13 shows a shift towards combining all visual survey hours (aerial and vessel) into one overall category of "total visual survey hours" to allow for better flexibility when scheduling visual monitoring throughout the study year. While aerial surveys were more productive in terms of value and proximity to pre-, during, and post-training events, flexibility to select from future aerial or vessel survey is desired so that as future training events are identified, the best technique can be applied. While Table 13 shows the final level of effort from US Pacific Fleet Monitoring as a range of hours, the actual level of effort in 2010 will be significantly higher than the values presented in the table, and also significantly higher than the estimated hours predicted in the original January 2009 SOCAL Monitoring Plan (192 hours). It is difficult to quantify and predict what the final contribution of the R&D program will be to overall visual survey efforts through 2010. R&D survey effort is more fluid in scheduling and each survey can vary in time from cruise to cruise. Often a window of availability is established for R&D monitoring in which actual survey effort may occur in specific time segments of that window. However, ultimately a significant amount of Navy funded

visual survey effort will be performed during 2010 in the SOCAL Range Complex. By way of example using results from 2009 monitoring, over 1,200 hours of total visual effort covering over 19,000 nm was conducted when tabulating the combined US Pacific Fleet and N45 R&D monitoring efforts.

MMO: Use of MMOs was more successful during 2009 in the Hawaii Range Complex (HRC) due to less major exercises impacting availability of naval vessels from which to perform the observation (DoN 2009c). For the SOCAL Range Complex, there were more major exercises (n=6) (DoN 2009b, 2009c), which restrict the availability of berthing space on each individual ship due to extra evaluators, technicians, and other support groups that often get underway with a Strike Group. Smaller scale unit level training in the SOCAL Range Complex is highly variable as compared to HRC with short notification of pending training events which hinders aligning transportation and scheduling of civilian MMOs. However, the Navy remains committed to use of MMOs in 2010 within the SOCAL Range Complex, but like visual surveys, is proposing listing a range of hours to account for uncertainty in the scheduling process. In lieu of slightly fewer hours of MMO, the Navy is adding at least one new technique to the overall 2010 monitoring plan (PhotoID) which was not in the original plan development. In addition, the Navy is functionally (i.e., scheduling, funding, level of effort) increasing the amount of PAM and tagging in the SOCAL Range Complex when both US Pacific Fleet and N45 R&D monitoring efforts are considered.

Marine Mammal Tagging: Opportunistic tagging marine mammals within the SOCAL Range Complex is being done and will continue in 2010 under the N45 R&D program. Future results from this effort will be presented in the US Pacific Fleet's Pacific Ocean 2010 Range Complex Monitoring Report. As detailed in the previous 2009 report (DoN 2009c), between August 2008 and August 2009, 12 individual marine mammals were tagged with satellite tracking tags in the SOCAL Range Complex which provides detailed movement data not available previously. The full monitoring report (DoN 2009c) contains more specific details and results of this tagging effort, and is also briefly summarized in Chapter 14 Research.

PAM: PAM within the SOCAL Range Complex will continue in 2010 with continued data acquisition from two US Pacific Fleet funded HARPs, as well as associated data analysis. PAM typically collects very large volumes of data that often require substantial post-event analysis. In addition, the N45 R&D program has 10 additional HARPs deployed in California marine waters within and outside of the SOCAL Range Complex. And finally, the Navy's permanently instrumented underwater range west of San Clemente Island also collects near continuous marine mammal vocalization data for analysis under the N45 R&D funded Marine Mammal Monitoring on Navy Ranges (M3R) program. Finally, US Pacific Fleet will also consider, but can not commit to a definitive metric, if other PAM devices can be employed within the SOCAL Range Complex depending on availability, funding, and training event opportunity. This optional PAM use is presented, again like visual surveys and MMOs, so that future flexibility will exist in the 2010 monitoring program to account for new or emerging technology.

PhotoID: As part of N45 R&D efforts in the SOCAL Range Complex, photographic identification of individual marine mammals is ongoing. This technique offers the ability to confirm presence or absence of specific individuals over time which may be indicative of geographic variability in distribution both in relation to Navy training events and in relation to normal movement patterns. As part of the 2010 monitoring plan, this field research will continue and results will be included in the US Pacific Fleet's Pacific Ocean 2010 Range Complex Monitoring Report.

Table II-10. Navy's final proposed FY10 monitoring plan for the SOCAL Range Complex.

Monitoring Technique	Implementation	
Visual Surveys (aerial or vessel) STUDIES 1,2,3,4, 5	Portions of major training exercises (MTE), or Unit Level Training (ULT) events using sonar (MFAS, HFAS), or offshore and inshore detonation events	Adaptive Management Review (AMR) for FY11
Marine Mammal Observers (MMO) STUDIES 1,2,3, 4, 5	Opportunistic; MTE, ULT, or offshore or inshore detonation events as available	
Marine Mammal Tagging STUDIES 1,2, 3	Present results from ongoing N45 R&D Program; Fleet funded opportunistic tagging as available	
Passive Acoustics Monitoring (PAM) STUDIES 1,2, 3	Present results from ongoing N45 R&D Program (HARPs, M3R); Continue data collection and analysis from two U.S. Pacific Fleet HARPs; add other Fleet funded PAM as available	
PhotoID STUDIES 2,3	Present results from ongoing N45 R&D Program	
SOCAL Exercise Summary From Navy Lookout Reports STUDY 5	Continue to collect/analyze marine mammal sightings from Navy lookouts during MTEs and present results	

TOTAL FY10 Commitment:

100-150 hours visual survey; 80 hours Marine Mammal Observers (including 36 FY09 missed hours); continue data collection/analysis from 2 Fleet-funded HARPs; conduct other Fleet-funded opportunistic PAM if available; conduct opportunistic Fleet-funded tagging; present results from N45 R&D visual survey/PAM (HARP and M3R)/tagging.

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

Study 2= If marine mammals and sea turtles are exposed to sonar, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

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

Study 4= What are the behavioral responses of marine mammals and sea turtles that are exposed to explosives at specific levels?

Study 5= Is Navy's suite of mitigation measures for sonar and explosives, and major exercise measures agreed to by Navy through permitting effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles

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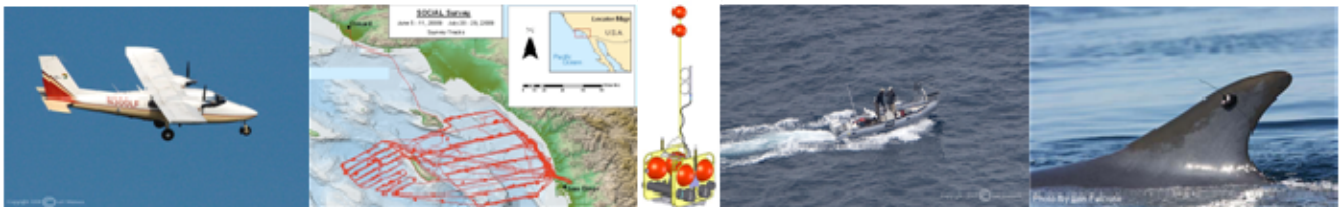
HRC Photos from left to right: Aerial survey track lines for June 2009 in HRC (Graphic courtesy of Marine MMRC-SES), UNDET off Oahu monitored for marine mammal and sea turtles (Photo by Anu Kumar), Spectrogram of minke whale vocalization in PMRF off Kauai (Graphic courtesy of Steve Martin).



SOCAL Photos from left to right: Twin-engine airplane used for marine mammal aerial monitoring (Photo by Lori Mazzuca), serial survey track lines for June and July 2009 in SOCAL (Graphic courtesy of Marine Mammal Research Consultants), Scripps Institute of Oceanography High-Frequency Acoustic Recording Package (Graphic courtesy of John Hildebrand), Rigid-hull Inflatable Boat used for cetacean tagging in SOCAL (Photo by Lori Mazzuca), Fin whale with satellite attached October 2008 (Photo by Erin Falcone).

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