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Marine Mammal Monitoring For The U.S. Navy's Hawaiian Range Complex (HRC) And Southern California (SOCAL) Range Complex

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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)

Marine Mammal Monitoring
For The U.S. Navy's
Hawaiian Range Complex (HRC)
And
Southern California (SOCAL) Range Complex

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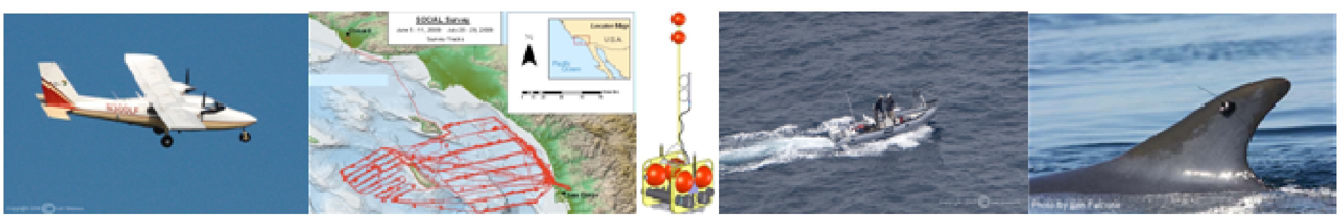
HRC Photos from left to right: Aerial survey track lines for June 2009 in HRC (Graphic courtesy of Marine MMRC-SES), UNDET off Oahu monitored for marine mammal and sea turtles (Photo by Anu Kumar), Spectrogram of minke whale vocalization in PMRF off Kauai (Graphic courtesy of Steve Martin).



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).

01 October 2009

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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

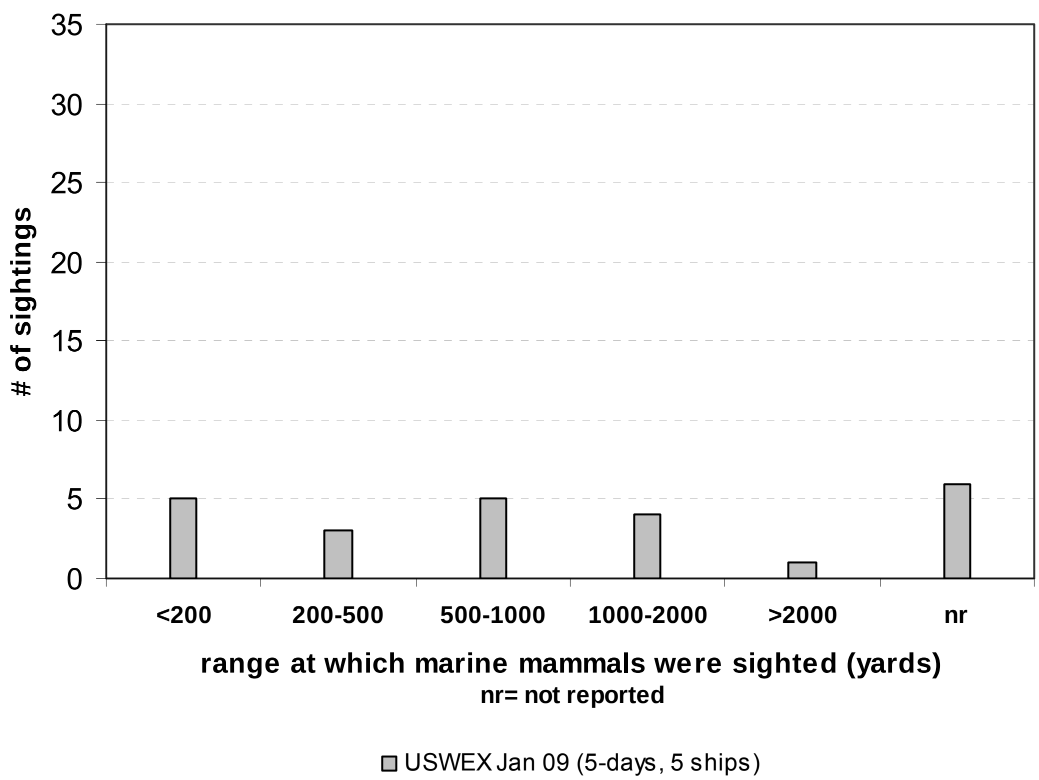
Given the focus on monitoring around Navy at-sea training events, a list of MTEs that occurred in the HRC between August 2008 and August 2009 is provided in **Table I-2**. Marine mammal sightings during MTEs are a form of compliance monitoring and represent substantial numbers of sightings. For HRC, 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	Associa ted 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.

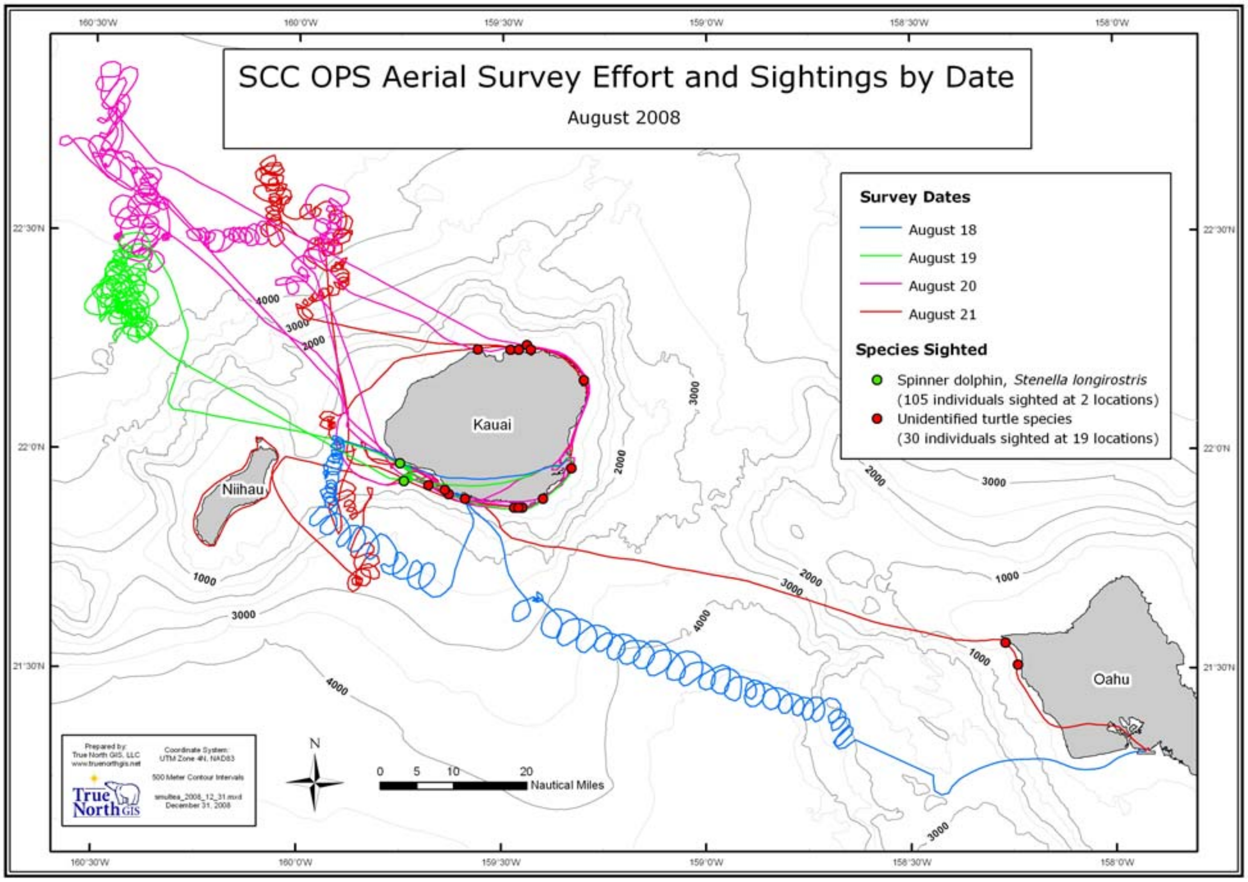


Figure I-1. August 2008 SCC aerial survey in the HRC.
Survey tracks are shown by survey date and locations of marine mammal and sea turtle sightings are also included. Straight-line tracks indicate transit periods, some of which were conducted along the Kauai shoreline. Corkscrew-shaped tracks indicate 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

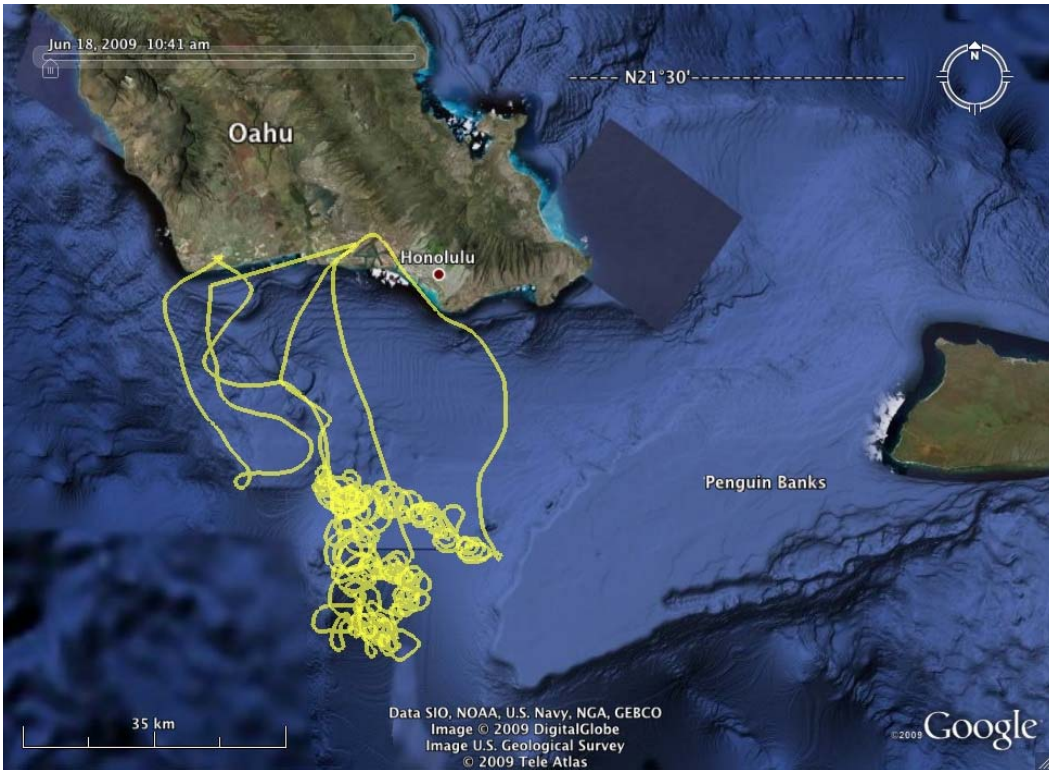


Figure I-2. Survey track from June 18, 2009 during ULT.

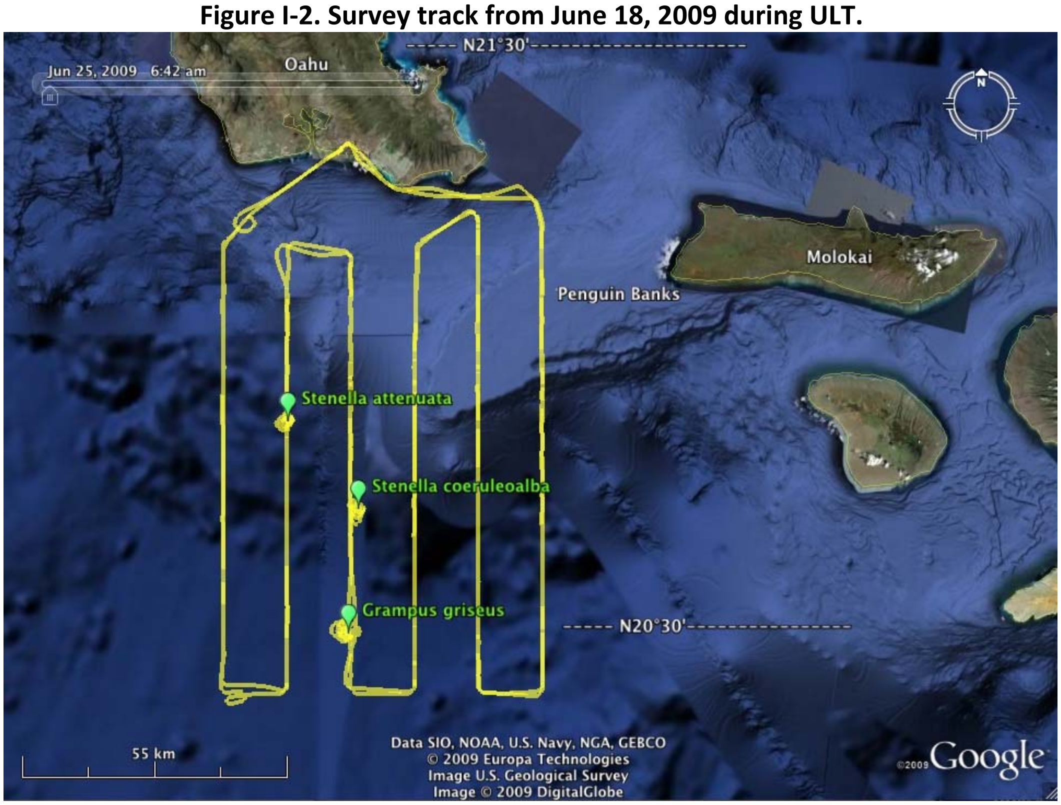


Figure I-3. Survey transects and visual sightings from June 25, 2009 after ULT.

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.

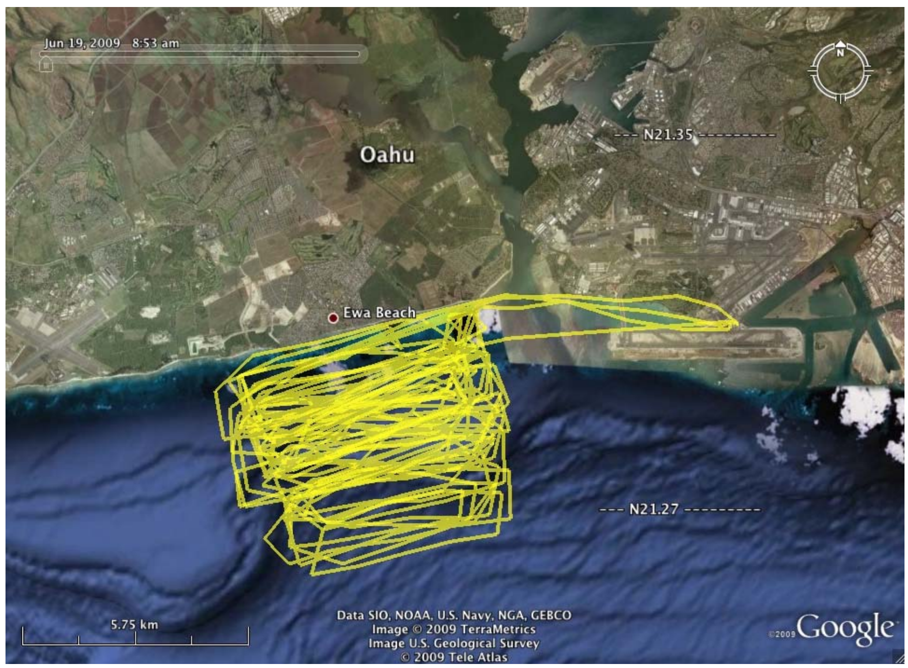


Figure I-4. Survey track from June 19, 2009 during UNDET.
NOTE: Vessel surveys and MMOs aboard MDSU vessels also occurred with this event. See vessel and MMO sections for more information on those surveys.

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° 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.

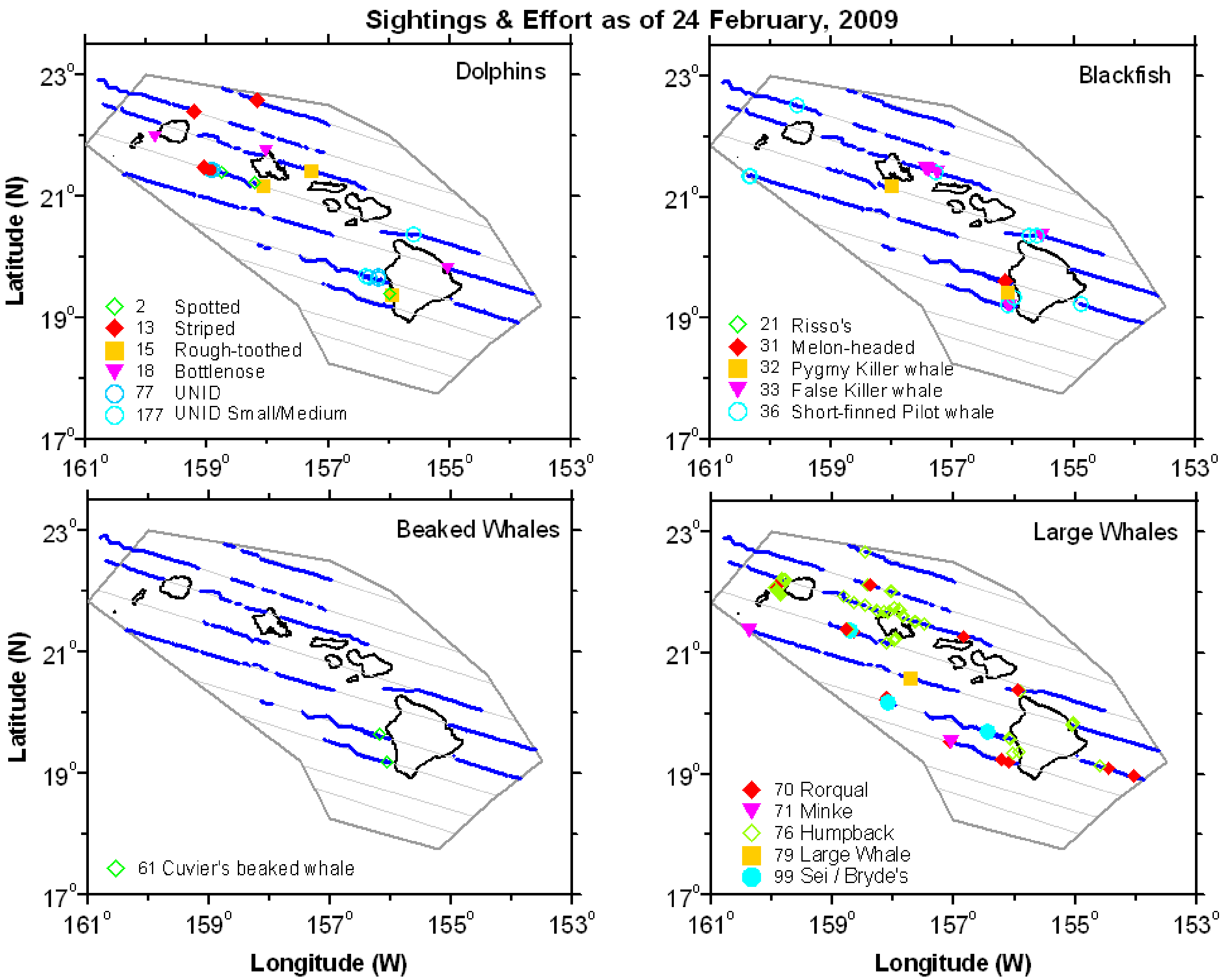


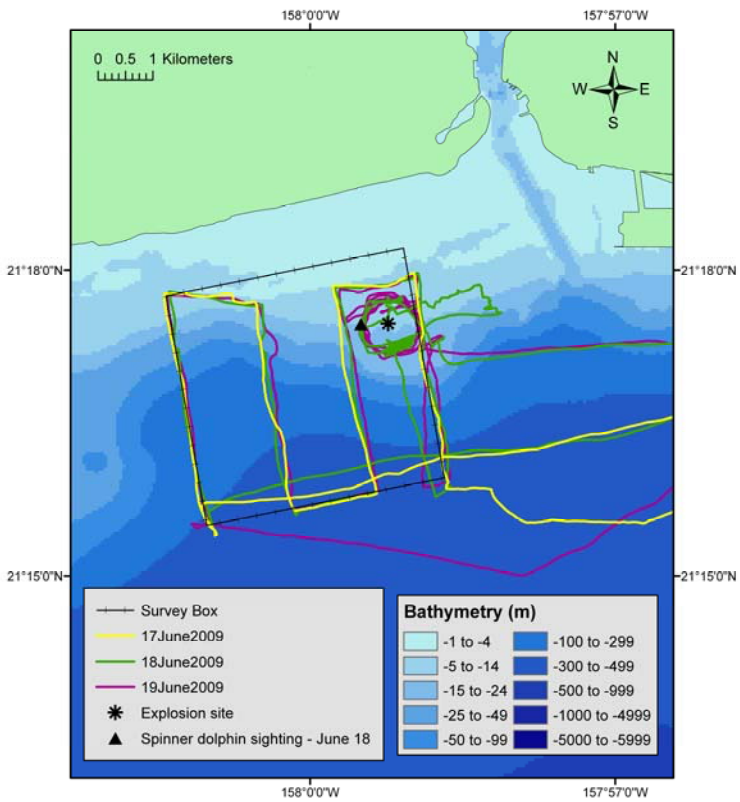
Figure I-5. Visual and acoustic survey effort (blue lines) and cetacean visual sightings during the cruise.

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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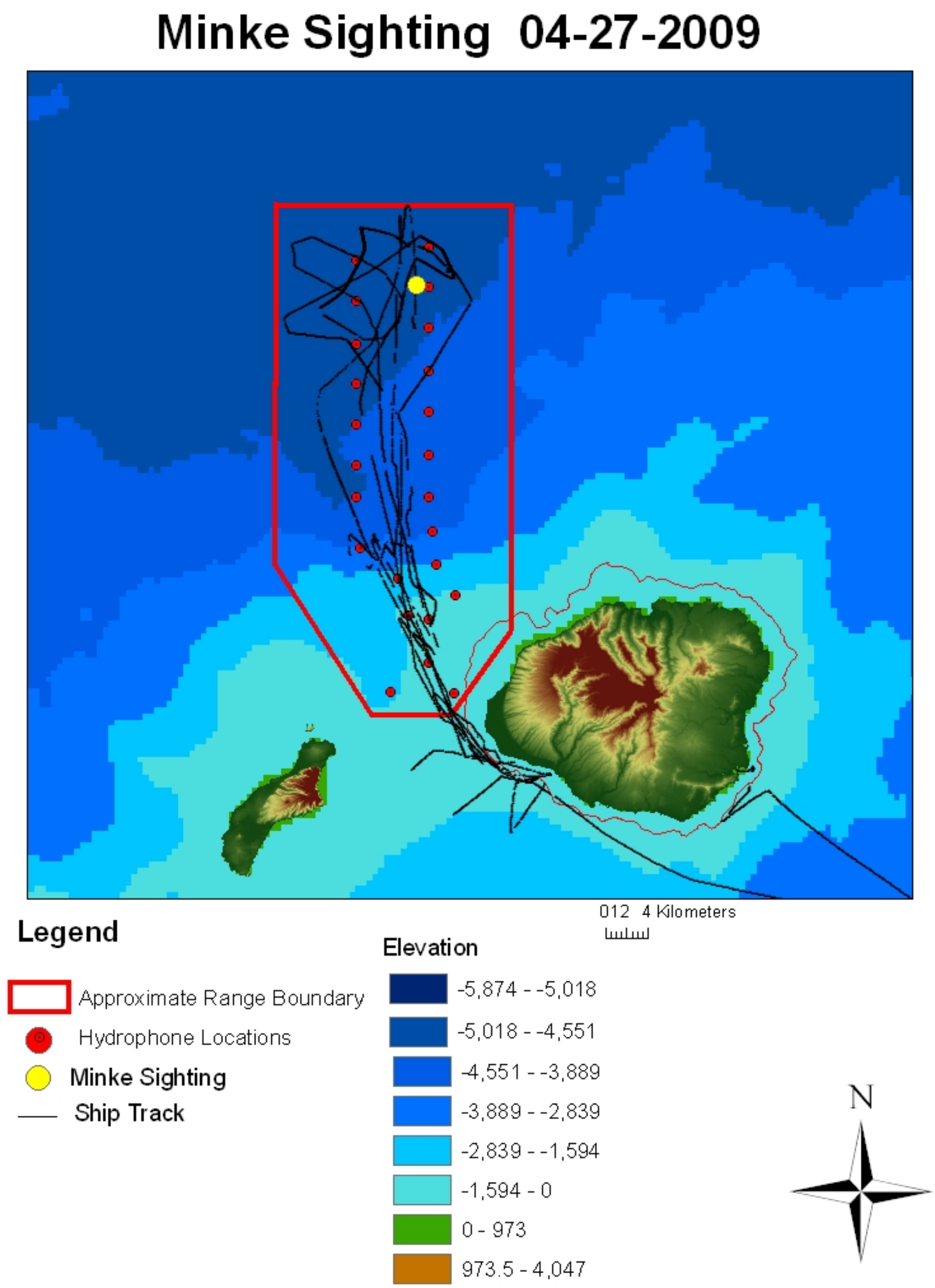


Figure 1. Kauai study area (red polygon, > 2000 km2) with completed ship tracks by the R/V Dariabar for the 21 days of effort resulting in 800 km surveyed for the 1.5 month field effort. Approximate locations of PMRF seafloor hydrophones used in this study designated by red circles. The visual sighting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

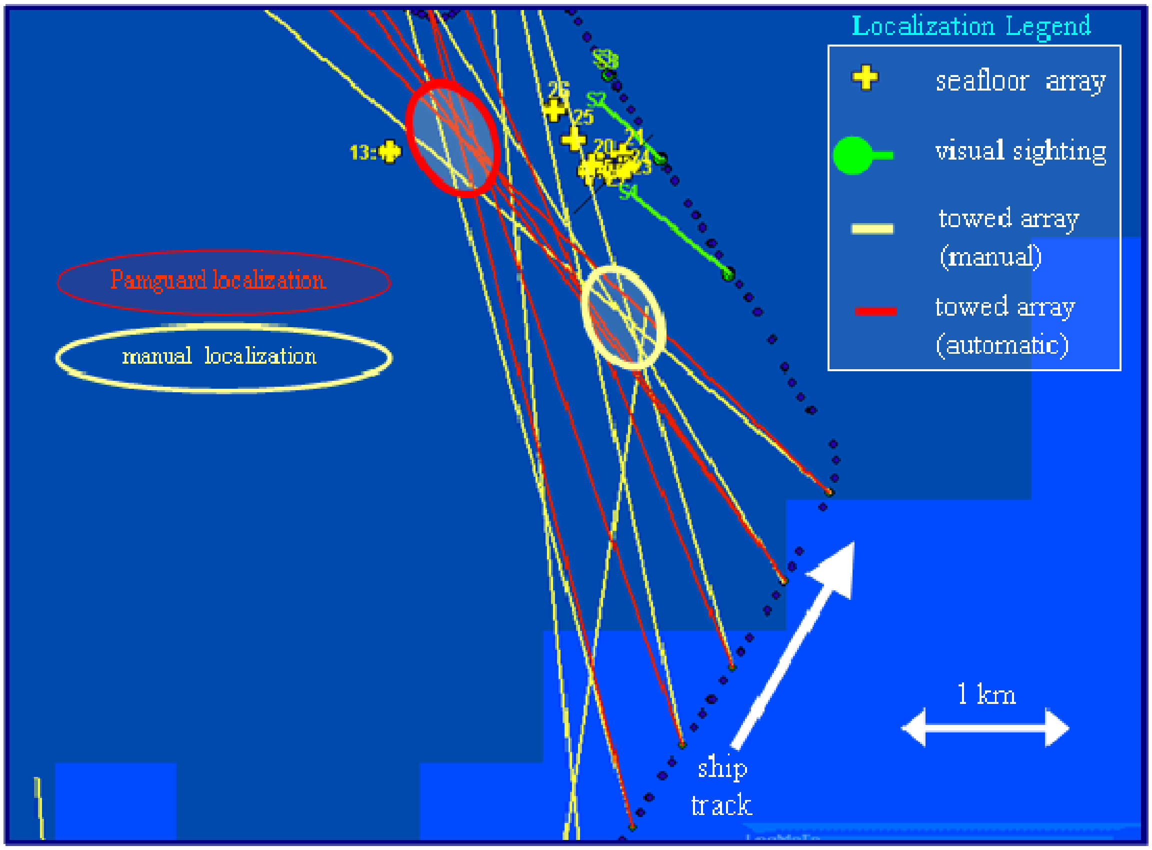
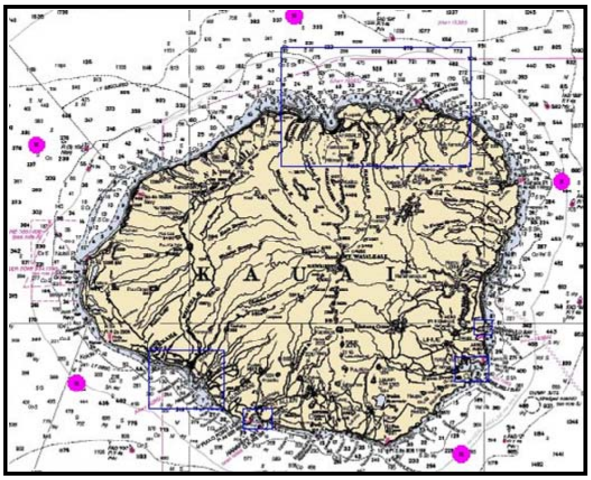
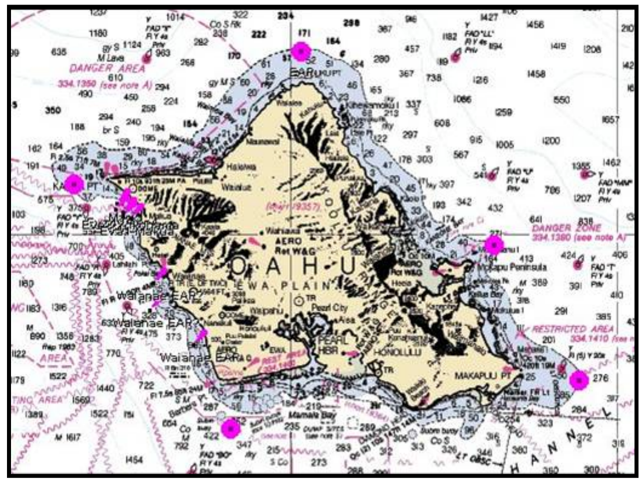


Figure 2. Map of the 27 April visual sightings (green lines) of a minke whale made after the research vessel was vectored towards the region of acoustic localizations made from the seafloor array (yellow crosses). This demonstrates the good agreement of seafloor array localization with the sighted position 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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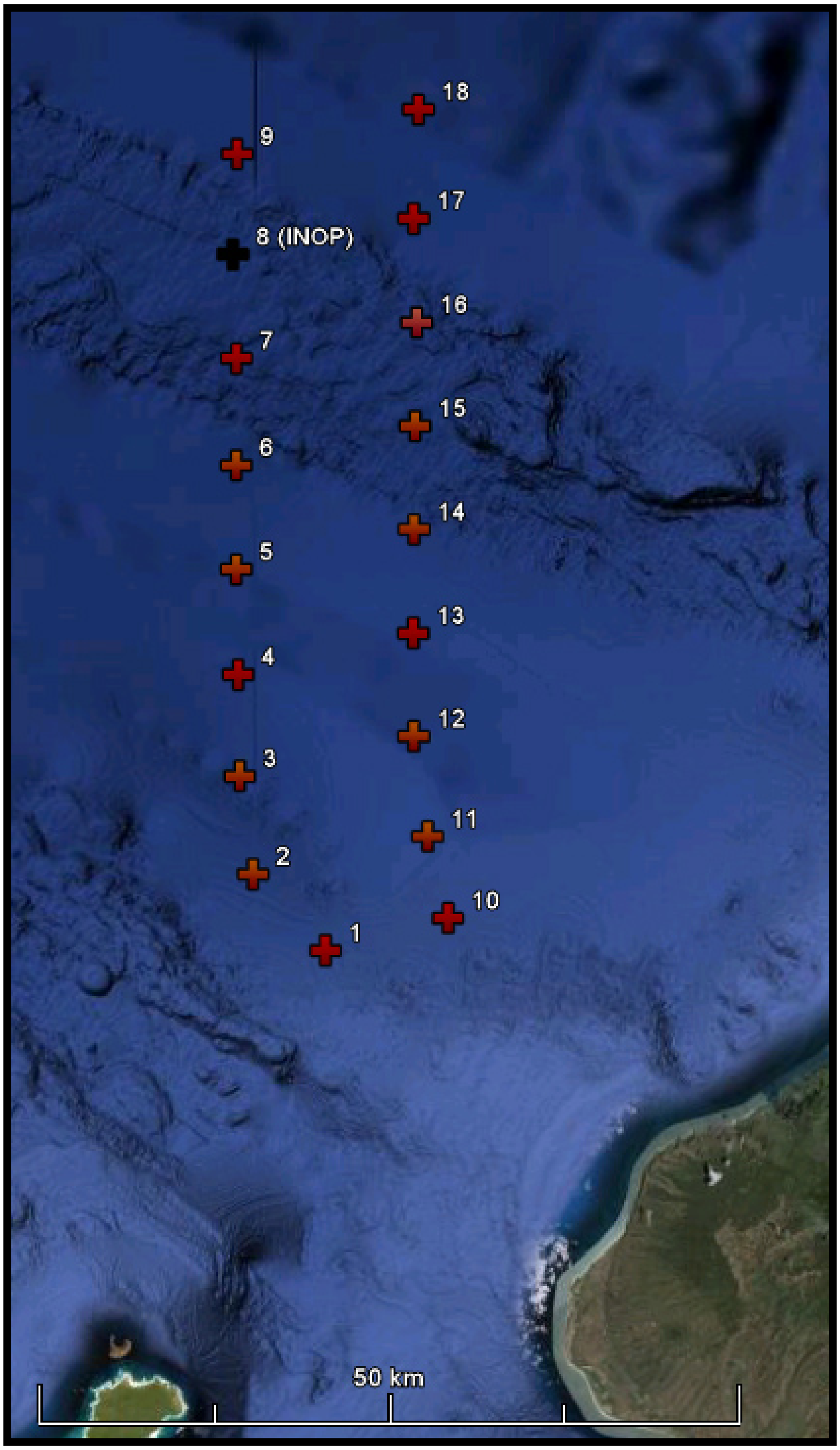


Figure 1 – Study area showing approximate locations of hydrophones at the Pacific Missile Range Facility Barking Sands Underwater Range Expansion area. Water depths range from 1800m to over 4600m. Western Kauai seen at lower right, northern Niihau at lower left.

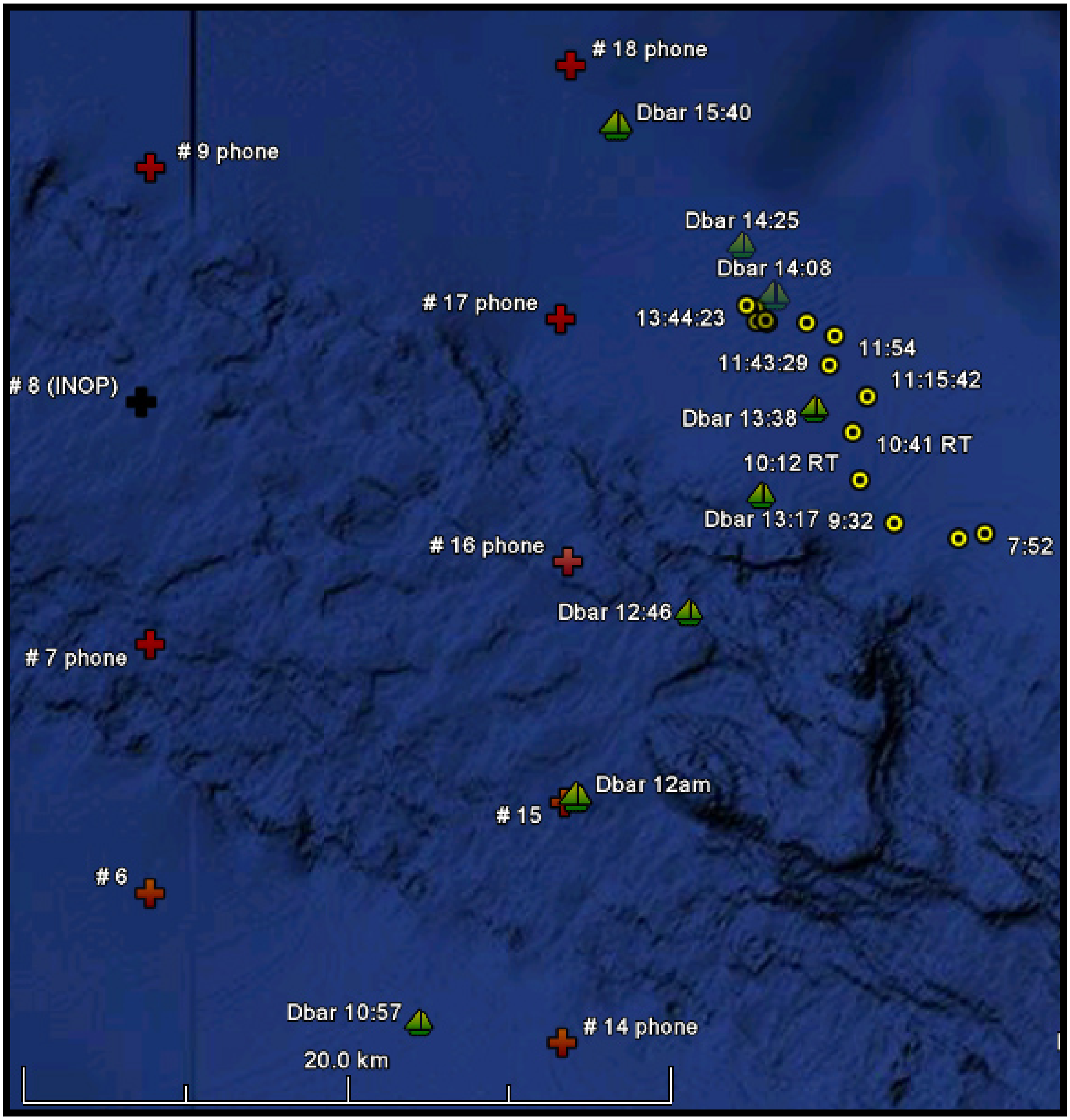


Figure 2 – Overview of 27April 2009 minke whale visual sighting at 14:00 HST by the crew of the R/V Dariabar. Red icons are PMRF hydrophones, green sailboat icons are the R/V Dariabar positions and the yellow dots indicate a subset of minke whale locations determined using PMRF hydrophones. Hawaiian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

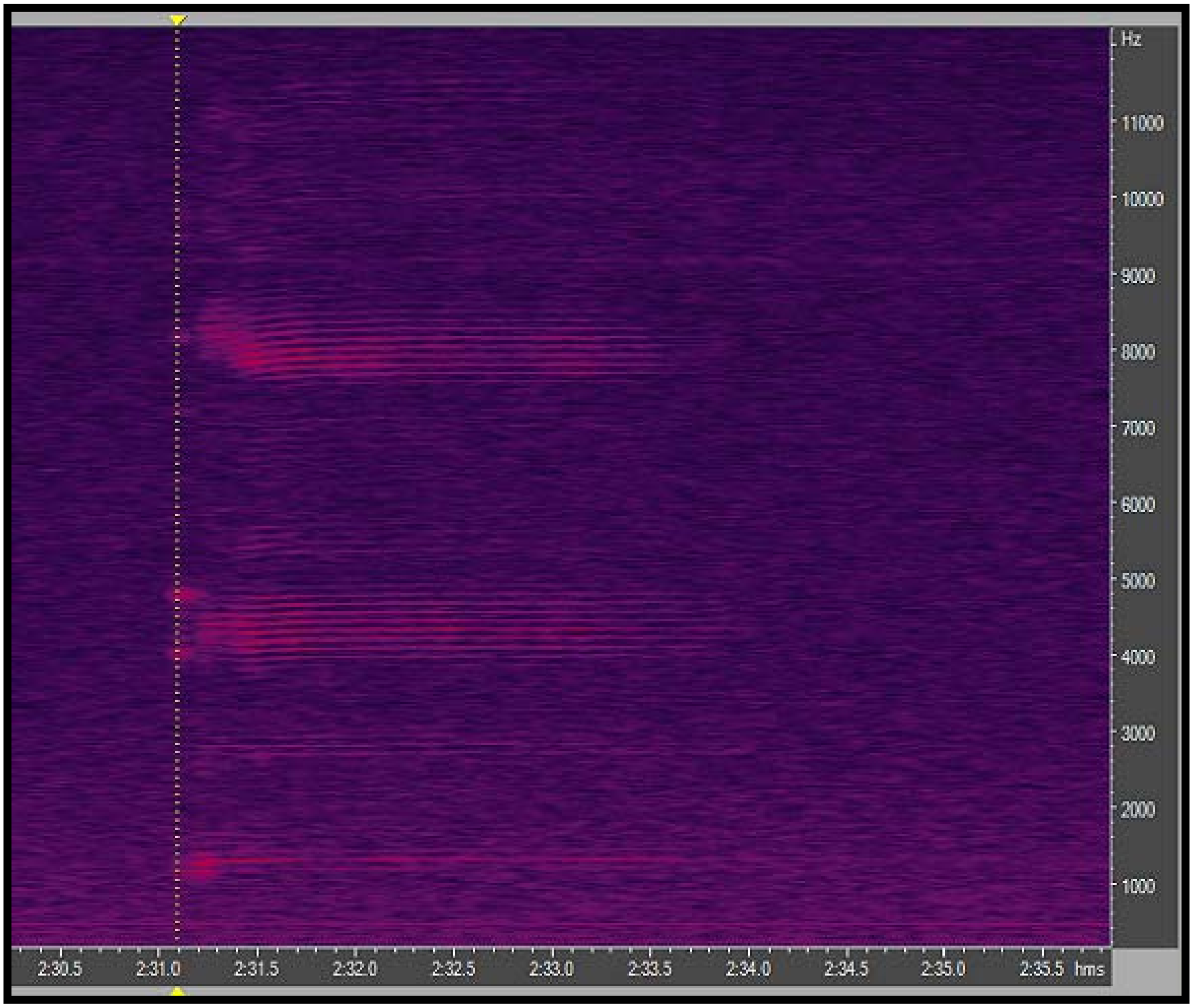


Figure 3 – Spectrogram (DC to 12.2kHz) for a boing received on hydrophone #17 at 13:21:58 HST. The figure shows the spectral complexity of the boing. The horizontal range of the animal from hydrophone # 17 is calculated using arrival time differences to be 6.8km. The three strongest groupings of boing 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.

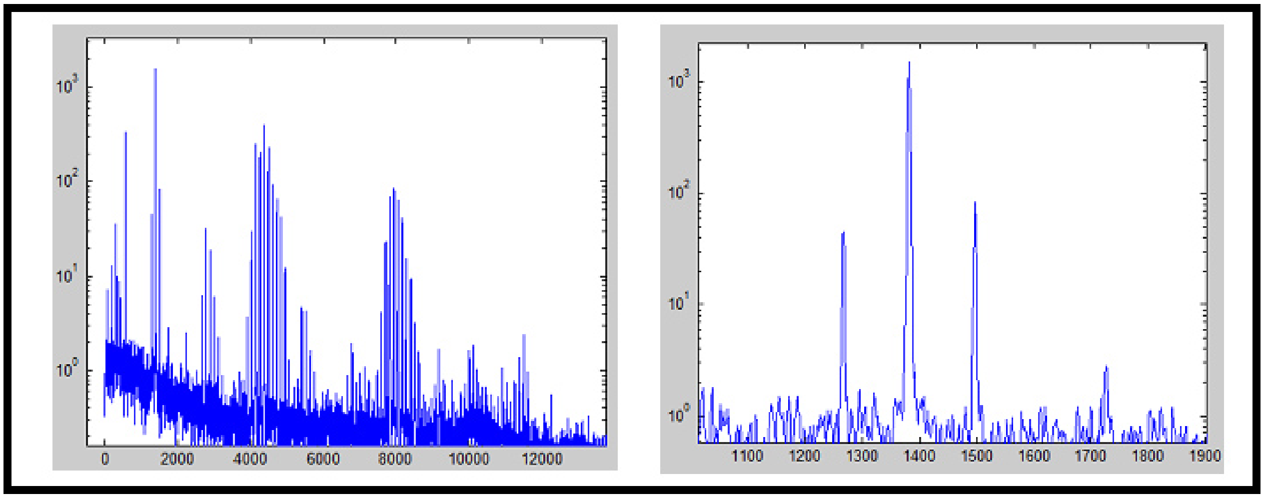
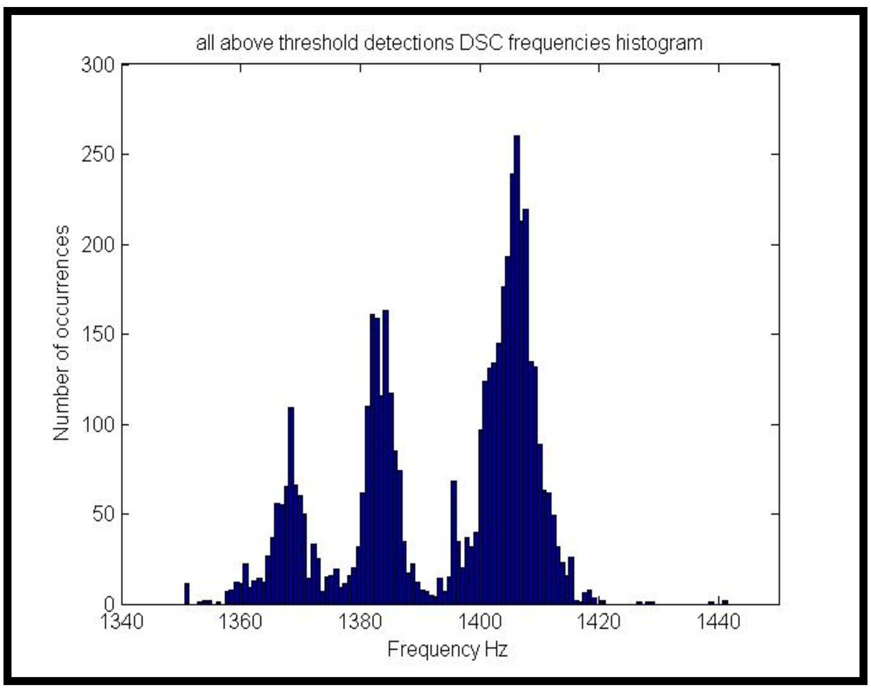


Figure 4 – High resolution spectral view of the same minke boing vocalization shown in figure 2. 128Kpt FFT's averaged over the duration of the boing (50% overlap) of 96KHz sampled data (0.73 Hz bin width). Vertical axis is relative magnitude(log scale). Left – frequency span from 0 Hz to 13 KHz, strongest 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.

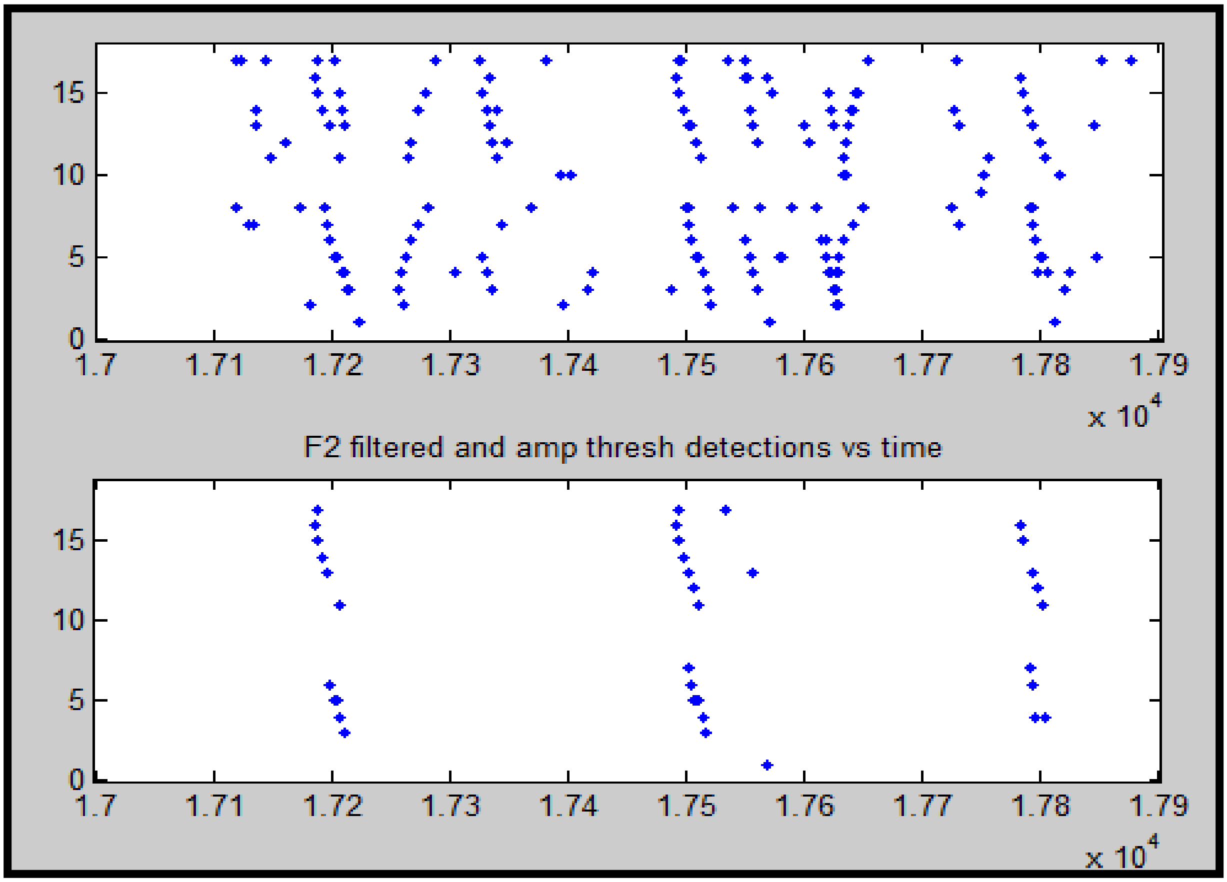


Figure 6 – Fifteen minutes of auto detection data plotted for hydrophone number (vertical axis) vs. time in seconds (horizontal axis). Upper plot shows all detections > 50dB relative amplitude. Lower plot shows only detections with dominant signal component between 1381.5Hz to 1386.5 Hz. Three boings 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.

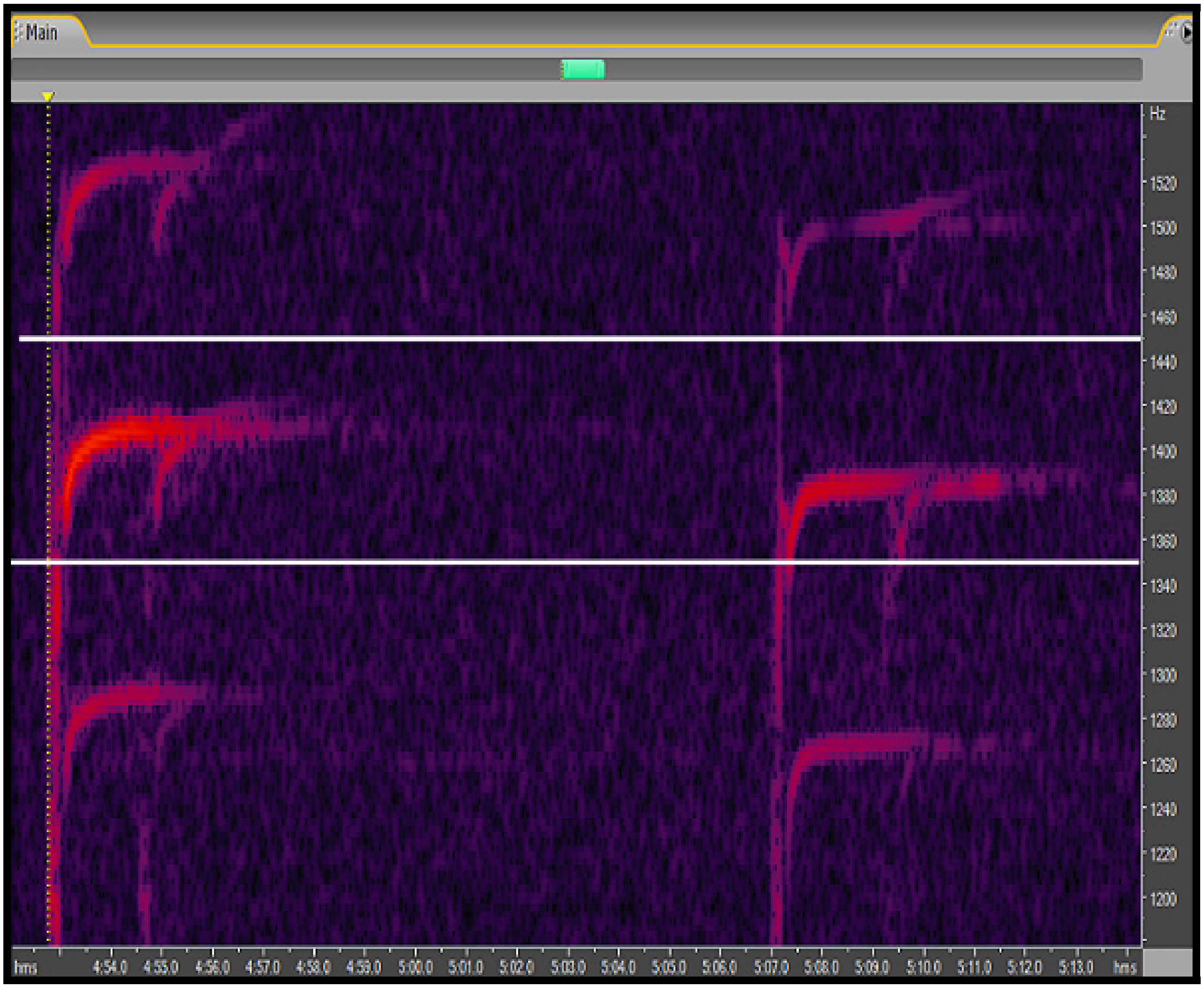


Figure 7 –Twenty second spectrogram (1180Hz to 1550Hz) of two boings received on hydrophone #14 at 13:44 HST on 27April 2009. The two horizontal white lines indicate the band of 1350Hz to 1450Hz. The first boing on the left is a relatively strong signal from a Minke whale in the southern end of the range, 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).

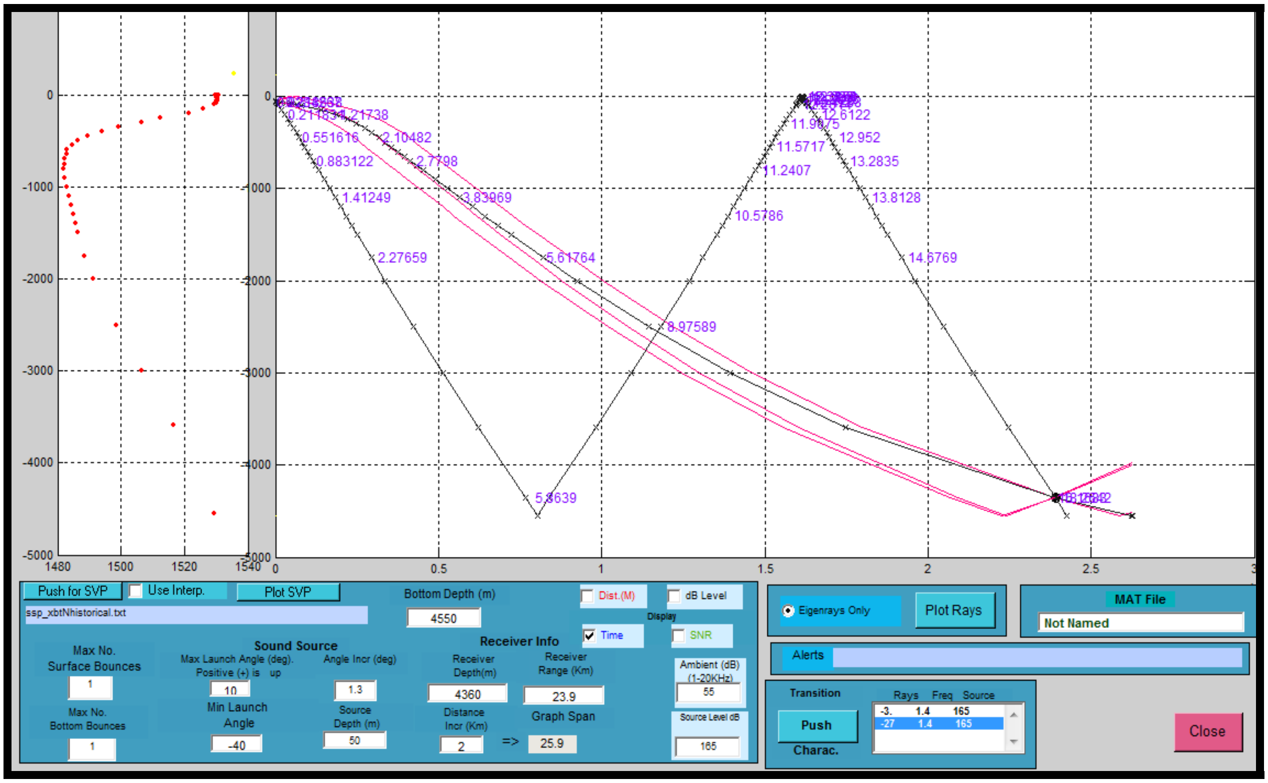


Figure 8 – Ray trace program results for modeled animal depth of 50m, bottom depth of 4550 m, hydrophone depth of 4360m, horizontal range 23.9km, sound speed 0-700m from XBT data 27 April 2009 combined with historical deeper data (courtesy Nosal). Five eigenrays found (direct, surface, bottom, surface-bottom 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.

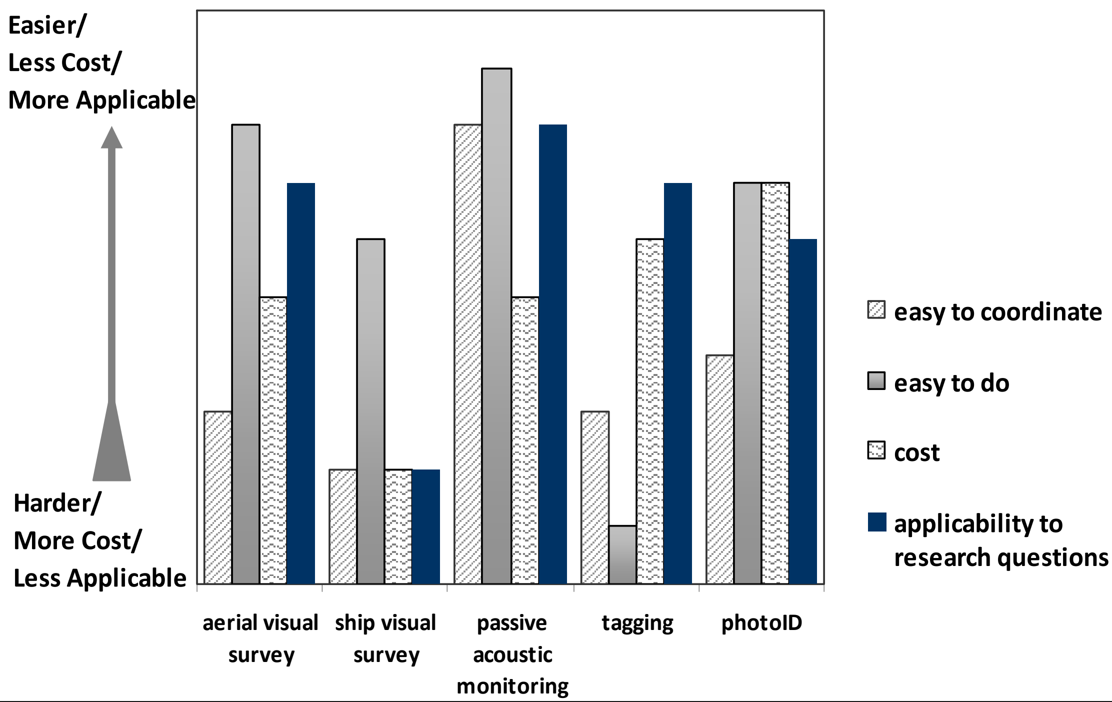
In March 2009, CNO N45 convened government and academic researchers to review the Navy's range complex monitoring plans. This diverse group of experts reviewed the methods that currently exist for monitoring, methods expected to be available in five years and the Navy's current plans. The team reinforced 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	

<u>Total FY10 commitment:</u>

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).

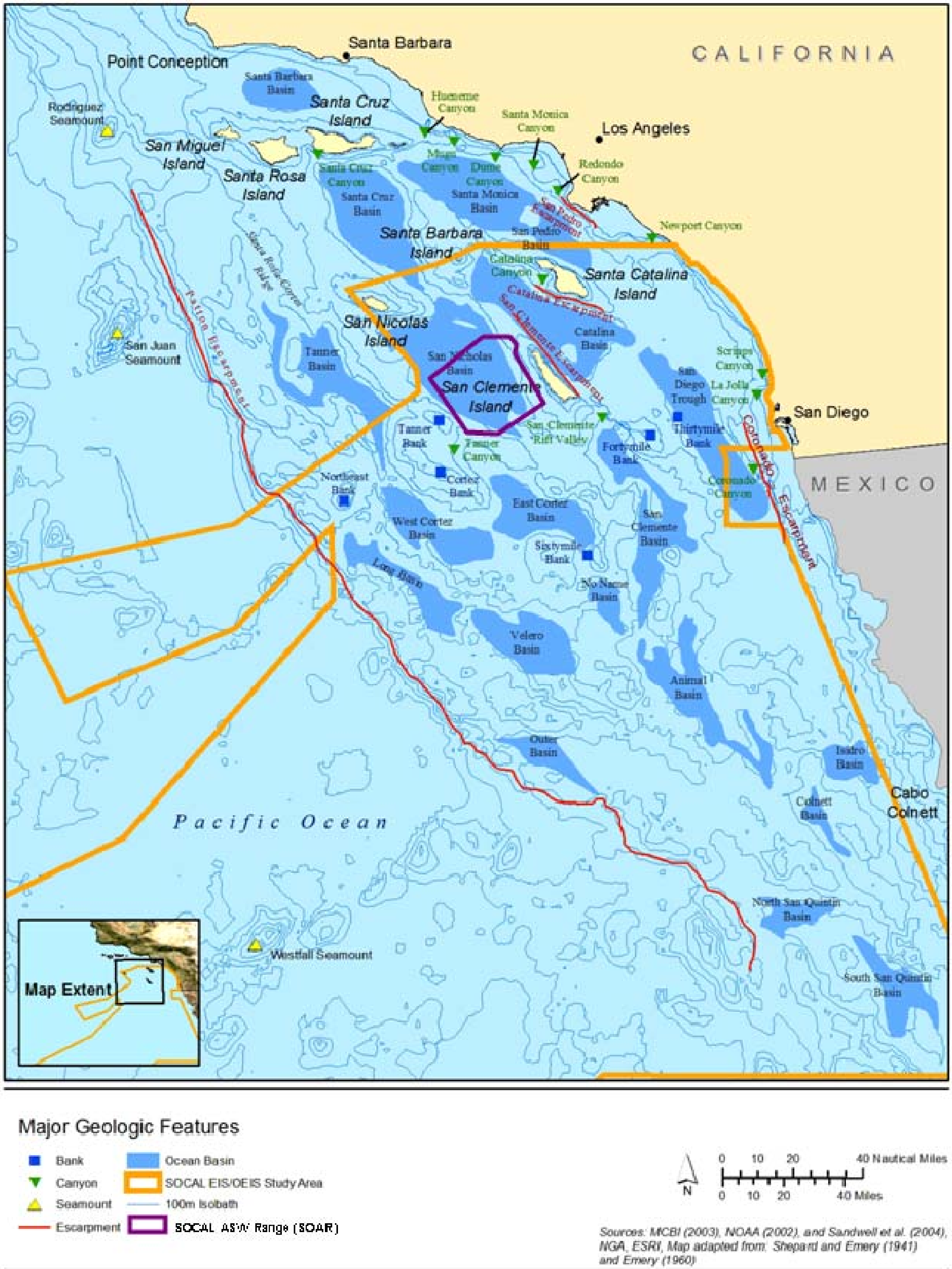


Figure II-1. Southern California Range Complex and regional offshore underwater features.

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 Clemente 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	0.9	0.9	0.9	0.9	1.0	1.2	1.5
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	0.9	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	1.0	1.2	1.4	1.5	1.6	1.5
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	1.3	1.5	1.8	2.0	2.1
1973	1.8	1.2	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	1.0	1.5	1.9	2.2	2.3
1983	2.3	2.0	1.5	1.2	1.0	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	1.3	1.2	1.1	1.0	1.2	1.4	1.6	1.6	1.5	1.3	1.1
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	0.9	0.9	1.0	1.4	1.6
1992	1.8	1.6	1.5	1.4	1.2	0.8	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	1.2	1.3
1995	1.2	0.9	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	1.3	1.7	2.0	2.2	2.4	2.5	2.5
1998	2.3	1.9	1.5	1.0	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	0.8	0.9	1.0	1.1	1.3	1.5	1.4
2003	1.2	0.9	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	0.9	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	0.9	1.1	1.1
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	-1.1	-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.

U.S. Navy Marine Species Awareness Training DVD viewed by ship bridge personnel and lookouts prior to major exercises

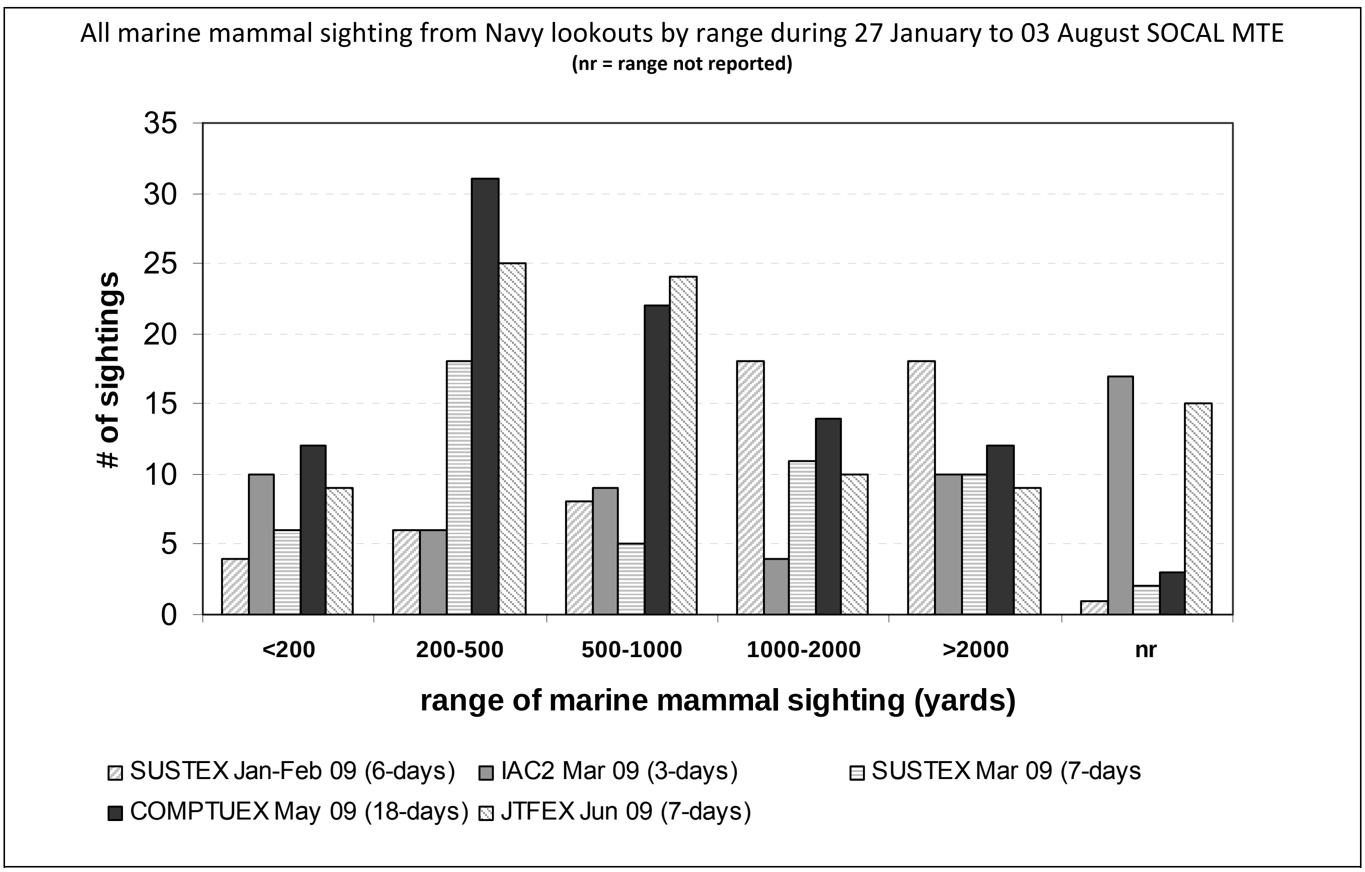

Lookouts on board U.S. Navy vessel (U.S. Navy photo)


Dolphins bowriding in front of a Navy ship off SOCAL in March 2009 (U.S. Navy photograph)

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**).

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

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

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.

<table>
<tr><th>Survey Date</th><th>Time Flown (hrs)</th><th>Distance Flown (nm)</th><th>MTE?</th><th>Approximate SOCAL Areas Surveyed (see Figures II-1 and II-9 for more detail)</th><th># Of Indiv. Or Grp. Sightings</th><th>Total # Of Marine Mammals Sighted</th><th>Notes</th></tr>
<tr><td>17-21 Oct 2008</td><td>27</td><td>2,380</td><td>During COMP-TUEX</td><td>Catalina Basin and San Diego Trough (east of San Clemente Island-SCI); San Nicolas Basin (west of SCI)</td><td>115</td><td>12,587</td><td rowspan="2">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</td></tr>
<tr><td>15-18 Nov 008</td><td>23</td><td>2,140</td><td>After JTFEX</td><td>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)</td><td>185</td><td>5,732</td></tr>
<tr><td>5-11 Jun 2009</td><td>30</td><td>3,192</td><td>After JTFEX</td><td>Around SCI; Catalina Basin and San Diego Trough (east of San Clemente Island); San Nicolas Basin (west of San Clemente Island)</td><td>161</td><td>9,489</td><td>1,099 digital photos taken; 83 min digital video taken; observation of 31 unique focal follows (from 5 to 48 min)</td></tr>
<tr><td>20-28 Jul 2009</td><td>34</td><td>3,507</td><td>During non-sonar COMP-TUEX</td><td>Catalina Basin and San Diego Trough (east of San Clemente Island); San Nicolas Basin (west of San Clemente Island)</td><td>240</td><td>22,719</td><td>2,301 digital photos taken; >49 min digital video taken; observation of 45 unique focal follows (from 5 to 38 min)</td></tr>
<tr><td>Totals:</td><td>114</td><td>11,219</td><td></td><td></td><td>701</td><td>50,527</td><td></td></tr>
</table>

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 Rate*s*- 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)

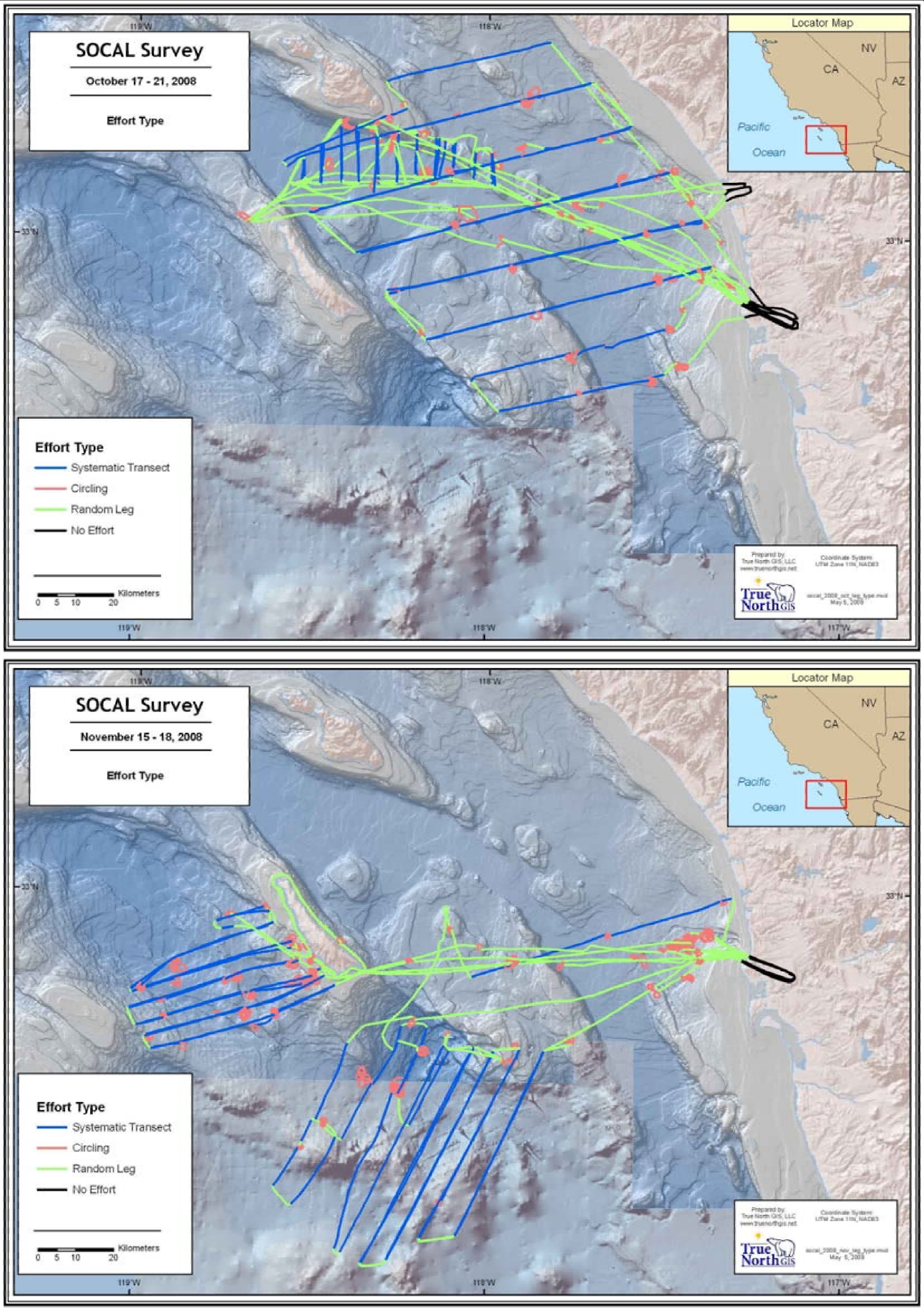
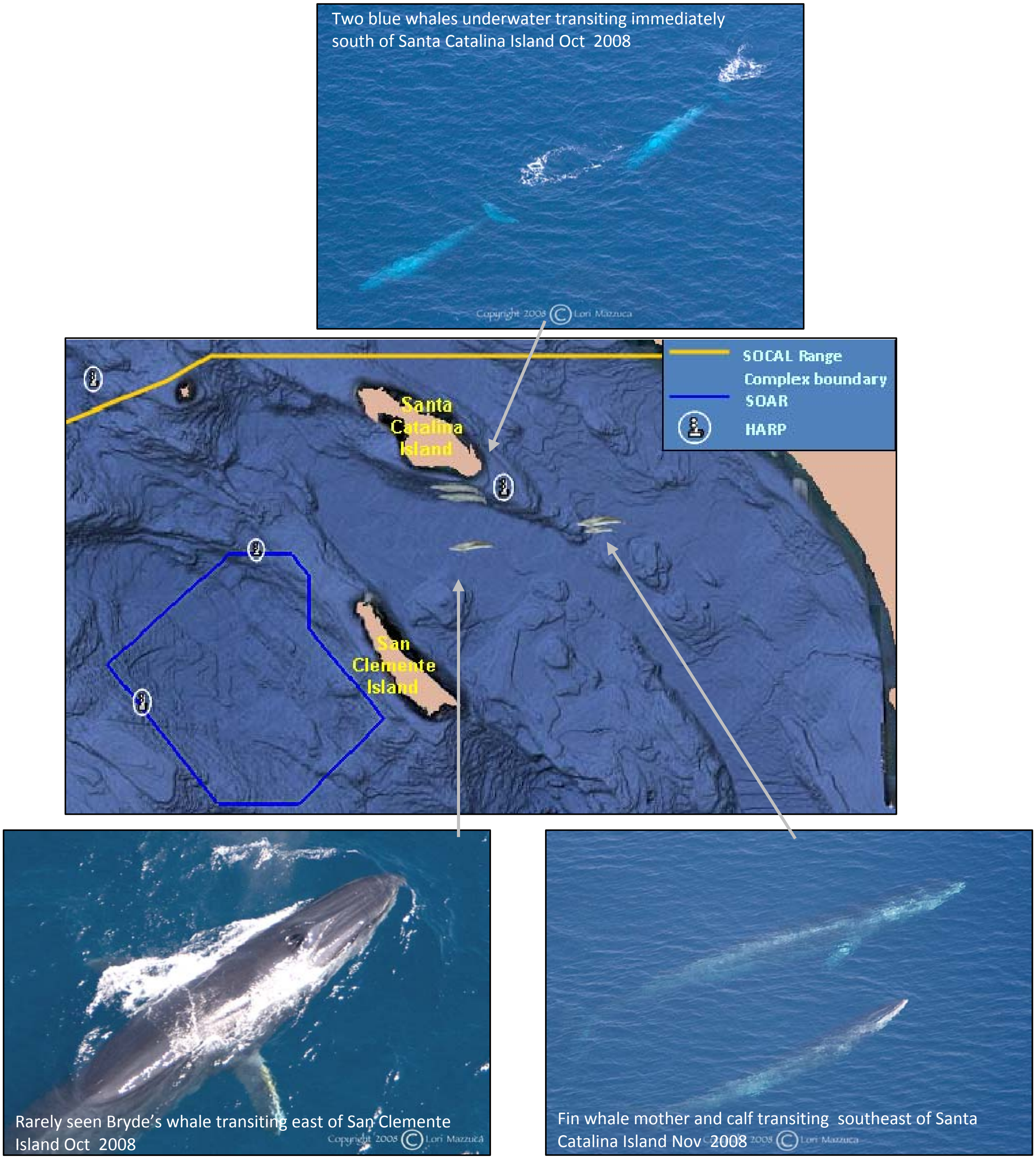


Figure II-4. Aerial survey track lines and observation effort in SOCAL during a Major Training Event (MTE) (15-21 Oct 2008 - top panel), and after a MTE (15-18 Nov - bottom panel).



Two blue whales underwater transiting immediately south of Santa Catalina Island Oct 2008

Rarely seen Bryde's whale transiting east of San Clemente Island Oct 2008

Fin whale mother and calf transiting southeast of Santa Catalina Island Nov 2008

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.

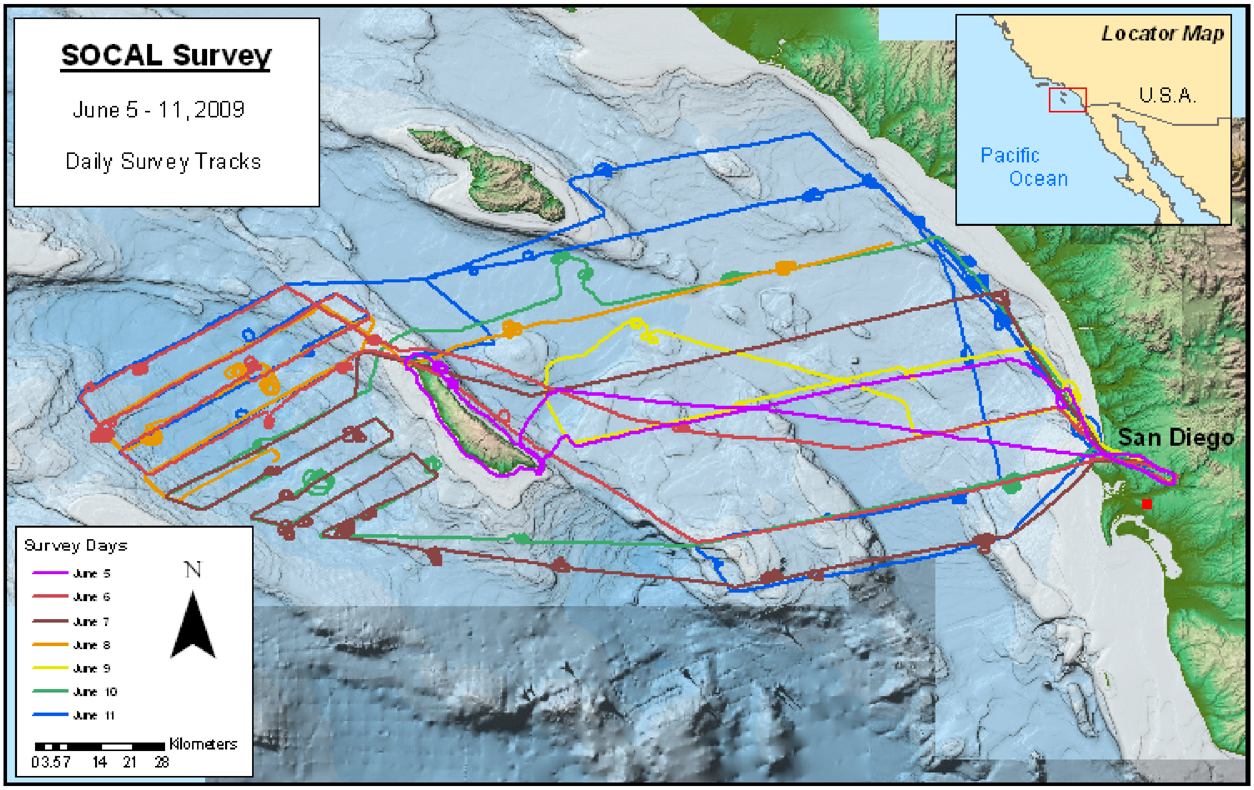
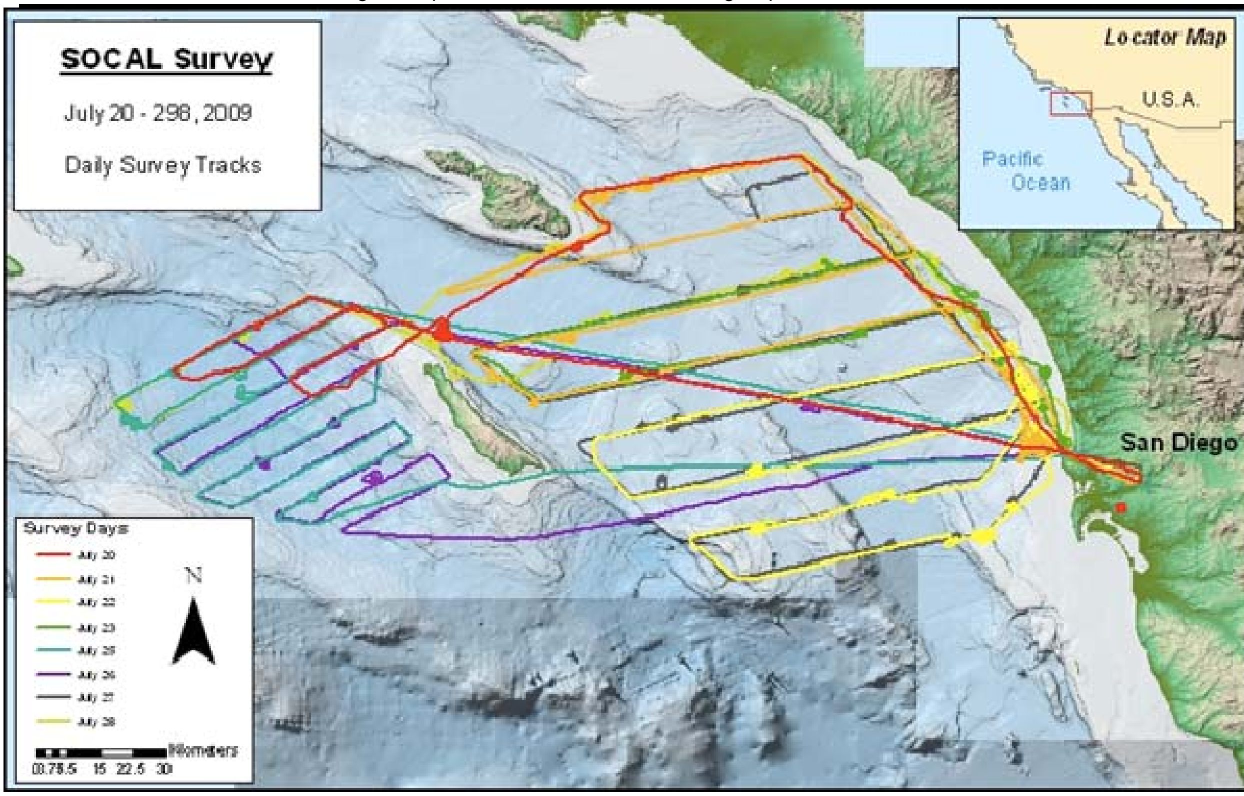


Figure II-6. Daily aerial survey track lines in SOCAL 5-11 June 2009 after a Major Training Event.

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)



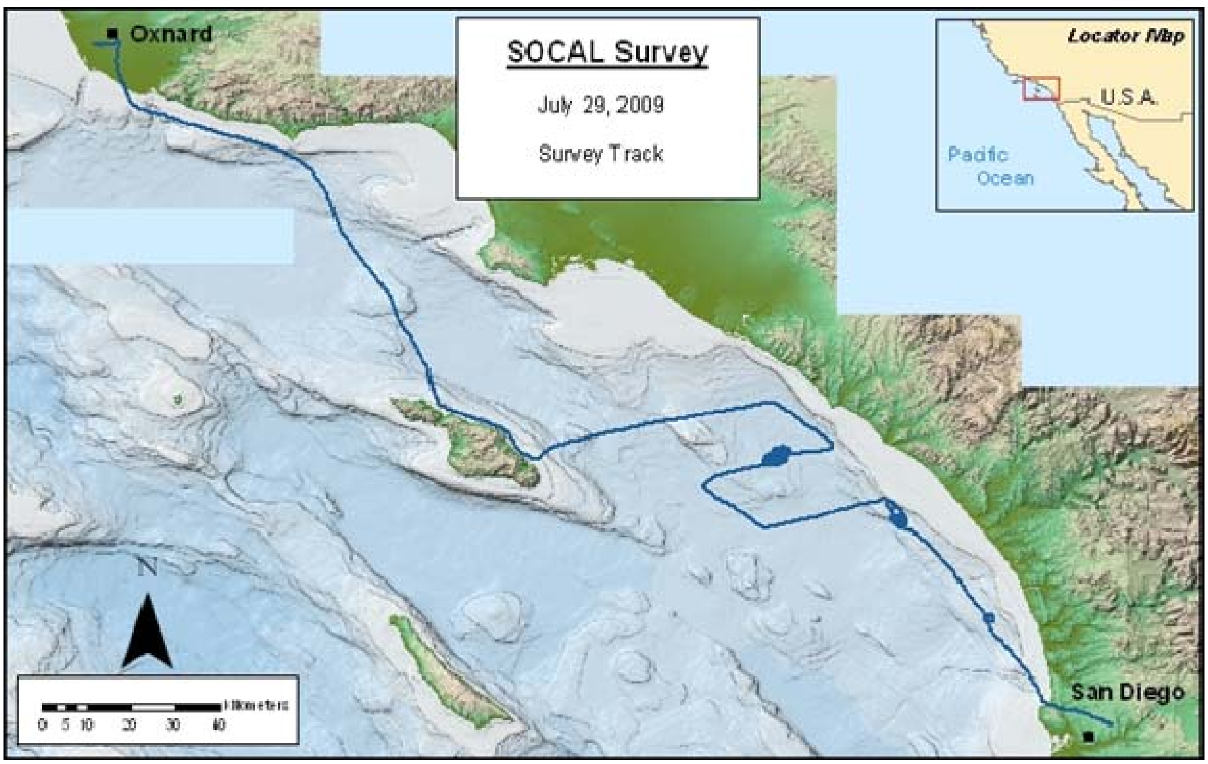
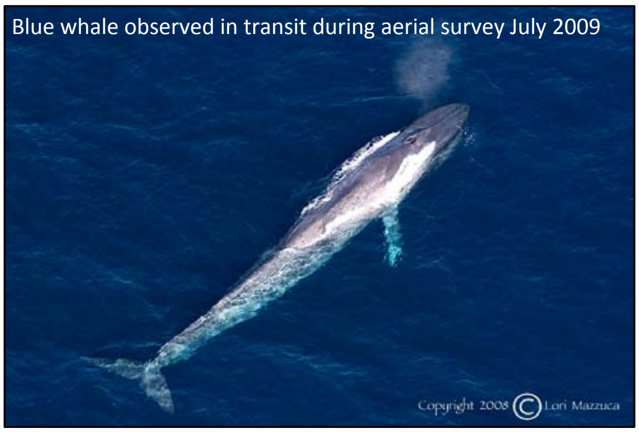


Figure II-7. Aerial survey track lines in SOCAL 20-28 July 2009 during a Major Training Event (top panel), and final return leg 29 July (bottom panel) .

Two fin whales and Pacific white-sided dolphins observed during aerial survey July 2009



Blue whale observed in transit during aerial survey July 2009

Pod of Risso's dolphins observed in transit during July 2009

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.

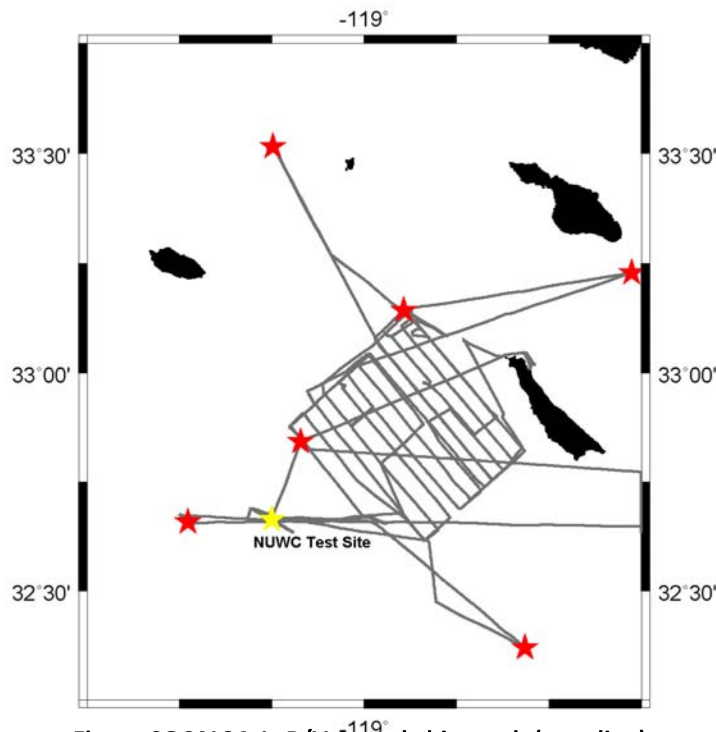


Figure SOCAL34-1. R/V Sproul ship track (gray line) for June 21-28, 2009, with HARP locations (red stars), and non-monitoring related sound propagation test site (yellow star).

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.

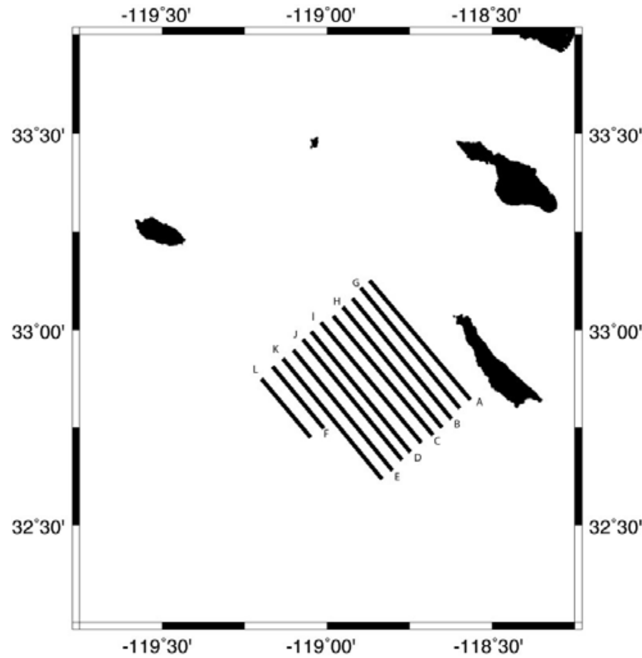


Figure SOCAL34-2. Location of the transect lines covering the area of the SOAR hydrophone arrays.

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	

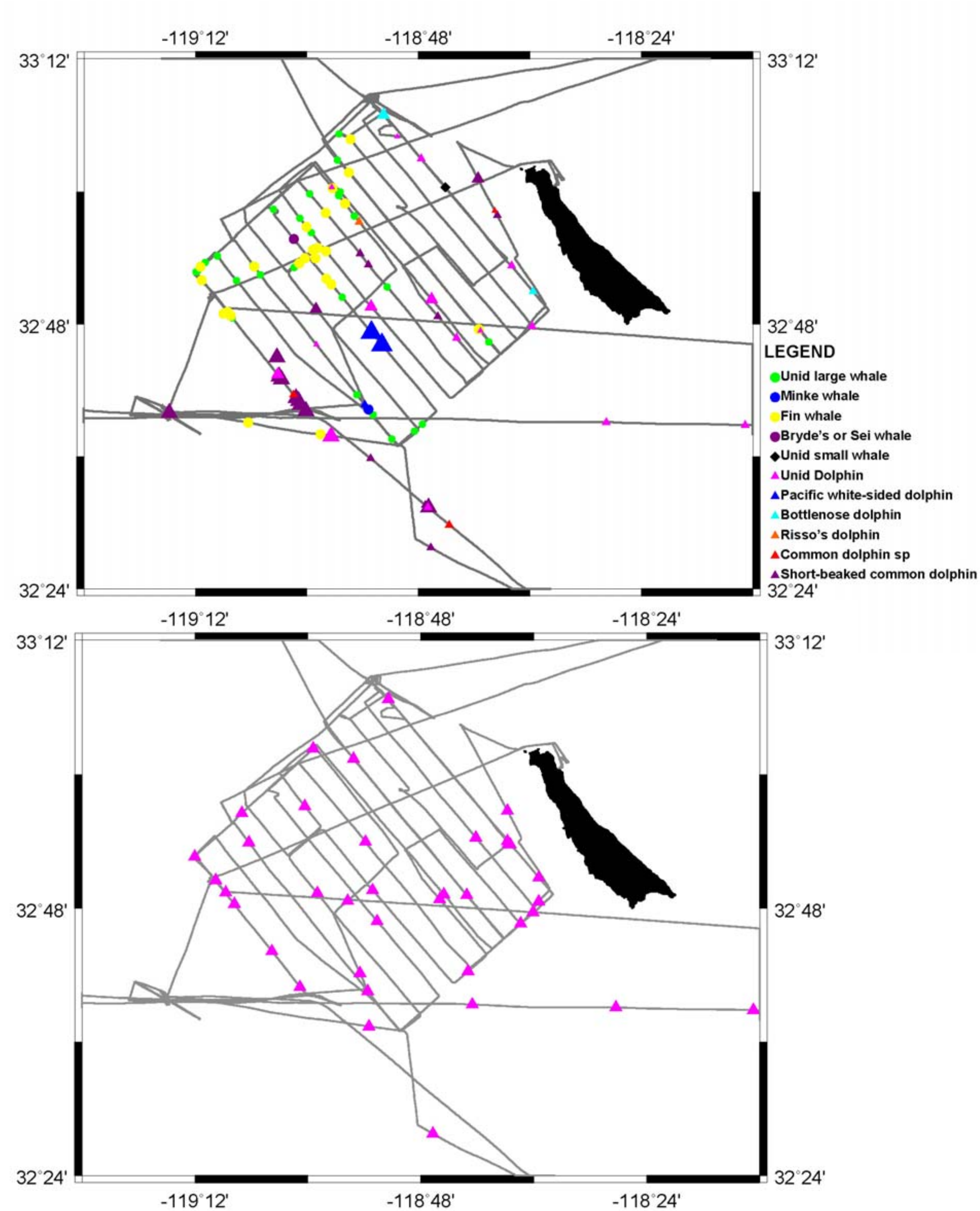


Figure SOCAL34- 3. (top panel) Visual cetacean sightings during SOCAL34. The species is denoted by the color of the symbol and the group size is denoted by the size of the symbol. (bottom panel) Acoustic array odontocete detections during SOCAL34.

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.

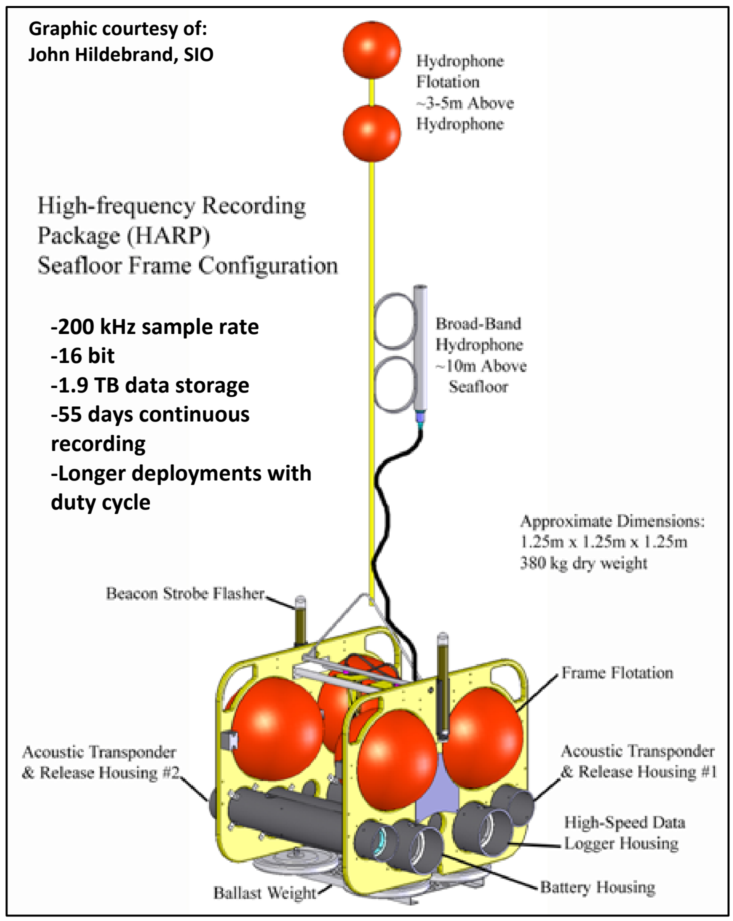
Site	Latitude	Longitude	Depth (m)
Socal34-E	32.65898°N	119.4772°W	1,334 (4,377 ft)
Socal34-G2	33.14265°N	118.8931°W	1,106 (3,629 ft)
Socal34-H	32.84282°N	119.1716°W	992 (3,254 ft)
Socal34-M	33.51545°N	119.2466°W	902 (2,959 ft)
Socal34-N	32.36977°N	118.5648°W	1,287 (4,222 ft)

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.



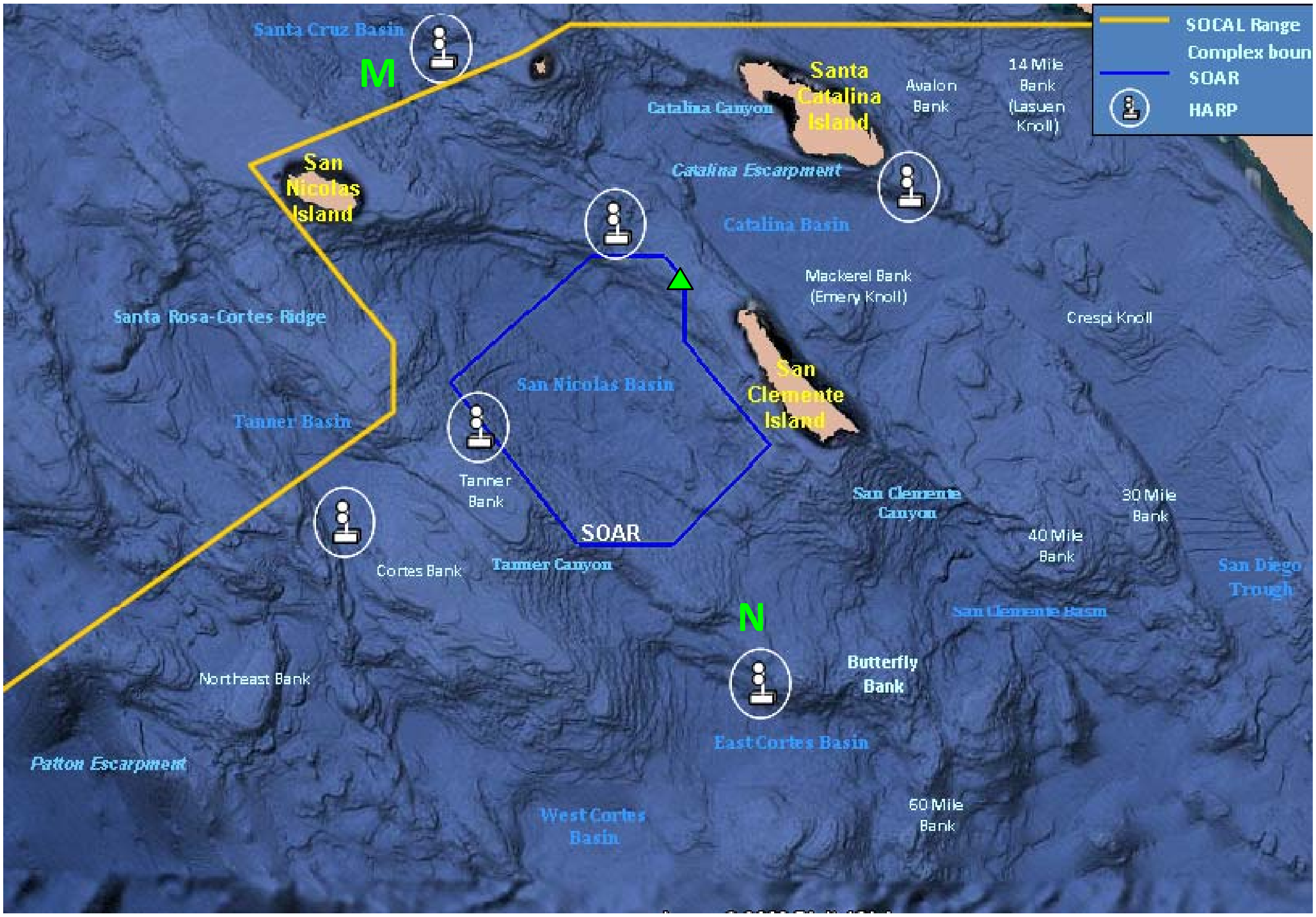


Figure II-9. Locations of FY09 Navy-funded (Research and Development and Compliance programs) bottom-mounted passive high-frequency acoustic recording packages (HARP) within the northern portion of SOCAL Range Complex.

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.

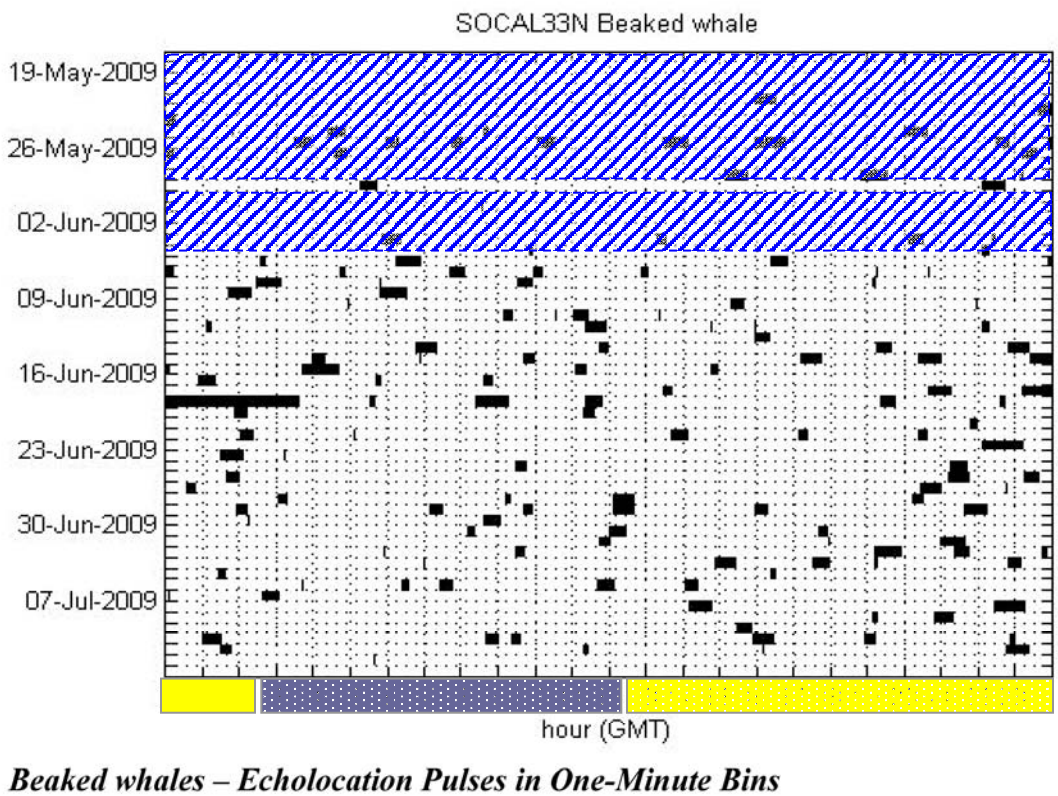


Figure II-10. Plot of beaked whale echolocation detections by time from HARP Site N, south of San Clemente Island between 19 May to 12 July 2009.

(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	

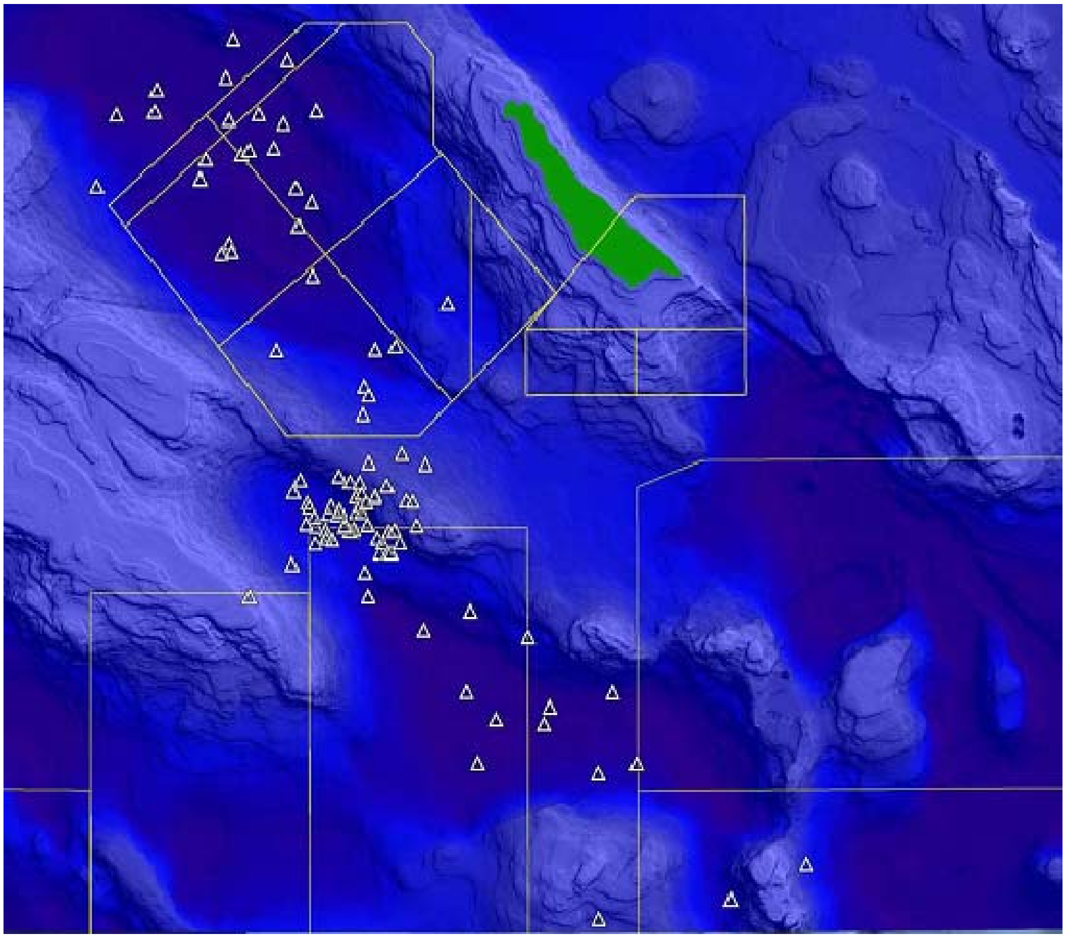


Figure CRC-1. Map showing daily location of a satellite tagged Cuvier's beaked whale over a period of 106 days. The maximum distance moved from the original tagging location is currently 151 km (82 nm) (graphic courtesy of Greg Schorr, Cascadia Research Collective).

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.

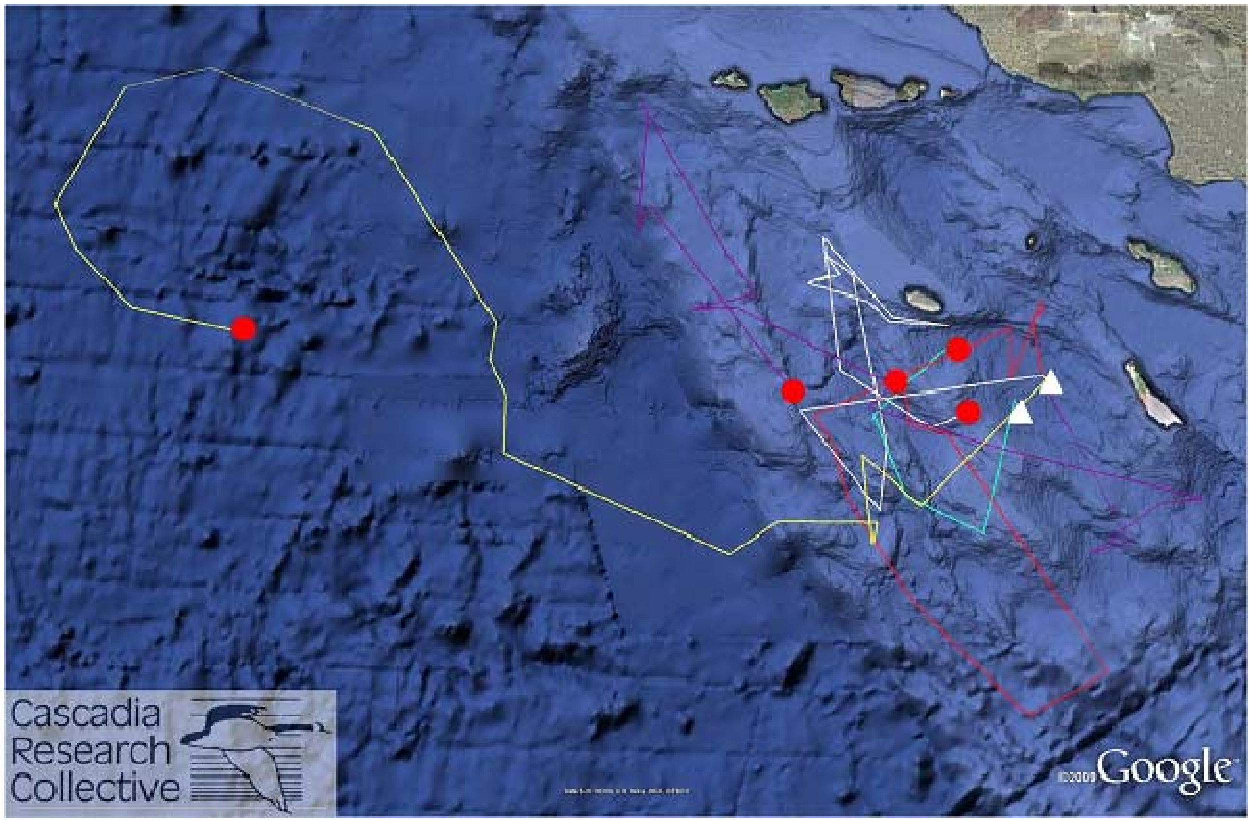


Figure CRC-JUL-2. Movement vectors of five satellite tagged fin whales 25 July through 13 August 2009.

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.

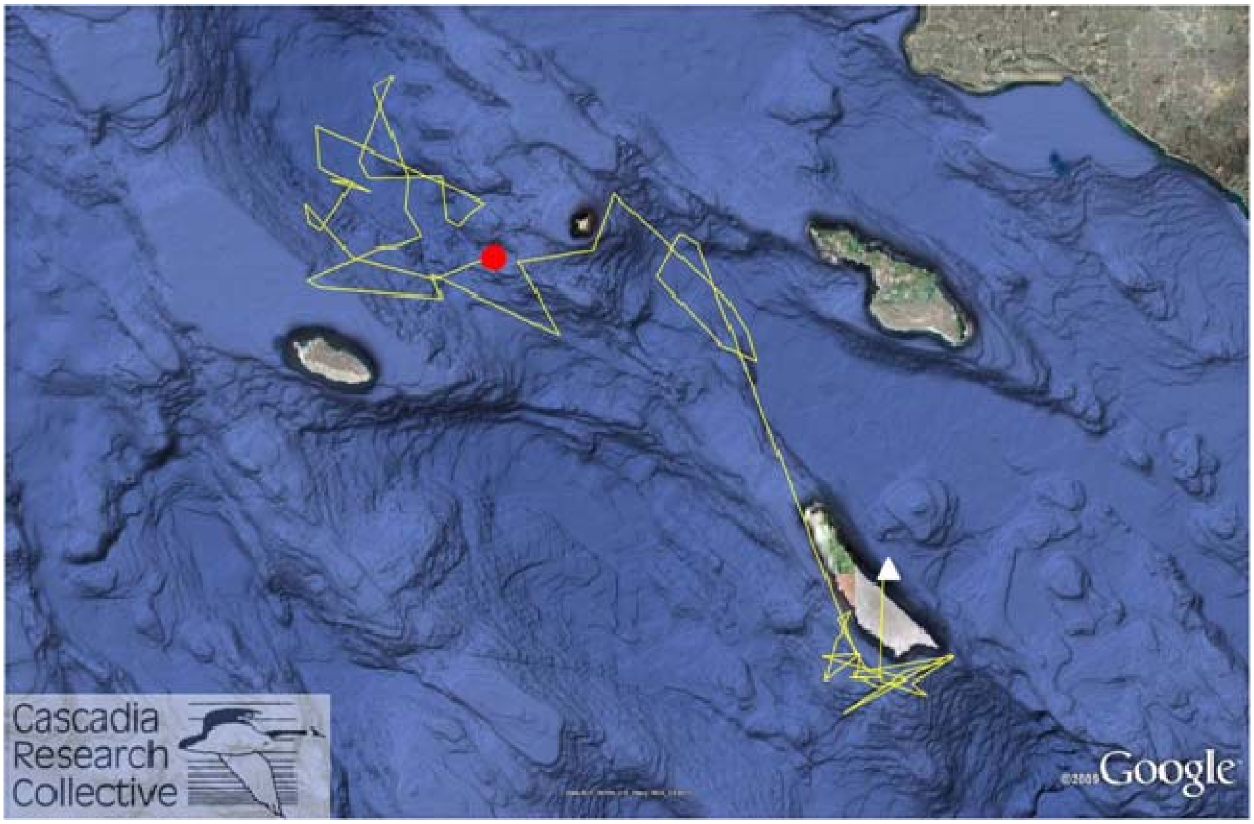


Figure CRC-JUL-3. Movement vectors of a satellite tagged Risso's dolphin 19 July through 2 August 2009.

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.

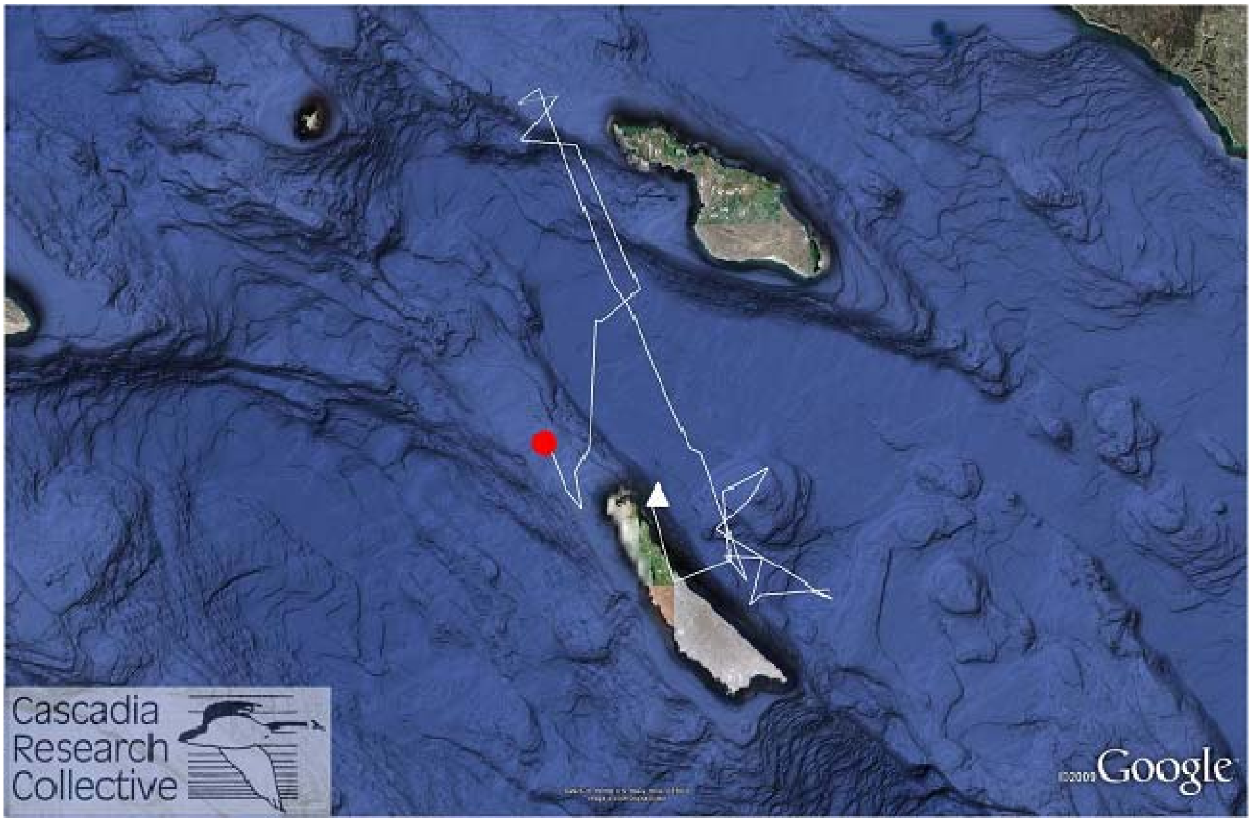


Figure CRC-JUL-4. Movement vectors of a satellite tagged bottlenose dolphin 20 July through 13 August 2009.

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.

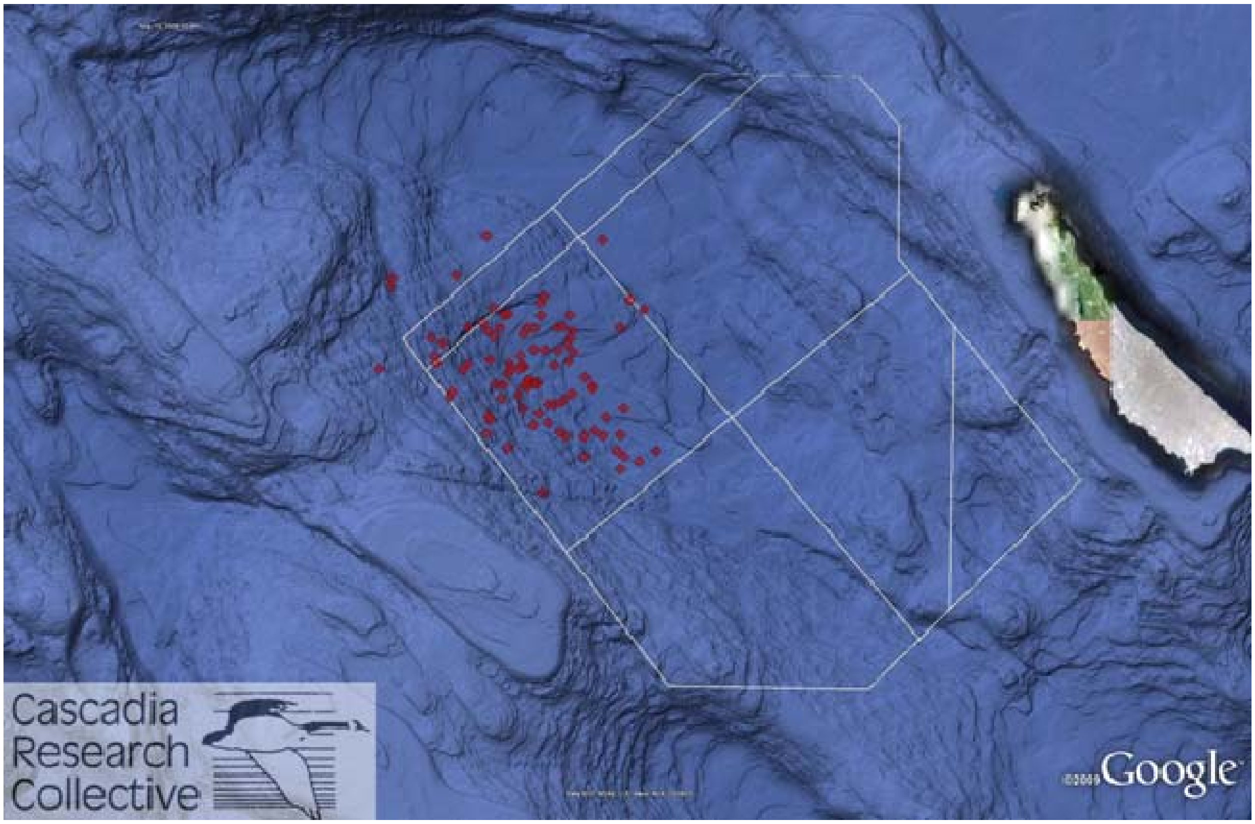


Figure CRC-JUL-5. Argos received locations from the second satellite tagged Cuvier's beaked whale on the SOAR, 20 July through 13 August 2009.

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.

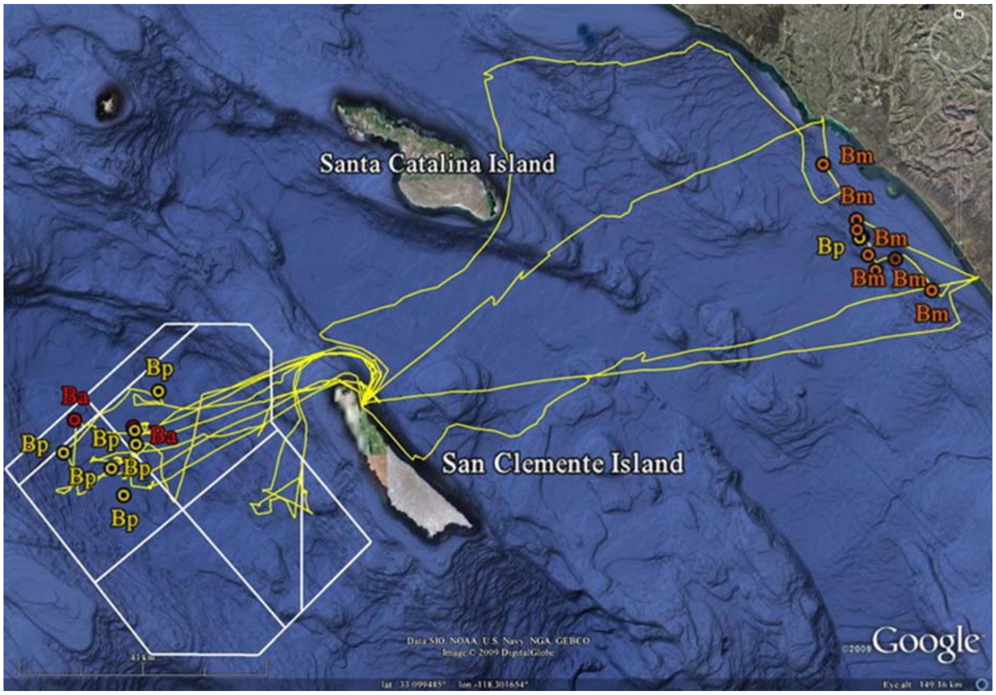


Figure CRC-JUL-6. Baleen whale sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

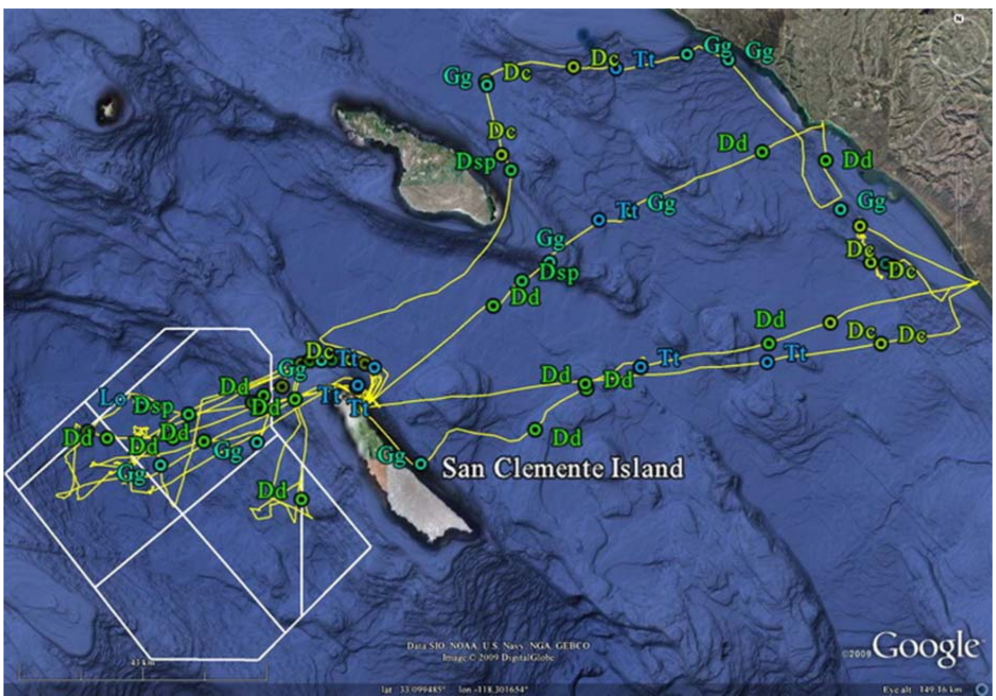


Figure CRC-JUL- 6. Dolphin sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

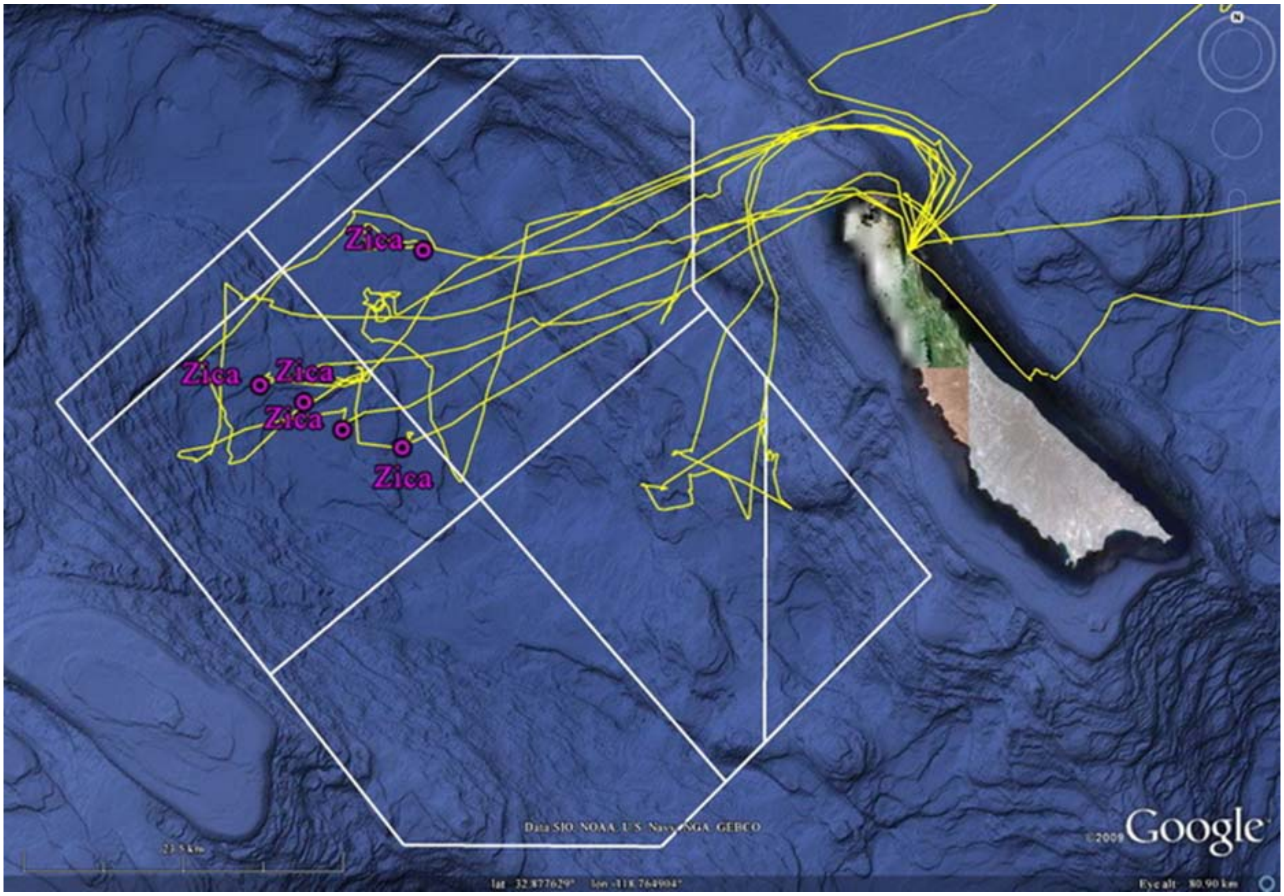


Figure CRC-JUL-7. Cuvier's beaked whale sightings during 18-26 July 2009 CRC visual and tagging effort in SOCAL.

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

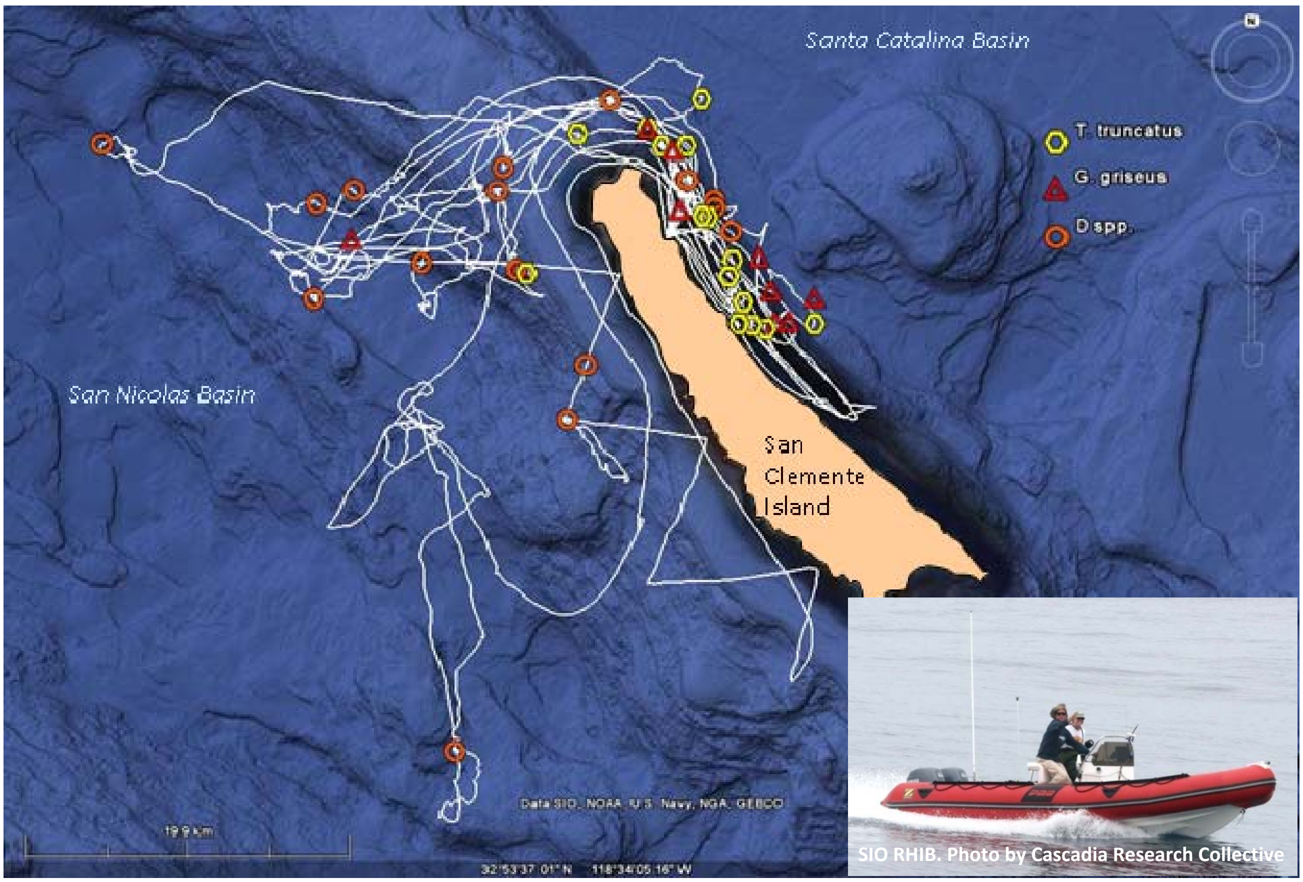


Figure SIO-RHIB-JUL-1. SIO RHIB survey tracks and sighting locations for bottlenose dolphins, Risso's dolphins, and common dolphins (Delphinus spp.) 20-28 July 2009 near San Clemente Island.

CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATION (CALCOFI)

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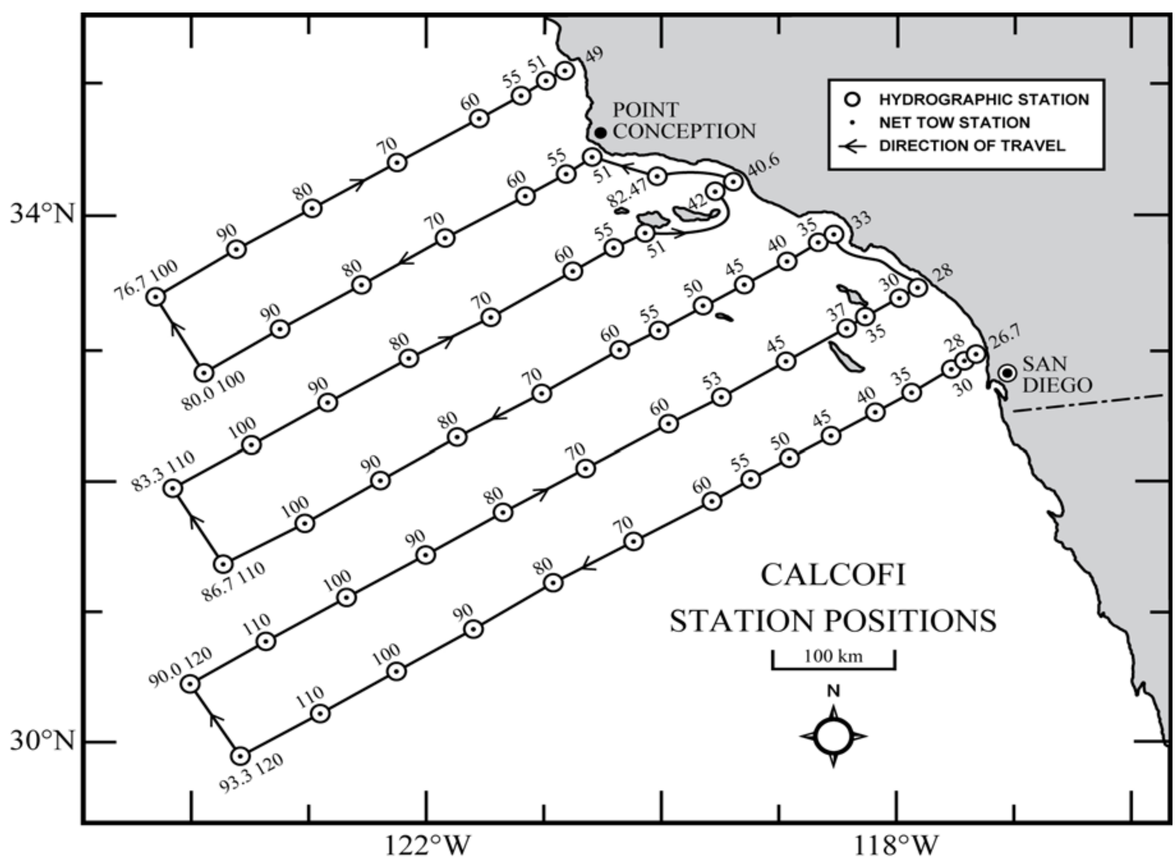
Cetacean survey data from California Cooperative Oceanic Fisheries Investigation (CalCOFI) cruises conducted in southern California has been funded by the Navy R&D program (Marine Mammal Acoustic Monitoring and Habitat Investigation, Southern California Offshore Region). CalCOFI cruises have been conducted 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.

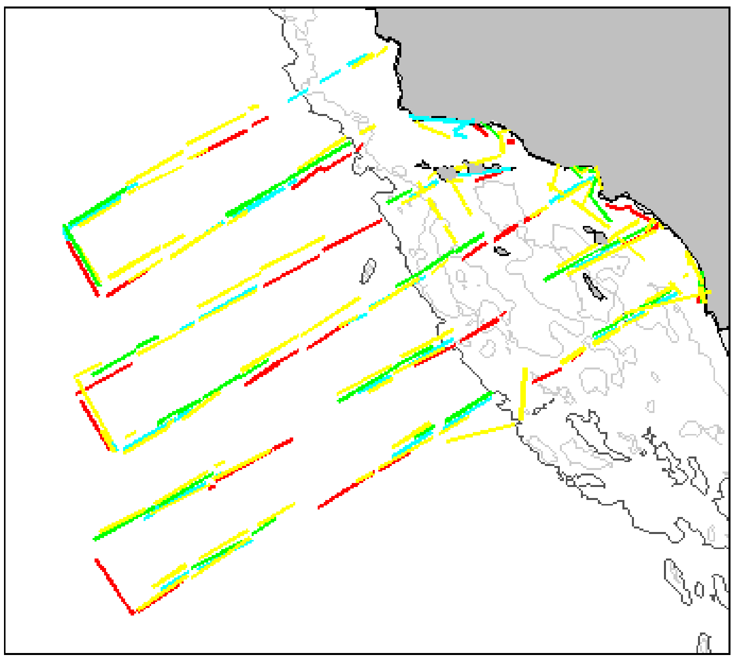


CalCOFI station locations off Southern California (graphic courtesy of CalCOFI program)

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



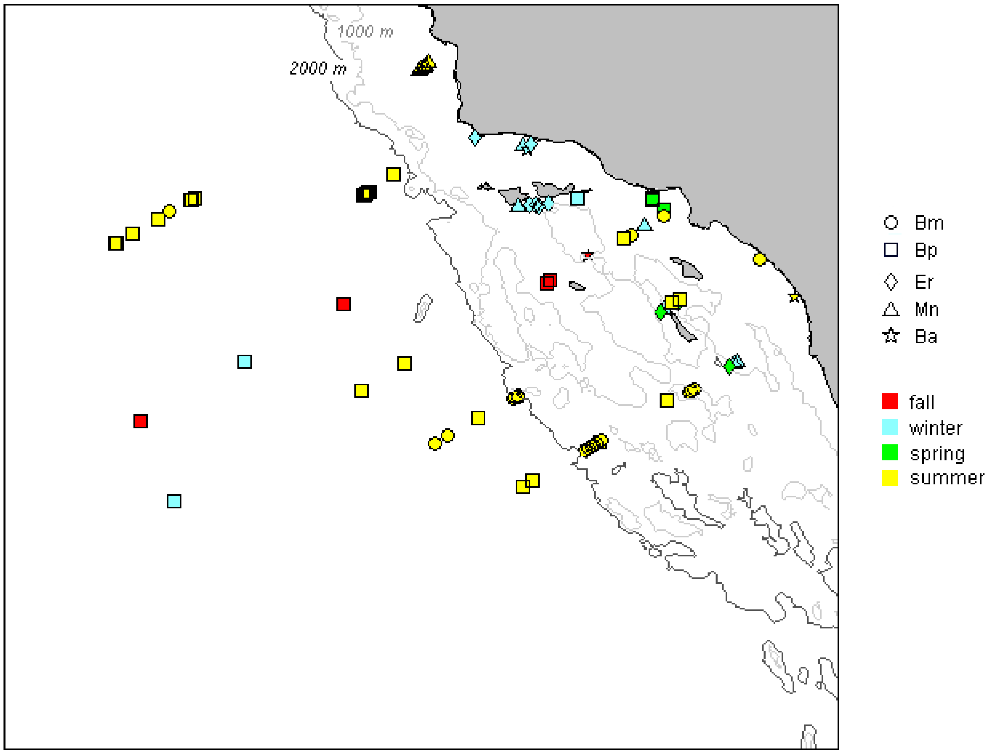
Marine mammal visual effort trackline on CalCOFI cruises between August 2008 and August 2009 CalCOFI cruises

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



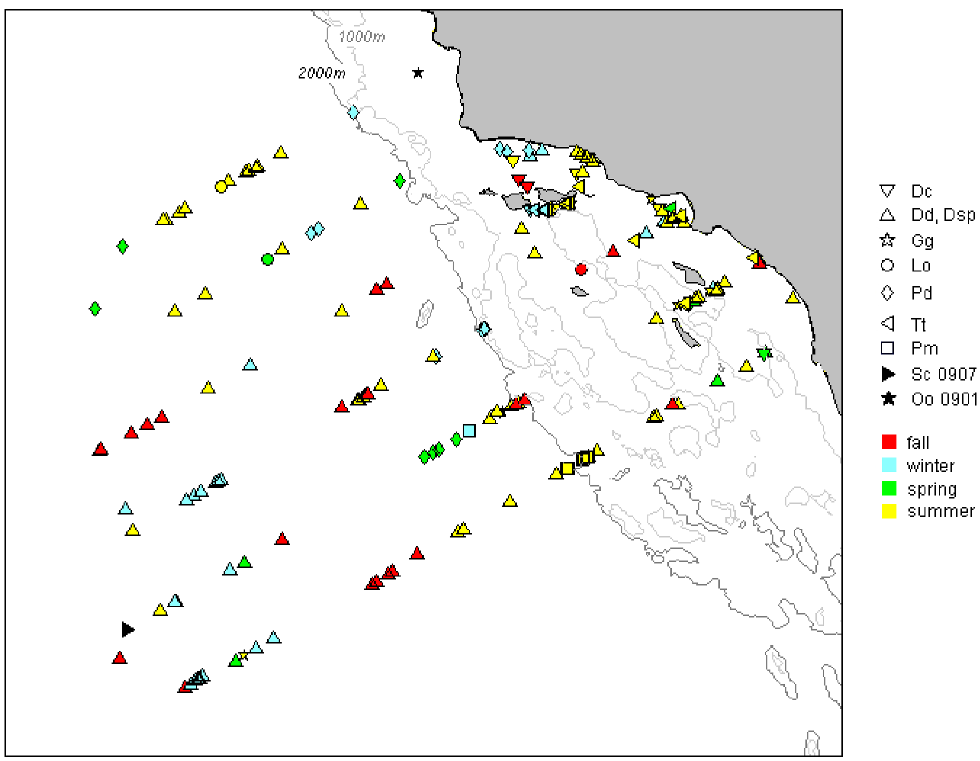


Figure CalCOFI-1. Baleen whale sightings (top) and toothed whale sightings (bottom) during CALCOFI cruises between August 2008 and August 2009.

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).

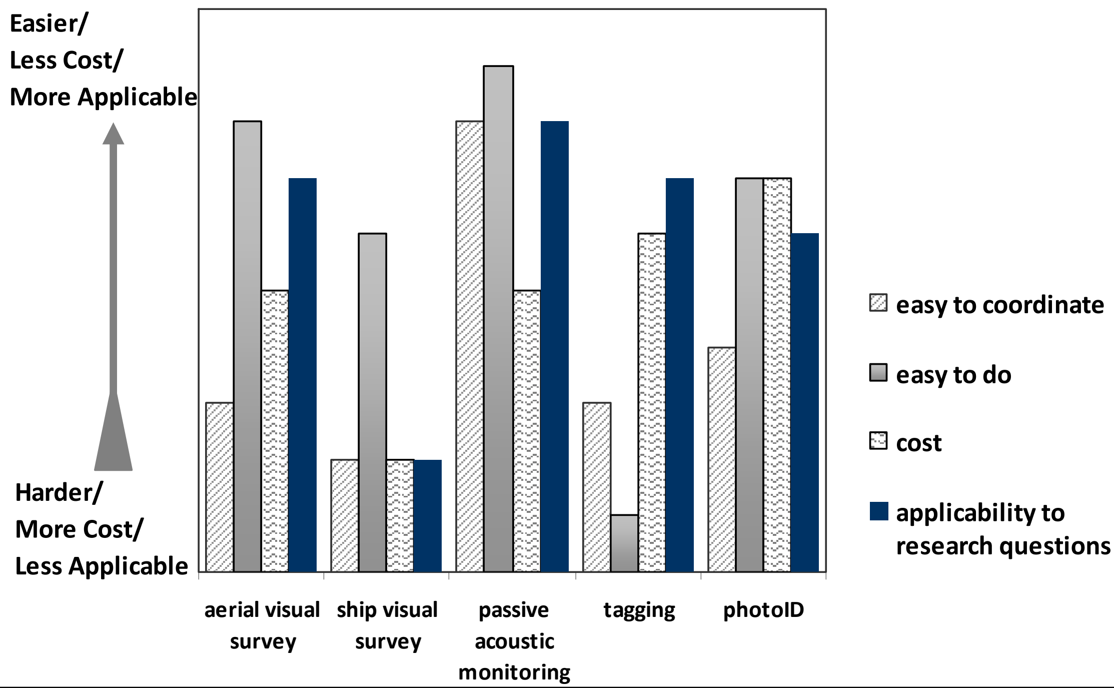
More disruptive were either cancellations or major date shifts in Navy training events based on logistics, fiscal, or operational needs that occurred this year. These kind of changes are difficult to predict and more importantly, more difficult to reschedule from a monitoring prospective when survey 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.



<u>Definition of Subjective Categories</u>

“**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), <u>or</u> Unit Level Training (ULT) events using sonar (MFAS, HFAS), <u>or</u> 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	

<u>TOTAL FY10 Commitment</u>:

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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For The U.S. Navy's
Hawaiian Range Complex (HRC)
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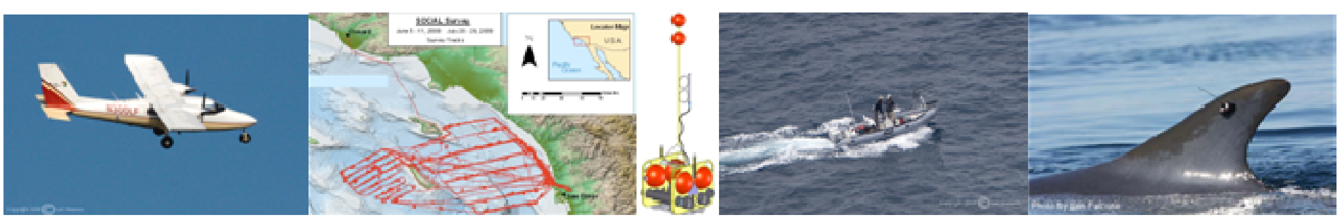

SOCAL Photos from left to right: Twin-engine airplane used for marine mammal aerial monitoring (Photo by Lori Mazzuca), serial survey track lines for June and July 2009 in SOCAL (Graphic courtesy of Marine Mammal Research Consultants), Scripps Institute of Oceanography High-Frequency Acoustic Recording 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).

01 October 2009

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Aerial Survey Monitoring of Marine Mammals and Sea Turtles
in Conjunction with SCC OPS 08 Training Exercises off Kauai and Niihau, Hawaii August 18-21, 2008

Field Summary Report

FINAL REPORT
May 2009

Contract #N62742-08-P-1942

Submitted to:

NAVFAC Pacific
EV2 Environmental Planning
258 Makalapa Drive, Ste. 100
Pearl Harbor, HI 96860-3134

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Executive Summary

Aerial surveys to monitor for marine mammals and sea turtles (MM/ST) were conducted in conjunction with the August 2008 US Navy Submarine Commanders Course (SCC OPS) 08 training event in the Hawaii Range Complex on the Pacific Missile Range Facility Barking Sands Range off Kauai and Niihau, Hawaii, on four consecutive days from 18-21 August 2008. The purpose of the survey was to monitor potential effects of the training event on these species. This effort involved assessing the feasibility of conducting searches for MM/ST in front of an Arleigh Burke class naval destroyer, the *USS O'Kane* DDG 77 (*O'Kane*). During monitoring, the *O'Kane* was underway following a non-systematic course and speed and intermittently transmitting mid-frequency active sonar (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 and/or unusually behaving animals. The approach involved flying elliptical-shaped patterns in advance of the *O'Kane* that extended from the front of the ship (~200 yards [yd]) out to ~2500 yd) 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.

Surveys were conducted with a small fixed-wing Partenavia P68 Observer flying at 100 knots (kt) groundspeed and an altitude of 800 ft (244 m). Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal biologists, at least two with >10 years of related experience. One biologist was the data recorder/video camera operator and the other two were observers. Behavioral observation methods followed protocols previously implemented from small fixed-wing aircraft to monitor baseline behavior and reactions of whales and dolphins to various anthropogenic stimuli. Observers were not informed of the times and types of underwater transmissions during Navy activities, nor the course of the *O'Kane*.

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. No sightings were recorded while escorting the *O'Kane*, although observation conditions were predominantly poor near the *O'Kane* (Beaufort >4 during 80% of 19 hr). In general, previous reported densities of MM/ST are very low in the deep offshore waters where the *O'Kane* operated compared to near-shore Hawaiian waters (reviewed in Smultea 2008). During the 9.5 hr away from the *O'Kane*, 20 sightings were recorded, 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 ~1200-1500 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 Bf 6 sea conditions, demonstrating that a large marine species could be tracked underwater in the clear tropical water conditions in the *O'Kane*'s vicinity.

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. This information can be used to continue developing effective monitoring approaches and to gather behavioral data, including baseline data, on the potential effects of Navy activities on marine resources as required under the Navy's marine species monitoring plan for the Hawaii Range Complex. Recommendations for marine mammal monitoring during future similar Navy activities have been presented.

Citation for this report is as follows:

Smultea, M.A. and J.R. Mobley, Jr. 2009. Aerial Survey for Marine Mammals and Sea Turtles in Conjunction with SCC OPS Navy Exercises off Kauai, 18-21 August 2008, Final Report, May 2009. Prepared by Marine Mammal Research Consultants, Honolulu, HI, and Smultea Environmental Sciences, LLC., Issaquah, WA, under Contract No. N62742-08-P-1942 for Naval Facilities Engineering Command Pacific, EV2 Environmental Planning, Pearl Harbor, HI.

Photo Credits on Cover: Partenavia P68 Observer aircraft used during the survey, photo courtesy of Lori Mazzuca; Hawaiian spinner dolphin (*Stenella longirostris*) observed near Kauai during RIMPAC July 08 vessel survey, photo courtesy of Thomas Jefferson. Cetacean photo taken under NOAA Permit No. 642-1536-03 issued to Joseph R Mobley, Jr. Cover Page Graphics: Stasia Buffenbarger.

Section 1 Introduction

In support of the U.S. Navy's (Navy) marine species monitoring plan in the Hawaii Range Complex (HRC), Marine Mammal Research Consultants (MMRC), Honolulu, HI, was contracted by the Navy to conduct an aerial survey to monitor marine mammals and sea turtles (MM/ST) in conjunction with the SCC OPS 08 Navy training event involving mid-frequency-active sonar (MFAS) off Kauai and Niihau in the main Hawaiian Islands (Fig. 1). MMRC attended pre-planning sessions with the Navy Technical Representative (NTR) and other Navy staff at Pearl Harbor, Honolulu, Oahu, Hawaii, to coordinate survey efforts with the SCC 08 operations. These meetings were required given the complexity of multiple naval aircraft and vessel operations involved with the training event. The goal of the meetings was to ensure safety and open communication between the Navy and the aerial monitoring team during the survey.

The approach implemented for monitoring was to search for and follow MM/ST in front of the Arleigh Burke class naval destroyer, the *USS O'Kane* DDG 77 (O*'Kane*), while it was underway and intermittently transmitting MFAS. Observations by experienced marine mammal observers occurred from a small, fixed-wing Partenavia P68 Observer aircraft on four days from 18-21 August 2008. This included one day of transit from Oahu to Kauai; poor weather conditions precluded effort during the return transit to Oahu on 21 August.

The primary monitoring goals were as follows.

1. Monitor MM/ST to identify potential changes in behavior, orientation, location, distribution, and relative abundance relative to MFAS and other SCC OPS 08 activities. This included monitoring for any potentially dead, injured, distressed and/or unusually behaving animals.
2. Facilitate real-time communication between Navy biological observers on the *O'Kane* and those in the survey aircraft, as well as those between naval and observer aircrafts in order to communicate (a) animal sighting locations relative to the *O'Kane*'s location, and (b) observer aircraft altitude changes to allow safe monitoring relative to naval aircraft and vessel operations.
3. Obtain locations of animals so that received MFAS sound levels could be calculated and estimated by Navy personnel in post-survey analyses.
4. Assess the feasibility and capabilities of monitoring near- and sub-surface tracking and behavior of MM/ST from the survey plane near the *O'Kane*.
5. Evaluate effectiveness and feasibility of monitoring approaches during SCC OPS 08 and provide recommendations for future such efforts.

Accompanying a naval destroyer actively engaged in training events from a small aircraft to search for MM/ST for extended periods had not been previously implemented; thus, the project was considered a feasibility study. Additionally, *O'Kane* crew lookouts and professional Navy marine mammal biologists maintained watch for MM/ST during all daylight hours; lookouts also maintained watch during darkness hours.

Herein we describe the methods and results of our aerial monitoring survey in the context of other similar surveys and methodologies. We also evaluate the feasibility of the survey approach and provide recommendations for future efforts designed to monitor MM/ST during naval events and exercises. These topics are discussed in the context of short- and long-term monitoring goals summarized in the Hawaii Range Complex Final Monitoring Plan (Navy 2008) and the Southern California Range Complex Final Monitoring Plan (Navy 2009).

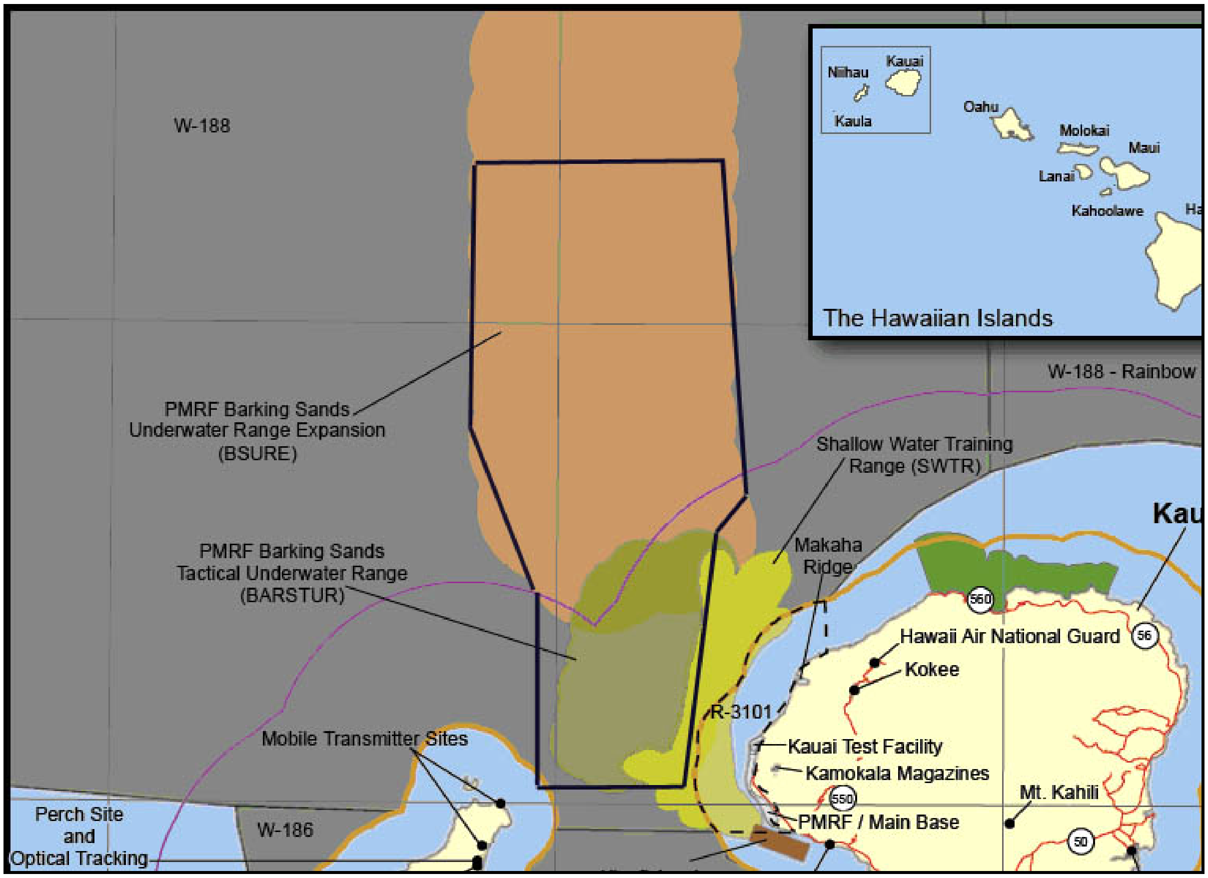

Figure 1. Location of the aerial survey monitoring area in and near the US Navy Pacific Missile Range Facility (PMRF) Range west and northwest of Kauai, Hawaii.

Section 2 Methods

Survey protocols were designed to meet the Navy goals outlined in the Statement of Work (SOW) while remaining adaptable to both *in-situ* and predicted weather conditions, as well as to naval activities. The survey methodology and sampling design were submitted and approved in advance, per the SOW, to the NTR. Per the SOW and NTR communications, the primary goals of this project were to locate and identify MM/ST during the training event, and to monitor and report observations of their behavior focusing on any changes potentially resulting from exposure to MFAS. This included monitoring for any potentially injured or harmed MM/ST and any unusual behavior or changes in behavior, distribution, numbers, and species associations of animals observed during the training event. Post-event analysis will be conducted by Navy personnel to correlate observed animal locations with estimated received sounds levels of MFAS. Current Navy policy does not allow civilian monitoring scientists access to MFAS transmission schedules.

The survey was undertaken from a twin-engine, fixed-wing Partenavia P68 Observer previously used to conduct numerous aerial surveys for MM/ST on behalf of the Navy in Hawaii and elsewhere (e.g., Mobley 2004, 2008a,b). The survey occurred from 18-21 August 2008. This included one full day accompanying the *O'Kane* on 18 August as it transited from Pearl Harbor in Honolulu, Oahu, to the training area off Kauai and Niihau, followed by three days within the training area (Fig. 1).

The SCC OPS 08 event involved several large naval vessels, submarines, and both fixed-wing and helicopter aircraft. Thus, daily survey periods were generally limited to relatively short time windows that did not conflict with naval airspace operations for logistical and safety reasons. These flight windows had to be identified and coordinated with the NTR and/or the air controller at Barking Sands each morning prior to take off and updated throughout the flight via cell phone, Inmarsat satellite phone, and/or the aircraft radio. Each morning after the flight window had been identified through communications with Navy personnel, the *O'Kane*'s position was communicated to the crew on the aircraft and the plane was flown to that location. This location was expected to be within the BSURE or BARSTUR ranges of the training event area located at minimum ~15 nm WNW of Kauai's Lihue Airport where the survey aircraft was located.

Observations were conducted en route to the *O'Kane*'s location following established line-transect survey protocol (see Mobley 2004, 2008a,b). Upon locating the *O'Kane* visual observations for MM/ST were conducted using two approaches (i.e., modes): search mode and focal follow mode (Table 1). The purpose of the first mode was to systematically search for animals by flying elliptical, "race track" shaped patterns in front of the *O'Kane*. The goal of this flight pattern was to cover a swath extending from ~200 yd in front of the ship out to ~2500 yd and ~2 nm wide. The pilot manually flew this pattern and frequently had to adjust the pattern to non-systematic and unpredictable changes in speed and headings of the *O'Kane* as it conducted training maneuvers. The resulting extended flight pattern was corkscrew-shaped (Fig. 2). This mode was to be maintained until a MM/ST sighting was made either by the aircraft or the vessel-based observers, or until there was a potential conflict with naval airspace. In addition, passive acousticians aboard the *O'Kane* occasionally alerted the aircraft observers to the presence of vocalizing cetaceans and communicated approximate bearings to these acoustic detections.

When a sighting was made, the aircraft was to cease the flight search pattern and begin circling the sighting following focal follow behavior mode (Table 1). The latter protocol has been successfully implemented during previous aerial studies monitoring the behavior of cetaceans, including near anthropogenic stimuli (e.g., oil and gas exploration activities and sounds, oil spills) (e.g., Richardson et al. 1985a,b, 1986, 1990; Würsig et al. 1985, 1989; Smultea and Würsig 1995; Patenaude et al. 2002). The objective was to circle the sighting at an altitude of 1200-1500 ft and a radial distance of ~1 km and record detailed behavioral observations using a digital video camera and paper data forms (Tables 2 and 3). Previous studies indicate that bowhead and adult humpback whales show few or no detectable reactions to a small aircraft circling at these altitudes and radial distance (e.g., Richardson et al. 1985a,b; Smultea et al. 1995; Patenaude et al. 2002; also see review in Richardson et al. 1995). These parameters are well outside the theoretical range of air-to-water sound transmission angle associated with over-flying aircraft (i.e., Snell's Cone -- see Urick 1972 and Richardson et al. 1995). Thus, these parameters were anticipated to avoid the potential for the aircraft to affect the behavior of the observed animals. However, very few studies on the effects of over-flying aircraft on cetaceans have been made, and no studies of the underwater received levels of an overflying Partenavia P68 Observer are known to exist to our knowledge.

Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal observers, at least two with >10 years of related experience. Roles and responsibilities of the four positions on the aircraft during the search and focal follow modes are depicted in Table 2**.** During focal follows, one observer used a Canon Vixia HF10 digital video camera with a built-in optical image stabilizer and 12x optical zoom to record behaviors in real time as indicated by a time stamp on the viewfinder screen. The microphone of the video camera was connected to the audio system of the aircraft so that all vocal input (e.g., behavioral descriptions) was recorded into the video camera data stream. Observers used Steiner 7 X 25 or Swarovski 10 X 32 binoculars as needed to identify species, group size, behaviors, etc. A Suunto handheld clinometer was used to measure declination angles to sightings when the aircraft was level and the sighting was perpendicular to the aircraft (see Mobley et al. 2000).

Scan-sampling and zero-one sampling approaches (Altmann 1974; Shane 1990; Smultea 1994, 2008; Mann 2000) were used to record the following information on the focal group approximately once per circling of the aircraft (e.g., at 1-2 min intervals) or when the parameter changed, as possible: (1) behavior state, (2) occurrence/non-occurrence and type of "conspicuous" individual behaviors, (3) estimated speed of travel (slow – 1-3 kt, medium – 4-6 kt, fast – >6 kt), (4) distance (declination angle) and magnetic bearing (range) relative to the *O'Kane* or other potential disturbance, (5) minimum and maximum spacing between individuals (i.e., dispersal distance) estimated in body lengths, and (6) aircraft altitude and estimated distance of the aircraft to the focal group (using a clinometer while the aircraft was level) (Table 2). For whales, continuous behavioral sampling (Altmann 1974) was to be used to record surface, dive, and respiration times (see Würsig et al. 1985, 1989). *Ad libitum* (Altmann 1974) detailed notes were also taken in the comments column of the form on school configuration, unusual behaviors or circumstances (e.g., birds feeding nearby, description of Navy activity), and/or any observed reactions to the vessel. Post-field analysis of video tape was to supplement these data and provide more detailed information on behaviors, inter-animal spacing, etc. Geographical Positioning System (GPS) locations were automatically recorded at 30-sec intervals and manually when a sighting was made. Environmental data including Beaufort sea state (Bf) and observation conditions (involving various glare and visibility conditions) were manually recorded at the start of each transect leg and when conditions changed. These methods are described in further detail in Green et al. (1993) and Mobley (2004, 2008a,b).

Table 1. Description of the two primary study approach modes designed to address monitoring goals of the aerial survey.

Mode	Aircraft Speed	Aircraft Altitude	Flight Pattern	Duration	Data Collected
Search	~100 kt	~800 ft	Elliptical shape ~200-2500 yd ahead of *O'Kane*'s bow and ~2 nm wide	Until MM or ST seen, then switch to Focal Follow Mode	Alert *O'Kane* of all MM/ST locations Species, group size & composition Time Lat/long location (automatic GPS) Bearing & declination angle to sighting Behavior state & individual aerial behaviors Reaction (yes or no & description)
Focal Follow	~65 kt	~1200-1500 ft	Circling at ~0.5 nm radius	≥30 – 60 min goal	<u>In order of priority:</u> Time Focal group heading (magnetic) Lat/long (automatic GPS) Behavior state Inter-animal dispersal distance (min & max in body lengths) Aircraft altitude (ft) Distance of aircraft to MM (angle) Reaction? Individual aerial behavior events Bearing & distance to *O'Kane* from MM (angle) Other nearby activity Surface & dive times Individual respirations

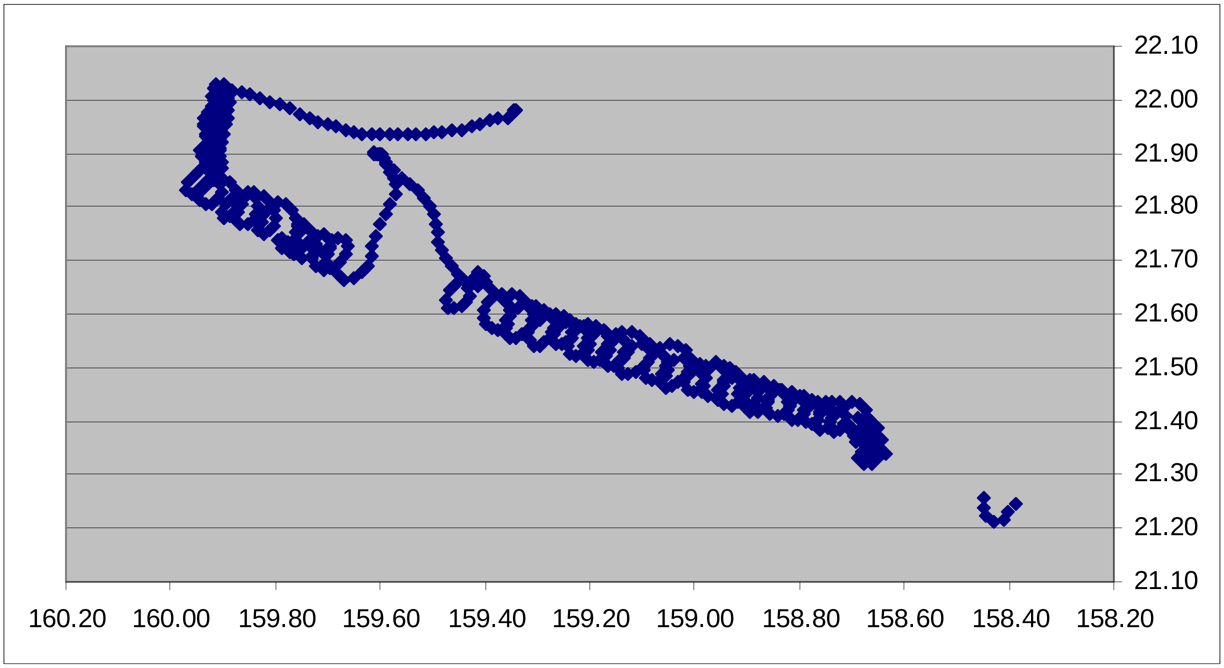

Figure 2. Actual flight path en route from near Pearl Harbor, Oahu, to Barking Sands, Kauai, on 18 August 2008 showing the typical elliptical-shaped flight pattern flown while searching for marine mammals and sea turtles in front of the USS *O'Kane*.

Table 2. Roles and responsibilities of the four personnel aboard the monitoring aircraft during the search mode and the focal behavior follow mode.[1/]

Aircraft Seat Position	Role during SEARCH Mode (~800 ft Altitude)	SEARCH Mode Responsibilities	Role during FOCAL Mode (Circling) (~1500 ft Alt & ~0.5 nm radial distance)	FOCAL Mode Responsibilities
Pilot (Left front)	Pilot	Fly elliptical-shaped pattern ~2 nm wide and ~200-2500 yd ahead of *O'Kane*. Maintain 800 ft altitude Communicate w/ PMRF & Range Director before entering range and when first approaching <2nm *O'Kane*	Pilot	Circle focal group clockwise @ 0.5 nm radius & 1200-1500 ft altitude as directed by behavior observer Keep animal(s) in middle of circle Avoid flying directly overhead animal(s) Keep track of sighting location
Right front	Recorder/ Back-up Observer	Record data Search for MM/ST Keep "big picture" track of relative position of *O'Kane*(s) & aircraft Communicate w/ *O'Kane* observers Monitor hand-held GPS Guide pilot to MM/ST location(s) Photograph to verify/identify spp.	Videographer	Videotape focal group through open window
Left center	Observer	Search for MM/ST	Notetaker	Fill out manual behavior data form and record with time: • orientation of MM when parallel w/ plane heading • *O'Kane* relative location • aircraft altitude & distance to MM (w/ clinometer) once per circling as possible when plane level Call out overall big picture description when behavior observer not talking (e.g., *O'Kane* & other activity, etc.)
Right center	Observer	Search for MM/ST	Primary Behavioral Observer	Keep track of focal group Call out 1x/circle as possible/when changes: focal behavior & other data (see Table 1)

[1/] MM = marine mammal; ST = sea turtle; PMRF = Pacific Missile Range Facility; w/ = with

Table 3. Definitions of behavior states and individual behaviors (events) used during focal animal/group follows. Behavior states are determined based on what >50% of the group is doing.

Behavior State	Code	Definition
REST	rest	>50% of group exhibiting little or no forward movement (<1 km/hr) remaining at the surface in the same location or drifting
MILL	mill	>50% of group swimming with no obvious consistent orientation (non-directional) characterized by asynchronous headings, circling, changes in speed, and no surface activity
TRAVEL	trav	>50% of group swimming with an obvious consistent orientation (directional) and speed, no surface activity
SURFACE-ACTIVE MILL	sac mill	While milling, occurrence of aerial behavior that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping behavior events—see below)
SURFACE-ACTIVE TRAVEL	sac trav	While traveling, occurrence of aerial behavior that creates a conspicuous splash (include all head, tail, pectoral fin, and leaping behavior events—see below)
Individual Behavior Event		
Breach	BR	Leap out of water with a twisting motion at >45º landing on water surface with large splash
Porpoise	PO	Leap fast out of water in forward "leap" motion at <45º creating splashes
Spin	SP	Leap clear of water and spin horizontally >1 time (dolphins only)
Bowride	BOW	Swims in front of vessel riding bow wave
Head Slap	HS	Leap out of water with forward thrust at >45º and slap ventral surface on water creating large splash
Feeding	FE	Seen chasing fish or prey and/or zig-zag pursuit swimming
Social	SOC	Two or more animals in physical contact
Tail Slap	TS	Slap water surface with ventral or dorsal side of tail flukes
Pectoral Fin Slap	PS	Slap water surface with pectoral fin
Other Behavior	OB	Behavior not listed above: describe
Whales Only		
Blow	BL	Visible respiration
No Blow Rise	NB	Surface with no visible blow/respiration
Peduncle Arch	PA	Arching of back without lifting tail/flukes
Fluke up	FU	Arching of back followed by lifting tail flukes into air (fluke facing up or down) usually before an extended dive
Unidentified Large Splash	US	Large splash associated with an unidentified/unseen behavior

Section 3 Results

Results are described below in the following four sections: effort, sightings, focal follows, and communications. Table 4 summarizes observation effort by date and by periods that the aircraft was accompanying and not accompanying the *O'Kane*. Figure 3 displays aerial survey tracks during visual observations by survey date and shows the locations of marine mammal and sea turtle sightings.

Effort

Aerial survey effort occurred on all four days of the survey period from August 18-21. The first day on 18 August was spent accompanying the *O'Kane* from near Honolulu to Kauai (Table 4). Portions of the next three days were spent with the *O'Kane* ~20-60 nm off the NW shore of Kauai when there were no airspace conflicts and when the *O'Kane* moved off range (i.e., outside the training event range--see below) as depicted in Table 4. About ~40-60 min of transit time one-way was required to reach the *O'Kane* from the Kauai Lihue airport. The aircraft usually returned to shore once per day then made a second flight on the same day, either to refuel or to avoid conflicts with periods of naval aircraft operations (Table 4). On August 19 and 20, the *O'Kane* went off range, away from the scheduled training event to conduct drills and unit-level training. This allowed the civilian observer aircraft to accompany the *O'Kane* for more hours than originally anticipated, with minimal maneuvering to avoid airspace conflicts. On the last survey day (August 21), the civilian aircraft spent the morning with the *O'Kane* as the Beaufort sea state (Bf) steadily deteriorated from Bf 2 to Bf 7 by ~14:00. The NTR and aircraft observers decided to seek calmer waters in leeward areas (near Niihau and within the Kaulakahi Channel between Niihau and Kauai) to attempt opportunistic sighting and behavioral observation of MM/ST. However, the strong wind quickly mounted to Bf 7 conditions in the channel by ~15:00. Thus, observations ceased and the aircraft returned to Oahu; no observations were conducted during the transit due to Bf >6.

A total of 28.5 hr of aerial monitoring effort was conducted over the four-day survey period from 18-21 August. This included 19.0 hr accompanying the *O'Kane* in offshore waters of Kauai and Niihau, representing 67% of the total flight time (Table 4). The remaining 9.5 hr of flight time was spent in transit or conducting opportunistic searches or focal follows for MM/ST. For example, when range safety or Bf conditions precluded accompanying the *O'Kane*, opportunistic survey effort was expended searching for cetaceans in order to conduct "practice focal follows" off range.

Observation conditions offshore where the *O'Kane* was located consisted largely of strong high wind and thus high (poor) Beaufort conditions that severely limited the ability of observers to sight MM/ST. Of the total ~19 hr spent with the *O'Kane*, most (80%) was a Bf 5, 6 or 7; the remaining ~9.5 hr (20%) was Bf 2-4 (Fig. 4). In comparison, only 38% of the 9.5 hr of survey effort while not accompanying the *O'Kane* was Bf 5-7 and occurred predominantly during transits in offshore areas. Calmer conditions of Bf 2-3 (42%) were typically found in lees along the west shore of Kauai during transits.

Sightings

No MM/ST were seen from the observer aircraft during the 19.5 hr while surveying in conjunction with the *O'Kane*. However, two groups of spinner dolphins and 18 sightings of unidentified sea turtles were recorded during the nearly 10 hr of transit and opportunistic survey time (Table 5). The spinner dolphins were seen in the lee off the NW shore of Kauai during the initial and return transits from the *O'Kane* on August 19 (Fig. 3, Table 5). All 18 sea turtle sightings were also made during transits, all close to the coastline within the protected lees of mainly Kauai but also Oahu (Fig. 3).

On August 19 at ~13:35 the aircraft observers received a satellite phone call from the Navy biologist (NTR) reporting that a group of pilot whales had been initially seen ~5 min earlier from the *O'Kane*. The

Table 4. Summary of survey times by date and periods when observer aircraft was accompanying and not accompanying the *O'Kane*.

Date 2008	Flight Times	Total Flight Time	Time not with *O'Kane*	Time with *O'Kane*	No. Sightings Near *O'Kane*	No. Sightings Away from *O'Kane*
18 August	13:10-17:06 17:20-19:29	6.1 hr	13:10-13:31 17:01-17:06 17:20-17:27 19:08-19:29 (0.9 hr)	13:32-17:00 17:28-19:07 (5.1 hr)	0	0
19 August	09:23-15:00	5.6 hr	09:23-10:19 14:06-15:00 (1.8 hr)	10:20-14:05 (3.8 hr)	0	4
20 August	06:19-08:25 09:45-14:00 15:09-18:10	9.4 hr	06:19-06:52 07:57-08:25 09:45-10:04 13:01-14:00 15:09-15:49 17:31-18:10 (3.7 hr)	06:53-07:56 10:05-13:00 15:50-17:30 (5.7 hr)	0	13
21 August	06:45-10:25 12:00-15:47	7.4 hr	06:45-07:15 10:01-10:25 12:00-12:20 14:01-15:47 (3.1)	07:16-10:00 12:21-14:00 (4.4 hr)	0	3
TOTALS:		28.5 hr	9.5 hr	19.0 hr	0	20

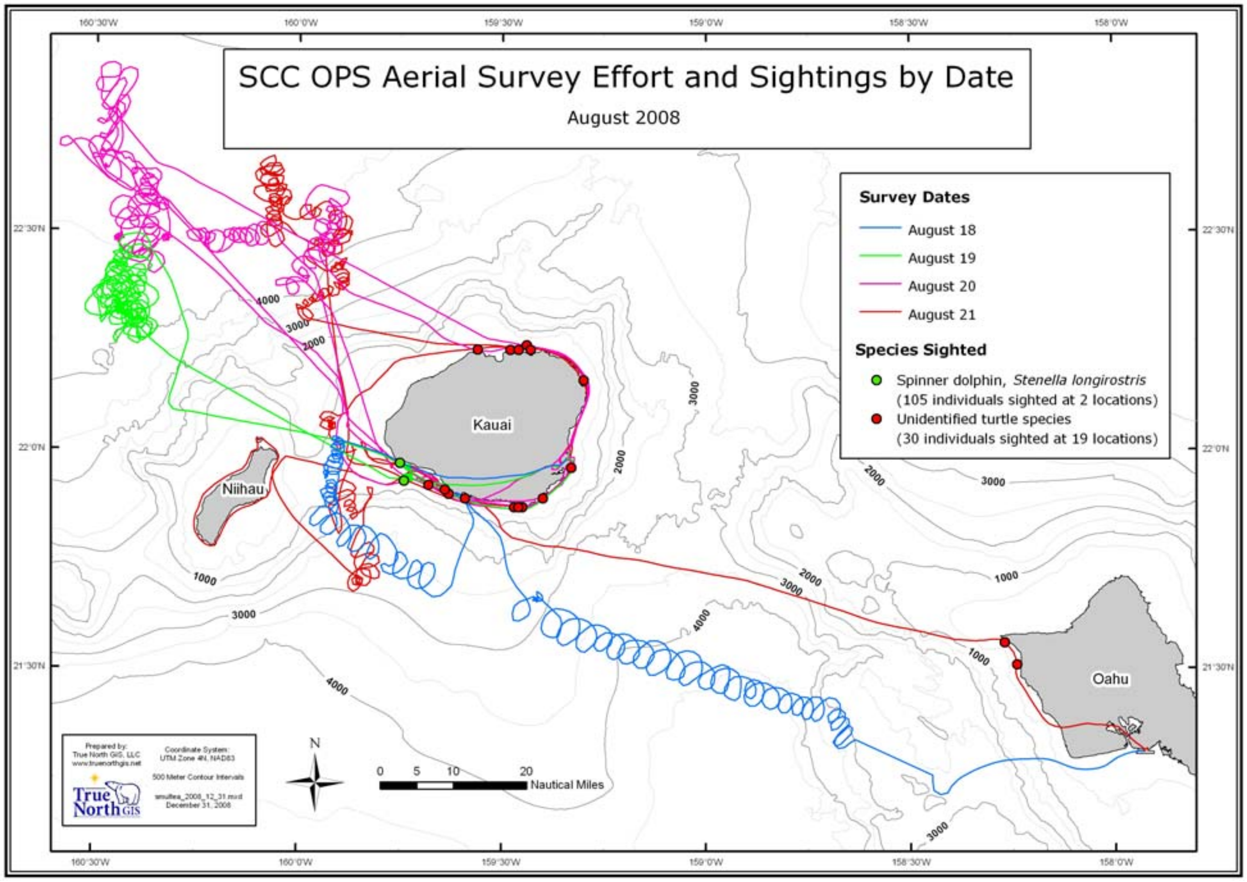

Figure 3. Aerial survey tracks during visual observations by survey date and locations of marine mammal and sea turtle sightings. Straight-line tracks indicate transit periods, some of which were conducted along the Kauai shoreline. Corkscrew-shaped tracks indicate when the aircraft was accompanying the O'Kane or conducting an opportunistic focal follow.

NTR informed the aircraft personnel that it was not until the ~9th satellite phone dialing attempt that she was able to successfully reach the aircraft observers. At the time of this communication, all the animals had dived. Thus, the NTR suggested that the observer aircraft search for the animals behind the *O'Kane*. Although the aircraft observers circled the last known location of the pilot whales for ~30 min, they were unable to re-sight the animals. Overall, the civilian aircraft observers did not see the animals probably due to several factors including: 1) the elapsed time (~5 min) it took Navy Biologists to make initial communication due to INMRSAT failure; 2) the elapsed time (another ~5 min) it took to subsequently reach the presumed location of the animals yet remain outside the minimum required radar safety guidelines aft of the *O'Kane* (in this instance >1 nm), and 3) a Beaufort sea state 6.

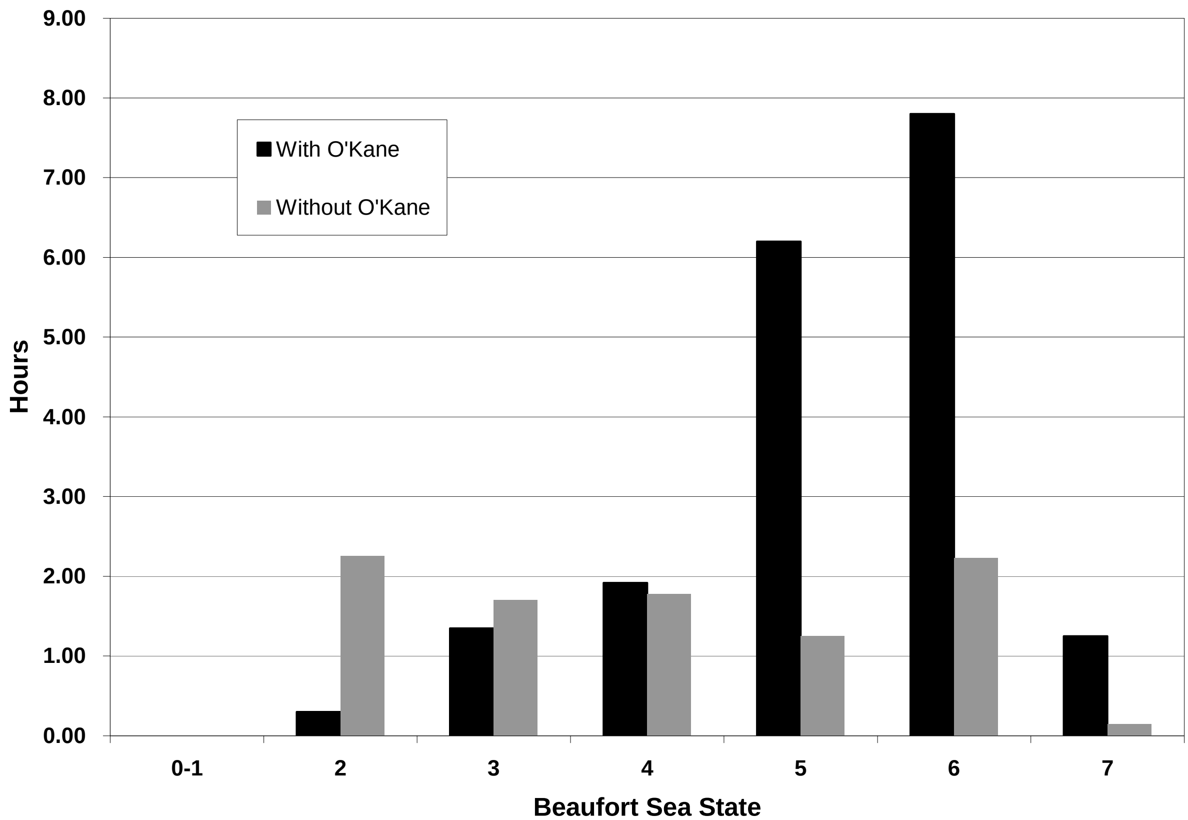

Figure 4. Beaufort sea state conditions during periods the observer aircraft was accompanying and not accompanying the *O'Kane*.

On several occasions, the NTR Navy Biologist aboard the *O'Kane* alerted the aircraft observers that the contracted Navy acoustician aboard the *O'Kane* for the survey was detecting cetacean vocalizations, including sperm whales and delphinids. The rough approximate bearing and distance (in nm) to the detection from the *O'Kane* were communicated to the aircraft observers. Aircraft observers searched these general locations for up to 10-20 min each time, but no sightings were made and observation conditions were marginal (i.e., high Bf). On one of these occasions on August 20, a whale shark was sighted from the aircraft during a Bf 6 and video was taken of it for several minutes as it swam ~30 ft below the surface.

In addition, submarines were observed from the aircraft several times and tracked for a few minutes while they were ~60 ft below the water surface. This was done to opportunistically assess the feasibility of tracking a large cetacean underwater near this depth.

Focal Follows

Two opportunistic focal follows were conducted during transits on two groups of spinner dolphins sighted off NW Kauai on August 19. The two groups were circled for ~10 min each, respectively, and video tape was taken on both groups.

The first focal follow was a group of ~80 spinner dolphins seen at 9:41 near (<1 nm) the west-central coast of Kauai as the aircraft transited to the *O'Kane*'s location (Figure 3, Table 5). The aircraft initially flew over the group at an altitude of ~800 ft when the dolphins were first seen during "search mode" (see Table 1). The aircraft then turned and began circling the dolphins, gradually increasing altitude to ~1200 ft and radial distance to ~0.5 nm over the next few minutes. The group was engaged in surface-active milling behavior throughout the encounter, with some individuals intermittently displaying spins and leaps. The overall movement of the group was to the northwest along the Kauai shoreline. Video was taken by the front right observer.

The second focal follow was a group of ~25 spinner dolphins seen at 14:30 approximately 2 nm off the central-west coast of Kauai as the aircraft transited at 800 ft altitude back to Lihue to refuel after leaving the *O'Kane*'s location (Figure 3, Table 5). The aircraft turned, increase its altitude to ~1200 ft, and began circling the dolphins at a radial distance of ~0.3 nm, gradually increasing its altitude to ~1500 ft over the next few minutes. Throughout the observations, the dolphins were engaged in fast travel to the north (toward the coastline) in close formation with <0.5 body length between individuals. Video tape was taken although Bf 4 and heavy glare made it difficult to track the dolphins. The aircraft departed after ~10 min in order to refuel.

No "harassment" due to the civilian observation aircraft as defined under the MMPA and/or ESA occurred during the survey based on observations made by the experienced observers aboard this aircraft. No obvious changes in headings or behavior states were observed among the two spinner dolphin groups during the short time durations that they were circled by the civilian observer aircraft.

Communications

Part of the survey goal was to assess the best method and means of communicating information between biological observers aboard the *O'Kane* and research aircraft observers. In previous surveys devoid of Navy platform involvement, cell phone calls and/or text messaging was determined to be the most reliable form of communication if within cell tower range, up to ~5 nm or more offshore in some instances (e.g., see Smultea 2008). However, for National security reasons, Navy platforms did not allow cell phone use at anytime when underway. Hence, cell phone use between Navy biologists on the *O'Kane* and civilian biologists aboard the observer aircraft was not an option during this survey. Prior to taking off and after landing, however, cell phones were used to communicate information between land-based Navy personnel and aircraft observers while they were still on Kauai. While at sea, however, cell phones aboard the civilian observer aircraft did not work reliably while in the air as it was difficult to hear and the *O'Kane* was far offshore during most of the survey where there was no cell phone service.

The most convenient and reliable means of communications between the *O'Kane* and aircraft observers *in situ* was usually satellite phone, although connection errors were often experienced (see *Sightings* sub-section above). In addition, communications between the observer aircraft pilot and the NTR aboard the *O'Kane* were sometimes facilitated through radio communications with PMRF. However, the marine VHF radio used by the NTR aboard the *O'Kane* and the aircraft UHF radios could not be used to directly communicate given the differences in maritime versus aviation radio frequency sensitivities. In addition, the *O'Kane* was short one radio communication device as it was in need of repair, and they did not have frequencies available for use on either side of the narrow band that the civilian aircraft had available.

Table 5. Summary of marine mammal and sea turtle sightings seen from the observer aircraft by species and date.

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

Section 4 Discussion

The following discussion begins with a general assessment of the feasibility and success of the implemented approach for aerial monitoring of MM/ST in front of the *O'Kane*. This is followed by a general review of past data from the survey area to provide a relative context for the contribution of this and future monitoring surveys in the HRC. Recommendations for future similar aerial monitoring programs are discussed in the subsequent Section 5.

Feasibility of Approach

The primary goal of our aerial monitoring survey was to assess the feasibility of searching for and conducting focal follows of MM/ST from a small civilian aircraft while accompanying a Navy destroyer actively engaged in training involving intermittent transmissions of MFAS. Survey results successfully demonstrated that the destroyer could be accompanied by the aircraft while it flew elliptical-shaped patterns ~200-2500 yd in front of the vessel. Although no MM/ST were seen by aircraft observers near the *O'Kane*, two opportunistic focal follows of spinner dolphins including videotaping of behaviors were successfully conducted in lee-protected waters away from the *O'Kane*. Results indicate that these are feasible methods that can be used to monitor cetaceans near an active Navy vessel.

Another survey goal was to assess the feasibility of seeing and tracking cetaceans below the water surface from the civilian aircraft. Although no whales were seen by the aircraft observers, they successfully sighted, tracked and obtained video of the dolphins described above as well as a whale shark as it swam >30 ft below the surface in Bf 6 sea conditions. In addition, submarines were observed from the aircraft several times and tracked for a few minutes while they were ~60 ft below the water surface. Also, in Bf 5 conditions, a large flattened cardboard box (~5 ft X 5 ft) was tracked and videotaped as it floated ~1 yd below the water surface. The latter non-cetacean trackings were done to opportunistically assess the feasibility of tracking a large cetacean underwater at various depths. These efforts demonstrated that small to large marine species could be tracked underwater in the clear tropical water conditions in the *O'Kane*'s vicinity, including in Bf 6 conditions. However, under poor Bf conditions, the ability to continuously track objects was compromised by the rough sea-surface conditions.

One limitation of the usefulness of the implemented approach specifically for waters offshore of Kauai/Niihau (and other similar regions) is that the predominant Bf 5-6+ sea conditions severely limited the ability of aircraft observers to sight MM/ST; this was expected based on previous studies and documented typical sea conditions in this region (e.g., Buckland et al. 2001, Barlow 2006, see review in Smultea 2008).

Another serious limitation of this approach with respect to Navy monitoring is the potential for airspace conflict with naval aircraft operations. At least for the SCC OPS 08 training event, windows within which the observer aircraft could fly without potential airspace conflict were limited to relatively short periods and could be interrupted on short notice. However, effective communications between the aircraft pilot and the PMRF 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. This was particularly useful on two days when the *O'Kane* left the range for drills and unit level training. This allowed the aircraft to accompany the *O'Kane* for many more hours than originally anticipated prior to the actual training event.

In general, the approach described herein is optimally suited to conditions where predominant expected sea states are <5-6 and where MM/ST densities are scientifically documented to be higher. Further recommendations are summarized in Section 5 *Recommendations*.

Past Cetacean Studies Near Kauai and Niihau

Few intensive systematic data are available on cetaceans in the Kauai-Niihau project area, particularly during summer. A review of these data was provided in the final field report summarizing the results of vessel-based monitoring of MM/ST in conjunction with Navy RIMPAC July 2008 exercises near Kauai and Niihau (Smultea 2008). The latter survey was concentrated in the waters between Kauai and Niihau primarily within the Kaualakahi Channel, although there was some overlap with the survey reported herein in waters northwest of Kauai. In general, available data suggest that relatively few cetaceans, mostly odontocetes, occur in the offshore windward waters of Kauai and Niihau throughout the year (e.g., Mobley 2004, 2008a,b; Mobley et al. 2000; Barlow 2006; reviewed in Smultea 2008). As noted by Barlow (2006): "The overall density of cetaceans in Hawaiian waters is lower than in most areas that have been previously surveyed" (p. 454). Barlow attributed this low density to the relative low productivity of subtropical waters. Additionally the poor sighting conditions described here likely contributed to lower-than-average sighting rates of target species.

Of most relevance to the SCC OPS 08 survey is that few if any MM/ST were anticipated to be observed in the deep offshore waters where the *O'Kane* occurred, even without the presence of the *O'Kane*. This was based on effort during a small number of previous aerial and vessel surveys conducted during summer in these waters as well as the anticipated high wind and rough sea conditions in this region (Smultea 2008). The predominant, strong NE summer tradewind and wave conditions with Bf >4-5+ typically preclude effective visual observations in the northern offshore waters of Kauai and Niihau and sighting rates/densities there are generally low (e.g., Au et al. 2000; Mobley et al. 2000; Norris et al. 2005; Mobley 2005, 2007; Barlow 2006; Baird et al. 2008c). Such conditions reduce sighting effectiveness (e.g., Barlow et al. 2001; Buckland et al. 2001; Barlow and Gisiner 2006). Thus, even if the aircraft had not been accompanying the *O'Kane*, given the predominantly high Bf conditions experienced, few if any sightings were expected in the offshore survey waters. However, observers aboard the *O'Kane* briefly sighted one group of pilot whales off the bow during Bf 6 while the aircraft circled nearby. In addition, the aircraft observers sighted a whale shark while circling near the *O'Kane* in a Bf 6.

Mobley (2004) reported a summer/fall (July-November) sighting rate of 0.006 sightings/km (0.011 sightings/nm) in 2002 in the BARSTUR and BSURE Navy ranges where the August 2008 SCC OPS survey occurred; this figure was based on 2815 km (1520 nm) of systematic aerial survey effort during 10 surveys and a total of nine odontocete sightings. However, our data cannot be directly compared because ~67% of all our survey effort was spent circling the small area in front of the *O'Kane* as opposed to the systematic line-transect effort conducted by Mobley (2004).

Summary and Relevance of Survey Results

This study contributes the following information relevant to the goals identified in the SOW and the Navy's Marine Species Monitoring Plans for the Hawaiian Islands and Southern California (Navy 2008, 2009).

- It is feasible to fly an elliptical-shaped search pattern in front of a non-systematically traveling Navy destroyer when there are no potential naval airspace conflicts.
- Focal follows of delphinids including videotaping can successfully be conducted from a circling aircraft similar to previous studies of dolphins (e.g., Smultea and Würsig 1991), bowhead whales (e.g., Richardson et al. 1985a,b, 1986, 1990, Würsig et al. 1985, 1989), and humpback whales (e.g., Smultea et al. 1995).
- Focal follows should be conducted at altitudes of at least ~1200-1500 ft and radial distances of at least ~0.5 nm to avoid and minimize the potential for focal animals to react to the aircraft. This is based on results of the limited available studies of a few cetacean species (mostly whales) as well as preliminary observations during this study. We recommend that the latter protocol be followed

unless it can be statistically demonstrated that particular species do not exhibit detectable reactions to the aircraft at closer distances.

- It is not possible to assess whether the lack of sightings by aircraft observers while with the *O'Kane* in offshore deep waters was associated with the *O'Kane*'s presence and/or activities. Available studies indicate that baseline density in this region is very low. Furthermore, sighting conditions were predominantly poor. These factors suggest that aircraft observers were unlikely to sight MM/ST near the *O'Kane* whether or not the *O'Kane* was present.
- In general, the predominant environmental conditions and estimated MM/ST densities in the project area are not conducive to effective monitoring for these species.
- The sample size (*n* = two dolphin groups) collected during this study is too small to allow meaningful quantification and interpretation of potential baseline behavior of spinner dolphins as observed from a circling aircraft. However, some general observations follow.
    - As expected, sightings of MM (*n* = 2) and ST (*n* = 18) from the aircraft were higher with Bf <4 in lees close to the Kauai and Oahu coast than in deep, offshore waters where Bf was >4 (*n* = 0).
    - Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for future planned Navy activities identified for the HRC and the SOCAL Range Complex in the Navy's associated monitoring plans (Navy 2008, 2009).
- This survey helped to identify both limitations of and recommendations for future SCC OPS and other monitoring-related efforts as discussed in the following section.

Section 5 Recommendations

As requested in the SOW, this section provides recommendations for future monitoring efforts relative to what was learned during this survey. Recommendations focus on experiences during this survey and those from recent similar past monitoring surveys in the HRC (e.g., Norris et al. 2005; Mobley 2008a,b; Smultea et al. 2007, 2008), as well as other relevant professional experience. The recommendations are briefly summarized below.

- Continue to assess the feasibility of the approach described herein to conduct focal follows while accompanying a Navy vessel that intermittently transmits MFAS. Where SCC OPS or other similar training events or exercises occur, this approach would be most useful in areas where expected baseline densities of MM/ST are higher, where the expected predominant observation conditions are better (i.e., Bf <5), and where potential naval airspace conflicts are minimal. In Hawaii, this could be during the winter humpback season in areas near the 100-fathom isobath.

- Apply this approach to facilitate collection of multiple before-during-after (i.e., A-B-A) exposure conditions ideally from the same group for at least 10 different groups for at least 30-60 min each (e.g., see Mobley et al. 1988; Smultea et al. 1995). This study approach allows for pair-wise comparisons to control for inter-group/individual variability, which in turn typically requires a much smaller sample size and provides greater statistical power to determine significance (e.g., Zar 1984; Mobley et al. 1988; Maybaum 1990, 1993; Frankel and Herman 1993; Smultea et al. 1995).

- Conduct pre- and post-exercise aerial surveys in the area to address potential presence/absence and distribution/redistribution effects relative to the MFAS exercise activities. The post-exercise/event survey could also serve to identify any potential stressed, injured, or dead floating MM/ST. Post-exercise surveys including island coastlines were implemented during several USWEX and RIMPAC training events in Hawaii (Mobley 2008a,b) with no detections of injured or stranded animals. Additionally, during aerial monitoring surveys conducted by MMRC in November 2008 within several days after the cessation of the 2008 JTFEX and COMPTUEX Navy exercises off southern California, trained aerial observers twice spotted a dead pinniped and a dead blue whale (the latter >10 nm away) floating at the water surface (Smultea and Mobley in prep.). The latter two sightings were reported by the Navy to the National Marine Fisheries Service.

- Conduct a-priori power analyses of available baseline behavioral data from species of concern to determine the sample size required to identify a statistically significant change in behavioral parameters proposed to be monitored relative to potential effects of Navy activities (e.g., MFAS). For example, there are considerable existing baseline behavior data available for humpbacks and a few other cetacean species from which these analyses could be run. It is prudent to conduct power analyses prior to committing to the resources required to conduct monitoring to determine whether the monitoring goals can be addressed given the limited resources (e.g., plane or vessel time, etc.).

- Continue feasibility studies using recently developed software (e.g., Noldus or BioObserver for the iPhone) to collect focal follow behavioral data as narrated in the field as well as to analyze behavioral data collected on videotape. These types of programs allow efficient, accurate, and standardized transcription of behaviors including while observing video tapes post-field collection. The program should also be capable of conducting desired statistical tests and descriptions, including power analyses, tests of significance, etc.

- Continue to collect video of the behavior of animals during focal follows. We successfully collected video footage of two groups of spinner dolphins that contributes to baseline focal follow data for this species as observed from a small fixed-wing Partenavia aircraft in the HRC. These data may be useful for comparison with future monitoring assessments. Detailed transcription of video-taped behavior provides a more-detailed database on the behavior of delphinids in this area for which there are very few previous data. The greater detail and accuracy facilitated by recording behavior to videotape may reveal subtle changes in behavior that are not evident during *in situ* observations and from associated field notes, as found in studies of other cetaceans relative to anthropogenic activities (e.g., Malme et al. 1983, 1984; reviewed in Richardson et al. 1995). Videotape also reduces the potential for observer error during field behavioral observations, as taped sessions can be reviewed repeatedly. Examination of videotape also allows for more accurate measure and quantification of some behavioral variables that can be indicative of stress, including inter-individual body lengths and respiration rates; the former variable can be measured relatively from the video tape using calipers (Smultea and Würsig 1995).

- Design and conduct studies to assess potential effects of the observer aircraft on focal follow species. Based on limited studies of some cetacean species, flying a small aircraft at altitudes of 1200-1500 ft and radial distances of 500-1500 yd is highly unlikely to affect behavior of observed animals in a statistically detectable way (e.g., see Richardson et al. 1985a,b, 1986, 1990, 1995; Würsig et al. 1985, 1989; Smultea and Würsig 1991; Patenaude et al. 2002). At these parameters, the aircraft is calculated to be well outside the theoretical air-through-water transmission cone (i.e., "Snell's Cone") of sound from an over-flying aircraft (Urick 1972; reviewed in Richardson et al. 1995). However, it is prudent and strongly suggested that studies be conducted to assess the potential effects of the specific Partenavia observer aircraft on species of concern and other species in the HRC. This would serve to validate/evaluate the aforementioned assumptions, particularly since they are mostly based on bowhead whales in cold temperate and polar waters. Assessing potential effects of the circling observer aircraft could be done a number of ways.
    - The aircraft could begin circling at a large radial distance (e.g., 2-3 nm) and at a select altitude, gradually closing in on the focal group until a reaction is observed and/or until the aircraft is directly overhead. This could be repeated at different altitudes and for different species, etc.
    - The ideal non-intrusive approach would be to track animals from land using a theodolite before, during and after an aircraft circled overhead (e.g., see Smultea et al. 1995). This approach uses the A-B-A study method and thus typically requires a relatively small sample size to detect a statistically significant effect and/or sufficient statistical power to conclude no effect.
    - Controlled overflights of an underwater hydrophone such as a sonobuoy (at various pre-selected water depths) should be conducted at pre-selected altitudes and radial distances as well as various flight patterns (e.g., straight-line passbys and circling) and during different Bf sea states to record associated underwater sounds, as all these factors influence received sound levels. This will allow measurement of received underwater sound levels of the aircraft at various frequencies and distances relative to the known frequencies used by marine mammals of concern. These data can then be used to estimate received levels of underwater aircraft sounds near marine mammal sightings. Similar studies have been conducted in the Arctic relative to bowhead whales though with very different aircraft (e.g., a Twin Otter and a Bell 212 helicopter) and in very different water conditions and temperatures, which affect the transmission of underwater sounds (e.g., reviewed in Urick 1972; Richardson et al. 1995).
- Conduct a literature review and short summary paper of parameters successfully used to identify and quantify significant behavioral and stress reactions in MM/ST in response to stimuli. Considerable literature is available on the reactions of MM/ST to various anthropogenic stimuli such as underwater sounds, predators, etc. Quantifying behavioral data and collecting sufficient such data to measure significant changes in various behavioral parameters (e.g., respiration and dive patterns,

inter-individual spacing, orientation, etc.) is challenging. Selecting and using parameters that have been shown in past studies to be indicative of stress and/or that result in what could be considered MMPA/ESA level B take is critical to solid protocol development. Given the size of the related literature database available, a thorough up-to-date review of this literature is important to support the choice of behavioral parameters used to study and quantify potential effects of Navy activities on MM/ST.

- Review Data on Navy Activities and Strandings. Compilations and analyses of data on marine mammal strandings in Hawaii and other Navy ranges are limited (e.g., Mazzuca et al. 1998, 1999; Maldini et al. 2003; Ligon et al. 2007; Mobley 2007). There are even fewer available reports comparing locations and the nature of Navy activities concurrent to strandings in the Pacific (e.g., NOAA and Secretary of the Navy 2001; NMFS 2005; Southall et al. 2006). Given the elevated public, regulatory, and conservation concerns regarding this issue surrounding many stranding events, it is prudent to examine historical data to better understand the evidence or lack thereof for correlating strandings with Navy activities. It is known that many cetaceans strand due to natural causes (e.g., Perrin and Geraci 2002; Geraci and Lounsbury 2005), while other publications show a correlation with military actions at sea (e.g., Balcomb and Claridge 2001; Brownell et al. 2004; Fernández et al. 2005).

- Conduct a cost-effectiveness and safety analysis of monitoring approaches. This type of analysis would objectively evaluate, quantify, and qualify the cost-effectiveness, contribution value of results, and observer safety of various monitoring techniques to address the Navy's monitoring objectives/questions related to training events. For example, the utility vs. cost as well as complimentary value of photo-ID vs. various tagging techniques vs. vessel surveys vs. aerial surveys vs. acoustic monitoring, etc., could be evaluated. This would help to assess which approaches and in what combination would be most cost-effective but could also feasibly and reasonably address Navy monitoring goals. This analysis should include assessing the resulting expected sample sizes and significance of contributing results obtained.

Section 6 Acknowledgements

We are grateful to Navy NTR Lori Mazzuca for her support, coordination, and facilitation in the implementation of this project. Many thanks to the hard-working, dedicated and good-natured field observers and technical assistants Mark Deakos, Alexis Rudd, and Andrew Titmus. Mahalo to John Weiser for his superb piloting skills. Thanks also to Stasia Buffenbarger for the cover-page graphics, Stu Smith for GIS assistance and mapping, Jenelle Black for document formatting, and Suzanne Garrett and Cynthia Anderson for data entry and logistics assistance.

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APPENDIX B HRC SUBMARINE COMMANDER'S COURSE AERIAL MONITORING FEBRUARY 2009

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Aerial Survey Monitoring for Marine Mammals and Sea Turtles in the Hawaii Range Complex in Conjunction with a Navy Training Event

SCC OPS February 15 – 19, 2009

Final Field Report

Submitted to:
NAVFAC Pacific
EV2 Environmental Planning
258 Makalapa Dr., Ste 100
Pearl Harbor, HI 96860

Submitted by:
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Cover Photo: Humpback whales (*Megaptera novaeangliae*) photographed with a telephoto lens from the aircraft during an aerial monitoring survey in Hawaii. Photograph by J. Mobley taken under NOAA Permit No. 642-1536-03 issued to Joseph R. Mobley, Jr. Graphic: K. Lomac-MacNair.

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Section 1 Introduction

Aerial surveys to monitor for marine mammals and sea turtles (MM/ST) were conducted in conjunction with the February 2009 US Navy Submarine Commander's Course (SCC OPS) in the Hawaii Range Complex (HRC) on the Pacific Missile Range Facility instrumented range off Kauai and Niihau, Hawaii (Figure 1). Surveys occurred on five consecutive days from 15-19 February 2009 near the *USS Russell* involved with the event typically ~100 km (50 nm) west or northwest of Kauai. The survey methodology and sampling design were submitted and approved in advance, per the Statement of Work (SOW), to the NTR and followed previously established protocol implemented for monitoring of a SCC OPS off Kauai in August 2008 (Smultea and Mobley 2009).

Prior to the event the co-Principal Investigator (JM) and pilot (JW), along with Navy biologists, participated in a briefing to the *USS Russell* Commanding Officer as well as the pre-planning conference at Pearl Harbor, Honolulu, Oahu, Hawaii, to coordinate survey efforts with the SCC OPS February 09 training event.

Per the SOW, the goal of the aerial survey was to monitor and report the presence/absence, distribution/redistribution, reaction/no reaction, injury, and/or mortality of MM/ST during the SCC. This involved monitoring and reporting, in as detailed fashion as possible, the surface behavior of MM/ST. In particular, we were to monitor for any changes in the near-surface behavior, orientation, occurrence, and location of animals relative to the *Russell*'s activities using a systematic search and focal follow method. This included monitoring for any potentially dead, injured, distressed and/or unusually behaving animals.

As indicated in the SOW, it was recognized *a priori* that post-survey analyses were not expected to be completed under this task as sample size was expected to be limited in offshore survey waters based on previous regional survey data (e.g., Mobley et al. 2000, Barlow 2006, Smultea and Mobley 2009; also see review in Smultea 2008). Rather, survey data collected during this monitoring effort were to be compiled with previous (e.g., Smultea and Mobley 2009) and subsequent data, and interpreted over time by the Navy to facilitate increased sample size and thus data validity and relevance.

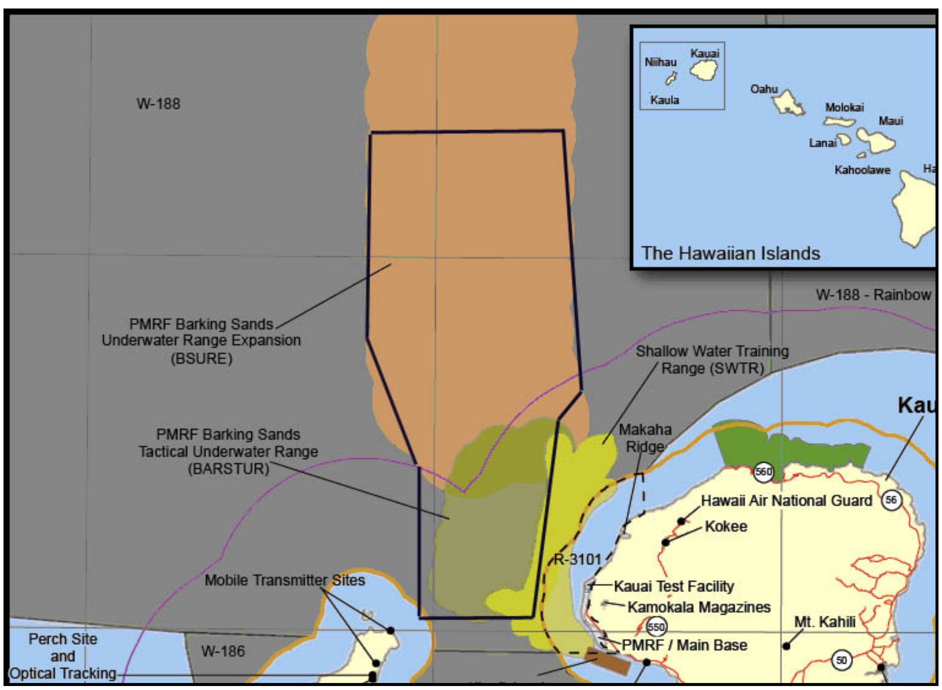

Figure 1. Location of the aerial survey monitoring area in and near the US Navy Pacific Missile Range Facility (PMRF) Range west and northwest of Kauai, Hawaii.

Section 2 Methods

Monitoring effort followed protocol first implemented in August 2009 for another SCC OPS (see Smultea and Mobley 2009 for details). The approach again involved flying elliptical-shaped patterns in advance of the Navy vessel (i.e., the *Russell*) that extended from the front of the ship (~200 yards [yd]) out to ~2500 yd) over a width of ~4 km (2 nm). When range and/or safety conditions precluded accompanying the *Russell*, focal follows were conducted opportunistically when target species were sighted off range.

Surveys were again conducted with a small fixed-wing Partenavia P68 Observer flying at 100 knots (kt) groundspeed and an altitude of ~800 ft (244 m), as stipulated under the terms of NOAA permit no. 642-1536 issued to the co-Principal Investigator (JM), unless the pilot was directed to fly at alternate altitudes by flight controllers for safety reasons. Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal biologists, at least two with >10 years of related experience. One biologist was the data recorder/video camera operator and the other two were observers. Observers were not informed of the times and types of underwater transmissions during Navy activities, or the course of the *Russell*. Observers maintained contact with Navy biologists who monitored MM/ST from aboard the *Russell*.

During the first August 20089 SCC OPS aerial monitoring, sighting and behavioral data were handwritten on custom-made forms (see Smultea and Mobley 2009). However, during the Feb 2009 SCC OPS aerial monitoring, data-collection software (Handbase 4.0) was used on a Palm Pilot TX to collect basic sighting and environmental data (this same set-up was used during aerial monitoring surveys for the Navy off southern California in Oct-Nov 2008—see Smultea et al. 2009). SpectatorGo, a behavioral data collection program developed by Biobserve, was used for interval sampling of behavior. This program was later modified to work on the iPhone so that both GPS and altitude data could be incorporated with every data entry. An MMRC/SES team member (M. Deakos) worked closely with the developers to improve the software to match the project's needs. By customizing the program's configuration, behavioral states and events could be collected much more efficiently and accurately using the iPhone's touch screen.

Section 3 Results

Effort

The survey aircraft was able to accompany the *Russell* during 13.9 hours (hr) (51%) of the total 27.3 hr of flight time (Table 1). The remaining 13.4 hr (49%) while not with the *Russell* involved primarily transit time to and from the offshore location of the vessel (see Figures 2-6). In comparison, during similar MM/ST monitoring during the August 2009 SCC OPS off Kauai, the survey aircraft accompanied the Navy's USS *O'Kane* during 19.0 (67%) of the 28.5 hr of flight time.

Table 1. Summary of survey times by date and periods when the observer aircraft was accompanying and not accompanying the *Russell*.

Date 2009	Flight Periods (Wheels Up-Down)	Total Flight Time	Period not with *Russell*	Total hr	Beaufort Sea State	Period with *Russell*	Total hr	Bf Sea State	No. Sightings Near *Russell* (# indiv)	No. Sightings Away from *Russell* (# indiv)	Comments
15-Feb	16:00-16:30 17:26-18:16	1 h 20 min	17:26-18:16	1 h 20 min	NA NA	0	0		na	2 (7 HW)	Transit from Molokai Transit Honolulu to Lihue. *Russell* departed later during darkness.
16-Feb	7:45-11:44 13:00-16:42	7 h 41 min	7:45-8:24 10:36-11:44 13:00-13:28 16:07-16:42	2 h 51 min	6 6 6 6	8:25-10:35 13:29-16:06	4 h 50 min	6 6	1 (1 HW)	22 (1 ST & 39 HW)	1 HW focal follow for ~33 min, ~1.5-2 nm from *Russell* in Bf 5
17-Feb	08:00-08:50 10:10-11:00 11:35-16:09	6 h 24 min	11:35-12:13 15:01-16:09	3 h 38 min	6 6	12:14-15:00	2 h 46 min	6	0	11 (14 HW)	Gauge malfunction during check on runway; transit to/from Oahu for mechanical inspection. (resumed survey at 11:35)
18-Feb	07:50-11:47 13:07-15:48	6 h 38 min	07:50-08:21 11:21-11:47 13:07-13:43 14:17-15:48	3 h 7 min	5 5 3 3	8:22-11:20 13:44-14:16	3 h 31 min	6 3	0	20 (22 HW)	Conducted ~1 hr 15 min of HW focal observations in lee near Kekaha after persistent rain and low clouds precluded continued observations near *Russell*.
19-Feb	8:34-12:04 13:49-14:52 (*16:09-16:53 transit no observing Bf 7*)*	5 h 17 min (incl. transit)	8:34-8:57 11:41-12:04 13:49-14:14 14:21-14:52	2 h 30 min	6 6 6	08:58-11:40 14:15-14:20	2 h 47 min	6 6	8 (14 HW & 1 Unid. Dolph.)	4 (5)	Exercise unexpectedly ends at 08:00 (had been noon) & *Russell* headed to Kaualakahi Channel then S to refuel offshore. Conducted ~2 hr 21 min HW focal follows near *Russell*, some simultaneous to *Russell* observers. Attempted 2nd p.m. flight to *Russell* but Bf 7 & increasing distance (>40 nm) precluded observations. No observations during return transit to Oahu (Bf 7).*
			*(16:09-16:53)**		7						
TOTALS:		***27 h 20 min***		***13 h 26 min***			***13 h 54 min***		***9 (14 HW, 1 Unid. Dolph.)***	53 (92 HW/8 UW/1 ST	

Figure 2. Aerial survey tracks during visual observations February 15, 2009, and locations of marine mammal and sea turtle sightings. 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 *Russell* or conducting an opportunistic focal follow.

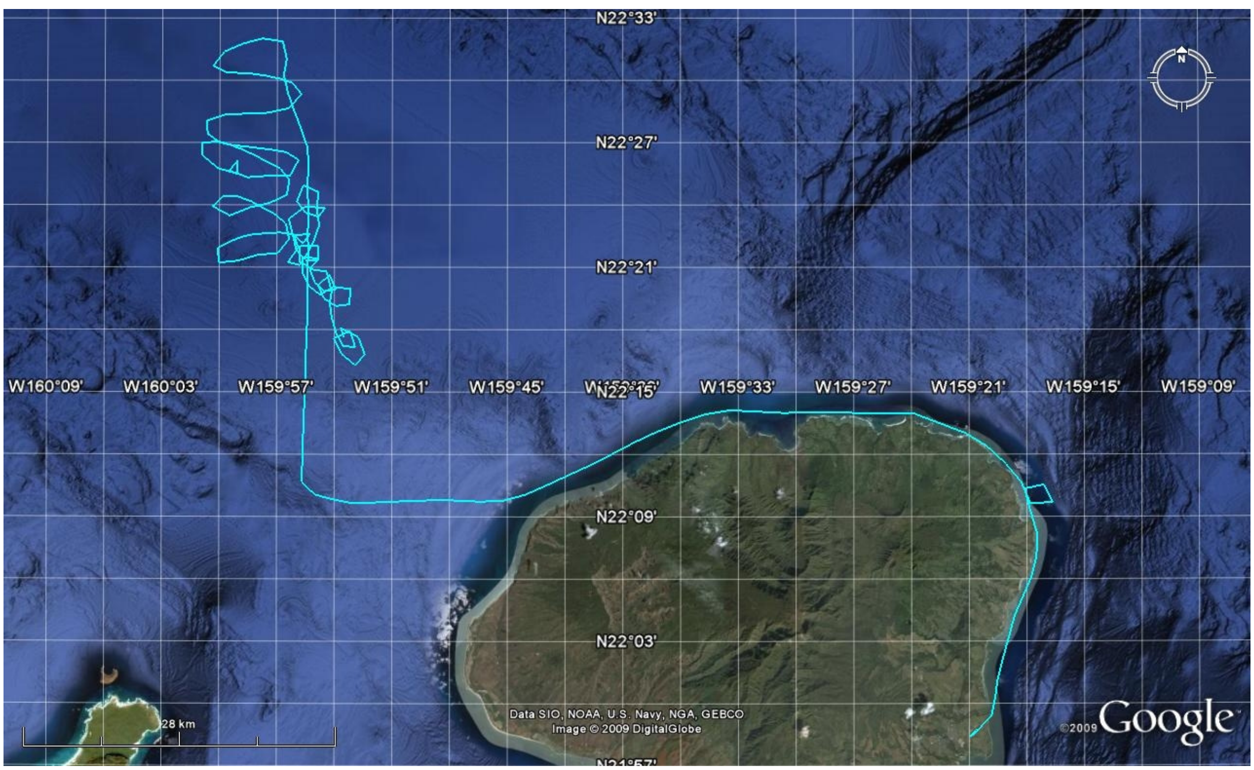

Figure 3. Aerial survey tracks during visual observations February 16, 2009, and locations of marine mammal and sea turtle sightings.

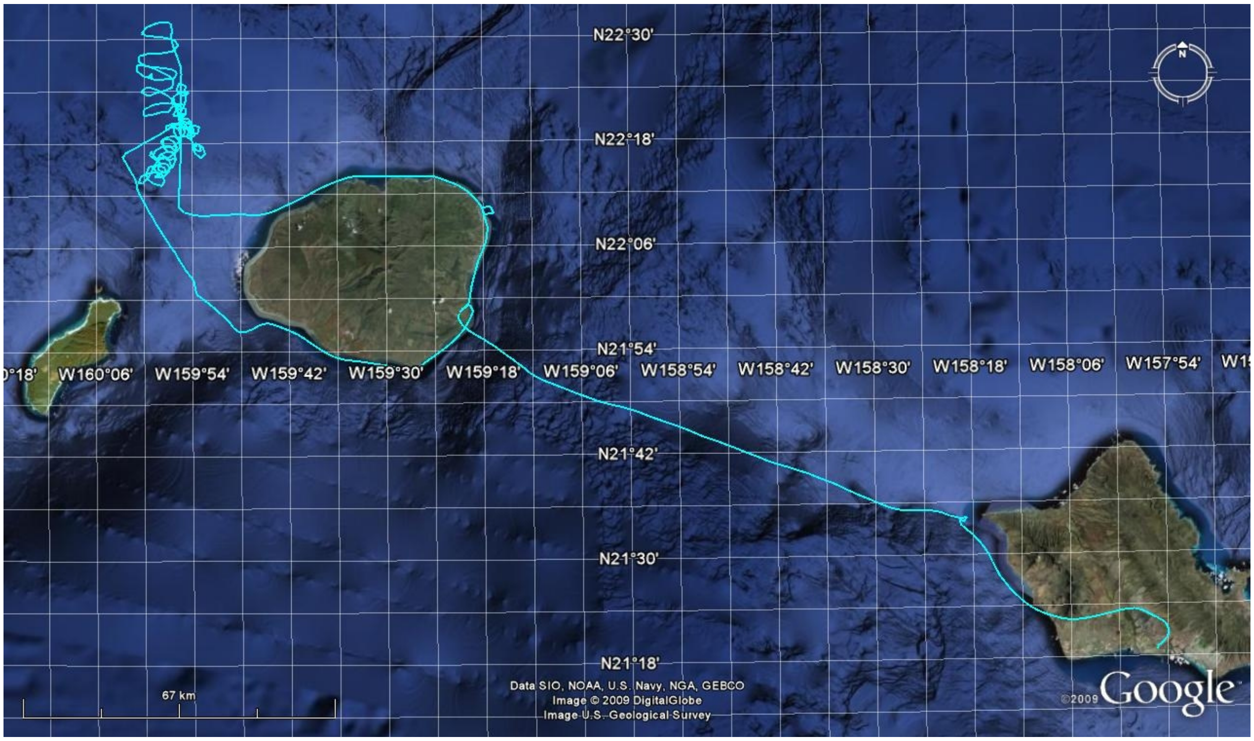

Figure 4. Aerial survey tracks during visual observations February 17, 2009, and locations of marine mammal and sea turtle sightings.

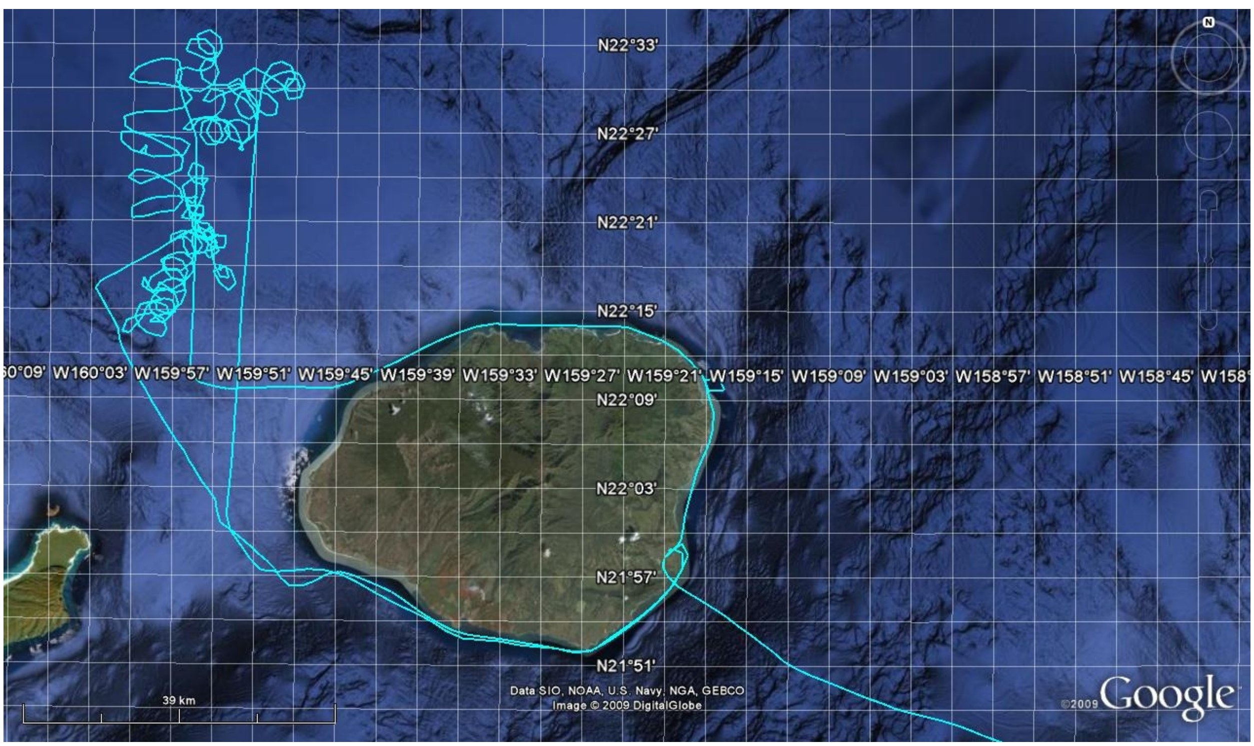

Figure 5. Aerial survey tracks during visual observations February 18, 2009, and locations of marine mammal and sea turtle sightings.

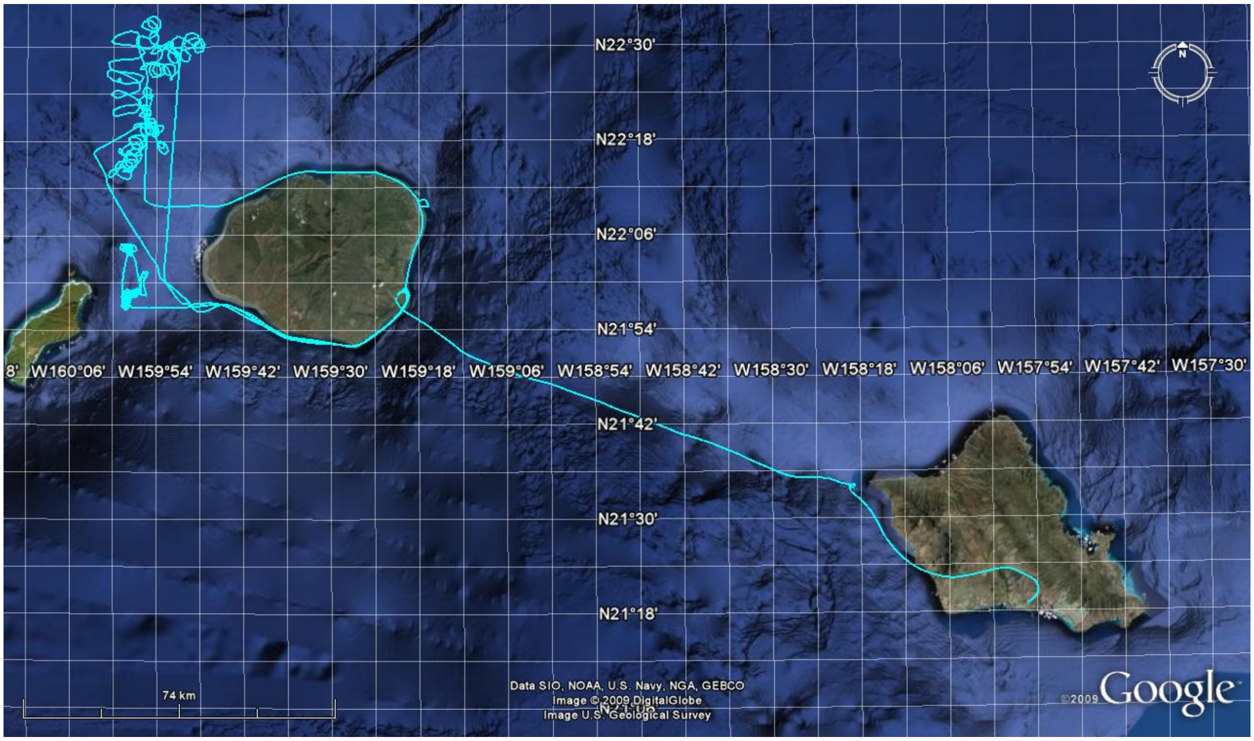

Figure 6. Aerial survey tracks during visual observations February 19, 2009, and locations of marine mammal and sea turtle sightings.

Effort with Respect to Beaufort Sea State

Similar to previous results (Smultea and Mobley 2009), observation conditions were predominantly poor near the *Russell* during the SCC in offshore Kauai waters (Bf >4 during 96% of 14.5 hr) (Figure 7). In comparison, during SCC OPS Aug 08 aerial monitoring, Beaufort was >4 during 80% of 19.0 hr of effort.

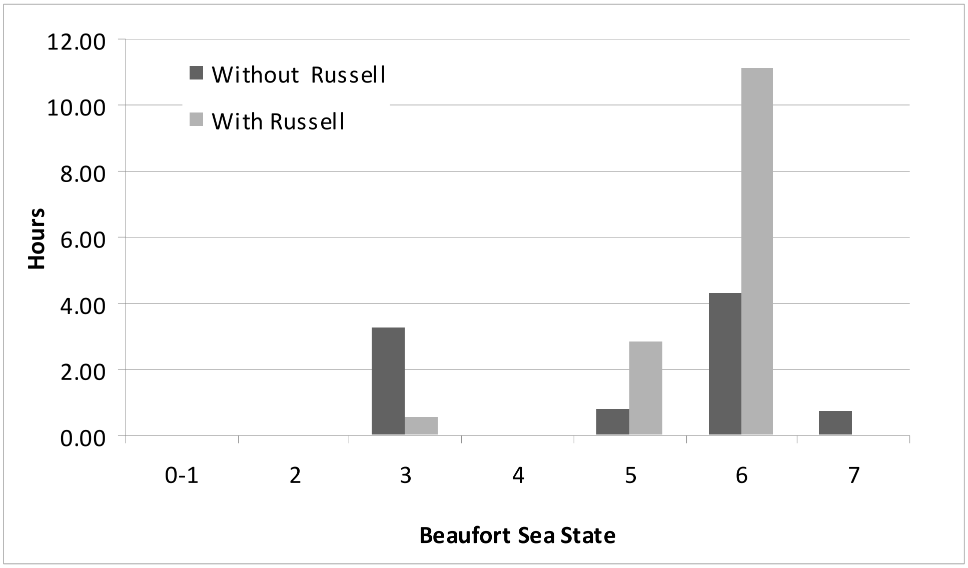

Figure 7. Beaufort sea state conditions during periods the observer aircraft was accompanying and not accompanying the *Russell*.

Sightings

A total of 63 sightings was 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 (Figures 2-6, Table 2, Appendix A). 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 SCC (Table 1); a focal follow was done on this whale (see *Focal Follows* below). An additional seven sightings were seen within view (~20-30 km) on the last survey day (Feb 19) after the training 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 (Figures 2-6 and Figure 8. Locations of sightings made during the 15-19 Feb 2009 SCC OPS aerial monitoring survey off Kauai, Hawaii. In addition, one probable bottlenose dolphin was seen with one of these humpback groups on Feb 19 (Appendix A).

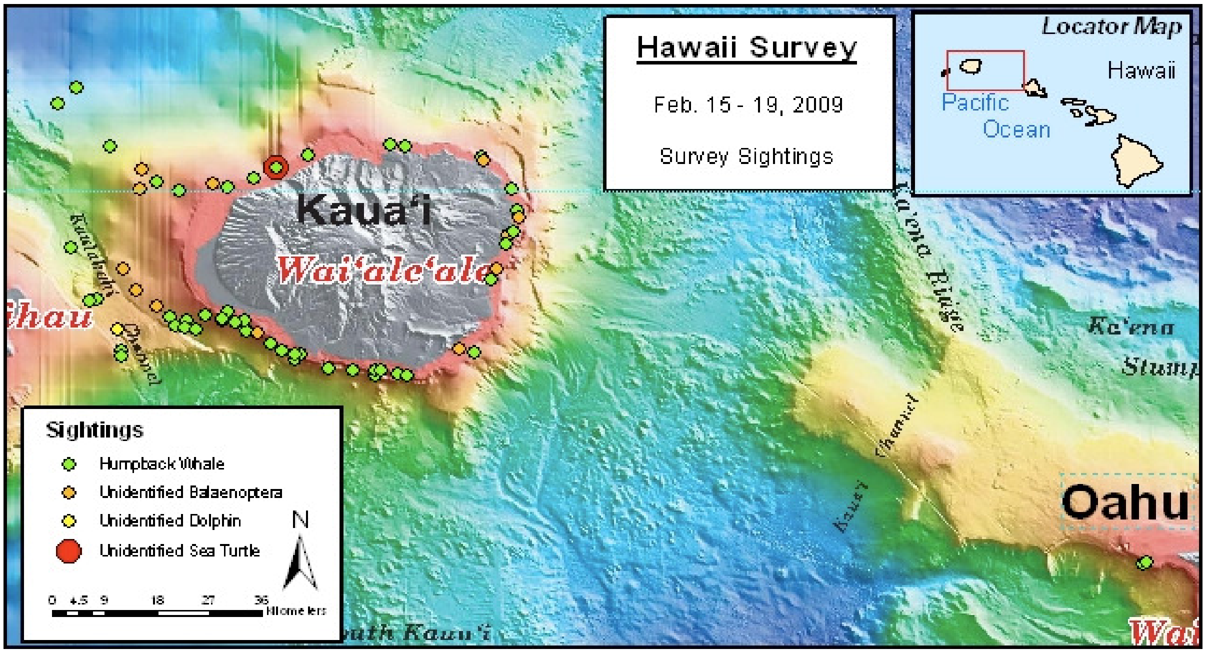

Figure 8. Locations of sightings made during the 15-19 Feb 2009 SCC OPS aerial monitoring survey off Kauai, Hawaii.

Of the total 63 sightings, most (53 groups or 84%) were humpback whales. The remaining sightings were 8 unidentified baleen whale groups, 1 probable bottlenose dolphin, and 1 unidentified sea turtle (Table 2). The unidentified baleen whales were likely humpback whales but the sightings were too far away to confirm species.

Table 2. Number of sightings by species and periods with and without the *Russell* in view (<20-30 km) during the February 2009 SCC OPS aerial survey monitoring. Only one of these sightings, a single humpback whale, was seen near (<2 km) the *Russell* while the aircraft circled in front of the *Russell* in deep offshore waters during the SCC training event from February 16-18, 2009.

	Within View (<20-30 km) of *Russell*		Away from *Russell* (i.e., Transit)		Total	
Species	**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**	**53**	**101**	**63**	**106**

Focal Follows

Only one focal behavioral follow was conducted while monitoring near the *Russell* during the training event period while MFAS may have been operating (Feb 16). After the SCC and the MFAS transmission period had ended on Feb 19, one focal follow was conducted near (<4 km) two Navy vessels (see below) (Table 2). The remaining 10 focal follows occurred during transits to and from the *Russell*'s location in protected lee areas near shore. Focal follows were conducted while circling at an altitude of ~1000-1500 ft and a lateral distance of ~1 km (summarized in Appendix B).

Focal sessions occurred on Feb 16 (n = 1), Feb 17 (n = 3), Feb 18 (n = 6), and Feb 19 (n = 5)(Appendix B). Session durations ranged from ~1 min (i.e., when a group affiliated with another group) to ~2+ hr (Feb 19), though most were <3-10 min long in duration. At least brief (a few min) digital video recordings were made on 13 of the 15 focal groups (Appendix B). The video camera did not have whales in continuous view because the animals dove, glare interfered with filming, observers lost track of the animals in high Bf, etc. 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 individual 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.

On 18 Feb we conducted "practice" focal follows on six humpback whale groups in the lee off the western side of Kauai to ascertain whether the newly developed behavioral software program adapted for the iPhone (BioSpectator Go) was useful and suited to our focal follow goals. One group was a humpback mother-calf pair. Other groups included several individuals or pairs that affiliated to form a surface-active, social competitive group of ~5 humpbacks. A small vessel passed near some of these whales (Appendix B).

Post-SCC, on Feb 19, while the *Russell* was in transit from the SCC area,six focal sessions were conducted in the Kaulakahi Channel between Kauai and Niihau. The *Russell* and/or other similarly large 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 (Table 2). 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 (Appendix B). It was later learned from Navy biologists aboard the *Russell* that MFAS was not being transmitted at this time. 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).

Communications

The most convenient and reliable means of direct communications between the *Russell* and aircraft observers *in situ* was usually satellite phone, or a VHF radio, although connection errors were often experienced. In addition, communications between the observer aircraft pilot and the Navy biologists aboard the *Russell* were sometimes facilitated through radio communications with PMRF. Daily locations of the *Russell* and thus daily survey locations were usually communicated via cell phone from Navy POCs to the co-PI (JM) before the observer aircraft left the Lihue airport and/or once in the air via the PMRF flight tower. Daily communications with Navy biologists aboard the *Russell* and the NTR were also conducted via cell phone before and/or after each daily flight while on land to communicate any changes in schedules and training, etc.

Section 4 Discussion

It is not possible herein to assess the effects or lack thereof of the Feb 2009 SCC OPS on MM/ST as observed during this aerial survey monitoring effort, as recognized in the SOW. Thus, this section is meant to summarize key relevant results and limitations, and provide a "lessons learned" review of the monitoring effort. Per the SOW, the data obtained in this study are meant to contribute to a growing baseline of information on the distribution, occurrence, and behavior of MM/ST near Navy training events in the HRC per the HRC marine species monitoring plan (DoN 2008). Key relevant results are summarized below.

Relevance of Key Results

Overall, the Feb 2009 SCC OPS aerial monitoring survey effort demonstrated the successful implementation and utility of a number of key issues as summarized below.

Logistics and Planning

Search and behavioral observations of MM/ST from a civilian observer aircraft were conducted safely and successfully for the second time (e.g., see Smultea and Mobley 2009 re Aug 2008 SCC OPS monitoring) with minimal interference with at-sea naval training involving multiple large vessels and aircraft (both fixed-wing and helicopters). On some occasions, up to three aircraft were observed from the observation aircraft at one time. Key to this ability was attending pre-planning meetings and maintaining pre- and during-survey communications with Navy biologists aboard the *Russell*, the NTR and other Navy POCs. This included the project PIs and pilot attending a pre-planning meeting with CPF biologist and operational staff, P-3 pilots, and PMRF range control in Honolulu and speaking with them in person about logistical details including obtaining contact numbers and radio communication frequencies. It is recognized that Navy personnel must coordinate complicated logistics to assure smooth and safe observer aircraft operations near Navy surface vessels and aircraft to avoid interference with Navy training events and maintain safe operations.

Communications

Efficient and timely communications are key to safe and successful surveys. Given the complexity and rapidly changing nature of the project logistics (e.g., *Russell* and other SCC location and activities, etc.) it is critical to have a consistent Navy POC (e.g., the NTR) available on a daily basis to ensure smooth communications and logistics. Use of an aircraft VHF radio by the Navy biological observers aboard the *Russell* to communicate with the aircraft observers *in situ* was also key to maintaining real-time communications regarding planning logistics, sighting locations, etc. Maintaining frequent communications with the PMRF flight tower and Navy POCs via cell phone each day was also integral. The observer aircraft pilot was also key in responding quickly and efficiently to Navy flight tower requests to change altitude, headings, etc., to avoid interfering with Navy training events, primarily in air space but also near operating vessels.

Protocol Approach Feasibility

Results indicate that these are feasible methods that can be used to monitor cetaceans near an active Navy vessel. Survey results successfully demonstrated for the second time (see Smultea and Mobley 2009) that a Navy destroyer could be accompanied by the civilian observer aircraft while it flew elliptical-shaped patterns ~200-2500 yd in front of the vessel. For the first time a sighting was made during and near the Navy destroyer (*Russell*) during the training period. In addition, eight humpback whale sightings and six focal behavioral follows were made within view of the *Russell* and other Navy surface vessels (during the *Russell*'s return transit through a shallower and thus more densely populated humpback area). Although the sample size was small, the survey protocol approach facilitated the collection of behavioral data, including video and detailed behavioral notes, *before*, *during* and *after* the *Russell*'s close passing of a group of focal humpback whales (on Feb 19). The latter periods are an important aspect and requirement of the Navy's HRC marine species monitoring plan (DoN 2008). Observing groups before, during and after exposure to a stimulus is the ideal observation protocol to minimize variability in data across subjects, thereby increasing the statistical value of the observations (reviewed in Smultea and Mobley 2009).

Tracking Cetaceans Below the Water Surface

Humpback whales were tracked and videotaped using focal follow protocol for extended periods of time below the water surface in the vicinity of the *Russell* and other Navy vessels during this survey (on Feb 16 and 19—see Appendix B). These efforts further demonstrate preliminary results of the August 2008 SCC OPS aerial monitoring that small to large marine species can be tracked underwater in the clear tropical water conditions of the HRC during amenable Bf conditions. However, under poor Bf conditions, the ability to continuously track objects is compromised by the rough sea-surface conditions.

Limitations

- One limitation of the usefulness of the implemented approach specifically for waters offshore of Kauai/Niihau (and other similar regions) is that the predominant Bf 5-6+ sea conditions severely limit the ability of aircraft observers to sight and consistently track MM/ST. This was expected based on previous studies and documented typical sea conditions in this region (e.g., Buckland et al. 2001, Barlow 2006, Smultea and Mobley 2009, see review in Smultea 2008).
- Another limitation of the HRC location for monitoring of the SCC OPS is the relatively low documented density of MM/ST sightings in the deep offshore waters characterizing the main training areas used for both the Feb 2009 and Aug 2008 SCC OPS. This severely limits the ability to collect statistically meaningful and valid sample sizes, even over a long period and multiple such monitoring efforts. However, if training events are conducted in or near shallower more coastal waters, particularly during the winter humpback residency, the ability to obtain larger sample sizes would be significantly increased as evidenced by the eight sightings and six focal sessions with humpbacks made within view of the *Russell* as it passed and stopped for a period between Kauai and Niihau in transit after the SCC.
- A serious limitation of this approach with respect to Navy monitoring is the potential for airspace conflict with naval aircraft operations. During both the Feb 2009 and the Aug 2008 SCC OPS monitoring, windows within which the observer aircraft could fly without potential airspace conflict were limited to relatively short periods and could be interrupted on short notice. However, early groundwork laid by CPF, protocol developed during the pre-sail meeting, and continued effective communications between the aircraft pilot, the *Russell*, the PMRF air tower (range control) and the P-3 pilots 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.

In general, the approach described herein is optimally suited to conditions where predominant expected sea states are <5-6 and where MM/ST densities are scientifically documented to be higher. Further recommendations are summarized below under *Recommendations*.

Section 5 Recommendations

Following are recommendations for future similar MM/ST aerial monitoring efforts during training events. See Smultea and Mobley (2009) for further details and recommendations specifically for SCC OPS monitoring in the HRC. Also see Smultea et al. (2009) for additional relevant recommendations based on results of aerial monitoring during Major Training Events (MTE) in the SOCAL based on aerial surveys conducted there in fall 2008 and summer 2009.

- It is not possible to assess whether the paucity of sightings by aircraft observers while with the *Russell* in offshore deep waters was associated with the *Russell*'s presence and/or activities. Available studies indicate that baseline density in this region is very low. Furthermore, sighting conditions were predominantly poor. These factors suggest that aircraft observers were unlikely to sight MM/ST near the *Russell* whether or not the *Russell* was present.

- In general, the predominant environmental conditions and estimated MM/ST densities in the deep offshore waters of the area are not conducive to effective monitoring for these species.

- It is highly recommended that this SCC OPS protocol approach be implemented in the Navy SOCAL operating area during a training event. Sighting rates and density of marine mammals are significantly higher throughout the year and the environmental conditions are significantly better for collecting pertinent data in the SOCAL vs. HRC. For example, the sighting rate was ~5-6 sightings per hour of aerial effort in the primary SOCAL range vs. <1 sighting per hour in the offshore waters of the primary HRC SCC OPS area used in 2008-2009. Furthermore, the Bf was >4 for >75% of the SCC OPS aerial monitoring during Aug 2008 and Feb 2009 vs. Bf <4 for >50% of the SOCAL fall 2008 and summer 2009 MTE aerial survey (see Smultea and Mobley 2009; Smultea et al. 2009).

- The sample size collected during this study is too small to allow statistically meaningful quantification and interpretation of potential baseline behavior or potential effects of Navy vessels and training, as anticipated in the SOW.

- More detailed analyses on baseline data and relative to the locations and activities of the *Russell* and other Navy vessels involved in the Feb 2009 SCC OPS are possible and recommended to further explore existing and future data. This includes calculation of respiration and dive rates, rates of surface-active behavioral events, orientation rates, dispersal distance between individuals within a group, spatial distribution and orientation of sightings relative to SCC locations and activities, etc. The utility, value, and integrity of the more detailed behavioral data to address the five main questions identified in the HRC marine monitoring plan should also be assessed (DoN 2008).

- Focal follows should be conducted at altitudes of at least ~1200-1500 ft and radial distances of at least ~1 km (0.5 nm) to avoid and minimize the potential for focal animals to react to the aircraft. This is based on results of the limited available studies of a few cetacean species (mostly whales) as well as preliminary observations during this study and also the recent related results of aerial survey monitoring for the Navy in SOCAL (Smultea et al. 2009). We recommend that the latter protocol be followed unless it can be statistically demonstrated that particular species do not exhibit detectable reactions to the aircraft at closer distances.

- Data collected during this study contribute to baseline data important in developing and implementing effective marine mammal monitoring for future planned Navy activities identified for the HRC in the Navy's associated monitoring plans (DoN 2008).

Section 6 Acknowledgements

We are grateful to Navy personnel from US Pacific Fleet Environmental and Naval Facilities Engineering Command Pacific for their support, coordination and facilitation in the implementation of these surveys. Many thanks to the hard working survey and analysis crew consisting of Mark Deakos and co-pilot/GIS specialist/observer Stu Smith. Thank you to Jenelle Black for assistance with document preparation. Also we thank pilot John Weiser.

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Appendices

Appendix A. Locations of Marine Mammal and Sea Turtle Sightings Made off Kauai and Niihau during the February 2009 SCC OPS during Aerial Monitoring Surveys.

Date	Time	Count	# Calves	Species Common	Species Latin	Lat °N	Long °W
2/15/09	17:42:36	3	0	Humpback Whale	*Megaptera novaeangliae*	21.5576	158.3257
2/15/09	17:43:40	4	0	Humpback Whale	*Megaptera novaeangliae*	21.5626	158.3193
2/16/09	8:04:00	1	0	Unidentified sea turtle	Unidentified sea turtle	22.2007	159.6586
2/16/09	8:04:00	3	0	Humpback Whale	*Megaptera novaeangliae*	22.2007	159.6586
2/16/09	8:05:00	2	0	Humpback Whale	*Megaptera novaeangliae*	22.1839	159.6960
2/16/09	8:06:00	3	0	Humpback Whale	*Megaptera novaeangliae*	22.1677	159.7345
2/16/09	8:08:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.1634	159.8106
2/16/09	9:59:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.2352	159.9155
2/16/09	11:04:00	2	0	Humpback Whale	*Megaptera novaeangliae*	22.3303	159.9678
2/16/09	11:11:00	4	0	Humpback Whale	*Megaptera novaeangliae*	22.3042	159.9963
2/16/09	11:35:00	3	0	Humpback Whale	*Megaptera novaeangliae*	22.2166	159.3441
2/16/09	11:37:00	2	0	Humpback Whale	*Megaptera novaeangliae*	22.1650	159.2971
2/16/09	11:38:00	3	0	Humpback Whale	*Megaptera novaeangliae*	22.1298	159.2888
2/16/09	11:41:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.0191	159.3298
2/16/09	13:05:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.0910	159.3026
2/16/09	13:06:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.1194	159.2855
2/16/09	13:12:30	1	0	Humpback Whale	*Megaptera novaeangliae*	22.2388	159.4839
2/16/09	13:15:20	3	0	Humpback Whale	*Megaptera novaeangliae*	22.2209	159.6118
2/16/09	13:19:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.1731	159.7576
2/16/09	16:30:52	2	0	Humpback Whale	*Megaptera novaeangliae*	21.8888	159.6312
2/16/09	16:32:10	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8759	159.5796
2/16/09	16:34:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.8629	159.5078
2/16/09	16:35:12	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8655	159.4731
2/16/09	16:39:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8999	159.3544
2/17/09	11:41:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8647	159.4581

Appendix B (cont'd)

Date	Time	Count	# Calves	Species Common	Species Latin	Lat ºN	Long ºW
2/17/09	11:45:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8971	159.6234
2/17/09	11:48:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9457	159.7139
2/17/09	11:52:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9581	159.8242
2/17/09	11:53:00	1	0	Unidentified Balaenoptera	Balaenoptera	21.9755	159.8451
2/17/09	11:56:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.0356	159.8969
2/17/09	15:11:00	2	1	Humpback Whale	*Megaptera novaeangliae*	22.1769	159.8444
2/17/09	15:22:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9534	159.7973
2/17/09	15:23:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9608	159.7695
2/17/09	15:35:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9665	159.7345
2/17/09	15:55:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9040	159.6523
2/18/09	7:57:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.8715	159.5064
2/18/09	8:00:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8989	159.6320
2/18/09	8:00:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.8989	159.6320
2/18/09	8:01:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9163	159.6696
2/18/09	8:02:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9341	159.7065
2/18/09	8:02:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9341	159.7065
2/18/09	8:03:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9518	159.7429
2/18/09	7:58:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.1976	159.8685
2/18/09	8:12:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.1655	159.8710
2/18/09	11:40:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.2121	159.3396
2/18/09	11:44:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.0766	159.3059
2/18/09	11:45:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.0374	159.3213
2/18/09	13:14:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.0970	159.2943
2/18/09	13:26:00	2	0	Humpback Whale	*Megaptera novaeangliae*	22.2348	159.4605
2/18/09	14:36:00	1	0	Unidentified Balaenoptera	Balaenoptera	22.0013	159.8757
2/18/09	14:39:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9431	159.8156
2/18/09	14:39:30	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9401	159.8000
2/18/09	14:40:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.9376	159.7835

Date	Time	Count	# Calves	Species Common	Species Latin	Lat °N	Long °W
2/18/09	14:42:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9558	159.7440
2/18/09	15:00:00	2	1	Humpback Whale	*Megaptera novaeangliae*	21.9540	159.7079
2/19/09	8:38:00	1	0	Unidentified Balaenoptera	Balaenoptera	21.9059	159.3778
2/19/09	8:41:00	2	0	Humpback Whale	*Megaptera novaeangliae*	21.8710	159.4983
2/19/09	8:42:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8731	159.5416
2/19/09	8:46:00	1	0	Unidentified Balaenoptera	Balaenoptera	21.9327	159.6895
2/19/09	8:47:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9497	159.7234
2/19/09	9:00:00	1	0	Humpback Whale	*Megaptera novaeangliae*	22.0711	159.9770
2/19/09	9:27:00	3	0	Humpback Whale	*Megaptera novaeangliae*	21.9886	159.9368
2/19/09	9:34:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.9840	159.9474
2/19/09	10:43:00	3	0	Humpback Whale	*Megaptera novaeangliae*	21.9368	159.9047
2/19/09	10:50:00	1	0	Unidentified Dolphin (Probable Bottlenose Dolphin)	Unidentified Small Delphinid (Probable *Tursiops truncatus*)	21.9386	159.9061
2/19/09	10:58:00	4	0	Humpback Whale	*Megaptera novaeangliae*	21.9028	159.8983
2/19/09	11:29:00	1	0	Humpback Whale	*Megaptera novaeangliae*	21.8961	159.8983

Appendix B. Summary of Behavioral Observations of All Marine Mammal and Sea Turtle Sightings made during the February 2009 SCC OPS aerial monitoring survey off Kauai, Hawaii. (Grp=group, Beh=behavior, Hdg=heading, Min=minimum, Max=maximum, mg=magnetic, BL=body lengths, HW=humpback whale, Trav=travel, SAC= surface-active, unid=unidentified, Unk. = Unknown, alti=altitude, Bf=Beaufort sea state.)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
15-Feb	17:42:36	1	No	3	0	HW	None seen	Trav	Trav	220	1	2		No	No	circled once, slow travel
15-Feb	17:43:40	2	No	4	0	HW	None seen	Trav	Trav	220	1	2		No	No	slow travel
16-Feb	8:04:00	3	No	1	0	Unidentified sea turtle	None seen	Rest	Logging/ Resting					No	No	logging at surface
16-Feb	8:04:00	4	No	3	0	HW	None seen	Unk.	Unk.		1	3		No	No	
16-Feb	8:05:00	5	No	2	0	HW	None seen	Trav	Trav	135				No	No	
16-Feb	8:06:00	6	No	3	0	HW	None seen	Trav	Trav					No	No	
16-Feb	8:08:00	7	No	1	0	HW	None seen	Unk.	Unk.					No	No	
16-Feb	9:59:00	9	Yes	1	0	HW	Unknown, pilot saw unidentified large splash then saw whale	Trav	SAC Trav				unid. splash	No	Yes	first seen <3 km USS *Russell*, first saw unidentified large splash at 09:59 then blow and swimming underwater at 10:00 & 10:02; aircraft turned and began circling at 1000 ft alt & 1000 m radial distance, difficult to track in Bf 5 so we don't feel confident we saw all blows & behavior
16-Feb	10:00:00	9	(Yes-same as above)			*same HW as above*	Saw 1 humpback blow then saw it swimming underwater (can see through water surface)		SAC Trav	180			blow			
16-Feb	10:02:00	9	(Yes-same as above)			*same HW as above*	Change in behavior state: no longer SAC travel, just travel		Trav	180			under-water swim			resighting, seen traveling S underwater, we are not seeing all behaviors as difficult to track whale consistently in Bf 5-6
16-Feb	10:05:00	9	(Yes-same as above)			*same HW as above*	Unknown		Unk.	unk			blow			resighting

Appendix B (cont'd)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
16-Feb	10:11:00	9	(Yes-same as above)			*same HW as above*	Change in behavior state: now SAC travel = breached twice, heading now different than last sighting at 10:02		SAC Trav	unk			breach			resighting, second sighting at 10:11 did 2 breaches, seen again underwater at 10:13 , <1.5 nm from *Russell*
16-Feb	10:13:00	9	(Yes-same as above)		0	*same HW as above*	Still SAC travel	Unk.	SAC Trav	unk			breach			resighting
16-Feb	10:20:00	9	(Yes-same as above)			*same HW as above*	Now traveling, change in behavior state from surface-active travel to travel; also change in heading		Trav	90			under-water swim			resighting
16-Feb	10:26:00	9	(Yes-same as above)			*same HW as above*	None seen, still traveling E		Trav	90			blow			resighting, blows seen, traveling E
16-Feb	10:28:27	9	(Yes-same as above)			*same HW as above*	Last seen traveling E		Trav	90			blow			resighting, traveling slowly to E underwater can see below surface of water, departed whale location at 10:33 because we had been with whale for >30 min and because did not resight a
16-Feb	11:04:00	10	No	2	0	HW	None seen	Unk.	Trav	270				No	No	seen in transit
16-Feb	11:11:00	11	No	4	0	HW	Change in Behavior State	Unk.	Trav	270			blow	No	No	seen in transit
16-Feb	11:35:00	12	No	3	0	HW	None seen	Trav	Trav	270				No	No	seen in transit
16-Feb	11:37:00	13	No	2	0	HW	None seen	Trav								seen in transit
16-Feb	11:38:00	14	No	3	0	HW	None seen	Trav								seen in transit

Appendix B (cont'd)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
16-Feb	11:41:00	15		1	0	HW	None seen	SAC Trav	SAC mill							outside Lihue harbor
16-Feb	13:05:00	16	No	1	0	Unknown Balaenoptera	None seen	Unk.								
16-Feb	13:06:00	17	No	1	0	Unknown Balaenoptera	None seen	Unk.								
16-Feb	13:12:30	18	No	1	0	HW	None seen	Trav								
16-Feb	13:15:20	19	No	3	0	HW	None seen	Trav								
16-Feb	13:19:00	20	No	1	0	Unknown Balaenoptera	None seen	Trav	Trav	45						
16-Feb	16:30:52	21	No	2	0	HW	None seen	Trav	Trav	90						
16-Feb	16:32:10	22	No	1	0	HW	None seen	Trav								
16-Feb	16:34:00	23	No	2	0	HW	None seen	Trav								
16-Feb	16:35:12	24	No	1	0	HW	None seen	Trav								
16-Feb	16:39:00	25	No	1	0	HW	None seen	Trav								
17-Feb	11:41:00	26	No	1	0	HW	None seen	SA Trav	SAC Trav				breach	No	No	
17-Feb	11:45:00	27	No	1	0	HW	None seen			210				No	No	
17-Feb	11:48:00	28	No	2	0	HW	None seen	Trav		270				No	No	
17-Feb	11:52:00	29	No	1	0	HW	None seen			180				No	No	
17-Feb	11:53:00	30	No	1	0	Unknown Balaenoptera	None seen							No	No	
17-Feb	11:56:00	31	No	1	0	Unknown Balaenoptera	None seen							No	No	
17-Feb	15:11:00	32	Yes	2	1	HW	None seen initially	Trav		180	0.5	1		No	Yes	focal pod
17-Feb	15:22:00	33	No	1	0	HW	None seen initially;	SAC	Trav				breach	No	No	
17-Feb	15:23:00	34	Yes	1	0	HW	None seen initially	Mill	Trav		1	5		No	Yes	focal pod

Appendix B (cont'd)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
17-Feb	15:35:00	35	No	2	0											
17-Feb	15:55:00	36	Yes	1	0	HW	None seen initially	Trav	slow Trav		0.5	1		No	Yes	focal pod,
18-Feb	7:57:00	37	No	2	0	HW	None seen	Trav			1	0		No	No	
18-Feb	8:00:00	38	No	1	0	HW	None seen							No	No	
18-Feb	8:00:00	39	No	2	0	HW	None seen	Trav		90				No	No	
18-Feb	8:01:00	40	No	2	0	HW	None seen			180				No	No	
18-Feb	8:02:00	41	No	1	0	HW	None seen			360				No	No	
18-Feb	8:02:00	42	No	2	0	HW	None seen							No	No	
18-Feb	8:03:00	43	No	1	0	HW	None seen	Trav		180				No	No	
18-Feb	8:12:00	44	No	1	0	Unknown Balaenoptera	None seen							No	No	
18-Feb	8:13:00	45	No	1	0	Unknown Balaenoptera	None seen							No	No	
18-Feb	11:40:00	46	No	1	0	Unknown Balaenoptera	None seen							No	No	
18-Feb	11:44:00	47	No	1	0	HW	None seen	SA Trav						No	No	
18-Feb	11:45:00	48	No	1	0	Unknown Balaenoptera	None seen	SA Trav						No	No	
18-Feb	13:14:00	49	No	1	0	HW	None seen			180				No	No	
18-Feb	13:26:00	50	No	2	0	HW	None seen			90				No	No	
18-Feb	14:36:00	51	Yes	1	0	Unknown Balaenoptera	None seen							No	No	focal pod
18-Feb	14:39:00	52	Yes	2	0	HW	None seen	Trav		90				No	Yes	focal pod

Appendix B (cont'd)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
18-Feb	14:39:30	53	Yes	2	0	HW	None seen	Trav	Trav	0	1	2		No	Yes	Did focal and video on pair of adult humpbacks off Kekaha in lee; circled at 1500 ft alt and ~1 km radial distance; this pod affiliated with the single hw sighting 19 and sighting 18 and formed a competitive group of 5 adults; video taped this group and did focal session; circled at 1500 ft and radial distance ~1 km
18-Feb	14:40:00	54	Yes	2	0	HW	None seen	Trav	Trav	0				No	Yes	short focal session
18-Feb	14:42:00	55	Yes	1	0	HW	None seen	Trav	Trav	270				No	Yes	single humpback near focal humpback of two whales that appeared to affiliate with our focal 2 whales sighting 17
18-Feb	15:00:00	56	Yes	2	1	HW	None seen	Trav	Trav		0.5	1			Yes	focal pod of mother calf, vessel stopped to watch for short period, N of Kekaha in lee, circled at 1500 ft alt and ~1 km radial distance
19-Feb	8:38:00	57	No	1	0	Unknown Balaenoptera	None seen	SA Trav		0	0	0	breach	No	No	
19-Feb	8:41:00	58	No	2	0	HW	None seen			90	1	1		No	No	
19-Feb	8:42:00	59	No	1	0	HW	None seen			90	0	0		No	No	
19-Feb	8:46:00	60	No	1	0	Unknown Balaenoptera	None seen			0	0	0		No	No	
19-Feb	8:47:00	61	No	1	0	HW	None seen			200	0	0		No	No	
19-Feb	9:00:00	62	Yes	1	0	HW	None seen	Trav		270	0	0		No	No	focal pod; initially sighted by Russell observers then we followed it

Appendix B (cont'd)

2009 Date	Time	Grp #	Focal Follow?	Group Size	# Calf	Species	Reaction/ Change in Behavior?	Init Beh State	Behav. States	Anim Hdg (mg)	Min Disp (BL)	Max Disp (BL)	Indiv Beh Event	Photos ?	Video ?	Comments
19-Feb	9:27:00	63	Yes	3	0	HW	Changed respiration rate (fewer blows per surfacing), dive time, and behavior state and heading as two large Navy vessels approached then passed them			variab.				No	Yes	focals and videotaped
19-Feb	9:34:00	64	No	1	0	HW	None seen						SS			seen while w/focal 6
19-Feb	10:43:00	65	Yes	3	0	HW	Changed behavior state		SAC, social, competitive, Trav, SAC Trav					No	Yes	focals & videotaped
19-Feb	10:50:00	66	No	1	0	Unid Dolphin, Prob Bottlenose	None		Trav, mill with humpbacks in Pod 9 <1 whale BL from humpbacks					No	Yes	this light-colored probable bottlenose dolphin was seen with we believe the 2 humpbacks whales of Pod 9 briefly as we were leaving to rejoin the Russell.
19-Feb	10:58:00	67	Yes	4	0	HW	Changes in behavior state and heading		SAC, social, competitive, Trav, SAC Trav					Yes	Yes	focal pod: circled at 1500 ft al & ~1 km radial distance
19-Feb	11:29:00	68	Yes	1	0	HW	Unknown		Trav, social					No	Unk.	this humpback appeared to affiliate with Pod 11 to make a total group size of 5 adult humpbacks

APPENDIX C HRC ULTRA C UNIT LEVEL TRAINING AERIAL MONITORING JUNE 2009

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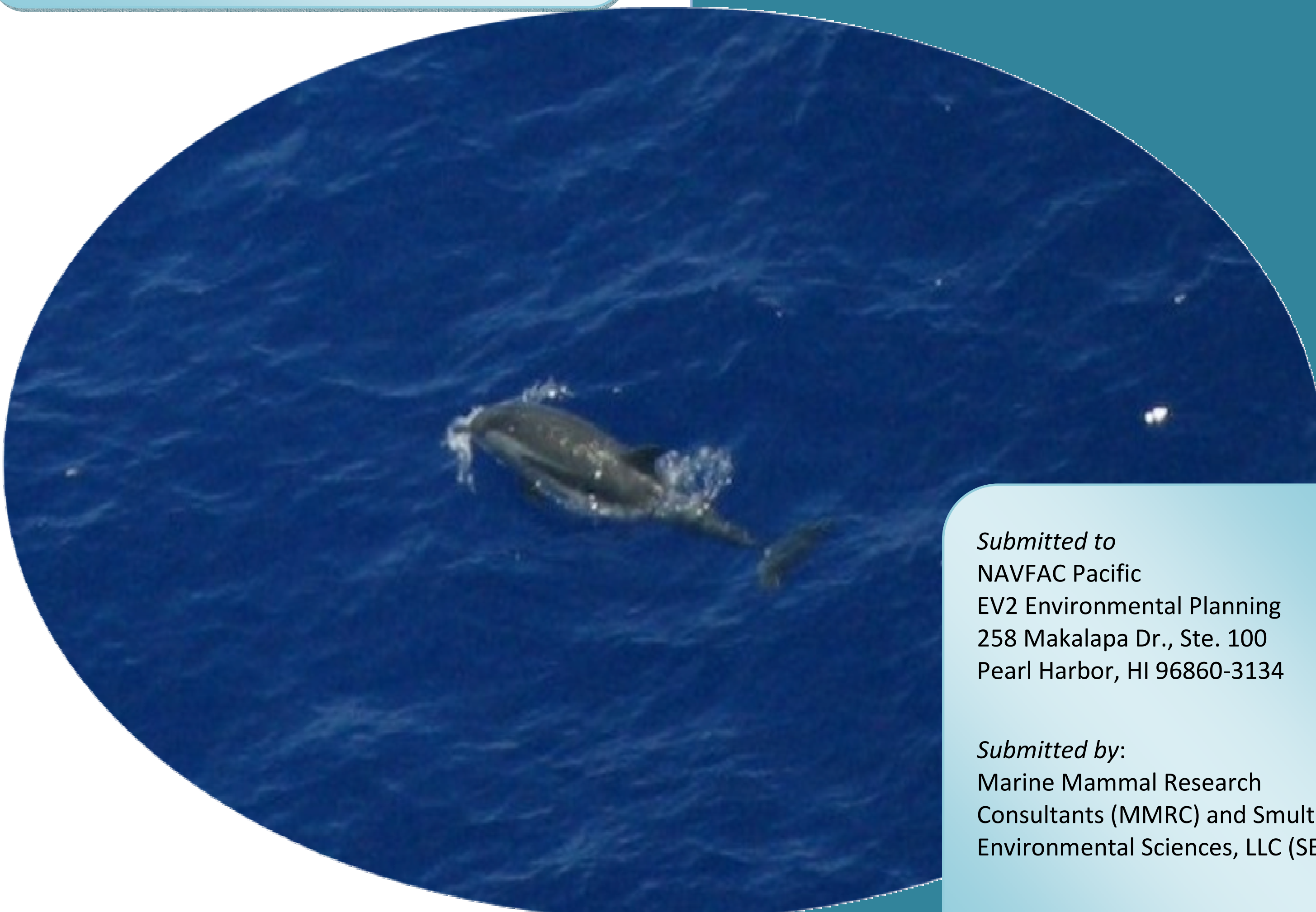
Aerial Survey Monitoring for Marine Mammals and Sea Turtles off Oahu, Hawaii, in Conjunction with a Unit Level Training Event and Underwater Detonations

Hawaii Range Complex

June 17-25, 2009

Final Field Report



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Submitted by:
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Cover Photo: A striped dolphin (*Stenella coeruleoalba*) photographed with a telephoto lens from the aircraft during the HRC June 09 aerial monitoring survey. Photo by Mark Deakos

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Executive Summary

A total of 44.96 hr of aerial surveys for marine mammals and sea turtles (MM/ST) was conducted on the Hawaii Range Complex (HRC) on eight of the nine-day survey period from 17-25 June 2009 in conjunction with a unit level training event (ULT) and six underwater detonations (UNDET). The surveys consisted of three parts: (a) observations near the Navy warship *USS Hopper* during a ULT (June 17-18); (b) observations before, during and after UNDET activities (June 19); and (c) systematic line-transect surveys in warning areas south of Oahu after the *Hopper* had finished training in that area (June 20-25). Beaufort sea state (Bf) conditions were generally high (modal Bf = 6) due to unusually strong prevailing trade winds for all but the final survey day. During the first two days with the *Hopper*, observations were conducted from a fixed-wing aircraft flying elliptical-shaped orbits to search for MM/ST near the *Hopper* for a total of 12.8 hr of observation. A single sighting of two unidentified dolphins was recorded on the first day at a minimum estimated distance of 1.4 km from the *Hopper*. For the subsequent single day of UNDET activities, 6.4 hr of observations were conducted from a helicopter flying pre-set line transects in a 5.75 x 5.75-km box. A total of 38 sightings of sea turtles were recorded during this effort; no marine mammals were observed. Over the last six days of transect surveys in the warning areas south of Oahu, a total of 25.7 hr of observations were conducted from a fixed-wing plane. On the last day of surveys (June. 25) a total of three cetacean species were sighted, consisting of one sighting each of Risso's dolphins, spotted dolphins, and striped dolphins. The clustering of sightings on the final day was likely due to improved sea state conditions compared to previous survey days.

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Section 1 Introduction

Marine Mammal Research Consultants (MMRC), in collaboration with Smultea Environmental Sciences, LLC. (SES), was contracted by the US Navy to perform aerial surveys for marine mammals and sea turtles (MM/ST) in support of the Navy Hawaii Range Complex (HRC) marine monitoring plan (Navy 2008) over a nine-day period from June 17-25, 2009. These surveys were planned in conjunction with a unit level training event (ULT) in the region of the island of Oahu, Hawaii. The ULT involved the Navy vessel *USS Hopper* (*Hopper*), employing mid-frequency active sonar (MFAS) with MM/ST observers blind as to MFAS deployment status, as well as underwater detonations (UNDET) at Puuloa Underwater Range in an inshore area. For observations associated with the *Hopper*, surveys were conducted directly with the *Hopper* while it was underway (June 17-18) and subsequently in an area where the *Hopper* had operated but after the *Hopper* had returned to port (June 20-25).

The overall monitoring objective was to detect, identify and observe all MM/ST given their protected status under the Endangered Species Act (1973) and/or the Marine Mammal Protection Act (1972). This included recording the time, location, and species identity (as possible) and observing the behavior of all target species.

Section 2 Methods

General Approach

Surveys were generally flown at a speed of ~100 kt and altitude of ~244 m (800 ft) as stipulated under the terms of NOAA permit no. 642-1536 issued to the co-Principal Investigator (JM), unless the pilot was directed to fly at alternate altitudes by flight controllers for safety reasons. Three observation aircraft were used: (1) a twin-engine, high fixed-wing Partenavia Observer (P68) equipped with two bubble windows and a camera porthole in the co-pilot window; (2) a twin-engine, high fixed-wing Aerocommander, and (3) a Robinson 44 helicopter (Table 1). Flight dates are summarized in Table 1.

Crew consisted of two experienced observers and an experienced data recorder/photographer/ videographer in addition to the pilot. Location data from a WAAS-enabled global positioning system (GPS) receiver were recorded automatically at 30-sec intervals or whenever a sighting was made. Suunto clinometers were used to obtain declination angles of sightings when the sighting was perpendicular to the aircraft using standard line-transect methodology (e.g., Buckland et al. 2001). Environmental data including Beaufort sea state (Bf), glare and visibility, were taken at the start of each survey leg or when conditions changed, as was information on effort type (see Mobley 2008, Mobley et al. 2000, Smultea and Mobley 2009, Smultea et al. 2009 for further methodology details).

When a sighting occurred, the declination angle to the sighting was called out by the observer as was species identity (if readily identifiable), group size/composition (including presence/absence of calf), general behavior, and any observed potential reactions (defined as a change in heading or behavior or a behavior deemed unusual by the experienced observers). Following the initial sighting, the aircraft typically broke from the transect line and orbited the sighting to confirm species identification, obtain more detailed behavioral observations, and take photographs. Species determination of cetaceans was often made possible via photographs taken with a Canon EOS 5D camera equipped with a 400-mm telephoto lens. A Canon Vixia HF10 high-definition video camera with an internal stabilization feature was available to obtain detailed behavioral data as feasible (though it ended up not being used during this survey).

Table 1. Hawaii Range Complex (HRC) Aerial Survey Flight Log 17-25 June 2009.

Date	Platform	Training Event Monitored	Time Wheels Up	Time Wheels Down	Total Hours
6/17/2009	Fixed-Wing, Twin-Engine Partenavia P68 Observer (FW OBS)	Anti-submarine Warfare Training (ASW)	10:21 15:28	13:55 18:30	*3:34* *3:02*
6/18/2009	FW OBS	ASW	10:55 12:35	11:13 18:30	*0:18* *5:55*
6/19/2009	Robinson 44 Helicopter	Underwater Ordnance Detonation	8:30 9:15 12:50	8:45 11:50 16:30	*0:15* *2:35* *3:40*
6/20/2009	FW OBS	ASW	10:30 14:53	13:46 18:35	*3:16* *3:42*
6/21/2009	FW OBS	ASW	9:54	13:13	*3:19*
6/22/2009	No survey due to poor weather (Bf>6)		-	-	*0*
6/23/2009	Fixed-Wing Aerocommander (FW AC)	ASW	10:05	12:17	*2:12*
6/24/2009	FW AC	ASW	8:32 12:41	11:34 15:40	*3:02* *2:59*
6/25/2009	FW AC	ASW	7:00 11:12	10:29 14:52	*3:29* *3:40*
TOTAL					**44:58 (44.96)**

Observations during ULT with *USS Hopper*

During the first two days of the surveys (June 17-18), observations were conducted from a fixed-wing Partenavia Observer (P68) aircraft while traveling in front of the *Hopper* which was conducting unit level training (Figure 1 and Figure). The aircraft flew elliptical orbits in front of the *Hopper* over waters ~20-35 km south of Oahu. 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 (see Smultea and Mobley 2009 and Smultea et al. 2009 for detailed methodology). 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.

Communications were maintained between the observation aircraft and *Hopper* personnel via use of a hand-held aviation-band VHF radio operated by *Hopper* crew. Communications were initiated in the event of a sighting or prior to joining or leaving the *Hopper*.

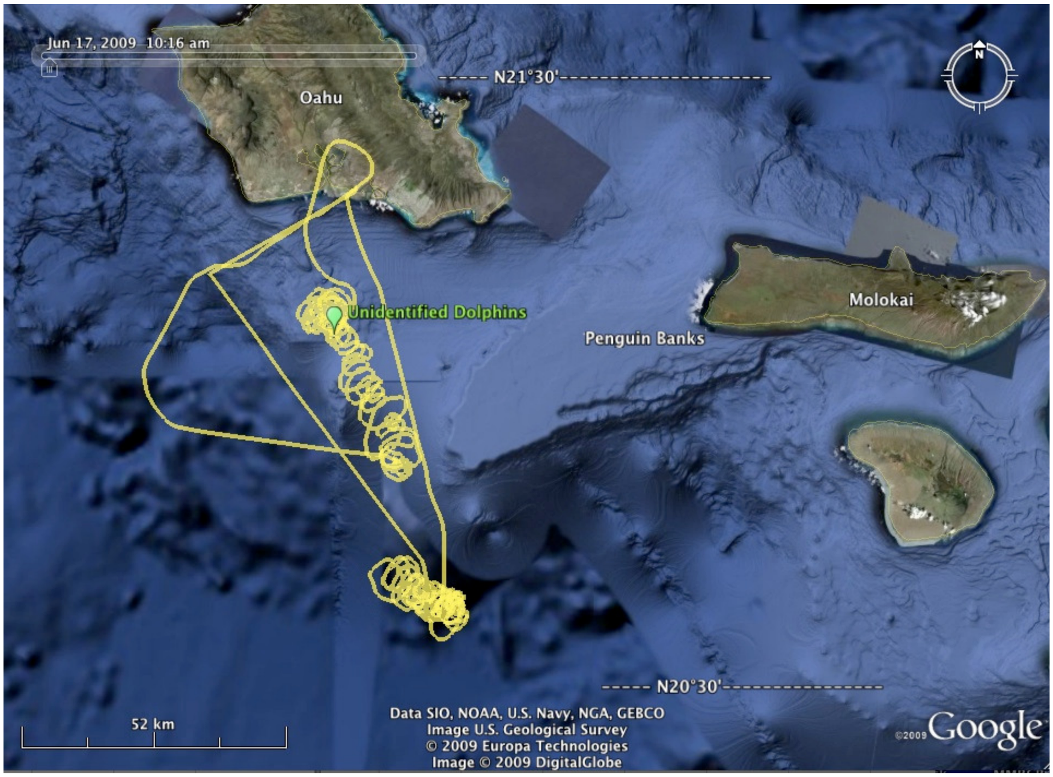

Figure 1. Map of Survey Route June 17, 2009

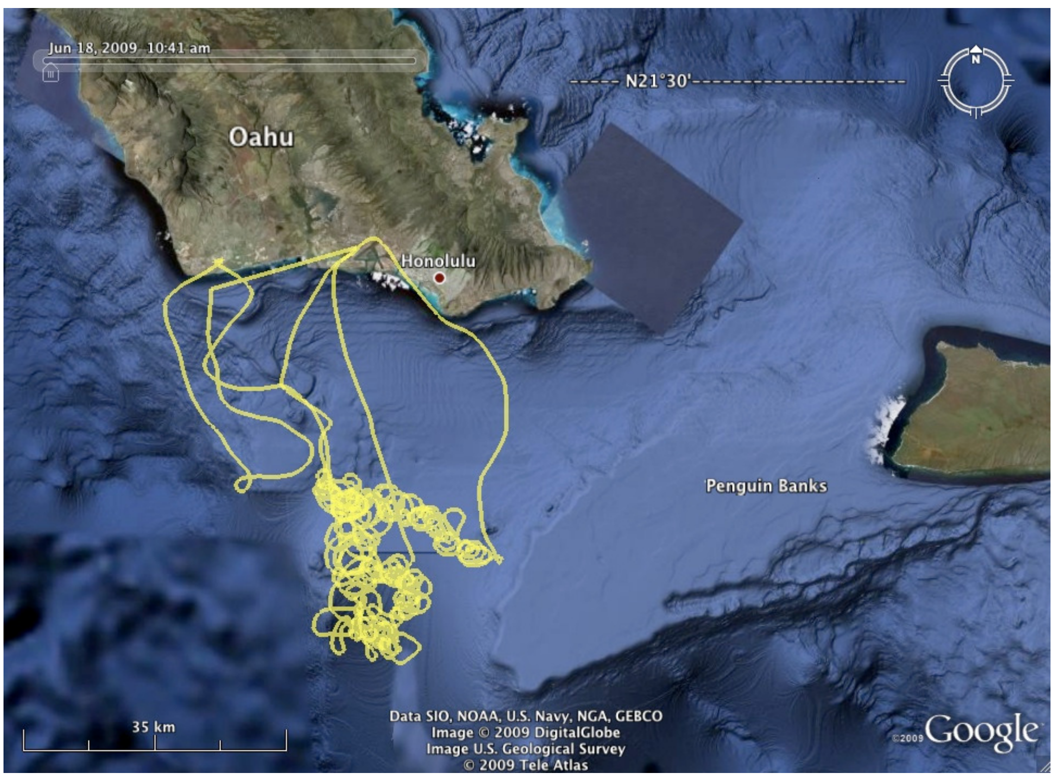

Figure 2. Map of Survey Route June 18, 2009

Observations During UNDET Activity

On the third day of the survey series (June 19), observations were 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). 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 9:15-11:50 and from 12:50-16:30 with a break to return to Honolulu Airport to fuel in-between the sessions (Table 1). 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 ~11:30. The two subsequent detonations occurred between ~11:40 - 13:00 while the helicopter was off-site refueling. Post-detonation observations from the helicopter occurred at the survey grid from ~12:55 – 16:25. Communications were maintained with naval personnel from the Mobile Dive and Salvage Unit One (MDSU) via cell phone and texting given the close proximity to shore. Professional biological observers were aboard the MDSU vessels as well as monitoring for MM/ST in and near the survey grid from a small NOAA-contracted vessel.

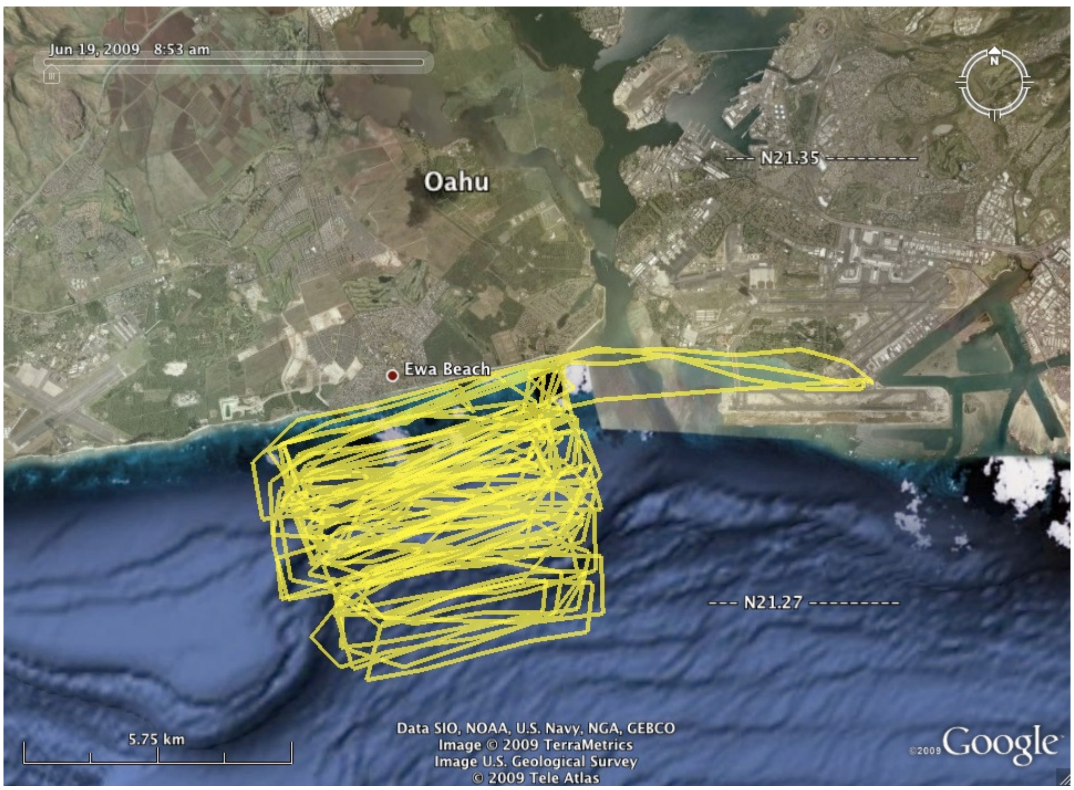

Figure 3. Map of Survey Route June 19, 2009

Survey Transect Observations

For five of the six final five days of the survey series, surveys were flown following pre-set north-south oriented transect lines in the general area where *Hopper* training had been conducted (~15-35 km south of Oahu)(Figure - Figure 8). Surveys followed north-south systematic transect lines connected at the endpoints by random lines. However, on day three (June 22) of the final six survey days, tradewinds were so strong and widespread that observations could not be conducted by the observation aircraft due to unfavorable and unsafe wind and wave conditions (Table 1).

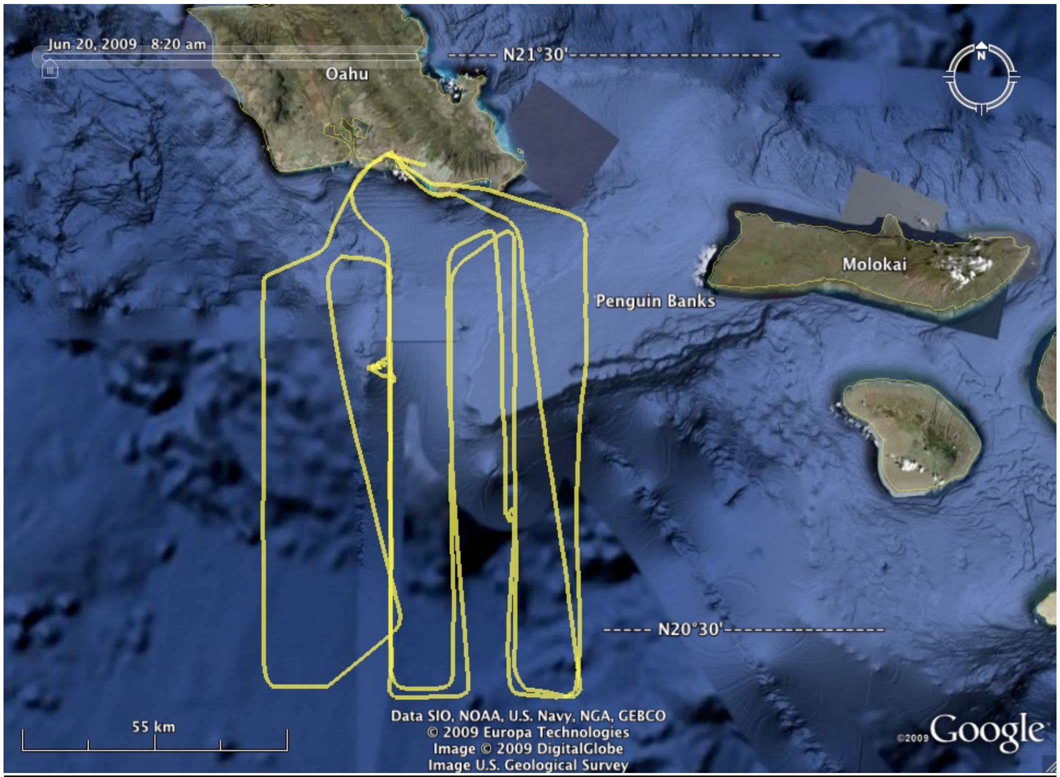

Figure 4. Map of Survey Route June 20, 2009

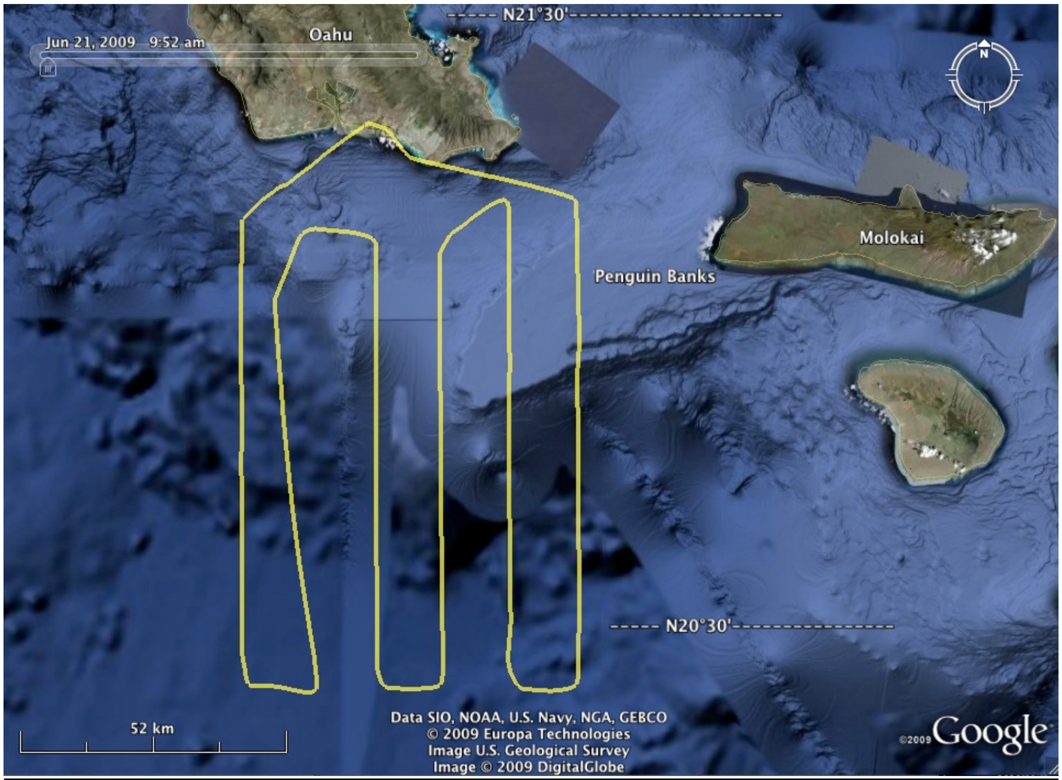

Figure 2. Map of Survey Route June 21, 2009

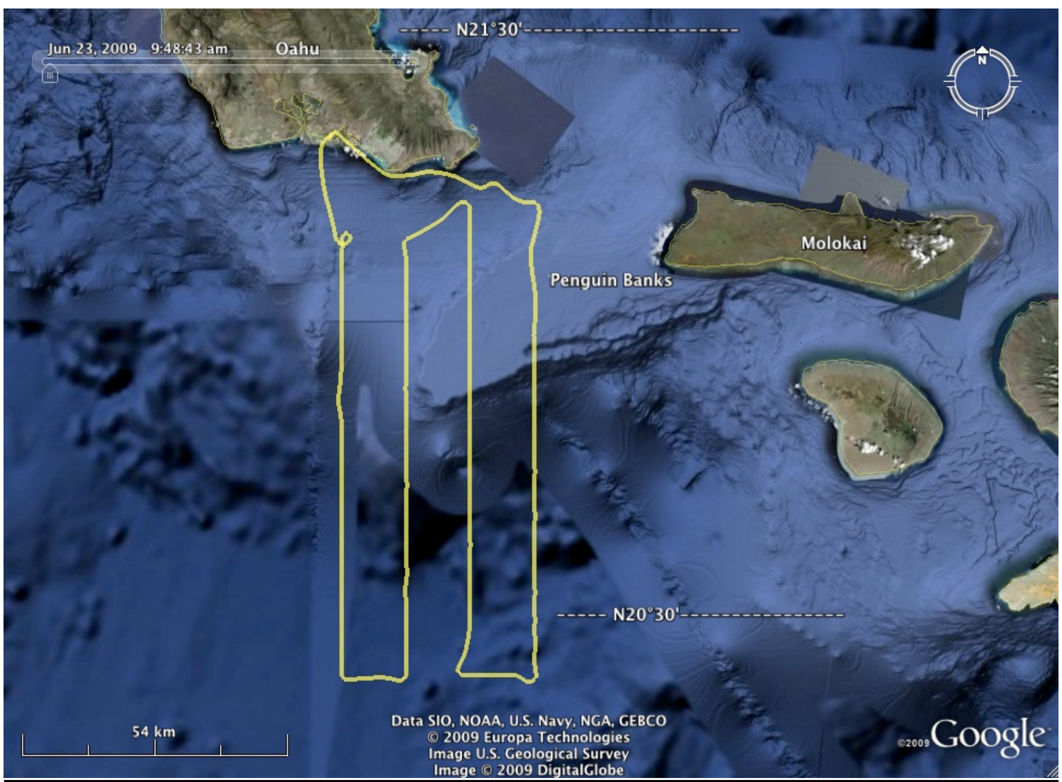

Figure 3. Map of Survey Route June 23, 2009

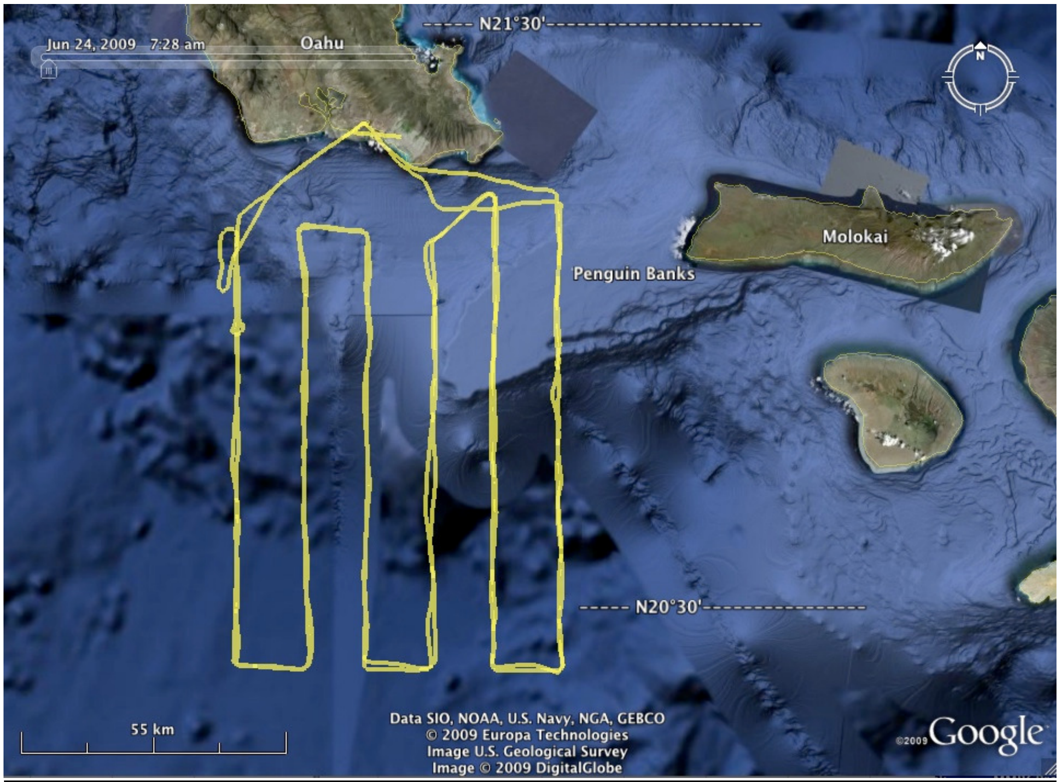

Figure 4. Map of Survey Route June 24, 2009

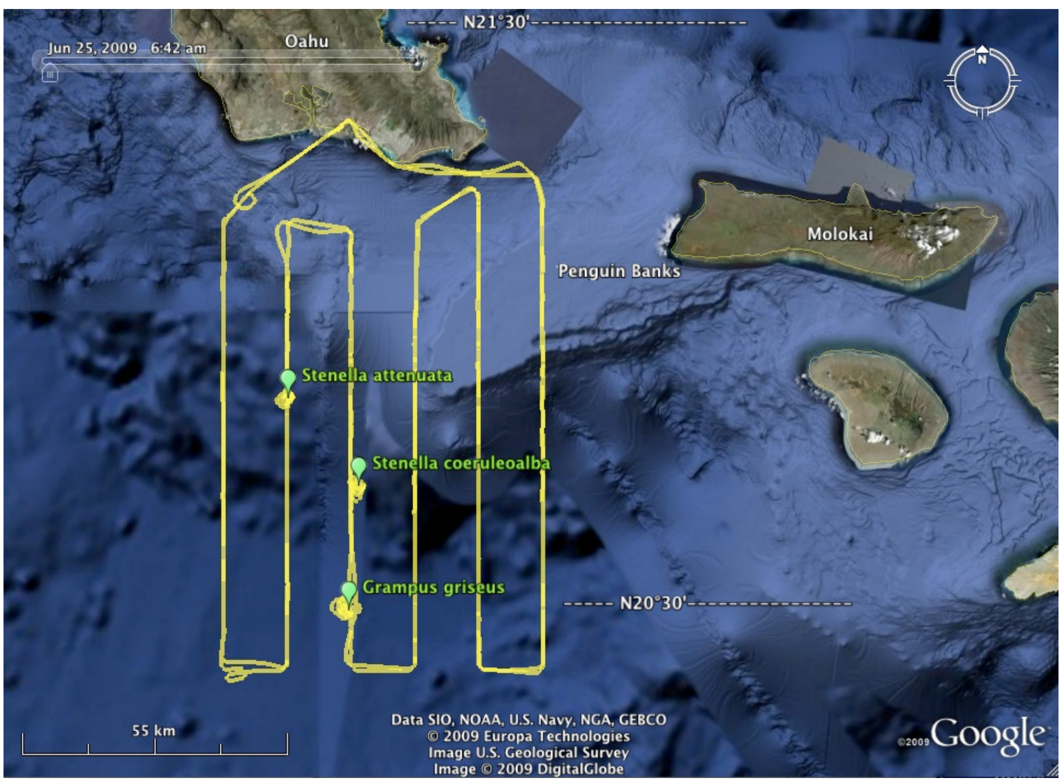

Figure 8. Map of Survey Route June 25, 2009

Section 3 Results and Discussion

Survey conditions were generally hampered by poor Bf conditions due to the exceptionally strong tradewinds that prevailed during all but the final day (Table 2 and Figure 5). The modal Bf value was 6, corresponding to winds in excess of 21 knots. Bf is an important factor affecting visibility during marine surveys: as Bf increases above 2, detectability of marine mammals decreases (Buckland et al. 2001).

Sightings were recorded on only three of the nine survey dates: June 17, 19 and 25 (Table 3 and Appendix A). A single sighting of a group of two unidentified dolphins was made within the first hour of surveying with the *Hopper* on the first day (June 17) at 12:07. Based on analysis of GPS tracklines, the two dolphins were sighted at a minimum distance of 1.4 km from the *Hopper*. Since observers were blind to the status of MFAS transmissions, it was not known whether the dolphins were exposed to MFAS. The dolphins were sighted briefly as they traveled away from the *Hopper* toward a bearing of ~260° magnetic. The observation plane circled for several minutes where the dolphins had first been seen but observers were unable to relocate the dolphins in the Bf 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.

All sightings on June 19, during monitoring of the UNDET activities, were comprised of 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 marine mammal species were seen likely due to the shallow water in that area (< 15 m). No unusual behaviors, reactions/changes in behavior were noted among any of the sea turtles seen.

A total of three cetacean sightings occurred on the final survey date (June 25) when sea state conditions improved (Bf modal =4, range = 2 to 6). Those sightings included a group of Risso's dolphins, a group of striped dolphins, and a group of spotted dolphins (Table 3 and Appendix A). All three sightings were seen during a Bf 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. Short descriptions of these encounters are provided below.

1. A group of ~9 Risso's dolphins (including one calf) was first seen at 8:40 traveling toward ~300° (magnetic). No apparent reactions/changes in behavior were noted among these dolphins. Nearest-neighbor dispersal distance ranged from ~1 to 30 body lengths. The dolphins were circled by the plane for ~23 min during which time 23 photos were taken.
2. A group of ~12 striped dolphins was first observed at 13:02 while they were surface-active milling (a behavior state that includes individual behaviors creating conspicuous splashes, e.g., porpoising, leaps). One calf was seen in the group. Dispersal distance between individuals ranged from 1 to 10 body lengths. The plane circled the striped dolphins for ~15 min during which time 79 photos were taken (see photo on report cover page).
3. A group of ~30 spotted dolphins was sighted at 13:44 engaged in surface-active milling. The dolphins appeared to be feeding and were associated with birds. Dispersal distance between dolphins ranged from 1 to 15 body lengths. The plane circled the dolphins for ~17 min during which time 63 photos were taken. One possible reaction was noted and consisted of diving (sounding) quickly below the surface.

Low rates of sightings are typical for Hawaiian waters during the months outside of the Hawaiian humpback whale wintering season (Jan-April), particularly in offshore waters deeper than ~200 m (reviewed in Smultea 2008). This is likely due to the low productivity of tropical waters (Barlow 2006). The three cetacean species sighted during the survey (Risso's, striped, and spotted dolphins) typically occur in waters surrounding the main Hawaiian Islands (Balcomb 1979; Mobley et al. 2000). The normally low sighting rates were further suppressed in this case due to the strong trade wind conditions extant during the study period.

Table 2. Aerial Survey Effort Hours by Beaufort Sea State and Leg Type

	BEAUFORT SEA STATE								
LEG TYPE	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	***Totals***
Random	0:00	0:00	0:00	0:11	0:21	0:25	0:50	0:10	*1:56*
Systematic	0:00	0:00	0:21	2:44	3:29	3:32	7:42	1:32	*19:20*
Transiting	0:00	0:00	2:39	1:31	1:13	3:29	9:28	3:22	*21:43*
Totals	***0:00***	***0:00***	***3:01***	***4:26***	***5:03***	***7:26***	***18:00***	***5:04***	***43:00***

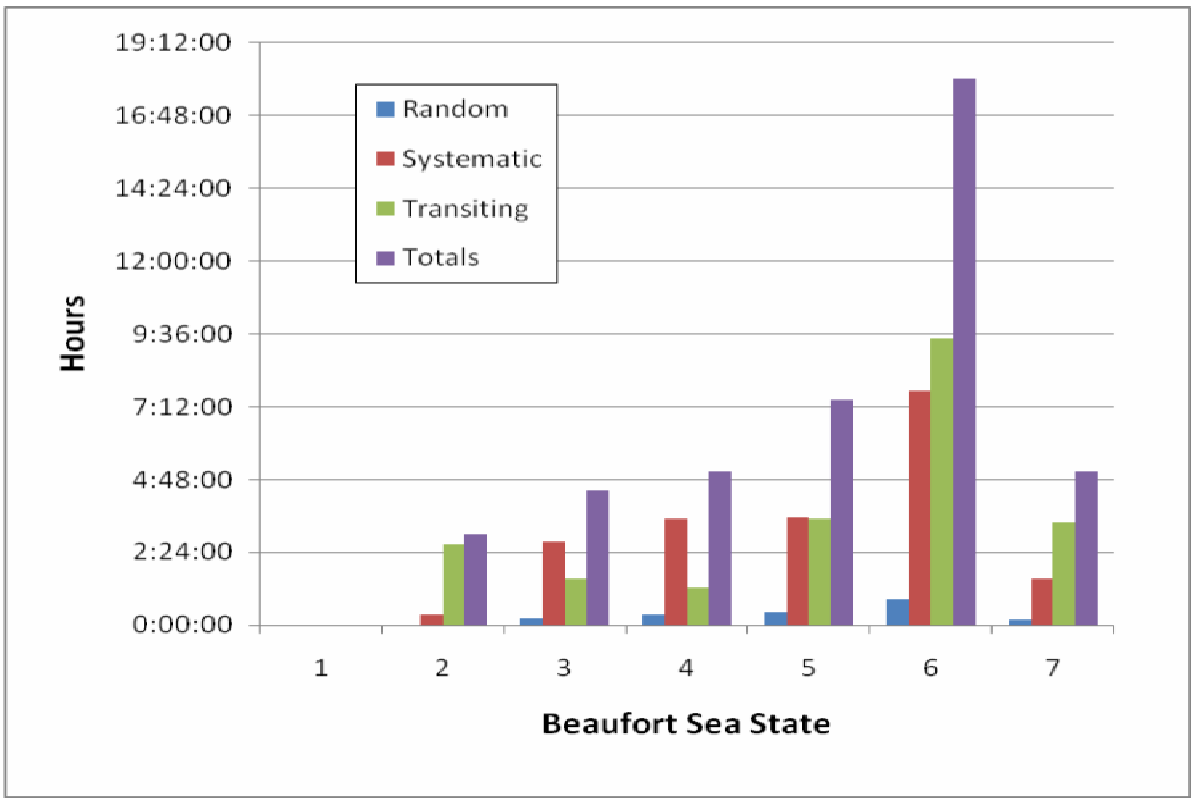

Figure 5. Beaufort sea state conditions during periods the observer aircraft was conducting Random, Systematic and Transiting observations during the HRC June 2009 aerial survey monitoring off Oahu, Hawaii.

Table 3. Marine Mammal and Sea Turtle 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
Unidentified Sea Turtle	*Chelonia* sp.	38	38
TOTAL		**42**	**91**

Section 4 Recommendations

As requested in the SOW, this section provides recommendations for future monitoring efforts relative to what was learned during this survey. Recommendations focus on experiences during this survey and those from recent similar past monitoring surveys we have conducted in the HRC (e.g., Mobley 2008; Smultea et al. 2009; Smultea and Mobley 2009), as well as other relevant professional experience. The recommendations are briefly summarized below.

- When aerial monitoring is desired, consider scheduling for training events that occur away from protected airspace near major airports. The UNDET event described here occurred immediately outside Class B airspace of Honolulu International Airport on a final approach path. As a result, our aerial monitoring activities created issues with air traffic controllers.
- When activities are planned requiring coordination with naval warships, designate on-land POC with knowledge of ship location. During the observation exercise with warship *Hopper*, refueling requirements required re-establishing the ship's location with as much as 1-2 hr intervening. In this case, approx 1-2 hr of potential observation time was lost during attempts to relocate ship.
- During training events involving civilian aircraft traveling into active warning areas, need to clarify which agency (FAA or military) is to provide air support. In this case, our aircraft was asked to broadcast different transponder codes by each agency which produced confusion.

Section 5 Acknowledgements

We are grateful to Navy personnel from US Pacific Fleet Environmental and Naval Facilities Engineering Command Pacific for their support, coordination and facilitation in the implementation of these surveys. We are also grateful to Dr. J. Hildebrand, Paula Hodgkiss, Linda Sawyer, and other assisting staff at the Scripps Institute of Oceanography and the California Institute of Technology for facilitating this contract. Many thanks also to the hard-working and good-natured survey crew and technical assistants including co-pilot/observer Stu Smith, Robert Uyeyama, Alexis Rudd, Andrew Titmus, and Jenelle Black. Also we are grateful for the competent piloting of our pilots, including John Weiser who flew the Partenavia and helicopter, and the two pilots of AFS Air, including John Sharky, who flew the Aerocommander.

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Appendix A List of All Sightings

Appendix A. List of all marine mammal and sea turtle sightings observed in the Hawaii Range Complex during the 17-25 June 2009 aerial monitoring survey off Oahu.

Date 2009	Estimated Group Size	Species	Scientific Name	Sighting Time	Location
17-Jun	2	Unidentified Dolphin	*Delphinidae* sp.	12:07:01	N21.07749 W157.96041
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:20:58	N21.28776 W158.03354
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	9:27:19	N21.29398 W158.03253
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:41:30	N21.29071 W158.01986
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:42:13	N21.29000 W158.03074
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:45:07	N21.30770 W157.98311
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:46:22	N21.30742 W158.00365
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	9:50:11	N21.29615 W157.98074
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:03:23	N21.29283 W158.01391
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	10:06:59	N21.29182 W158.02692
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:07:56	N21.30066 W158.03008
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:09:48	N21.30662 W157.99561
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:38:06	N21.29333 W158.01343
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:39:51	N21.30238 W157.98674
19-Jun	1	Unidentified Turtle	*Chelonia sp.*	10:43:00	N21.28709 W158.02345
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	10:58:04	N21.29191 W158.02732
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:02:08	N21.29840 W158.00345
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:03:05	N21.29033 W158.02877
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:06:35	N21.30696 W157.97880
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:24:32	N21.28817 W158.02780
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:24:59	N21.29472 W158.02454
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	11:28:25	N21.30505 W157.97605
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	11:39:49	N21.31326 W157.97845
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	12:56:06	N21.31650 W157.97288
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	12:59:54	N21.29943 W158.03273
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:03:01	N21.30210 W157.98285
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:38:43	N21.30504 W157.97661
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:39:00	N21.30504 W157.97661
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	13:39:17	N21.31428 W157.97902

Date 2009	Estimated Group Size	Species	Scientific Name	Sighting Time	Location
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:41:24	N21.29723 W158.02922
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	13:44:43	N21.29800 W157.97873
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	14:02:54	N21.29495 W157.98046
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:04:45	N21.28636 W158.02722
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:28:44	N21.28504 W158.03185
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:29:26	N21.29282 W158.03057
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:34:06	N21.29119 W158.02997
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:34:21	N21.29119 W158.02997
19-Jun	1	Unidentified Turtle	*Chelonia* sp...	14:40:40	N21.30073 W158.03009
19-Jun	1	Unidentified Turtle	*Chelonia* sp.	14:44:14	N21.31459 W157.97699
25-Jun	9	Risso's Dolphin	*Grampus griseus*	8:40:08	N20.48307 W157.90188
25-Jun	12	Stripped Dolphin	*Stenella coeruleoalba*	13:02:10	N20.70843 W157.88485
25-Jun	30	Spotted Dolphin	*Stenella attenuata*	13:44:37	N20.85654 W158.01728
TOTAL	**91**				

APPENDIX D HRC SUBMARINE COMMANDER'S COURSE MMO REPORT FEBRUARY 2009

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July 2009

Cruise Report, Marine Mammal Monitoring
Submarine Commanders Course 09-1
Hawaii Range Complex

Prepared for:
Commander, Pacific Fleet

Prepared by:
Dr. Stephen Jameson, Naval Facilities Engineering Command, Pacific

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List of Acronyms and Abbreviations

AM	amplitude modulated
CO	Commanding Officer
FM	frequency modulated
ft	feet
GUNNEX	Gunnery Exercise
HRC	Hawaii Range Complex
HST	Hawaii Standard Time
kts	knots (nautical miles per hour)
MFAS	mid-frequency active sonar
MMO	Marine Mammal Observer
nm	nautical miles
NMFS	National Marine Fisheries Service
PMAP	Protective Measures Assessment Protocol
PMRF	Pacific Missile Range Facility
SCC	Submarine Commanders Course
TOWEX	Towing Exercise
VHF	very high frequency
yd(s)	yards

SECTION 1: INTRODUCTION

In order to train with mid-frequency active sonar (MFAS), the Navy has obtained a permit from the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act and Endangered Species Act. The Hawaii Range Complex (HRC) Monitoring Plan, finalized in December 2008 for implementation in January 2009, was developed with NMFS to comply with the requirements under the permit. The monitoring plan and reporting will provide science-based answers to questions regarding whether or not marine mammals are exposed and reacting to Navy MFAS. The objectives of the monitoring plan are to answer the following questions:

1. Are marine mammals and sea turtles exposed to MFAS at regulatory thresholds of harm or harassment? If so, at what levels and how frequently are they exposed?

2. If marine mammals and sea turtles are exposed to MFAS in the HRC, do they redistribute geographically in the HRC as a result of repeated 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? Are they different at various levels?

4. What are the behavioral responses of marine mammals and sea turtles that are exposed to various levels and distances from explosives?

5. Are the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol [PMAP], measures agreed to by the Navy through permitting and consultation) effective at avoiding harm or harassment of marine mammals and sea turtles?

In order to answer these questions, data is to be collected through various means, including contracted vessel and aerial surveys, tagging, passive acoustics, and placing marine mammal observers (MMOs) aboard Navy warships.

As part of this data collection effort, two U.S. Navy MMOs (Dr. Stephen Jameson and Ms. Amy Farak) participated in the 2009-1 Submarine Commanders Course (SCC) on February 15-20. These MMOs were stationed aboard the USS RUSSELL (DDG 59). The primary goals of the SCC 09-1 monitoring effort were to:

1. Coordinate transit to the Pacific Missile Range Facility (PMRF) to allow RUSSELL and survey aircraft opportunity to test communications and familiarize ship to transect profiles (ship should be active);

2. Collect data on marine mammals observed during operations;
    a. Are marine mammals and sea turtles exposed to MFAS
    b. If so, at what levels
    c. Did exposed marine mammals/sea turtles show a behavioral response; and

3. Achieve close coordination between the contracted aerial survey team, Navy aircraft on the range, range control, and the MMO team aboard RUSSEL to facilitate maximizing survey time and project safety.

A secondary goal for the SCC 09-1 was to familiarize the MMOs with at-sea Navy operations and to gather information to facilitate future MMO opportunities. The results of this secondary goal are captured as "lessons learned" in Section 5.2.

SECTION 2: SCC 09-1 DESCRIPTION

SCC Ops is a requirement to provide the necessary training to prospective submarine commanders in rigorous and realistic scenarios involving undersea warfare.

Participants in SCC 09-1 included USS RUSSELL (DDG 59), USS CHAFEE (DDG 90), USS REUBEN JAMES (FFG 57), HMCS OTTAWA (FFH 341), USNS YUKON (T-AO 202), VP (fixed-wing patrol squadron), HSL-37 (helicopter antisubmarine squadron), and range control for surface and air.

SECTION 3: METHODS

3.1. SHIPBOARD MARINE MAMMAL MONITORING

On the morning of 13 February, the commanding officer (CO), executive officer, and other officers were briefed on the purpose of the marine mammal monitoring effort, the goals of the monitoring, the methods to be used by the shipboard MMOs and the survey aircraft, and to answer questions and finalize remaining details. That afternoon, a Pacific Fleet Environmental representative, the shipboard MMOs, and the survey aircraft pilot and principal investigator participated in the pre-sail brief for all vessel and aircraft participants in the SCC 09-1 exercise. During the pre-sail, the details regarding airspace concerns were finalized, as discussed in Section 3.2.

MMO surveys were conducted on a not-to-interfere basis, which means that the MMOs would not replace required Navy lookouts, would not dictate operational requirements/maneuvers, and would remove themselves from the bridge wing if necessary for the RUSSELL to accomplish its mission objectives. The only exception would be if a marine mammal was sighted by the MMO within the shut-down zone during MFAS (200 yards [yds]) and was not sighted by the lookout. In this case the MMO would report the sighting to the lookout for appropriate reporting and action.

The MMO survey was conducted on the bridge wing of the RUSSELL (66 feet [ft] above water's surface), with one MMO on each wing. During on-effort surveys, the MMOs would use the naked eye and 7X50 powered binoculars to scan the area from dead ahead to just abaft of the beam. In searching this area, the MMOs would start at the forward part of the sector and search aft. Binoculars were held so that the horizon was in the top third of the field of view. The field of view was scanned from the horizon towards the ship. Once the field of view was scanned, the binoculars were repositioned and the field of view was scanned again (Figure 1). Once the scan with the binoculars was completed, the eyes were rested for a few seconds and the entire sector was scanned with the naked eye.

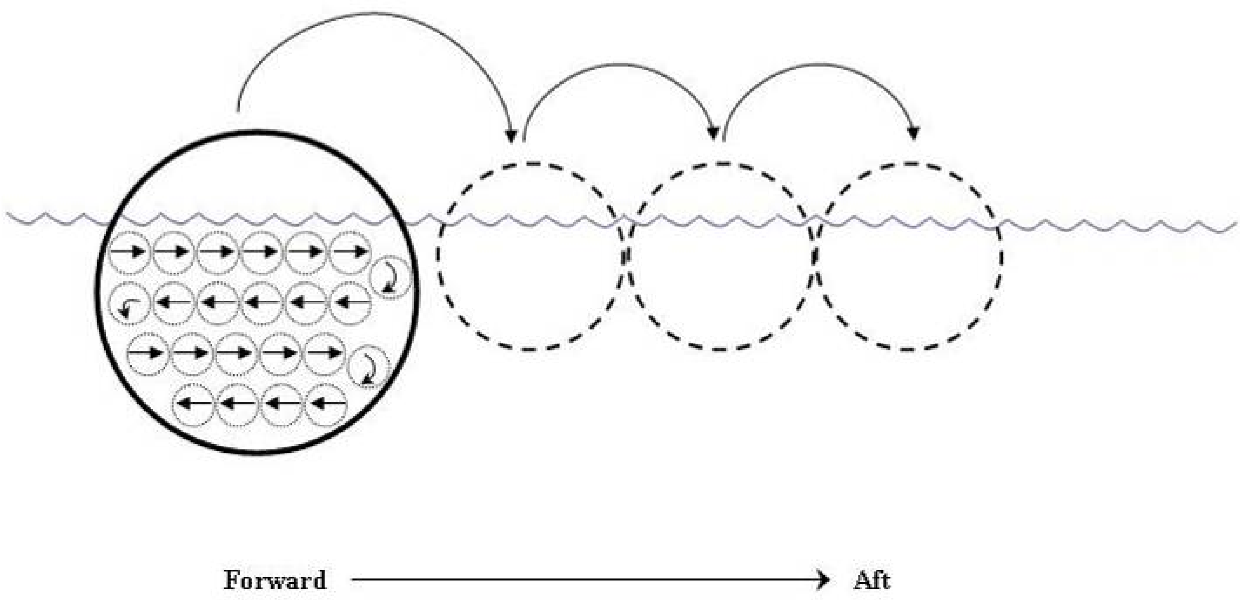

Figure 1. MMO Surface Searching Procedure

When an animal was visually detected, the MMO would collect information on twenty-three sighting, environmental, and sonar parameters (Table 1). When practical, still photography was obtained by the MMO using a Canon EOS Rebel XTi digital camera with 18-55 mm zoom lens.

In addition to collecting data on each sighting, the MMOs alerted the survey aircraft via a hand-held avionics VHF radio (Section 3.3) to the location of the animal(s) so that the aircraft could conduct a focal follow of the animal. If the aircraft was currently in a focal follow and another sighting was made, the aircraft would wait until the first focal follow was complete before heading to the second sighting. MMOs were not to inform the survey aircraft of the ships operations, particularly if MFAS was in use, so as to not bias any behavioral observations made by the survey aircraft.

Table 1. Shipboard MMO Data Category Descriptions

Data Category	Description
Sightings Information	
Effort (on/off)	On effort means actively searching for marine mammals; time spent off effort could result from vacating the bridge wing for operational reasons.
Date	Format in mm/dd/yy.
Time	Time provided in Hawaii Standard Time (HST).
Location	This is the location of the RUSSELL at the time of the sighting, provided by monitors on the bridge.
Detection Sensor	Either visual or aural (if detected passively by the sonar technician) and which MMO observed the animal.
Species/Group	Determined by the MMO.
Group Size	Estimated by the MMO.
# Calves	Estimated by the MMO.
Bearing (true)	Estimated by the MMO.
Distance (yds)	Estimated by the MMO; reticled binoculars or other measurement devices not available.
Length of contact	Estimated by the MMO.
Environmental Information	
Wave height (ft)	Estimated by the MMO.
Visibility	Estimated by the MMO.
BSS	Estimated by the MMO.
Swell direction (true)	Estimated by the MMO.
Wind direction (true)	Estimated by the MMO.
Wind speed (kts)	Provided by monitors on the bridge.
% glare	Estimated by the MMO.
% cloud cover	Estimated by the MMO.
Operational Information	
Active sonar in use?	Specifically refers to MFAS.
Direction of ship travel	Provided by monitors on the bridge.
Animal motion	Estimated by the MMO.
Behavior	Individual behaviors: breach, porpoise, spin, bowride, feeding, head slap, social, tail slap, pectoral fin slap, other Whale behaviors: blow, no blow rise, fluke up, peduncle arch, unidentified large splash Group behaviors: rest, mill, travel, surface active travel, surface active mill
Mitigation implemented	If MFAS in use, the measures implemented, if any, but the RUSSELL.
Comments	Other comments as necessary.

3.2. AERIAL MARINE MAMMAL MONITORING

The primary goals of the aerial monitoring were to locate and identify marine mammals and sea turtles during the training exercise, and to monitor and report observations of their behavior. This included monitoring for any potentially injured or harmed marine mammals and sea turtles and any unusual behavior or changes in behavior, distribution, numbers, and species associations of animals observed during the training exercise.

The survey was undertaken from a twin-engine, fixed-wing Partenavia P68 Observer previously used to conduct numerous aerial surveys for marine mammals and sea turtles on behalf of the Navy in Hawaii and elsewhere (Mobley Jr 2004, 2008). The survey occurred from 16-19

February 2009. Ancillary near shore observations (not associated with SCC 09-1) were conducted while transiting back and forth from RUSSELL.

The SCC 09-1 exercise involved multiple large naval vessels, submarines, and both fixed-wing (P-3) and rotary-wing (helicopters) aircraft. Thus, coordination of airspace use was paramount to the safety of all aircraft involved. In general, the airspace was divided into altitude strata, such that the helicopters would remain below 500 ft, the survey aircraft would remain between 1000-2000 ft, and the P-3 aircraft would remain above 3000 ft. However, when the P-3 aircraft were required to fly at lower altitudes to satisfy mission requirements, the P-3, survey aircraft, and range control would coordinate to ensure each aircraft could safety maneuver to the other stratum. Each morning, the survey aircraft would communicate with range control to determine the location of the RUSSELL and to verify the altitude in which they would enter the range.

Upon locating the RUSSELL, visual observations for marine mammals and sea turtles were conducted using two approaches (i.e., modes): search mode and focal follow mode. The purpose of the first mode was to systematically search for animals by flying elliptical, “race track” shaped patterns in front of the RUSSELL. The goal of this flight pattern was to cover a swath extending from the shutdown zone 1500 yds in front of the ship out to 3000 yds and ~2 nautical miles (nm) wide. The pilot manually flew this pattern and frequently had to adjust the pattern to non-systematic and unpredictable changes in speed and headings of the RUSSELL as it conducted training exercises. This mode was to be maintained until a marine mammal/sea turtle sighting was made either by the aircraft or the shipboard MMOs, or until there was a potential conflict with naval airspace.

When a sighting was made, the aircraft was to cease the flight search pattern and begin circling the sighting following focal follow behavior mode. The latter protocol has been successfully implemented during previous aerial studies monitoring the behavior of cetaceans, including near anthropogenic stimuli (e.g., oil and gas exploration activities and sounds, oil spills) (Richardson 1985; Richardson et al. 1985; Würsig et al. 1985; Richardson et al. 1986; Würsig et al. 1989; Richardson et al. 1990; Smultea and Würsig 1995; Patenaude et al. 2002). The objective was to circle the sighting and record detailed behavioral observations using a digital video camera and paper data forms.

In addition to this Navy cruise report focusing on ship-board activities, the aerial survey contractor (Dr. Joseph Mobley, University of Hawaii) will provide a comprehensive scientific report detailing their methods, observations, and recommendations.

3.3. COMMUNICATIONS

Communication between RUSSELL officers and MMOs was accomplished during meals in the wardroom and on the ship’s bridge as required.

After experimenting with satellite telephone and hand-held avionics VHF radios, it was determined that the avionics VHF radio was the most reliable method of communicating between RUSSELL MMOs and the aircraft. The satellite telephone did not always make a connection when calling the other party and was a very expensive means of communication. As such, it was considered the back-up communications device. Efforts were made to integrate the avionics

VHF radio into the RUSSELL communications network but this was not possible because the ship system was FM based and the avionics VHF was AM based.

3.4. SCHEDULE OF EVENTS

RUSSELL departed Pearl Harbor, Hawaii, on 15 February at 1830 Hawaii Standard Time (HST). SCC 09-1 operations commenced on 16 February at 0725 and were suspended at 0750 on Thursday, 19 February, with intermittent periods of no MFAS use. RUSSELL then proceeded thru the Kaulakahi Channel toward Oahu for at-sea refueling. During this time, MMO (Jameson) requested the ship use MFAS periodically, as a greater chance of marine mammal sightings were expected in the channel and the potential for observing behavioral reactions would also be greater. MFAS was operated, after leaving the Channel, for approximately 10 minutes (using normal duty cycles) on the hour from 1200 through 1400, at which time MMOs requested MFAS cease, as sea state and vessel location were not optimal for sighting marine mammals and sea turtles. Gunnery Exercises (GUNNEX) using the 5 inch bow gun and the mid-ships Gatling gun were conducted on 20 February, followed by ship Towing Exercises (TOWEX) and return to Pearl Harbor. A detailed schedule of events is provided below in Table 2.

Table 2. Schedule of Events

16 February	
Time	**Notes**
0700	MMOs on effort
0725	Marine Mammal Watch Set
0825	Survey aircraft on effort
1115	MMOs and survey aircraft off effort
1300	MMOs on effort
1330	Survey aircraft on effort
1600	Survey aircraft off effort
1630	MMOs off effort

17 February	
Time	**Notes**
0700	MMOs on effort
0800	Low visibility detail stationed
1046	Marine Mammal Watch Set
1130	MMOs off effort
1215	Survey aircraft on effort
1300	MMOs on effort
1445-1515	MMO (Farak) off effort
1500	Survey aircraft off effort
1630	MMOs off effort
2000	Marine Mammal Watch Secured
2230	Marine Mammal Watch Set

18 February	
Time	**Notes**
0700	MMOs on effort
0825	Survey aircraft on effort
0909	Marine Mammal Watch Secured
1130	MMOs and survey aircraft off effort
1137	Marine Mammal Watch Set
1200	MMO on effort
1348	Survey aircraft on effort
1413	Low Visibility Detail Set
1420	Survey aircraft off effort
1630	MMOs off effort
1920	Marine Mammal Watch Secured

19 February	
Time	**Notes**
0100	Marine Mammal Watch Set
0700	MMOs on effort
0750	FINEX (MFAS secured)
0808	Marine Mammal Watch Secured
0900	Survey aircraft on effort
1145	MMOs and survey aircraft off effort
1200	Marine Mammal Watch Set
1208	MFAS as requested*
1245	MMOs on effort
1410	MFAS Secured, Marine Mammal Watch Secured
1430	Survey aircraft on effort but immediately turns around becasue of high winds and distance offshore
1600	MMOs off effort

* MFAS requested by MMO (Jameson)

20 February	
Time	**Notes**
0700	MMOs on effort
0815	GUNNEX commence, Lookouts present
0830	GUNNEX FINEX
0930	TOWEX commence
1045	MMOs off effort
1200	TOWEX; MMOs on bridge, but visibility restricted (off effort)
1440	MMOs on effort, TOWEX FINEX
1600	MMOs off effort
1700	Arrived dockside

SECTION 4: RESULTS

4.1. SHIPBOARD MARINE MAMMAL MONITORING

Ship position reports were requested by and provided to the MMOs at 0800, 1200, and 1600 for each day at sea (Table 3). These reports allow for a rough ship track to be identified (Figure 2).

Nine marine mammal and sea turtle sightings were recorded by the MMOs (Table 4 and Table 5). Eight of these sightings were of humpback whales, which were primarily sighted within the Kaulakahi Channel between Kauai and Niihau (Figure 2). The one remaining sighting was of a small hardshell sea turtle, of which species could not be identified. HMCS YUKON reported numerous whale sightings during MFAS use, and reported these sightings to the RUSSELL. However, YUKON sighting reports were frequently transmitted to RUSSELL much later than when the sighting was made, or when the survey aircraft was not on station, and therefore could not be verified by the survey aircraft.

4.2. AERIAL MARINE MAMMAL MONITORING

Sightings and focal follow information will be reported by the contractor under a separate report.

On 19 February during a focal follow survey at approximately 1000, the survey aircraft contacted the MMOs and requested information on operational information (if the ship was active), as “interesting” behaviors were being observed for a pod of humpback whales. One of the MMOs (Jameson) responded indicating that the RUSSELL was not engaged in MFAS operations and that this knowledge should not be used to change the original recorded observational data of the aircraft observers. Aircraft observer (Mobley) responded back and confirmed that their recorded observation would not be changed based on this knowledge. Therefore, the analysis in the survey aircraft’s final report needs to reflect this agreement.

Table 3. Ship Position Report

Map ID*	Date	Time	Closest Point of Land	Location/ Heading	Heading	Barometric Pressure/ Temperature	Wind Speed/ Direction	Beaufort Sea State
1	02/16/09	0700	30.4 nm NW of Kauai	22° 40.1′N 159°55.2′W	190°T	30.14/72°F	19 kts/083°T	5
2	02/16/09	1100	15.0 nm NW of Kauai	22° 17.3′N 159°58.1′W	270°T	30.25/73°F	20 kts/099°T	5
3	02/16/09	1600	26.5 nm NW of Kauai	22° 30.4′N 159°58.9′W	180°T	30.09/73°F	17 kts/083°T	5
4	02/17/09	0855	37.19 nm NW of Kauai	22° 42.2′N 160°02.6′W	150°T	30.14/73°F	13 kts/093°T	5
5	02/17/09	1130	21.0 nm NW of Kauai	22° 30.7′N 159°55.7′W	166°T	30.14/74°F	22 kts/070°T	6
6	02/17/09	1600	25.0 nm NW of Kauai	22° 30.8′N 159°55.8′W	223°T	30.13/75°F	26 kts/075°T	6
7	02/18/09	0700	27.0 nm NW of Kauai	22° 41.1′N 159°47.4′W	000°T	30.06/71°F	20 kts/069°T	5
8	02/18/09	1100	29.0 nm NW of Kauai	22° 25.0′N 159°54.8′W	180°T	30.10/71°F	19 kts/043°T	5
9	02/18/09	1600	26.0 nm NW of Kauai	22° 36.0′N 159°53.2′W	180°T	30.00/71°F	32 kts/050°T	7
10	02/19/09	0710	22.2 nm NW of Kauai	22° 26.6′N 159°58.4′W	090°T	30.04/70°F	25 kts/045°T	6
19	02/19/09	1200	24.0 nm N of Niihau	21° 37.9′N 159°52.5′W	180°T	29.99/73°F	23 kts/043°T	6
21	02/19/09	1600	57.0 nm S of Kauai	20° 58.7′N 159°48.4′W	065°T	29.90/73°F	21 kts/061°T	5
22	02/20/09	0700	47.0 nm S of Oahu	20° 36.0′N 158°19.6′W	090°T	29.94/71°F	8 kts/071°T	4
23	02/20/09	1200	15.0 nm S of Oahu	21° 02.6′N 158°07.4′W	025°T	29.98/70°F	11 kts/038°T	4
	02/20/09	1600	Pearl Harbor Entrance Channel					

* Map ID related to the labeled numbers in Figure 2.

Table 4. Marine Mammal Sightings Data – Sightings 1-5

Data Category	Sighting 1	Sighting 2	Sighting 3	Sighting 4	Sighting 5
Map ID[1]	11	12	13	14	15
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° 01.82′N 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				

1. Map ID related to the labeled numbers in Figure 2.
2. Directed survey aircraft to sighting.
3. Not observed by MMO, notified plane for focal follow

Table 5. Marine Mammal Sightings Data – Sightings 6-9

Data Category	Sighting 6	Sighting 7	Sighting 8	Sighting 9
Map ID[1]	16	17	18	20
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° 53.58′W	21° 56.8′N 159° 45.3′W	21° 56.27′N 159° 52.02′W	20° 59.59′N 158° 10.57′W
Detection Sensor	MMO (Farak)	MMO (Jameson)	Navy Lookout	Navy CO
Species/Group	Humpback whale	Humpback whale	Humpback whale	Unidentified Hardshell Turtle
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. Map ID related to the labeled numbers in Figure 2.
2. Still photos attempted; distance did not allow for decent picture
3. Not observed by MMO, notified plane for focal follow
4. MMO not at bridge wing rail during towing exercise. CO spotted turtle next to ship and notified MMO.

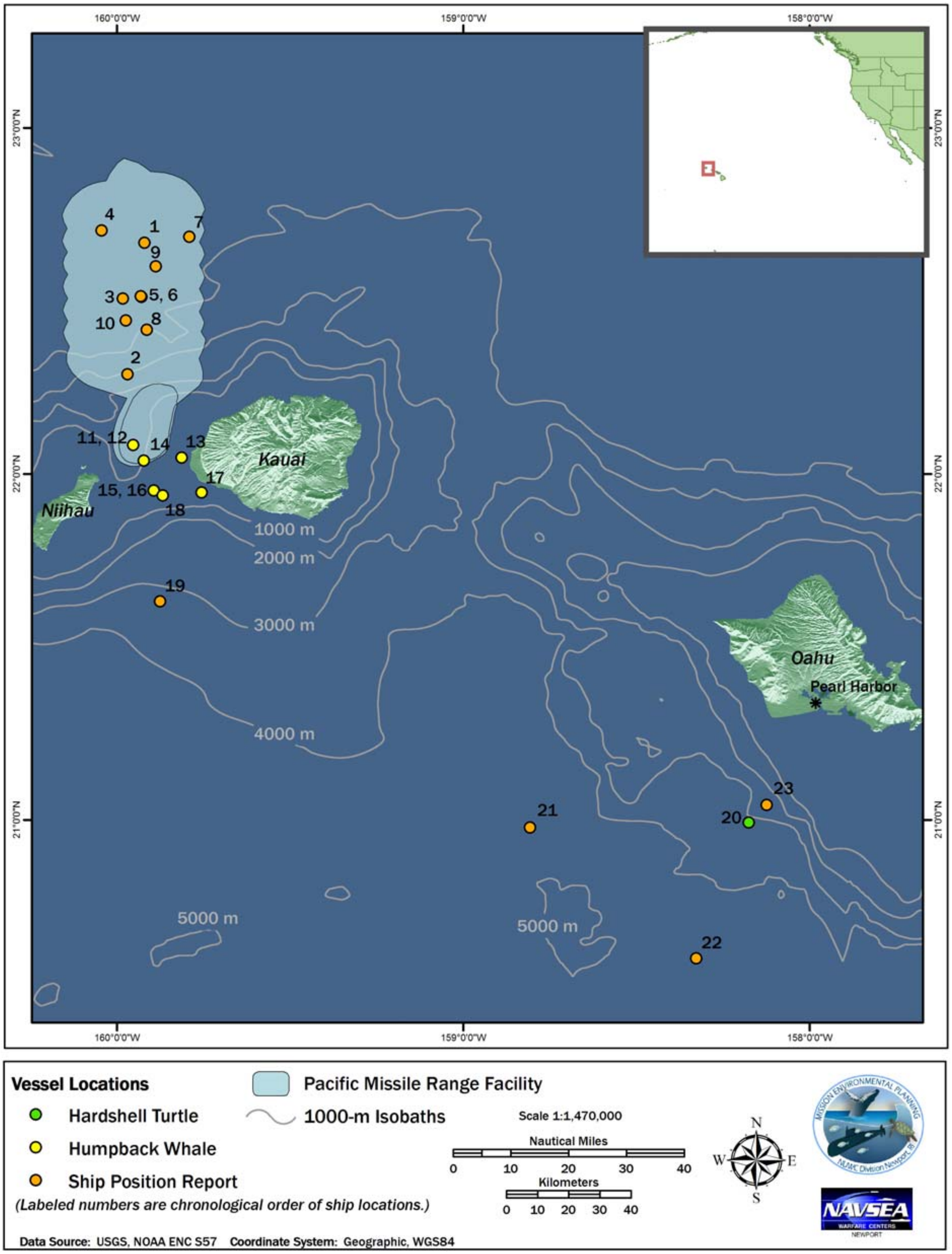

Figure 2. Vessel Locations at Sighting and Position Reports

SECTION 5: CONCLUSION

5.1. MARINE MAMMAL MONITORING

The goals of the SCC 09-1 monitoring effort are provided below, with a conclusion regarding each of the goals:

1. Coordinate transit to the Pacific Missile Range Facility (PMRF) to allow RUSSELL and survey aircraft opportunity to test communications and familiarize ship to transect profiles (ship should be active)

   RUSSELL departed Pearl Harbor at 1830 on 15 February. The nighttime transit from the harbor to the PMRF did not allow for the survey aircraft to familiarize itself with the ship transect profiles. Communications were discussed and tested following the pre-sail meetings on 13 February.

2. Collect data on marine mammals observed during operations

   a. Are marine mammals and sea turtles exposed to MFAS?

      No marine mammal or sea turtle sightings were obtained by RUSSELL MMOs during MFAS operations (one humpback whale pod observation was obtained by the survey aircraft on 16 February). Distance from prime marine mammal habitat (primary reason) and sea conditions (secondary reason) severely limited the number of potential ship and aerial sightings during SCC 09-1 operations.

   b. If so, at what levels?

      No marine mammals or sea turtles were observed.

   c. Did exposed marine mammals/sea turtles show a behavioral response?

      No marine mammals or sea turtles were observed.

3. Achieve close coordination between the contracted aerial survey team, Navy aircraft on the range, range control, and the MMO team aboard RUSSEL to facilitate maximizing survey time and project safety

   Communications with the survey aircraft proved successful, as sightings made by the MMOs were successfully transmitted to the survey aircraft, which was then able to locate the animals. Communication between the survey aircraft, range control, and other aircraft was successful, maintaining safety of all participants.

5.2. LESSONS LEARNED

Many lessons learned were noted for the SCC 09-1 exercise, and are separated into those for shipboard monitoring, aerial monitoring, and operational information below.

5.2.1. Shipboard Marine Mammal Monitoring

- Given the layout of the DDG bridge, MMOs need to be located out on the bridge wing during on-effort surveys. The view from the pilot house does provide 180° view from port to starboard, but window pillars and personnel obstruct the view for the MMOs. Additionally, the lookouts are required to be on the bridge wing during MFAS use, and the MMOs would need to also be in this location to attempt any comparison between observers.

- Methods are needed to improve the distance estimation by MMOs. Reticled binoculars, binoculars with range-finders, or other means are needed to more accurately estimate distance to sightings.

- Any study designs to determine lookout effectiveness (as required by NMFS) should incorporate supervisor behavior, as well as lookout behavior, to determine if supervisors are enforcing the requirements of the lookout consistently among the watches.

- Verification of coordinates (for both MMO sightings and ship position reports) were required after the cruise for inclusion in this report. A method of minimizing errors in position is needed. One potential solution would be for the MMOs to have Global Positioning System (GPS) locations automatically recorded at set intervals to generate a trackline. Additionally, the position could be manually entered when a sightings is made.

- The experimental design did not attempt to reduce or eliminate other potential confounding factors in the environment (e.g., ship/aircraft noise/presence, other natural environmental factors, predators). As such, any observations of marine mammal responses cannot be validated as due to MFAS alone. In addition, no control was used in the experimental design.

5.2.2. Aerial Marine Mammal Monitoring

- The survey aircraft was limited by weather conditions (morning of 16 February, afternoon of 18 February, afternoon of 19 February), mechanical problems (magneto repair on the morning of 17 February) and distance from shore (afternoon of 19 February). Future aircraft contracts should be for air time provided, not for a fixed cost. It would also be more efficient to award one annual contract to cover survey aircraft services, rather than individual project contracts.

- Transit from port to the training location occurred at night, which caused a full day of surveys to be lost. Recommend using MMOs and survey aircraft when vessels will transit during daylight, as more animals are likely seen closer to shore during transit.

5.2.3. Operational Information

- Marine Species Awareness Training (MSAT) was not viewed at the beginning of this exercise. It was indicated that the training was provided the week prior during a different training event.

- Recommendations for updates to the MSAT include: (1) having a one-button playback of the entire DVD, so that it can be streamed throughout the ship without needing someone to click through the training, (2) tailoring the training to brand new lookouts, who, according to one lookout, are unsure what to do when an animal is spotted.

- Future marine mammal monitoring would be better suited to areas nearer prime marine mammal habitat (e.g., Kaulakahi Channel) to improve the cost effectiveness of the effort.

SECTION 6: ACKNOWLEDGEMENTS

We thank the officers and crew of the USS RUSSELL (DDG 59) for their outstanding support and hospitality during this cruise and Ms. Julie Rivers (CPF) and LCDR Rob Thompson (CPF) for pre-cruise planning.

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APPENDIX E HRC MOBILE DIVING AND SALVAGE UNIT MMO MONITORING JUNE 2009

August 2009

Cruise Report
Marine Mammal Observer UNDET Monitoring
Hawaii Range Complex

Prepared for:
Commander, Pacific Fleet

Prepared by:
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Ms. Julie Rivers, Commander, Pacific Fleet

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List of Acronyms and Abbreviations

AM	amplitude modulated
CO	Commanding Officer
FM	frequency modulated
ft	feet
HRC	Hawaii Range Complex
HST	Hawaii Standard Time
kts	knots (nautical miles per hour)
MDSU	Mobile Diving Salvage Unit
MFAS	mid-frequency active sonar
MMO	Marine Mammal Observer
nm	nautical miles
NMFS	National Marine Fisheries Service
PMAP	Protective Measures Assessment Protocol
UNDET	Under Water Detonation
VHF	very high frequency
yd(s)	yards

SECTION 1: INTRODUCTION

In order to train with mid-frequency active sonar (MFAS), the Navy has obtained a permit from the National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act and Endangered Species Act. The Hawaii Range Complex (HRC) Monitoring Plan, finalized in December 2008 for implementation in January 2009, was developed with NMFS to comply with the requirements under the permit. The monitoring plan and reporting will provide science-based answers to questions regarding whether or not marine mammals are exposed and reacting to Navy MFAS. The objectives of the monitoring plan are to answer the following questions:

1. Are marine mammals and sea turtles exposed to MFAS at regulatory thresholds of harm or harassment? If so, at what levels and how frequently are they exposed?

2. If marine mammals and sea turtles are exposed to MFAS in the HRC, do they redistribute geographically in the HRC as a result of repeated 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? Are they different at various levels?

4. What are the behavioral responses of marine mammals and sea turtles that are exposed to various levels and distances from explosives?

5. Are the Navy's suite of mitigation measures for MFAS and explosives (e.g., Protective Measures Assessment Protocol [PMAP], measures agreed to by the Navy through permitting and consultation) effective at avoiding harm or harassment of marine mammals and sea turtles?

The Marine Mammal Observers (MMOs) effort provided data towards question 5 above.

SECTION 2: METHODS

2.1. MARINE MAMMAL OBSERVERS

MMO monitoring was conducted from a shipboard platform. In one instance MMOs were allowed to observe from the explosives and blast cap boats providing a direct vantage point of what was involved in the UNDET training and the mitigation measure in place. Shipboard observations occurred from small boats (less than 30 ft)All MMOs had a pair of 7x50 binoculars, data entry sheets (Table 1), clipboard, watch, and access to VHF communications with the other boats. MMOs were on effort throughout the duration of the day, from the time they left the dock till the time they got back. MMOS recorded all sightings by MMOs or Navy lookouts and noted whether mitigation measures were in place.

2.2. AERIAL AND VESSEL MARINE MAMMAL MONITORING SURVEYS

Vessel and aerial monitoring surveys were also conducted during this effort. The vessel survey was conducted by NMFS using 7x50 binoculars. The aerial survey was conducted by Marine

Mammal Research Consultants (MMRC) from a helicopter with three observers on board. The helicopter was based out of Honolulu International Airport and conducted line-transect surveys at approximately 1000 feet above sea level, within the Puuloa Training area (Figure 1). Aerial and vessel survey reports are provided separately.

2.3. COMMUNICATIONS

Communication between MMOs, MDSU, and NMFS was accomplished via VHF radio or direct communication with navy personnel on the boat. Communications between the aerial survey team and the MMO we performed using cell phone text messaging.

SECTION 3: RESULTS

3.1. VESSEL AND AERIAL MARINE MAMMAL MONITORING UNDET I

UNDET I Monitoring Participants

MMOs

- Julie Rivers (CPF)
- Jennifer Steele (NAVFAC Pacific)
- Anurag Kumar (NAVFAC Atlantic)

Navy Vessels Involved in UNDET training

- Whaler 27 ft (4 Navy Ops personnel and 2 Navy Biologist MMOs on June 18 and 1 on June 19)
- RHIB 24 ft (3 Navy Ops personnel and 1 Navy Biologist MMO)

Contracted Research Vessel

- NOAA 23 ft (4 Civilian Biologists)

DESCRIPTION OF ACTIVITY

Marine Diving and Salvage Unit One (MDSU 1) performed three underwater detonation (UNDET) events each on 18-19 June 2009 for a total of six UNDET events just south of Ewa beach in the center of the Puuloa training area (Figure 1). For safety, two boats are required when setting UNDET. The first boat (whaler [Figure 2]) had the 20 lbs charges and the second boat (Ridged Hull Inflatable Boat [RHIB]) has the blast caps. We departed at 0945 out to the range. Seas started out at BF 3-4 with about 2-3’ swell. There were four Navy divers on the RHIB. The first thing we did was set the buoy for the UNDET 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 explosive moved in to set the charge. The RHIB continued in a circle around the exclusion zone. They had two guys 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 UNDET 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 (Figure 3). Once everything is connected (Figure 4) the fuses are pulled and the divers swim immediately to the boat (Figure 5). The fuse has five minute timer before detonation. We move to a safe distance, roughly 200 yards and waited for the blast (Figure 6). They noticed an inbound private boat heading toward the UNDET site and immediately chased them away. After detonation the RHIB moves in immediately to recover expended materials from the blast cap (Figure 7). After that the RHIB continues to survey the area as the boat with the explosives moves back in towards the UNDET site to set another charge. By this time sea state was 4-5, with about a 4-5’ swell.

During the second UNDET, the whaler spotted another sea turtle within exclusion zone and the clock started again since they last saw the turtle. Almost after 30 minutes after second UNDET event the whaler spotted a group of about 10-20 spinner dolphins heading towards the site. Operations were halted till the dolphins cleared the range. The National Oceanic and Atmospheric Administration (NOAA) boat kept up with them as they moved out of the range (Figure 8 and 9). The RHIB 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 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’. The UNDET training concluded at around 1500.

Only a few dead fish were noticed at the surface and at the bottom. The UNDET site 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. The seas were in general rougher (Beaufort 6 with ~ 6’ swell) than the day before. Visibility was very poor from any vessel in the training area. When we 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 moved within 300 yards of the UNDET site. The RHIB had to chase them away and ask them to recall their diver. They were in a restricted area and a Notice to Mariners (NOTMAR) was issued. They then continued to monitor for the rest of the 30 minute period. Aerial surveys were conducted via helicopter on this day starting at 8am. I was able to coordinate with the aerial survey via txt messaging and gave them a five minute warning before detonation. They were able to observe the first UNDET and then had to refuel. Refueling took longer than anticipated and they unfortunately missed the next two UNDETs and were back on station one minute after the last UNDET. For all three UNDETs, neither the whaler, RHIB, nor the NOAA vessel saw any marine mammals or sea turtles during the monitoring period. UNDETs concluded at 1330. The aerial survey saw only sea turtles out on the site and continued to monitor the site till 1600. They commented that the plumes from the UNDET could be visible for approximately an hour as it drifted with the current (Figure 10).

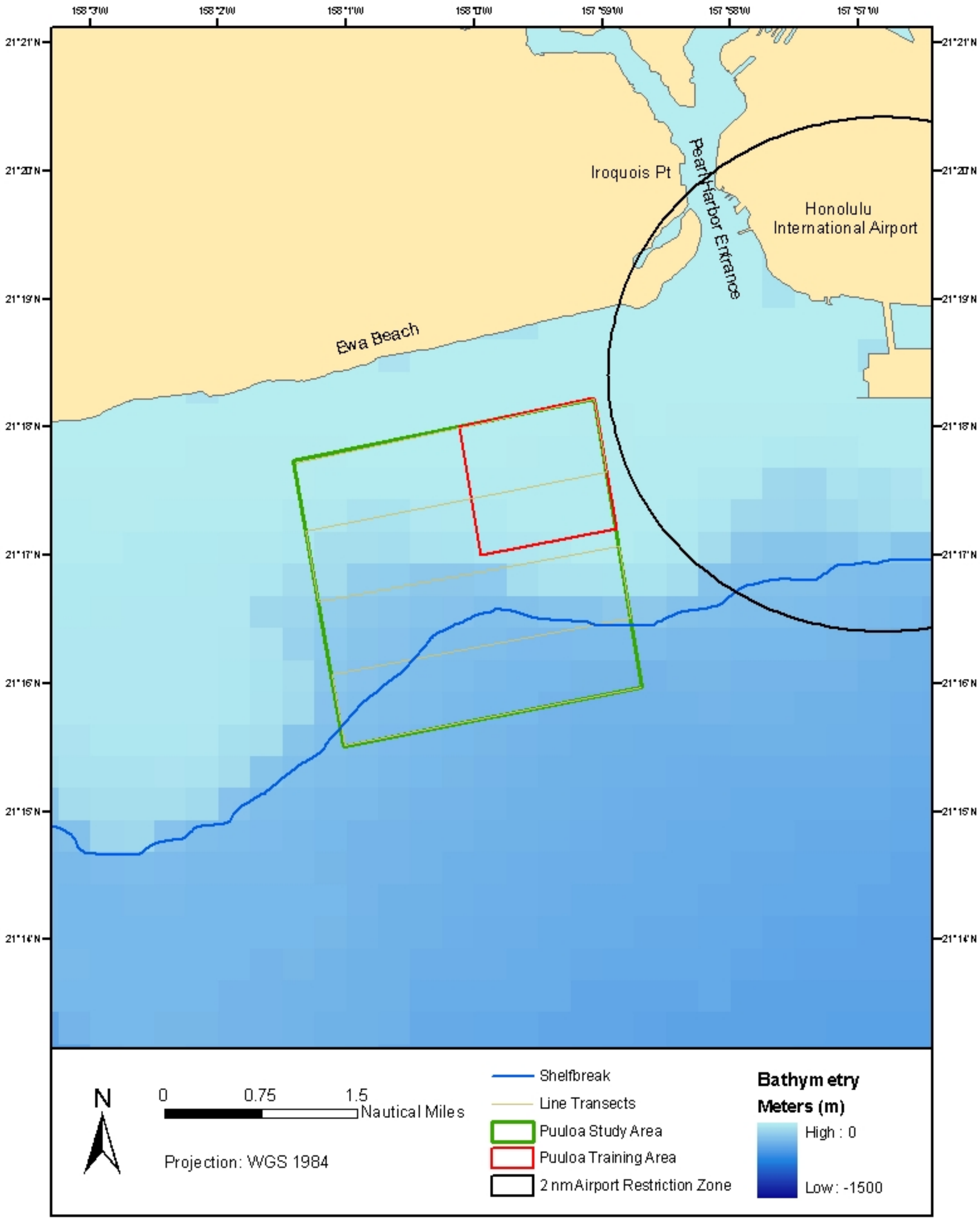

Figure 1. UNDET location in the center of the Puuloa training area.

Figure 2. Whaler with 20 lbs charges.

Figure 3. Blasting cap from RHIB.

Figure 4. Divers in water connecting blasting cap.

Figure 5. Five minute fuse lit, diver swimming immediately to RHIB.

Figure 6. 20 lbs UNDET.

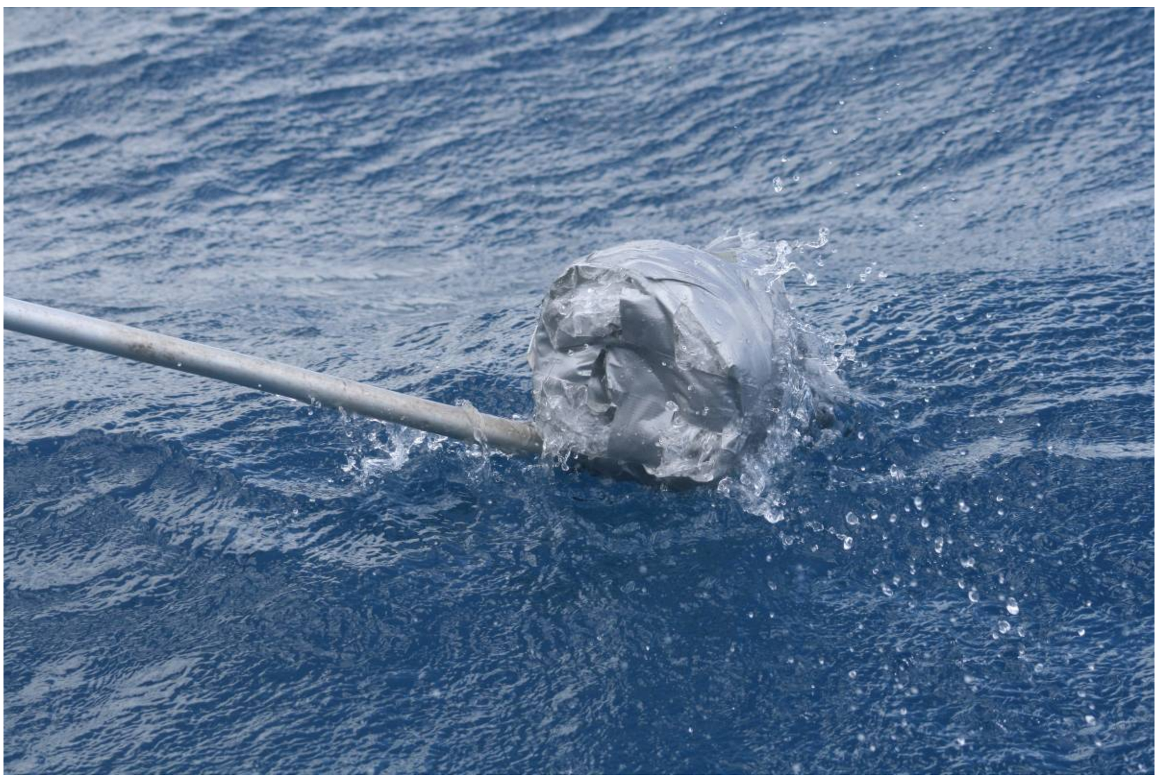

Figure 7. Collection of expended materials floating at the surface.

Figure 8. NOAA survey vessel.

Figure 9. Spinner dolphins spotted within the exclusion zone prior to UNDET. UNDET delayed until dolphins were outside 700 yard exclusion zone.

Figure 10. Example of the plume immediately post UNDET.

Table 1. Shipboard MMO Data Category Descriptions

Data Category	Description
Sightings Information	
Effort (on/off)	On effort means actively searching for marine mammals; time spent off effort could result from vacating the bridge wing for operational reasons.
Date	Format in mm/dd/yy.
Time	Time provided in Hawaii Standard Time (HST).
Location	This is the location of the MMO at the time of the sighting, provided by monitors on the bridge.
Detection Sensor	Either visual or aural (if detected passively by the sonar technician) and which MMO observed the animal.
Species/Group	Determined by the MMO.
Group Size	Estimated by the MMO.
# Calves	Estimated by the MMO.
Bearing (true)	Estimated by the MMO.
Distance (yds)	Estimated by the MMO; reticled binoculars or other measurement devices not available.
Length of contact	Estimated by the MMO.
Environmental Information	
Wave height (ft)	Estimated by the MMO.
Visibility	Estimated by the MMO.
BSS	Estimated by the MMO.
Swell direction (true)	Estimated by the MMO.
Wind direction (true)	Estimated by the MMO.
Wind speed (kts)	Provided by monitors on the bridge.
% glare	Estimated by the MMO.
% cloud cover	Estimated by the MMO.
Operational Information	
Direction of ship travel	Provided by monitors on the bridge.
Animal motion	Estimated by the MMO.
Behavior	Individual behaviors: breach, porpoise, spin, bowride, feeding, head slap, social, tail slap, pectoral fin slap, other Whale behaviors: blow, no blow rise, fluke up, peduncle arch, unidentified large splash Group behaviors: rest, mill, travel, surface active travel, surface active mill
Mitigation implemented	Measures implemented.
Comments	Other comments as necessary.

3.2. VESSEL MARINE MAMMAL MONITORING UNDET II

UNDET II Monitoring Participants

Navy Vessels Involved in UNDET training on July 9th, 2009

- Whaler 27'(4 Navy Ops personnel)
- RHIB 24' (3 Navy Ops personnel)
- RHIB 24' (1 Navy Ops personnel and 3 Navy Biologists)

MMOs

- Anurag Kumar (NAVFAC Atlantic)
- Steven Jameson (NAVFAC Pacific)
- CDR Jeffrey Juhala (Former veterinarian, visiting MDSU 5)

Contracted Research Vessel

- NOAA 23 ft (4 Civilian Biologists)

Contracted Small Aircraft

- Helicopter (3 Civilian Biologists and 1 pilot on June 19)

DESCRIPTION OF ACTIVITY

10:15 On station. Blast cap boat attempted to clear fish farm, no one was on deck to notify.

10:27 MMO saw green sea turtle about 100 ft from observation boat and 200 yards from UNDET site. Blast cap and charge boats were unable to see same turtle.

10:45 UNDET marker buoy went in the water. Blast cap boat started 30-minute sweep. Cleared fish farm

11:15 MMO saw green sea turtle about 100 ft from observation boat and greater than 700 yards from UNDET site.

11:22 MMO saw bottlenose dolphins near UNDET buoy moving towards Waikiki and away from the blast cap boat. Blast cap boat was unable to see them and also was busy setting up the blasting caps. Navy personnel on MMO boat were notified, however Navy personnel did not communicate to blast cap boat. If the bottlenose dolphins remained in the exclusion zone before divers went in the water, MMOs would have asked to intervene. MMOs followed their moment away from the UNDET site and noted that they were well outside the 700 yard exclusion zone before the divers went in the water. Therefore for the blast cap boat was not notified till after the UNDET.

11:37 UNDET event number one detonated. Blast cap boat went in to recover expended materials and commenced 30-minute monitoring period. Blast cap, charge, and MMO boat did not see any marine mammals or sea turtles

12:16 UNDET event number two. Blast cap boat went in to recover expended materials and commenced 30-minute monitoring period. Blast cap, charge, and MMO boat did not see any marine mammals or sea turtles

13:00 UNDET event number three attempted, but misfired. MDSU SOP is to wait 30-minutes before sending divers to investigate cause of misfire. During this time, they announced that they were monitoring for marine mammals and sea turtles at the time. Cause of misfire was poor connection at blast cap. Blast cap, charge, and MMO boat did not see any marine mammals or sea turtles

13:50 UNDET event number three reattempted and was successful.

Table 2. Marine Species Sightings Data – UNDET I

Data Category	Sighting 1	Sighting 2	Sighting 3
Effort (on/off)	on	on	on
Date	06/08/09	06/08/09	06/08/09
Time	10:26	10:50	13:09
Location	Inside Exclusion Zone	Inside Exclusion Zone	Inside Exclusion Zone
Detection Sensor	Navy Lookout	Navy Lookout	Navy Lookout
Species/Group	Green sea turtle	Green sea turtle	Spinner dolphins
Group Size	1	1	15
# Calves	0	0	undetermined
Bearing (true)	n/a	n/a	n/a
Distance (yds)	>10 from UNDET site	100 SW from UNDET site	150 from UNDET site
Length of contact	5 min	1 min	4 min
Wave height (ft)	4	4	4
Visibility	unrestricted	unrestricted	unrestricted
BSS	4	4	6
Swell direction (true)	SE	SE	SE
Wind direction (true)	SE	SE	SE
Wind speed (kts)	15 - 20	15 - 20	20-25
% glare	0	0	0
% cloud cover	20	20	20
Fish present	Yes	Yes	Yes
Animal motion	unknown	unknown	unknown
Behavior	Body	Body	Splashing, spinning
Mitigation implemented	Yes	Yes	1.5 hour wait period as R/V tracked pod till outside exclusion zone

Table 3. Marine Species Sightings Data – UNDET II

Data Category	Sighting 1	Sighting 2	Sighting 3
Effort (on/off)	on	on	on
Date	02/19/09	02/19/09	02/19/09
Time	10:27	11:15	11:22
Location			
Detection Sensor			
Species/Group	Green sea turtle	Green sea turtle	Bottlenose dolphins
Group Size	1	1	8
# Calves	0	0	undetermined
Bearing (true)	undetermined	undetermined	East
Distance (yds)	200 from UNDET site	>700 from UNDET site	<10 from UNDET site
Length of contact	30 seconds	30 seconds	4 minutes
Wave height (ft)	4-5	4-5	4-5
Visibility	unrestricted	10+	unrestricted
BSS	4-5	4-5	4-5
Swell direction (true)	SE	SE	SE
Wind direction (true)	SE	SE	SE
Wind speed (kts)	15-20	15-20	15-20
% glare	0	0	0
% cloud cover	10	5	10
Direction of ship travel	n/a	n/a	n/a
Animal motion	unknown	unknown	unknown
Behavior	Body	Body	Splashing/jumping
Mitigation implemented	Yes, though not possible for Navy Lookout to see from their location	Yes, though not possible for Navy Lookout to see from their location	Yes, though not possible for Navy Lookout to see from their location

SECTION 4: CONCLUSION

4.1. MARINE MAMMAL MONITORING

The monitoring effort was successfully completed for 2009 with 40 hours of MMO time logged observing UNDET training within the HRC. MDSU 1 was very cooperative and helpful with the coordination of having MMOs aboard. NMFS was contracted to provide independent observers conducting vessel surveys in the vicinity of the UNDET location, and as a result, had the opportunity to conduct a focal follow of dolphins observed in the area.

In general, the UNDET training requires Navy divers to be vigilant with a number of safety considerations, not only for the environment, but for the personnel on board and civilians in the vicinity. Overall they knew the mitigation requirements well and followed them as described in the MMPA permit and Hawaii Range Complex EIS. The MMO time spent with the Navy divers help foster the understanding of why these mitigation measures are in place and how important these measures are to protecting marine life and Navy training.

4.2. RECOMMENDATIONS

Having the opportunity to have MMOs onboard one of the UNDET boats provided an opportunity to directly observe that the mitigation measures were implemented. In addition, having the MMOs on the same boats at the Navy lookouts gave both the opportunity to sight the same animal. After the first day of monitoring, MDSU deemed it to be unsafe to have MMOs on the same boats with explosives or blasting caps, and provided a third observation platform. Having the MMOs on a different platform than the Navy lookouts made it difficult to evaluate mitigation effectiveness, though it did provide an opportunity to have observers at an independent monitoring location within the exclusion zone. Quite often during UNDET II, MMOs would site an animal within the exclusion zone, that given the average sea state conditions, would be impossible for the Navy lookouts to see from their vantage point on the other side of the exclusion zone. Typically sea turtle would only be seen by MMOs with 40 yards, and small odontocetes within 200 yards of the platform. Dolphins were observed moving fast through the area on both days (spinners and bottlenose); in both cases the animals were first observed between the second and third detonations and were traveling steadily. The bottlenose dolphins were outside of the exclusion zone within five minutes.

Therefore, given an effective rage of detection of 200 yards, it is very possible for Navy lookouts monitoring near the perimeter of the exclusion (700 yds) zone to miss animals moving into the area. Our recommendation is that Navy lookouts should focus more of their time monitoring for marine species nearer to the UNDET site.

SECTION 5: ACKNOWLEDGEMENTS

We thank the officers and crew of MDSU 1 for their outstanding support and hospitality during this cruise and CDR Jared East (CPF) and Ms. Mandy Shoemaker (NAVFAC Atlantic) for pre-cruise planning.

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APPENDIX F HRC MAIN HAWAIIAN ISLANDS LINE TRANSECT SHIP SURVEY FEBRUARY 2009

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2009 Report to PACFLT: Data collection and Preliminary Results from the Main Hawaiian Islands Cetacean Assessment Survey & Cetacean Monitoring Associated with Explosives Training off Oahu[1]

Erin Oleson & Marie Hill
NOAA-NMFS-Pacific Islands Fisheries Science Center

This report covers two separate activities carried out by the Cetacean Research Program at the Pacific Islands Fisheries Science Center from February to June 2009. A cetacean assessment survey of the main Hawaiian Islands was conducted by NMFS in February 2009. The survey was designed to conform to the 2002 NMFS HICEAS survey (Hawaiian Islands Cetacean Ecosystem Assessment Survey) so that abundance and distribution estimates would be comparable. Following a request from the Navy, additional survey lines were added to assess the region east and north of Kauai, and these lines were surveyed to the extent possible. The data collection methodology and preliminary results are summarized here. No formal support was provided for this survey effort by PACFLT, though partial data analysis support was provided. In addition, protected species presence was monitored prior to and during two days of explosives training off Pearl Harbor, Oahu, to fulfill the Navy's Hawaii Range Complex monitoring plan under the MMPA and ESA. Full support for this activity was provided by PACFLT. Detailed analyses of the explosive events and the acoustic data collected during the cetacean assessment survey in February are still underway. A post-doctoral researcher and acoustic analysis technician were hired in late-July to analyze the cetacean assessment cruise data.

Main Hawaiian Islands Cetacean Assessment Survey- February, 2009

The Pacific Islands Fisheries Science Center Cetacean Research Program conducted a visual and acoustic line-transect assessment survey of cetacean populations within the inner waters of the main Hawaiian Islands (MHI) EEZ. The survey was carried out using the NOAA Ship *Oscar Elton Sette* (Cruise OES-09-01). The inner waters of the MHI were last surveyed in the summer and fall of 2002, yielding abundance estimates for most cetacean species found in those waters. Our intention in the February 2009 survey was to collect the distributional and presence data needed to develop updated abundance estimates for the same species to look at the potential of seasonal movements and population trends since 2002. During this survey, sighted groups of cetaceans were photographically identified to evaluate individual movements and estimate population size. Some individuals were also biopsied to collect tissue samples for genetic analyses of stock structure. The cruise was to be conducted February 5 to March 2; however, mechanical problems with the *Sette*'s engines forced us to return to port on February 27.

[1] PIFSC Internal Report IR-09-029
Issued 25 September 2009

Methods- Visual Survey

Line-transect survey methods were used to collect abundance data. At the beginning of each day search effort began on the trackline. The ship travelled at 9–10 knots (through the water) along the designated trackline.

A daily watch for cetaceans was maintained by scientific observers on the flying bridge during daylight hours (approximately 0700 to 1830), except when the ship stopped to conduct sampling operations or when precluded by weather. Two teams of three observers worked in 2-hour rotations, scanning for cetaceans using 25x and, 7x magnification binoculars, and unaided eyes. Sighting conditions, watch effort, sightings, and other required information were entered into a computer attached to the ship's Global Positioning System (for course, speed, and position information).

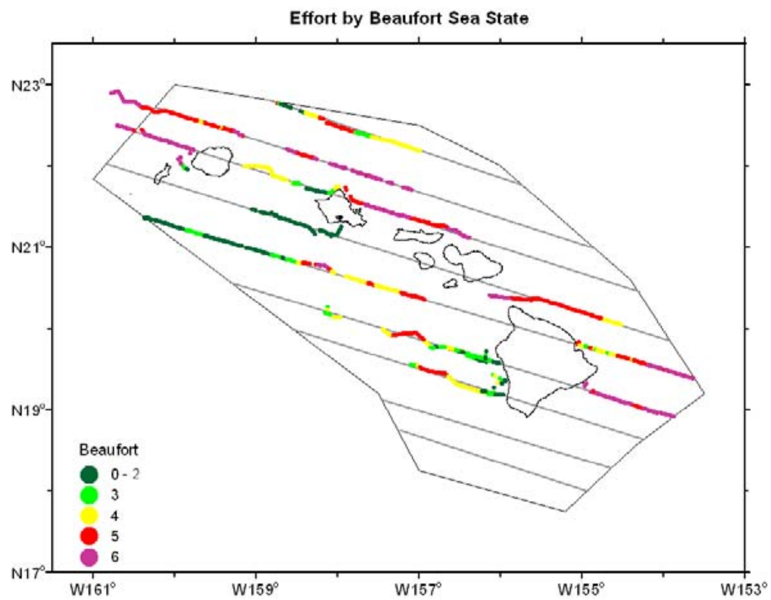

Figure 1.Main Hawaiian Islands inner exclusive economic zone survey region. Gray lines are the predetermined transect lines used to systematically survey the region. The colored lines indicate the region we've surveyed so far, by Beaufort sea state.

The grid of tracklines covered during the survey was established prior to the cruise and was intended to replicate the "Main Islands" stratum of the Southwest Fisheries Science Center 2002 HICEAS survey. The actual tracklines covered are shown in Figure 1. The entire grid was intended to be covered during the 28-day survey; however, some sections were not surveyed due to inclement weather or mechanical problems with the ship requiring an early return to Honolulu. On sighting a cetacean group or other feature of biological interest, the marine mammal observer team on watch requested that the vessel be maneuvered to approach the group or feature for investigation. When the ship approached a group of cetaceans, the observers made independent estimates of group size. Photographic operations occasionally commenced from the bow. In some instances, a small boat was deployed for biopsy, photographic, or other operations.

When the observers completed scientific operations for the sighting, the ship resumed the same course and speed as prior to the sighting. If the pursuit of the sighting took the ship more than 5 nmi from the trackline, the observers were notified. The Chief Scientist or Senior Mammal Observer specialists sometimes requested that, rather than proceed directly toward the next waypoint, the ship take a heading of 20 degrees back toward the trackline.

At times during the cruise, visual survey operations were not possible because of high winds or seas. Usually, survey operations were suspended at Beaufort Sea State 7 or higher. Also, if rain made visibility 1 nautical mile or less, visual observations were suspended until visibility increased. During these times, a single observer maintained a weather watch in order to notify the rest of the observer team when conditions improved.

Methods- Acoustic Survey

Acoustic operations during this survey included passive listening for marine mammals and active acoustic measurement of backscatter and oceanographic currents.

Table 1.Visual and acoustic survey effort.

Date	Start time	Start latitude	Start longitude	End time	End latitude	End longitude	Distance surveyed (nmi)	Average Beaufort
2/5/2009	1751	N21:13.00	W158:14.01	1832	N21:15.26	W158:21.05	6.9	4
2/6/2009	733	N21:59.89	W159:08.92	1819	N21:33.29	W157:45.14	74.4	3.9
2/7/2009	723	N20:38.58	W157:54.09	1414	N20:21.82	W156:56.14	54.9	4.5
2/8/2009	914	N19:34.40	W156:01.36	1811	N19:45.47	W156:37.15	34.9	3
2/9/2009	818	N19:34.48	W156:01.66	1820	N20:00.00	W157:26.76	84.0	3.6
2/10/2009	834	N21:15.60	W157:57.40	1818	N21:28.25	W159:03.06	56.0	1.8
2/11/2009	711	N21:21.13	W160:20.19	1833	N21:00.80	W159:10.84	63.7	2.1
2/12/2009	708	N21:00.07	W159:07.70	1828	N20:08.35	W157:57.84	92.0	3.5
2/13/2009	702	N19:33.39	W157:05.82	1701	N19:12.28	W156:03.97	62.1	4
2/14/2009	655	N19:13.45	W156:09.44	1752	N19:43.62	W156:10.75	55.7	2.3
2/15/2009	1225	N19:42.22	W156:05.12	1805	N19:25.53	W156:04.18	32.7	3.6
2/16/2009	713	N19:51.96	W155:02.03	1812	N19:23.11	W153:37.71	85.3	4.8
2/17/2009	659	N18:55.00	W153:51.95	1802	N19:14.25	W154:51.94	64.4	5.8
2/18/2009	648	N20:03.02	W154:30.71	1816	N20:24.51	W156:07.73	89.3	5.1
2/19/2009	No effort						0	7+
2/20/2009	745	N21:07.10	W156:22.65	1800	N21:33.22	W157:44.68	93.4	5.7
2/21/2009	710	N22:22.48	W159:09.80	1814	N22:53.77	W160:46.95	89.8	5.2
2/22/2009	728	N22:30.17	W160:42.44	1803	N21:57.69	W159:50.76	61.6	5.7
2/23/2009	721	N22:46.54	W158:44.60	1827	N22:11.03	W156:59.34	94.2	3.8
2/24/2009	716	N22:12.17	W158:37.66	1720	N21:42.67	W157:05.51	61.9	5.9
2/25/2009	No effort						0	7+
2/26/2009	No effort						0	7+
						Total	1257.2	

- **Passive Acoustics**

Two hydrophone arrays were available for use during this survey, a 6-element array towed 300 m behind the vessel and a 4-element array towed 350 m behind the vessel. One or the other array was towed during daylight hours to collect data on cetacean vocalizations and assist with the localization of target species. The array was deployed each morning prior to the start of visual observations and normally retrieved each evening after search effort ended (and whenever increased maneuverability was required).

The 6-element array contained two elements with a high-frequency response up to 250kHz. The high-frequency data was recorded opportunistically when cetacean vocalizations were heard on the other lower frequency elements. On 20 February, the 6-element array, provided by Scripps Institution of Oceanography, suffered a break in the tubing that houses the hydrophone elements. The 4-element array was used for the remainder of the cruise.

Signals received from the array were amplified and monitored by an acoustic technician. Two acoustic technicians rotated on 3-hour shifts during daylight hours. When cetacean sounds were detected either audibly or on the spectrogram display, incoming acoustic data was recorded to the computer's hard drive. A record was kept of acoustic effort, comments and 5-minute acoustic updates using the program WHALTRAK 2. Real-time visual displays of sounds were monitored using *Ishmael* software, which also allows for localization of vocalizing animals via beamforming and phone-pair (cross-correlation) algorithms. These angles could then be plotted on the WHALTRAK display and saved to file.

Sonobuoys were deployed periodically from either the *Sette* or a small boat on an opportunistic basis. Sonobuoys transmit acoustic data over a radio carrier frequency received by a VHF radio on the ship. A VHF antenna was mounted on the trawl house on the 01 deck for reception of the sonobuoy signals. Incoming signals were monitored using a scrolling spectrogram display in *Ishmael*, and cetacean sounds were noted.

- **Active Acoustics**

The scientific EK-60 depth sounder was operated continuously at 38 and 120 KHz and was interfaced to a data acquisition system to estimate micronekton biomass between 0 and 500 m. The vessel's navigational depth sounder was also used at the discretion of the Commanding Officer, but was generally secured while underway in deep waters. The ship's acoustic Doppler current profiler (ADCP) also ran continuously and was logged to a data acquisition system.

Results

Eighteen days of on-effort survey were completed during the cruise (Table 1), resulting in 117 sightings of 12 cetacean species, in addition to a number of unidentified cetaceans (Table 2). Over 1250 nmi of trackline were visually and acoustically surveyed. The geographic distribution of search effort and sightings is shown in Figures 1 and 2, respectively. 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 with the Navy's PMRF range and north of Kauai. An active training event in that region prevented dedication of additional effort there, though at least 20 on- and off-sightings were logged in the area north of Kauai alone.

Table 2. All on- and off-effort visual sightings. Sighting locations are shown on the maps in Figure 2.

CODE	SPECIES	Common name	Total
2	*Stenella attenuata* (offshore)	Spotted dolphin	3
13	*Stenella coeruleoalba*	Striped dolphin	4
15	*Steno bredanensis*	Rough-toothed dolphin	3
18	*Tursiops truncatus*	Bottlenose dolphin	3
31	*Peponocephala electra*	Melon-headed whale	1
32	*Feresa attenuata*	Pygmy killer whale	2
33	*Pseudorca crassidens*	False killer whale	6
36	*Globicephala macrorhynchus*	Short-finned pilot whale	9
61	*Ziphius cavirostris*	Cuvier's beaked whale	2
70	*Balaenoptera* sp.	Rorqual	14
71	*Balaenoptera acutorostrata*	Minke whale	2
72	*Balaenoptera edeni*	Bryde's whale	1
76	*Megaptera novaeangliae*	Humpback whale	56
77	unid. Dolphin		5
79	unid. large whale		1
99	*Balaenoptera borealis/edeni*	Sei whale/Bryde's whale	3
177	unid. small delphinid		1
277	unid. medium delphinid		1
	TOTAL		117

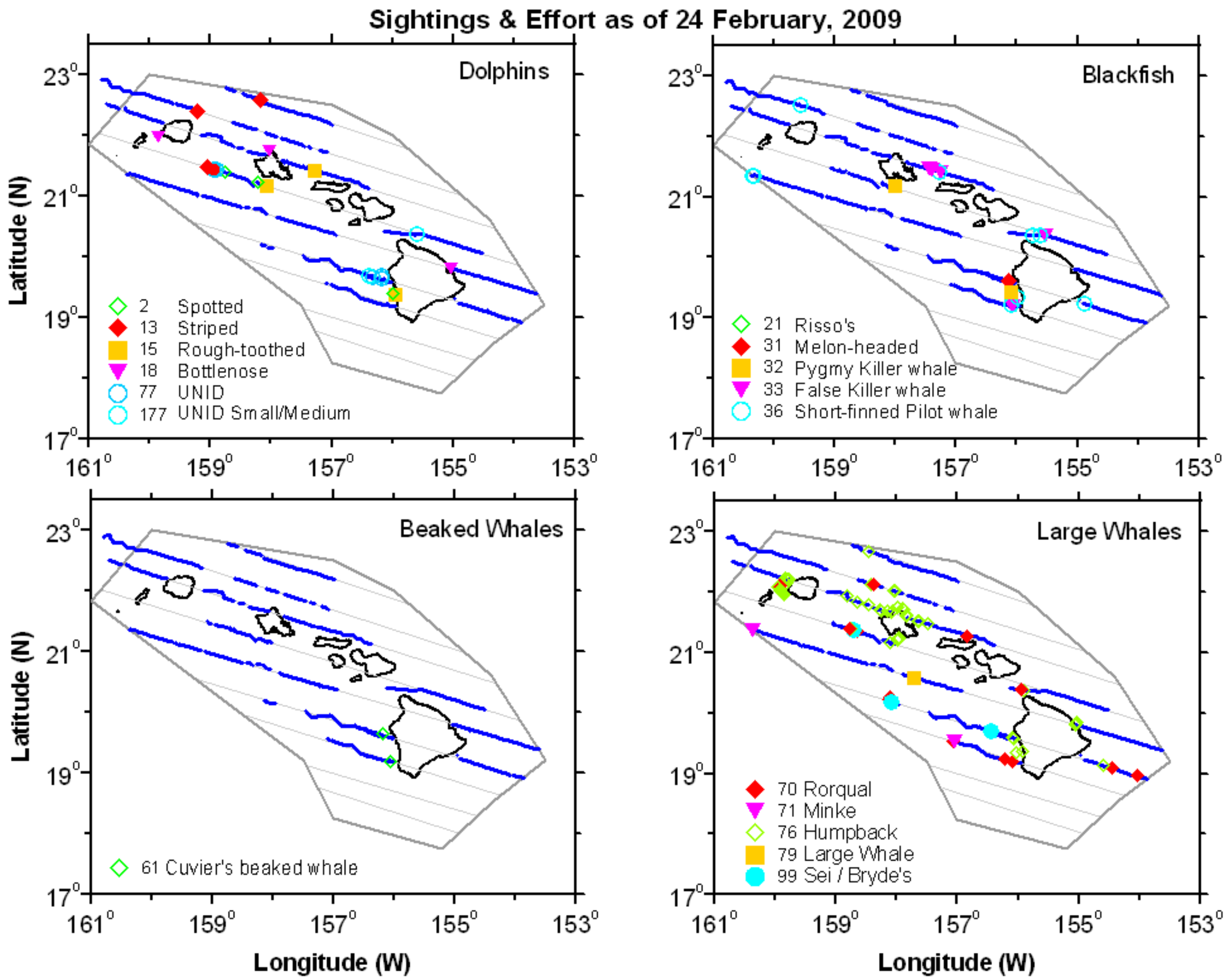

Figure 2. Visual and acoustic survey effort (blue lines) and cetacean visual sightings during the cruise.

- **Passive Acoustics**

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 significant number of unidentified cetacean schools were also detected, but were determined to be outside of the ship's 3 nmi search radius so were not pursued for species-ID.

Localization of cetacean vocalizations was hampered during the first part of the cruise as the spacing of the individual hydrophone elements within the 6-element array was too close together for robust determination of bearing angle to the sound source. Bearing angles were successfully computed during use of the 4-element array, as the elements are spaced more appropriately for lower frequency dolphin whistles.

Table 3. Number of acoustic detections on the towed array or sonobuoys.

SPECIES	Sighted schools acoustically detected	Acoustic detection-no visuals
Spotted dolphin	2	0
Striped dolphin	2	0
Rough-toothed dolphin	2	0
Bottlenose dolphin	2	0
Melon-headed whale	1	0
False killer whale	5	3
Short-finned pilot whale	4	0
Minke whale	0	Almost continuous
Bryde's whale	1	1
Fin whale	0	8
Humpback whale	?	Almost continuous
unid. Dolphin	1	15

A total of 42 sighted cetacean groups were acoustically detected with the hydrophone array (Table 3). 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. A complete list of all acoustic detections on the towed arrays and sonobuoys can be found in Appendix I.

- **Active Acoustics**

ADCP and multi-frequency echosounder data were recorded during the entire cruise, except during short periods when the pings produced by those instruments interfered with recordings of nearby cetaceans on the towed array.

Table 5. Cruise personnel during two legs February 5-19, and February 19-24..

Leg 1: 5-19 February

Name	Position	Affiliation
Erin Oleson	Chief Scientist	NMFS-Pacific Islands Fisheries Science Center (PIFSC)
Karin Forney	Co-Chief / Mammal Observer	NMFS-Southwest Fisheries Science Center (SWFSC)
Suzanne Yin	Lead Mammal Observer	NMFS-SWFSC
Allan Ligon	Lead Mammal Observer	Independent Contractor
Marie Hill	Mammal Observer	Joint Institute for Marine and Atmospheric Research (JIMAR)- University of Hawaii (UH)
Andrea Bendlin	Mammal Observer	JIMAR-UH
John Henderson	Mammal Observer	NMFS-PIFSC
Hannah Bassett	Acoustician	University of California San Diego (UCSD)- Scripps Institution of Oceanography (SIO)
Ali Bayless	Acoustician	UCSD-SIO

Leg 2: 19-24 February

Name	Position	Affiliation
Erin Oleson	Chief Scientist	NMFS-PIFSC
Suzanne Yin	Lead Mammal Observer	NMFS-SWFSC
Allan Ligon	Lead Mammal Observer	Independent Contractor
Marie Hill	Mammal Observer	JIMAR-UH
Andrea Bendlin	Mammal Observer	JIMAR-UH
Mark Deakos	Mammal Observer	Independent Contractor
Alexis Rudd	Mammal Observer	Hawaii Institute of Marine Biology (HIMB)-UH
Hannah Bassett	Acoustician	UCSD-SIO
Ali Bayless	Acoustician	UCSD-SIO

Appendix I. -- Table I. Acoustic detections on the towed hydrophone array. A large increase in detections at toward the later part of the cruise can be attributed in part to the use of a different towed array with a more gain at the low frequencies. Call types are identified as C = echolocation clicks, W = whistles, and BP = pulsed sounds.

Recording ID	Date (Local)	Time (Local)	Sighting #	Species	Call Types (C, W, BP)
TA02d	2/6/2009	14:07		unid dolphin	C, W
TA02f	2/6/2009	15:11	11	Bottlenose dolphin	C, W
TA04a	2/8/2009	10:08	20	Melon-headed whale	C, W
TA06b	2/10/2009	10:11	29	Rough-toothed dolphin	C, W, BP
TA06c	2/10/2009	11:57	31	Spotted dolphin	C, W, BP
TA06e	2/10/2009	17:31	37	Striped dolphin	C, W, BP
TA06f	2/10/2009	17:46	37	Striped dolphin	C, W, BP
TA08b	2/12/2009	8:52		UNID	W
TA08d	2/12/2009	10:39		UNID	W
TA09a	2/13/2009	11:36		UNID	W
TA09b	2/13/2009	12:43	49	False killer whale	W
TA09c	2/13/2009	13:43	49	UNID	W
TA09e	2/13/2009	15:06		False killer whale	C, W
TA09f	2/13/2009	17:00	52	Pilot whale	C, W
TA10a	2/14/2009	8:11		UNID	C
TA10b	2/14/2009	10:34	54	Pilot whale	C
TA10c	2/14/2009	11:20	57	Spotted dolphin	C, W, BP
TA10d	2/14/2009	13:01	58	Pygmy killer whale	
TA13h	2/17/2009	16:50		UNID	C
TA14b	2/18/2009	12:33		False killer whale + UNID	C, W, BP
TA14c	2/18/2009	15:13		Pilot whale	W
TA15a	2/19/2009	12:08		False killer whale	C,W
TA15b	2/19/2009	13:15		False killer whale	C,W
TA15d	2/19/2009	17:51		UNID	W
TA15e	2/19/2009	18:05		UNID	W
TA15f	2/19/2009	18:26		UNID	C, W
TA16c	2/20/2009	11:11		UNID	W
TA16e	2/20/2009	13:18		False killer whale	C
TA16f	2/20/2009	13:30	79, 80	False killer whale, Pilot whale, spotted dolphin	C, W, BP
TA16g	2/20/2009	15:23	81	False killer whale	C,W
TA16h	2/20/2009	17:00	82	False killer whale	W
TA16i	2/20/2009	17:28		False killer whale	W
TA17a	2/21/2009	9:50	87	Pilot whale	
TA17d	2/21/2009	12:42		Humpback + UNID	C
TA17e	2/21/2009	13:08		Humpback, minke + UNID	C
TA17f	2/21/2009	14:11		Humpback, minke + UNID	C
TA17g	2/21/2009	14:26		Humpback, minke + UNID	C
TA17h	2/21/2009	16:03		Humpback, minke + UNID	C, W
TA18a	2/22/2009	9:42	88	Humpback, minke + UNID	W
TA18b	2/22/2009	13:49		UNID	C, W
TA18c	2/22/2009	14:32	89-92	Humpback, minke + UNID	C, W

Table I (continued).

Recording ID	Date (Local)	Time (Local)	Sighting #	Species	Call Types (C, W, BP)
TA18d	2/22/2009	14:50	89-92	Humpback, minke	
TA18e	2/22/2009	15:58	93-96	Humpback, minke + UNID	C, W
TA18f	2/22/2009	16:58	93-96	Humpback, UNID	W
TA18g	2/22/2009	17:13	97-107	Bottlenose, humpback, minke	C,W
TA18h	2/22/2009	18:06	97-107	Bottlenose, humpback, minke + UNID	C, W
TA19a	2/23/2009	7:39		Minke	
TA19b	2/23/2009	8:19	108, 109	Humpback, minke, striped dolphin	C, W
TA19c	2/23/2009	13:54		Humpback, minke	
TA19e	2/23/2009	16:42		Minke, UNID	W
TA20a	2/24/2009	7:13		Humpback, minke + UNID	C
TA20b	2/24/2009	8:27	110-113	Humpback, minke	
TA20c	2/24/2009	10:16	114, 115	Humpback, minke	
TA20d	2/24/2009	14:07		Humpback, minke	

--Table II. Operable sonobuoy deployment locations and species that have been detected in the incoming acoustic data.

Recording ID	Date	Time (Local)	Latitude	Longitude	Sighting #	Species Heard: Humpback	Minke	Fin	Other
SB02	2/6/2009	10:20	21 52.90	158 47.29		x	x		
SB03	2/7/2009	7:32	20 38.1	157 52.6					
SB04	2/7/2009	10:07	20 31.30	157 29.53					Unidentified
SB05	2/8/2009	12:34	19 40.33	156 24.82			x	x	
SB06	2/8/2009	14:01	19 42.31	156 26.53	21 (Sei / Bryde's)				
SB08	2/9/2009	13:28	19 46.54	156 45.25		x	x	x	
SB12	2/10/2009	14:19	21 19.12	158 33.93		x	x		
SB14	2/10/2009	15:34	21 21.27	158 44.97	33 (Sei / Bryde's)	x	x		
SB16	2/11/2009	15:06	21 10.43	159 43.68		x	x		
SB18	2/11/2009	18:04	21 03.32	159 15.68		x	x		
SB21	2/12/2009	16:24	20 15.03	158 07.36	45, 46 (Sei / Bryde's)			x	?
SB22	2/13/2009	7:31	19 33.10	157 02 20	47, 48 (Minke)	x	x	x	
SB23	2/13/2009	11:25	19 29.45	156 55.45					
SB25	2/14/2009	8:02	19 12.13	156 06.77		x	x		
SB26	2/14/2009	12:01	19 23.25	156 00.60	58 (Pygmy killer whale)				Unidentified
SB28	2/15/2009	15:12	19 24.19	156 13.24		x	x		?
SB29	2/15/2009	17:13	19 20.49	156 03.93	62 (Humpback)	x			
SB30	2/16/2009	9:21	19 45.87	154 53.63		x			
SB31	2/16/2009	16:25	19 27.85	153 52.87		x	x	x	Unidentified dolphin
SB32	2/17/2009	8:28	18 57.853	154 05.173	67 (Rorqual)	x	x	x	
SB33	2/17/2009	12:20				x	x		
SB35	2/18/2009	8:09	20 07.01	154 44.52		x	x		
SB37	2/19/2009	11:49	21 03.43	157 43.84		x			
SB38	2/19/2009	14:42	20 55.73	157 18.74		x			
SB39	2/20/2009	10:45	21 16.4	156 47.7	78	x			
SB40	2/20/2009	16:32	21 28.67	157 30.79	83	x	x		False killer whale
SB42	2/21/2009	13:08	22 39.61	160 00.48		x	x		UNID
SB43	2/22/2009	9:12	22 25.29	160 26.90	88	x	x		Bryde's whale

Table II. continued.

Recording ID	Date	Time (Local)	Latitude	Longitude	Sighting #	Species Heard			
						Humpback	Minke	Fin	Other
SB45	2/23/2009	10:00	22 37.6	158 18.91	108, 109	x	x		Striped dolphin
SB46	2/23/2009	15:36	22 19.73	157 26.26		x	x	x	
SB47	2/24/2009	8:33	22 08.2	158 25.8	110-113	x	x		
SB48	2/24/2009	15:52	21 46.65	157 18.14		x	x	x	

Cetacean Monitoring Associated with Explosives Training

The Pacific Islands Fisheries Science Center Cetacean Research Program conducted at-sea occurrence and behavioral observations of cetaceans in association with 6 explosive events (~4 days of monitoring) off of Pearl Harbor. Three explosive events were carried out on each of two days, June 18 and 19. The region surrounding the events was surveyed for cetaceans 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. High winds and large swells created poor sighting conditions, such that we cannot assess whether such movements may have occurred.

Planned Operation

A survey of 4 gridded-transect lines covering a 2.5 nmi x 2.5 nmi area was conducted (Fig. 1) using the Program's 23' fiberglass boat during June 17-19 (Cruise SB-09-01). 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. The occurrence of monk seals and turtles was also noted; however, no biological sampling was carried out of these species.

The following information was collected at each cetacean sighting:

1) Location of sighting (GPS)
2) Species identification
3) Group size estimate and/or pod composition
4) Number of calves, if present

5) Duration of sighting
6) Detailed, as best as possible, behavior, disposition and reaction/no reaction to vessels or aircraft in the area
7) Direction of travel
8) Photographs and/or video, when possible
9) Environmental information associated with sighting event (Beaufort Sea State, wave height, swell direction, wind direction, wind speed, glare, percentage of glare, percentage of cloud cover, etc.)
10) If/when in proximity of Navy event, did the sighting occur (before, during or after detonations/event

Results

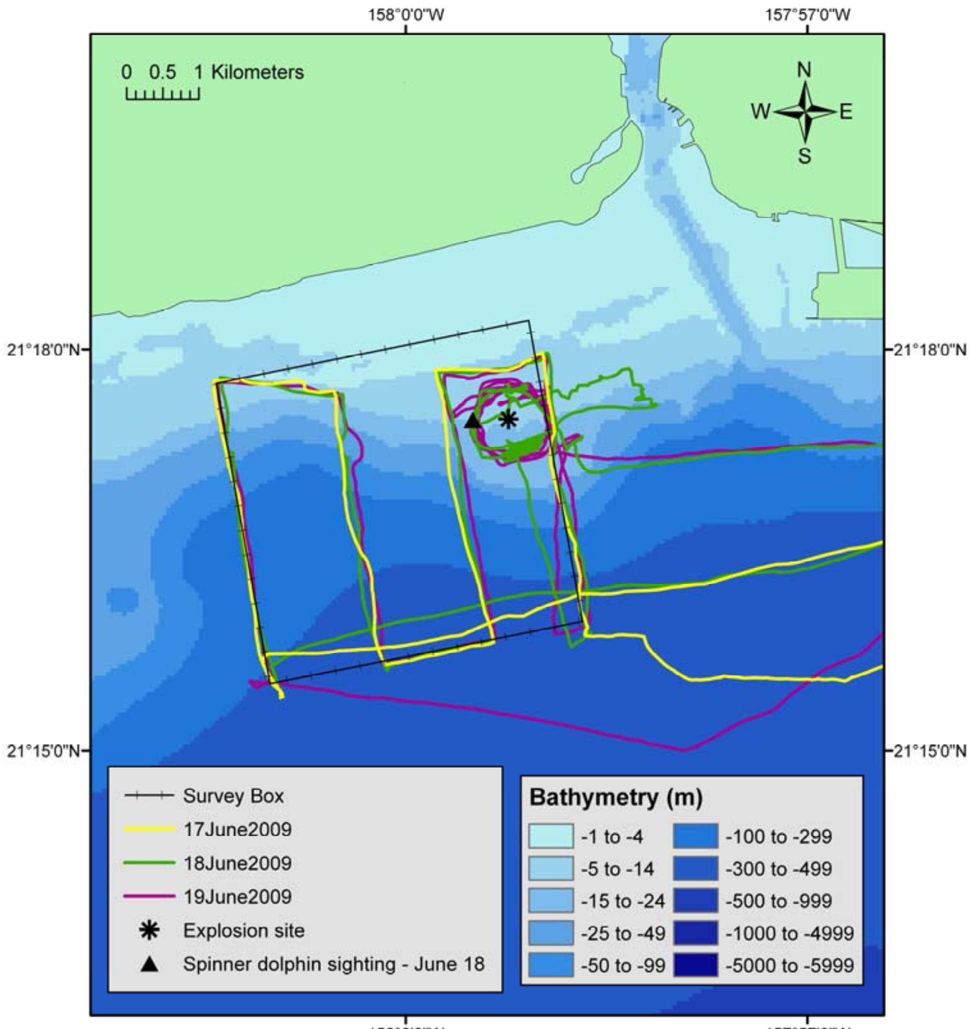

Figure 1. Map of survey effort prior to and during explosive detonations. A general survey was conducted on June 17, one day prior to explosives operations (yellow). Additional gridded surveyed were conducted on June 18 (green) and June 19 (purple) prior to explosive events on each of those days. No survey was conducted following explosives events or on June 20 due to very poor weather conditions.

Table 1. Summary of survey, detonation, and sighting events for pre- and during- explosive detonations.

Date	Time (HST)	Event	Latitude	Longitude	Notes/Weather
17-Jun-09	8:56	Begin transect survey	21.258	-158.017	Beaufort 3
17-Jun-09	10:02	End transect survey	21.266	-157.978	Beaufort 4
18-Jun-09	8:23	Begin transect survey	21.258	-158.017	Beaufort 4
18-Jun-09	9:52	End transect survey	21.266	-157.978	Beaufort 4
18-Jun-09	11:16	Explosive detonation #1	21.291	-157.987	
18-Jun-09	12:08	Turtle sighting	n/a	n/a	Seen by Navy whaler within proximity of explosion site; detonation of explosives postponed for 15 min.
18-Jun-09	12:26	Explosive detonation #2	21.291	-157.987	
18-Jun-09	13:06	Begin spinner dolphin sighting	21.291	-157.992	Seen by Navy Whaler within proximity of explosion site; PIFSC boat moved in to take photos and monitor movements
18-Jun-09	14:02	End spinner dolphin sighting	21.293	-157.975	Spinners moved out of area Beaufort 5
18-Jun-09	14:15	Explosive detonation #3	21.291	-157.987	
18-Jun-09	14:22	Survey 800 foot perimeter of detonation site	n/a	n/a	No sightings
18-Jun-09	14:57	End monitoring effort	21.291	-157.981	Beaufort 5
19-Jun-09	8:37	Begin transect survey	21.258	-158.017	Beaufort 4
19-Jun-09	10:00	End transect survey	21.266	-157.978	Beaufort 5
19-Jun-09	11:31	Explosive detonation #1	21.291	-157.987	
19-Jun-09	12:14	Explosive detonation #2	21.291	-157.987	
19-Jun-09	12:52	Explosive detonation #3	21.291	-157.987	
19-Jun-09	12:57	Survey 800 foot perimeter of detonation site	n/a	n/a	No sightings
19-Jun-09	13:06	End monitoring effort	21.287	-157.981	Beaufort 5
20-Jun-09	6:30	Survey cancelled			Beaufort 6

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 on site due to exposure to breaking waves on the inshore legs of 3 of the transect lines (Fig. 1). 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 (Table 1). The Navy explosives team observed a group of spinner dolphins prior to the last explosion on June 18. We proceeded to monitor this group (group size minimum, best, maximum: 23, 25, 30), collecting behavioral observations as they transited east through the explosives area until they had moved beyond 2 mi from the explosion site. At least one animal in the group was always at the surface and we were unable to track individuals to measure surfacing rates. The group was tracked traveling east northeast at roughly 2-3 kts until they were 2nmi from the detonation site. No significant changes in travel direction or speed, or any abnormal behavior was observed during the 45-minute follow. High winds often made it difficult to closely track the animals so fine-scale changes in behavior could not be evaluated. .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 (Fig. 2), though these have not yet been analyzed to determine sound pressure levels at various distances from the explosive site.

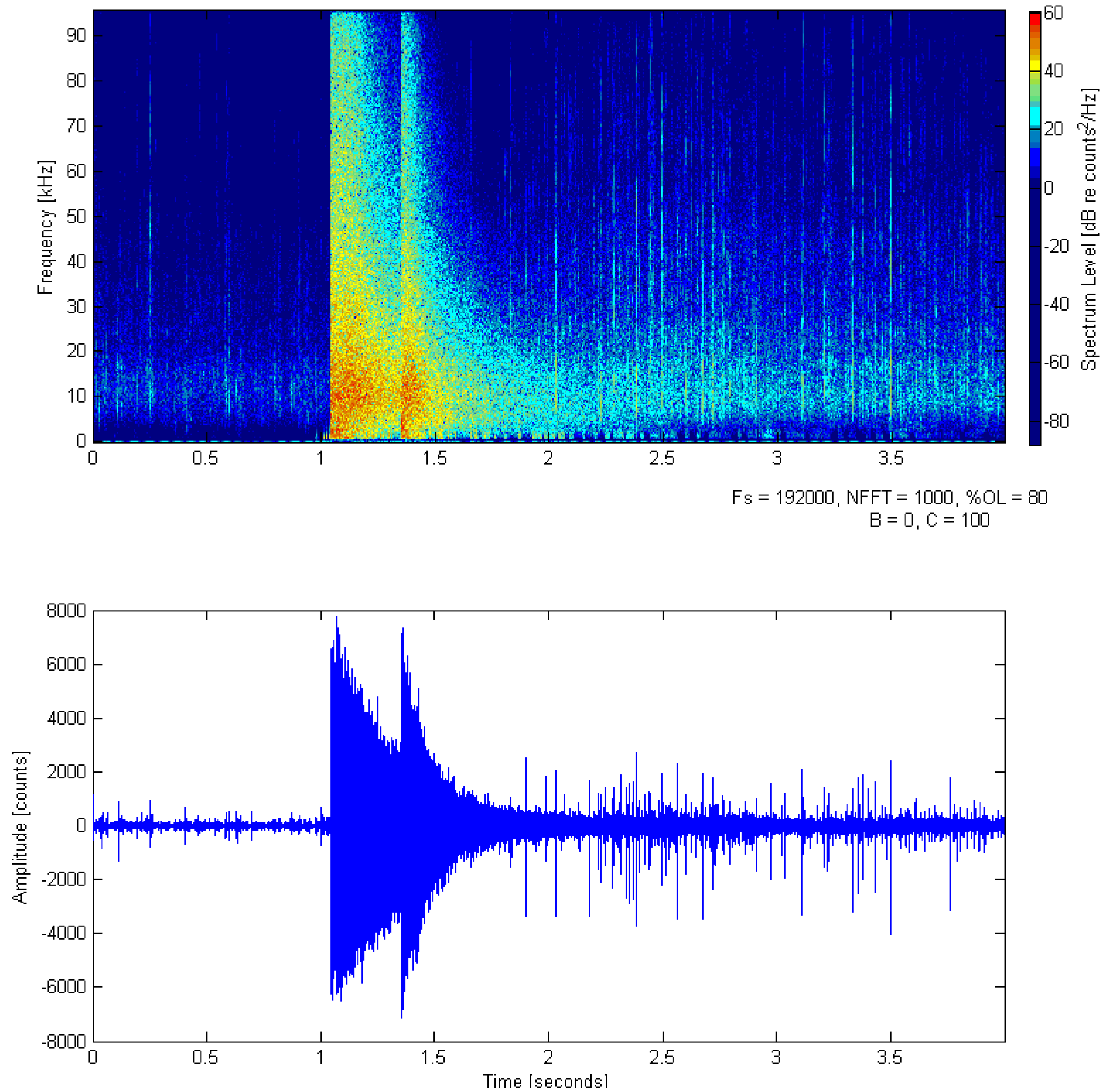

Figure 2. Spectrogram of first explosive event recorded on June 18 at a distance of approximately 400m from the explosive site.

APPENDIX G SOCAL MTE AERIAL MONITORING OCTOBER AND NOVEMBER 2008

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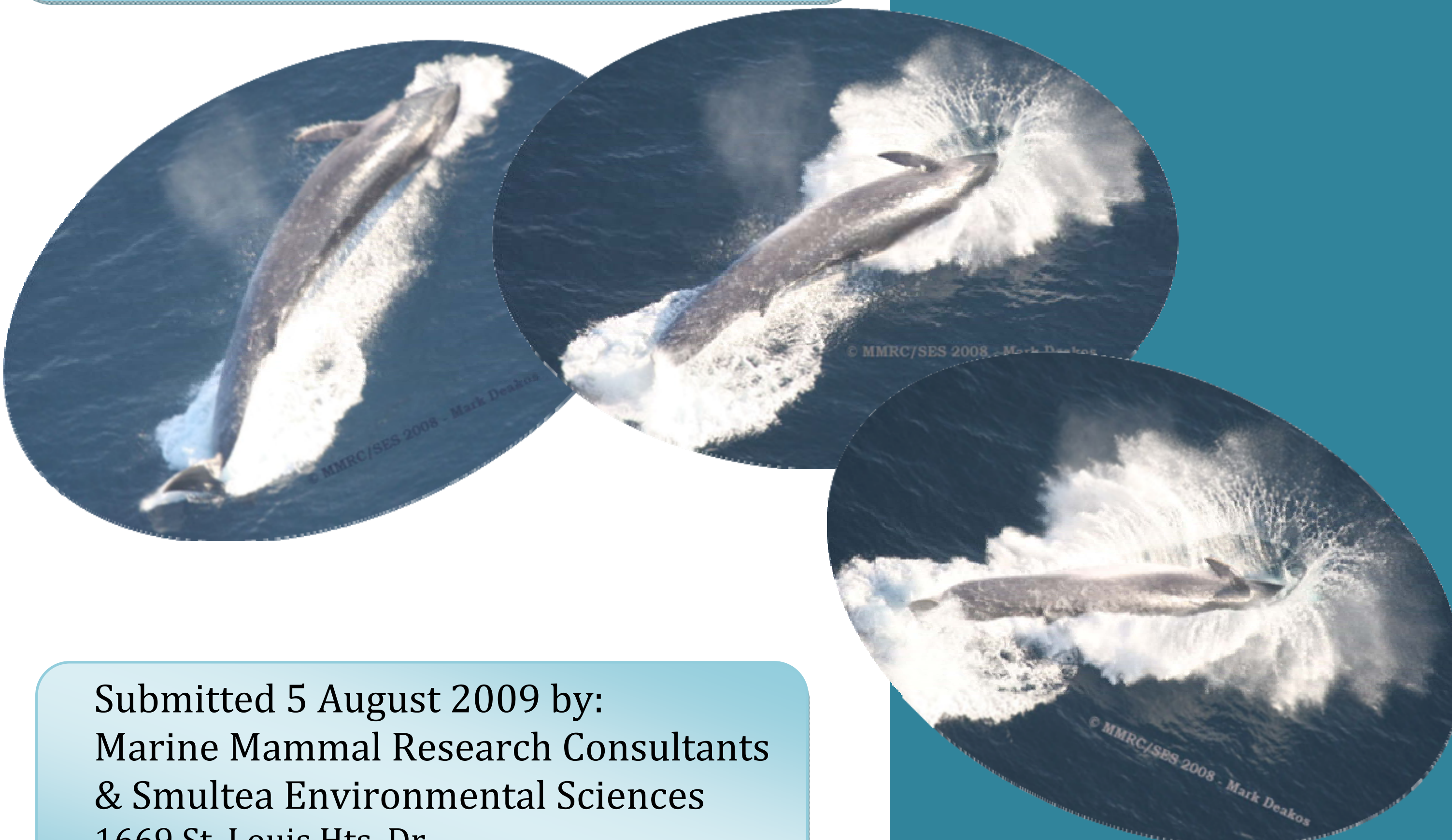
SOCAL October & November 2008 Final Report

Aerial Survey Marine Mammal Monitoring in Conjunction with Navy Exercises



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Cover Photo: A breaching fin whale (*Balaenoptera physalus*) photographed with a telephoto lens from the aircraft during the SOCAL marine mammal monitoring survey off San Diego, California, in October 2009. Photos by Mark Deakos

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Executive Summary

Aerial surveys were conducted in conjunction with two US Navy (Navy) Major Training Events (MTE) involving mid-frequency active sonar (MFAS) and explosives in October (Oct) and mid-November (Nov) 2008 in the Southern California Range Complex (SOCAL) off San Diego, California. The purpose of this survey was to monitor potential effects or lack of observable effects of MFAS and explosives on mammals and sea turtles (MM/ST) *during* a MTE from 17-21 Oct and beginning one day *after* a MTE from 15-18 Nov. Line transect aerial surveys, focal animal behavioral sampling, and shoreline surveys around San Clemente Island (SCI) were conducted to monitor the occurrence and distribution of MM/ST and to search for dead, injured, distressed and/or unusually behaving individuals, including strandings and near-strandings. As feasible, line-transect design layout followed that of previous bi-monthly aerial surveys conducted in part of the survey area in 1988-89 by the National Marine Fisheries Service (NMFS). Oct aerial surveys were coordinated with researchers from the Office of Naval Research (ONR) and Scripps Institution of Oceanography (SIO), University of California San Diego (funded by the Chief of Naval Operations [CNO N45] and ONR).

Aerial survey results are useful as they: (1) represent the largest concentrated systematic effort collected during Oct and Nov in the area, (2) suggest that the occurrence and relative numbers of species may differ from previous fall surveys, (3) begin to fill "data gaps" from little-surveyed regions within SOCAL (e.g., south [S] of SCI and between SCI and Santa Catalina Island), and (4) describe novel, systematic behavioral data for various species. Survey areas differed during Oct vs. Nov effort. For safety reasons during the Oct survey, the survey aircraft was not allowed to operate within a portion of the MTE area west of SCI due to a high volume of military aircraft flights and restricted air space. Therefore, this area could not be surveyed until Nov, post-MTE. Instead, Oct surveys were flown east (E) and northeast (NE) of SCI, including a previously, relatively little-surveyed area between SCI and Santa Catalina Island. During Nov, beginning two days after the MTE ended, surveys were flown west (W), S, and southeast (SE) of SCI.

Surveys were conducted with a Partenavia P68-C flying at ~100 knots (kt) groundspeed and ~305 meters (m) (1000 feet [ft]) altitude during transects, and ~365-455 m (1200-1500 ft) altitude and ~0.5-1.0 km (0.2-0.5 nautical mile [nm]) 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.

A total of ~4535 nm and ~50 hr of aerial survey observation effort occurred during the survey: 2462 nm *during* the MTE period from 15-21 Oct, and 2070 nm *after* the MTE period from 15-18 Nov. During both months, most of the total 4535 nm of effort (79% in Oct and 67% in Nov) was systematic or random effort, followed by focal follow circling (21% Oct and 33% Nov). Overall, Beaufort sea state (Bf) was predominantly calm: 65% of all observations occurred during a Beaufort 0-2 (Table 5, Figure 6). This was particularly true for Nov when Bf ranged from 0-3 and >99% was Bf 0-2 (Table 5). During October, Bf ranged from 1-6 with 54% of all effort occurring during Bf 1-3.

A total of 300 sightings of ~18,319 individual marine mammals was recorded: 115 groups and ~12,587 individuals during Oct, and 185 groups and ~5732 individuals during Nov based on all observation effort in Oct (2462 nm) and Nov (2070 nm). This total includes eight mixed-species groups. In total, 12 different species were verified. In both Oct and Nov the most frequently encountered species in terms of both number of groups and individuals was, as expected based on previous studies, common dolphins (*Delphinus* spp.) (27% of 115 total groups in Oct and 22% of 185 total groups in Nov). California sea lions (*Zalophus californianus*) were the second-most frequently seen species, again as expected per earlier studies. Some differences in relative number of species occurred during Oct vs. Nov. Risso's dolphins (*Grampus griseus*) were sighted more in Oct vs. Nov (18 groups/1951 nm vs. 1 group/1393 nm based only on systematic and random transect effort). No Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) were seen during Oct, while 11 such groups were seen during Nov.

In Nov, a dead California sea lion was seen on two consecutive days near the same location just off central-west SCI. A dead, subadult male blue whale (*Balaenoptera musculus*) was also seen during Nov, south of SCI, with rope line loosely draped around its lower body attached to two fishing buoys.

Among dolphin species, estimated mean group sizes were highest for common dolphins both in Oct and Nov, though the mean was higher during Oct vs. Nov (397 and 89 indiv/group, respectively) (Table 6). Mean group sizes for other delphinid species (*n* = 60 groups) were considerably smaller, and were smallest for baleen whale species (mean group size = 1.6 whales/group, *n* = 29 groups).

Overall, sighting rates 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 SCI in Nov); however, the actual SOAR MTE area was not surveyed in Oct due to airspace conflicts. 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). The number of sightings and thus sighting rates were considerably smaller for the remaining species/groups. Risso's dolphins had the second highest sighting rate in Oct (0.15 indiv/km, *n* = 18 groups). Sightings rates for combined whales were <0.01 indiv/km, and this rate was higher during Nov than Oct; however, the sample size was small (*n* = 29 individual whales).

Based on modal frequencies for four species analyzed, fin whales (*n* = 20) typically traveled with random headings and were usually spaced ≤3 BL apart in Oct (only 1 fin whale in Nov). Common dolphins were usually traveling, surface-active traveling or surface-active milling (surface active-milling was often associated with apparent feeding and diving birds). Commons were most frequently headed NE/E or W/SW in both Oct and Nov. Dispersal distance between individual commons was predominantly ≤3 BL in both Oct and Nov. Risso's dolphins were observed traveling in random directions in Oct and Nov. Most Risso's groups were spaced ≤3 BL apart. Pacific white-sided dolphins were seen only in Nov when they tended to be traveling and spaced ≤3 BL apart.

A total of 42 focal follows ranging in duration from 5-60 min were conducted: 22 in Oct and 20 in Nov. The longest focal follows occurred with a humpback group in Oct (30 min) and a fin whale group in Nov (60 min). Video taken during focal follows included observations of cetaceans below the water surface for extended periods.

Since MFAS transmission times and locations were unknown, and given the relatively small sample sizes observed for each species, only crude comparisons between the "pre" (Oct) and "post" (Nov) MTE periods were possible. Given these qualifying conditions, no animals were seen exhibiting unusual behaviors potentially related to stress or injury. No obvious differences were evident during (Oct) vs. after (Nov) the MTE period in the behavior state, headings, or inter-individual dispersal distance of the four cetacean species examined. It is interesting to note, however, that common dolphins were headed predominantly NE/E and SW/W in both Oct and Nov; this may be related to inshore/offshore movements during the day, possibly related to foraging and prey distribution.

Overall, the monitoring survey supports the utility of using aerial surveys to (1) provide a systematic "snapshot" over a large area (e.g., W of SCI) and short period of time on the occurrence, distribution, numbers, and behavior of marine mammals at reduced cost vs. large vessels, (2) collect quantifiable behavioral data known to be indices of stress/disturbance, (3) conduct (extended) focal follows of priority cetacean species including video-documentation of underwater behavior, (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 MM during line-transect and shoreline surveys, including dead floating animals.

This aerial survey was successfully conducted without interfering with at-sea naval training involving multiple Navy assets, but did require significant pre-survey coordination with up to four different Navy commands to ensure a safe survey location. This demonstrates the feasibility of continuing effective monitoring approaches and gathering behavioral data on the potential effects or lack of observable effects of Navy training activities on marine resources as required under the Navy's marine species monitoring plan for the SOCAL. Recommendations for marine mammal monitoring during future similar Navy activities are presented

Section 1 Introduction

In support of the U.S. Navy's (Navy) marine species monitoring plan in the Southern California Range Complex (SOCAL) (DoN 2009), Marine Mammal Research Consultants (MMRC) was contracted by the Navy to conduct aerial surveys to monitor marine mammals and sea turtles (MM/ST) during October (Oct) and November (Nov) 2008. This monitoring occurred in conjunction with two Navy Major Training Events (MTEs), a Joint Task Force Exercise (JTFEX) and a Composite Training Unit Exercise (COMPTUEX) involving mid-frequency-active sonar (MFAS) and explosives. Portions of these MTEs took place in the offshore waters near San Clemente Island (SCI) off San Diego, California. Naval training has been conducted within SOCAL for over 40 years, and marine mammals are also known to be abundant there (e.g., summarized in Carretta et al. 2000, 2008; DoN 2008, 2009). As part of SOCAL, the Navy operates the Southern California Anti-submarine Warfare Range (SOAR). The contracted work involved attending pre-survey planning meetings and developing an approach to address monitoring requirements including identification of priority species.

Planning Meeting

Meetings and communications with Navy personnel identified the actual survey areas, periods, and communications protocols to be used in these surveys. This was required to coordinate logistics and ensure safety and open communication between the Navy and the aerial monitoring team during the surveys given the complexity of multiple naval aircraft and vessel operations involved with the training events and other missions. Clearance from various Navy commands was obtained by Navy environmental planners on behalf of MMRC prior to the research aircraft flying in the SOCAL, particularly during the MTE period. In addition, MMRC attended pre-planning sessions with the NTR, other Navy staff, and local researchers, at Scripps Institute of Oceanography (SIO), La Jolla, California on 15-16 Oct 2008. The primary purpose of this meeting was to coordinate survey efforts with others conducting marine mammal research in the same region and period including the Naval Undersea Warfare Center (NUWC), SIO and Cascadia Research Collective (CRC). Other ongoing studies involved passive acoustics, tagging, photo-identification, and behavioral studies from small and large vessels (including the *R/V Flip* and California Cooperative Oceanic Fisheries Investigations [CALCOFFI] vessels), some of which were funded by the Office of Naval Research (ONR) and N45 funds (e.g., Falcone et al. 2009a,b). The meeting identified ways the various research groups and platforms could collaborate and assist one another in obtaining complimentary data and thus maximizing the utility of simultaneously operating studies. Goals of SOCAL marine mammal monitoring were also presented by Navy personnel.

Project Questions and Hypotheses

The goal of the Navy's SOCAL Marine Mammal Monitoring Plan (M3P) is to address five questions (identified in consultation with NMFS) related to assessing potential effects of MFAS and underwater detonations on MM/ST during Navy MTEs (see Table 1; DoN 2009). The plan involves a feasibility phase to identify, develop and improve upon monitoring protocol, and to gather baseline data that can be used to quantify potential effects of training activities. To this end, the aerial survey described herein was considered a pilot study to establish methodology to address SOCAL M3P questions. It was recognized *a priori* by the Navy and researchers involved in this survey that the ability to address and answer the SOCAL M3P questions is a long-term process (Table 1; DoN 2009). This process first requires identifying feasible data collection protocols relative to species occurrence and environmental conditions in the area. It was further recognized that a statistically valid sample size was highly unlikely to be attained in the short *during* (7 days) and *after* (5 days) MTE survey periods. This was particularly true for density and abundance estimates that typically require species samples sizes of at least ≥60-80

Table 1. Aerial survey study design, hypotheses, and variables examined to address the five main questions identified in the Navy's Southern California Range Complex Marine Species Monitoring Plan (DoN 2009) to assess impacts of exposure to Navy sonar and underwater detonations on marine mammals and sea turtles. (Acronyms defined in footnote)

Monitoring Plan Question Addressed	Null Hypothesis	Prediction to Test	Variables Measured to Test Prediction	Recording Method	Limitations	Can MP Question be Addressed?
Q1: Are MM/ST exposed to MFAS? At what levels?	*No MM/ST occur within the 3 NMFS received sound level criteria[1/] for MFAS*	MM/ST occur in 3 NMFS criteria isopleths	(1) # MM/ST seen below water (2) sound RL near MM/ST	Survey search using GPS, Event Recorder (Palm Pilot or iPhone), Camera, Video	(1) High Bf/glare can obscure MM/ST below water (2) Sound on/off times unavailable to researchers: Navy conducts post-field analyses (3) Best analyzed if researchers have sound data for post-field analyses	**YES** by Navy (distance vs. RLs near sightings) unless sound time data provided to researchers
Q2: Do exposed MM/ ST redistribute? How long?	*(1) # animals B/D/A MTE NS different* *(2) MM/ST do not leave area D MTE*	(1) Signif. lower # animals D vs. B/A MTEs (2) MM/ST consistently head away from MFAS source D vs. B/A: headings signif. different D vs. B/A MTE	(1) Sighting rate, density, abund., presence/ absence (2) Group headings	(1) Line-transect surveys (2) Focal follows: initially observed heading & extended focal follow orientation rate	(1) Sufficient sample size needed (>40-80 species sightings per experimental condition--Buckland et al. 2001). (2) Need to address other variables affecting occurrence (migration, prey distrib., etc.) (3) Can calculate min. sample size needed to determine significance (statistics using prelim./ baseline data)	**YES** if sample sizes sufficient, variance acceptable, baseline data available
Q3/4: Behavior response to various sound levels?	*(1) Behavior state, heading, dispersal distance, group size, NS different B/D/A MTE* *(2) Orientation & SAC behav. event rate, time at vs. below surface NS different B/D/A MTE*	(1) Signif. more animals D vs. B/A sound exposure travel vs. mill, rest; head away from sound; decrease indiv. space; reduce group size; dive longer, surface shorter period (2) Orientation rate less, SAC rate higher, surface time higher D vs. B/A sound exposure (3) Test all vs. RLs	Initial & subsequent observed behav. state, heading, spacing, group size, dive/ respiration/ surface- duration rates	(1) Initially observed behavior recorded (2) Focal follow continuous sampling as possible w video/ audio recording & data event & duration recorder	(1) Sufficient sample size needed to assess significance see (3) above	**YES** – see above
Q5: Do mitig. measures effective-ly avoid NMFS criteria exposure?	*(1) # Dead, stranded, injured animals same B/D/A MTE* *(2) # Animals in 3 NMFS criteria exposure same B/A*	(1) More such animals seen D/A vs. B MTE (2) Ramp up reduces # anim. exposed to NMFS criteria: density, sighting rates sig. less in 3 NMFS criteria D vs. B/A	(1) Condition / # of such animals (2) Density, abund., sighting rate	(1) GPS, Event Recorder (Palm Pilot or iPhone), Camera, Video (2) Line transect	(1) Necropsies needed to ascertain death cause, difficult for floating offshore carcasses (2) same as above	**YES** can contribute; observers on Navy ships also impt.

[1/] The three underwater sound exposure criteria threshold isopleths per DoN (2009a) and NMFS (2009) are Potential Behavioral Harassment, Temporary Threshold Shift (TTS), and Permanent Threshold Shift (PTS).

Full Questions: **Q1**: Are MM/ST exposed to MFAS @ NMFS' criteria for behavioral harassment, TTS or PTS? If so, at what levels are they exposed? **Q2**: If MM/ST are exposed to MFAS, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last? **Q3/4:** If MM/ST are exposed to MFAS/explosives, what are their behavioral responses to various levels? **Q5**: Is the Navy's suite of mitigation measures for MFAS & explosives (e.g., PMAP, major MTE measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of MM/ST

Acronyms: Q=Question, A=After; B=Before; Bf=Beaufort Sea State; D=During; MM=Marine Mammal, MFAS=Mid-Frequency Active Sonar, MTE = US Navy Major Training Event, NMFS=National Marine Fisheries Service, NS=Not Significant, PMAP= Protective Measures Assessment Protocol ; PTS=Permanent Threshold Shift, RL = Estimated Received Sound Source Level, SAC=Surface Active, ST=Sea Turtle, TTS=Temporary Threshold Shift sightings, although 40 may be enough in some circumstances (Buckland et al. 2001). It was also recognized that safety constraints and last-minute changes in Navy MTE logistics could occur (and they did). This made it difficult to conduct surveys in preferred areas (e.g., within the active SOAR range *during* the MTE) and following preferred methods (e.g., replicating line spacing and locations used during National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center [SWFSC] aerial surveys there in 1998-99 per Carretta et al. (2000).

An important factor limiting the ability to assess potential effects of MFAS in this report is that the Navy does not disclose MFAS transmission times and locations for national security reasons. Thus, it is not possible for us herein to compare data from specific operational MFAS "on" and "off" periods during MTEs nor data on distance and relative location of MFAS sources vs. sightings.

Given the above caveats project null hypotheses and predictions were developed to identify how aerial survey monitoring could contribute to addressing SOCAL M3P questions as well as the Statement of Work (SOW)(Table 1). This included identifying variables and methods that could be used to quantitatively and ideally statistically answer the hypotheses and predictions by Navy personnel with access to MFAS-related data. Limitations of these approaches were also preliminarily identified (e.g., sample size). These tactics were used to design, implement and conduct the aerial surveys as described below and in Table 1.

Approach

The approach implemented to address SOCAL M3P requirements was to conduct fixed-wing aircraft-based surveys to monitor the occurrence and behavior of MM/ST in the SOCAL relative to MFAS transmission periods. Two sets of surveys were conducted: one during (17-21 October) and the other after (15-18 Nov) MTE periods. Notably, sea turtles were considered unlikely to be seen in the MTE based on available data (reviewed in DoN 2008).

Primary monitoring goals were to:

1. Monitor the presence, occurrence, numbers and locations of MM/ST species *during* and *after* MTE periods to identify potential changes in behavior, orientation, location, distribution, and relative abundance relative to Navy training activities involving MFAS;
2. Search for potential stranded, injured or behaviorally stressed animals;
3. Circumnavigate SCI to look for floating and beached stranded or near-stranded animals;
4. Provide locations of animals to the Navy so that received MFAS sound levels could potentially be calculated and estimated by Navy personnel in post-survey analyses;
5. Assess the feasibility of monitoring near- and sub-surface tracking and behavior of MM/ST from the survey plane;
6. Evaluate the feasibility and effectiveness of monitoring approaches and provide recommendations for similar future efforts;
7. Opportunistically locate and describe cetacean sightings initially located acoustically with the Navy's stationary array or SIO's high-frequency acoustic-recording packages (HARPS) by other research groups to visually verify species and supplement acoustic detections; and
8. Opportunistically describe potential behavioral reactions of cetaceans to the survey platform.

The above goals were addressed using the following three modes:

1. a *search* mode involving line-transect and random surveys to collect initial sighting, location, and behavior information;
2. a *verify* mode involving subsequent circling and photographing of a sighting to verify species, estimate group size, and presence/absence of calves as feasible and/or
3. a *focal follow* mode to circle and conduct focal behavioral sessions at ~365-455 m (1200-1500 ft) altitude and ~0.5-1.0 km (0.3-0.5 nm) radial distance on priority species (or alternately species of secondary interest) for a minimum of 5 and ideally 30-60 min. Priority and secondary species of interest are defined below.

Priority Species

- MM/ST exhibiting unusual or distressed behavior;
- Near-stranded, stranded, or dead MM/ST;
- MM/ST species listed as endangered or threatened under the Endangered Species Act of 1973 (as amended) and any sea turtles. ESA-listed whale species include the sperm whale, blue, fin, and sei whales.
- Beaked whales (given their sensitivity to anthropogenic sounds implicated in some stranding events (e.g., Simmonds and Lopez-Jurado 1991, Frantzis 1998, Balcomb and Claridge 2001, Jepson et al. 2003, Evans and Miller 2004, Fernandez et al. 2005, Cox et al. 2006, DoN 2009)
- Risso's dolphins and dwarf or pygmy sperm whale (*Kogia* spp.), deep-diving odontocetes considered potential "surrogate" representatives for deep-diving beaked whales (see DoN 2009).

Secondary Species

Secondary species were those MM species known or suspected to occur in the survey area (e.g., Carretta et al. 2000; DoN 2008a; Jefferson et al. 2008) with no ESA status and/or that did not meet the priority species definition above but are protected under the Marine Mammal Protection Act of 1972 (as amended). Deep-diving secondary species were of higher priority than non-deep diving species, given their potential role as a surrogate representative for deep-diving beaked whales. These included:

- Common dolphins (*Delphinus* spp.)
- Other large non-ESA listed baleen whale species including Bryde's, minke, and gray whales
- Other delphinids
- Pinnipeds

In the following sections we describe the methods and results of our aerial monitoring survey in the context of other similar surveys and methodologies. We also evaluate the feasibility of the survey approach and provide recommendations for future efforts designed to monitor MM/ST during naval training events and MTEs. These topics are discussed in the context of short- and long-term monitoring goals summarized in the SOCAL M3P (DoN 2009).

Section 2 Methods

Survey protocols were designed to meet the Navy goals as outlined in the SOW and Table 1, while remaining adaptable to in-situ weather conditions and naval activities. The survey methodology and sampling design were submitted and approved in advance, per the SOW, to the Navy Technical Representative (NTR).

The survey was undertaken from a high-wing, twin-engine, fixed-wing Partenavia P68-C (Figure 1) following protocol similar to previous aerial surveys conducted by MMRC to monitor MM/ST on behalf of the Navy in Hawaii and elsewhere (e.g., Mobley 2004, 2007, 2008a,b; Smultea 2008; Smultea and Mobley 2009). Surveys occurred from 17-21 Oct during the MTE period and immediately after it from 15-18 Nov 2008 (the MTE ended on Nov 15). The pilot was familiar with the voice reporting procedures for the SOCAL as well as local and regional airspace.

Figure 1. The Partenavia P68-C fixed-wing, twin-engine aircraft used during the aerial survey monitoring.

Surveys were planned to cover areas near a MTE and then repeat flying the same area post-event the following month (Figure 2). However, survey areas ultimately differed during Oct vs. Nov due to Navy air space restrictions. Approximately one week prior to the first day of the Oct aerial survey, the observer aircraft was not allowed to fly in specified areas due to safety concerns associated with potential airspace conflicts. Instead of pre-planned areas, Oct surveys were flown E and NE of SCI, including a previously, relatively little-surveyed area between SCI and Santa Catalina Island to the NNE (Figure 3). During Nov, beginning the day the MTE ended on Nov 15, surveys were flown W, S, and SE of SCI.

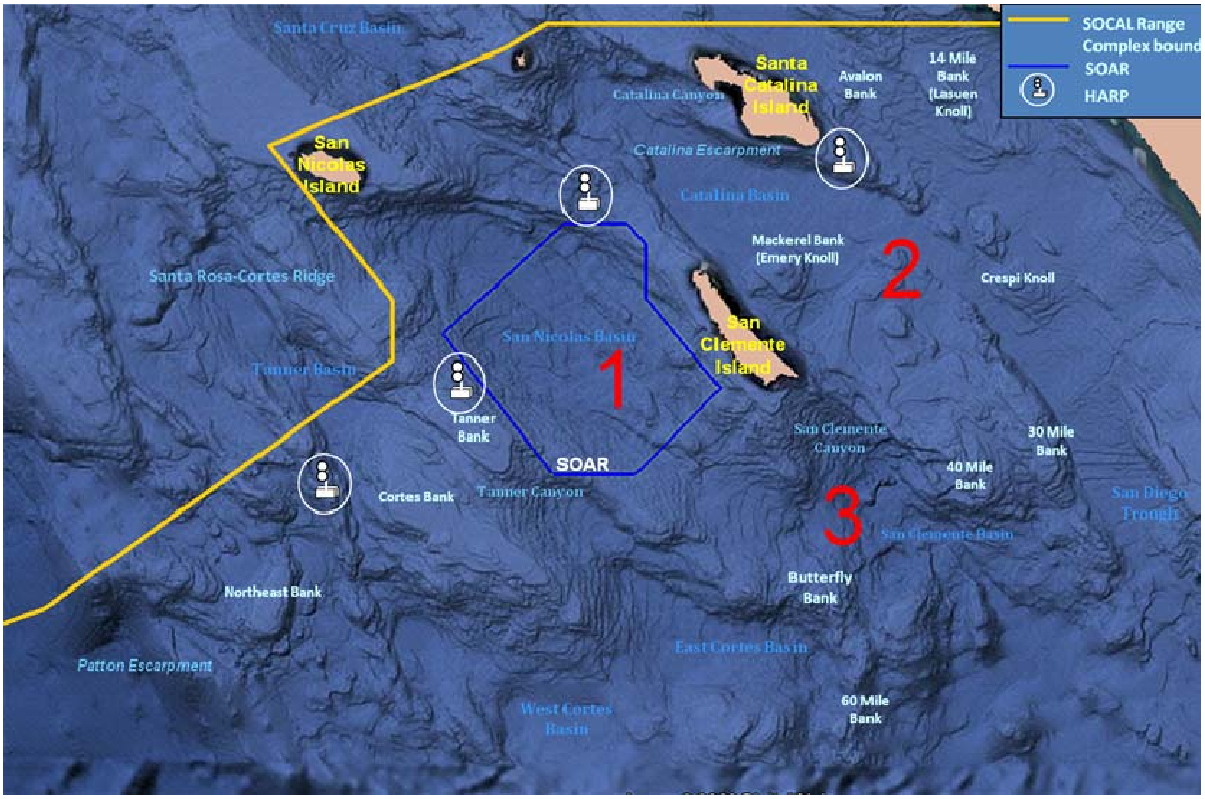

Figure 2. Location of the aerial survey monitoring area and underwater topographic features within the Navy's Southern California Range Complex (SOCAL). Numbers indicate survey areas of interest to the Navy in order of priority; orange line designates the SOCAL boundary; blue lines designate the Southern California Offshore Anti-submarine Warfare Range (SOAR); icons are approximate locations of Navy-funded bottom-mounted passive- acoustic high-frequency acoustic recording packages (HARP).

Prior to the Oct survey, Navy personnel installed a Position on Demand (POD) GPS tracking device on the observer aircraft so that it could be tracked by the Navy relative to Navy activities; this POD was removed prior to the Nov aerial surveys. Each morning the survey pilot filed a flight plan with air traffic control at Montgomery Airport upon departure. Our pilot also communicated with Navy air traffic control located at SCI to request local weather information, a summary of active areas to be avoided, and permission to fly within the SOCA to avoid potential conflict with other aircraft. To share sighting information with the visual observers and acoustic researchers aboard the FLIP we used a hand-held aviation VHF radio.

The general survey approach was as follows and as depicted in the flow chart in Figure 4:

1. Follow line transect lines and waypoints until a sighting is made;

2. Upon sighting a MM/ST group, record basic sighting information per established protocol (see Table 1) (e.g., Mobley et al. 2000; Mobley 2008; Smultea and Mobley 2009).

3. If the species is a **Priority Species** and appears suitable for a focal follow, the aircraft increases altitude to ~365-455 m and radial distance ~0.5-1.0 km and circles the sighting to obtain detailed behavior information as possible and logical for a minimum of 5 min, including photographs.

4. If the species is not selected for a focal follow, and species and group size are unknown, the aircraft circles the sighting to obtain digital photographs and estimate group size/composition.

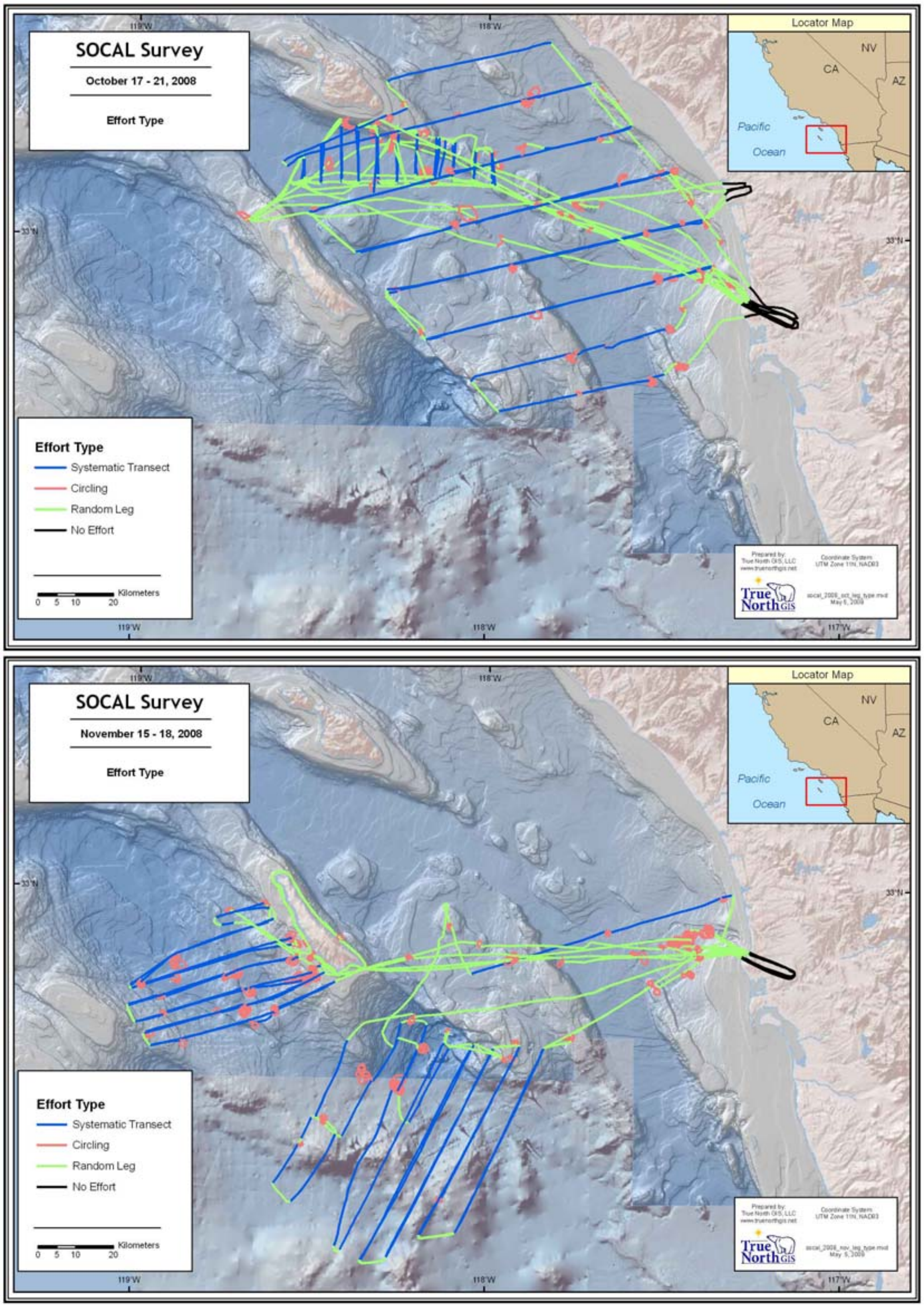

Figure 3. Aerial survey track lines and observation effort in the SOCAL during a Major Training Event (MTE) (15-21 Oct 2008 - top panel), and after the MTE (15-18 Nov - bottom panel).

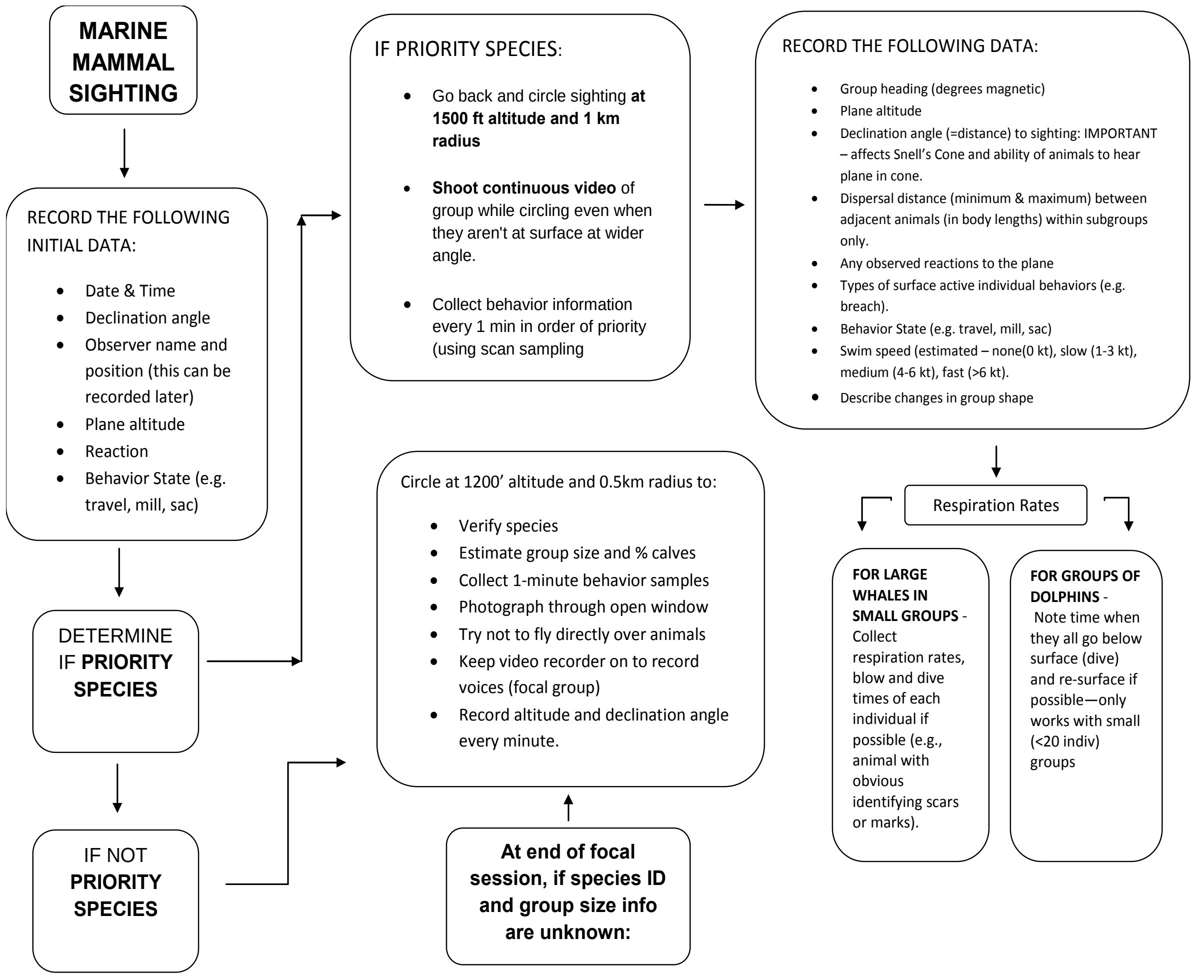

Figure 4. Protocol decision flow chart.

Survey effort involved four modes as described below and depicted in Figure 3:

1. *Search Mode* to locate and describe MM/ST via both *systematic* line-transect and *random* aerial survey observation effort. Random effort included observation effort between adjacent systematic transect lines and during transits to and from line transect locations.
2. *Identify* involving circling of the sighting to photo-document and confirm species, as possible, and to estimate group size and presence/minimum number of calves.
3. *Focal Follow* involving circling of a cetacean sighting to conduct extended behavioral observation sampling after species of interest is located.
4. *Shoreline Survey* involving circumnavigating clockwise around SCI ~0.5 km from shore to search for potentially stranded or near-stranded animals.

Observations from the monitoring aircraft involved four personnel including the pilot and three professionally trained marine mammal biologists; at least two observers had >10 years of related experience. Two biologists served as observers in the back middle seats of the aircraft and the third biologist was the recorder in the front right co-pilot seat. Roles and responsibilities of the four positions on the aircraft during the *Search, Identify, Focal Follow,* and *Shoreline Survey* modes are depicted in Table 3**.**

For the first time during surveys for the Navy, we used a data-collection software, BioSpectator, on a Palm Pilot TX (dimensions ~7 by 12 cm) to collect basic sighting and environmental data. The software was custom-designed to prompt the data recorder to select choices from pull-down menus on the Palm Pilot screen or to enter values using a screen keyboard. Example choices were various environmental conditions, leg effort type (e.g., systematic, random), species, group size, minimum number of calves, etc. (see Table 2). Each new entry was automatically assigned a time stamp. Each new sighting was automatically assigned a sequential sighting number. In addition, initially observed behavioral data were collected on the Palm Pilot when a sighting was first made. These included behavior state, heading, inter-individual dispersal distance, etc. (see Table 4 ethogram). Comments could also be entered although the small keyboard screen required more time to use than, for example, a full-sized computer keyboard. Hand-written notes were recorded by observers if needed for multiple simultaneous sightings.

One of three digital EOS Canon cameras with Image Stabilized (IS) zoom lenses was used to photo-document and verify species for each sighting as feasible/needed (40D with 100-400 mm ET-83C lens; 20D with 70-200 mm 2.8 lens and 1.4 converter; D60 with 100-400mm lens). For focal sessions, a Canon Vixia HF10 high-definition digital video camera with a built-in optical image stabilizer and 12x optical zoom lens was used to record behaviors in real time as indicated by a time stamp on the viewfinder screen. The microphone of the video camera was connected to the audio system of the aircraft so that all vocal input (e.g., behavioral verbal descriptions) was recorded into the video camera data stream. Observers used Steiner 7 X 25 or Swarovski 10 X 32 binoculars as needed to identify species, group size, behaviors, etc. A Suunto handheld clinometer was used to measure declination angles to sightings when the sighting was perpendicular to the aircraft. Geographical Positioning System (GPS) locations were automatically recorded at 30-sec intervals on a handheld Garmin GPS as well as by the aircraft WAAS GPS. Environmental data including Beaufort sea state (Bf) and observation conditions (involving various glare and visibility conditions) were recorded on the Palm Pilot at the start of each transect leg and when conditions changed. Methods are described further in Green et al. (1993), Mobley et al. (2000), and Mobley (e.g., 2004, 2008a,b).

Point-sampling and zero-one sampling approaches (Altmann 1974; Shane 1990; Smultea 1994, 2008; Mann 2000) were used to record the following information on each sighting when it was first seen and subsequently, for focal groups, approximately once per circling of the aircraft (e.g., at ~1-2 min intervals) or when parameters changed: (1) behavior state, (2) occurrence/non-occurrence and type of "conspicuous" individual behaviors (see Table 4), (3) estimated speed of travel (none – <1 kt, slow – 1-3 kt, medium – 4-6 kt, fast – >6 kt), (4) minimum and maximum dispersal distance (i.e., spacing) between individuals within a subgroup (estimated in body lengths), (5) aircraft altitude and estimated distance of the aircraft to the focal group (using a clinometer while the aircraft was level), and (6) any nearby vessels or aircraft (Table 2). For whales, continuous behavioral sampling (Altmann 1974; Smultea 1991) was used to record surface, dive, and respiration times (see Würsig et al. 1985, 1989). *Ad libitum* (Altmann 1974) detailed notes were also taken in a notebook or in the comments column of the Palm Pilot including information on school configuration, unusual behaviors or circumstances (e.g., birds feeding nearby, description of Navy activity), and/or any potential observed reactions. Post-field transcription of video tape was used to supplement these data and provide more detailed information on behaviors, inter-animal dispersal, etc.

The four study modes are described further below.

Search Mode

Search mode involved conducting line transect surveys at an altitude of ~357 m (1000 ft) to locate MM/ST following established line transect survey protocol (see Carretta et al. 2000; Buckland et al. 2001; Mobley 2004, 2008a,b)(Table 2). As feasible, line-transect design layout followed that of previous aerial surveys conducted 1-2 times per month over ~1.5 year in part of the survey area in 1998-99 by NMFS-SWFSC on behalf of the Navy (Carretta et al. 2000). Thus, as logistically possible, transect lines were positioned primarily along a WNW to ESE orientation generally perpendicular to the bathymetric contours/coastline to avoid biasing of surveys to follow depth contours (Figure 3). Transect lines described in Carretta et al. (2000) were spaced 22 km apart. Our transect lines were also spaced ~22 km apart between the coast and SCI (Figure 3). To the E and S of SCI our transect lines were spaced 11 km apart given the goal to intensively survey in a prescribed area. However, on Oct 20 and 21, the only area where we were allowed to safely fly in the SOCAL was a relatively small rectangle between SCI and Santa Catalina Island. Thus, we flew the same 6-km-spaced survey lines twice on each of these dates.

Identify Mode

Identify mode involved circling the sighting at ~357 m (1000 ft) altitude and a radial distance of ~0.2-0.5 km for several minutes to identify and document species and to estimate group size and composition. The focal power and high-resolution capability of our digital camera usually allowed us to confirm species at this altitude and distance. This was sometimes possible during or right after the sighting was photographed by examining the images on the camera viewfinder screen. Photographs were best accomplished by leveling the plane and orienting it parallel to the sighting to allow photography of the lateral and dorsal sides of the animals.

Identify mode was typically conducted on secondary species (e.g., non-Priority species) when they were first seen. However, if the sighting was or could be a priority species, *focal follow* mode was sometimes instigated rather than *identify* mode--see below. We usually did not circle groups of <3 individuals due to the difficulty in resighting such small groups. Any changes in behavior state or potential reactions to the aircraft were noted. In general, altitudes of <365 m (1200 ft) and radial distances within and near the edge of Snell's cone radius are considered more likely to occasionally elicit potential behavioral reactions to the plane (see above). At altitude 305 m (1000 ft), the theoretical radial distance to the edge of Snell's cone in flat Beaufort 0-2 conditions is ~72 m (231 ft); at altitude 365 m (1200 ft) this radius is 86 m (277 ft); at altitude ~457 m (1500 ft) the radius is 108 m (346 ft). Within Snell's cone at these altitudes, the sound of an over-flying fixed-wing aircraft can be heard at or near the water's surface and to some undetermined water depth (Figure 5) (see Urick 1972 and Richardson et al. 1995).

Focal Mode

Focal follow mode was conducted on priority species, and occasionally (non-delphinid) whales and secondary species. For these focal groups, the *identify* mode was bypassed and *focal follow* mode was started. This was done to avoid and minimize potential aircraft effects when flying at the lower typical ~305-m (1000-ft) altitude of *identify* mode. When a focal session started, the aircraft increased altitude to at least 365 m (1200 ft) and usually 457 m (1500 ft) and began circling the sighting at a radial distance of ~0.5-1 km. Further focal mode protocol is described in Table 2. This protocol was first used for Navy marine mammal monitoring from a twin-engine fixed-wing Partenavia aircraft during the August 2008 aerial surveys conducted in conjunction with the SCC OPS event off Kauai, Hawaii (Smultea and Mobley 2009). When animals sounded and were no longer visible, a watch was maintained by at least two observers to resight the animals. The pilot and recorder worked together to share location information useful in anticipating where the next surfacing location might occur. This general focal behavior study approach has been successfully implemented during previous aerial studies monitoring the behavior of cetaceans, including near anthropogenic stimuli (e.g., oil and gas exploration activities and sounds, oil

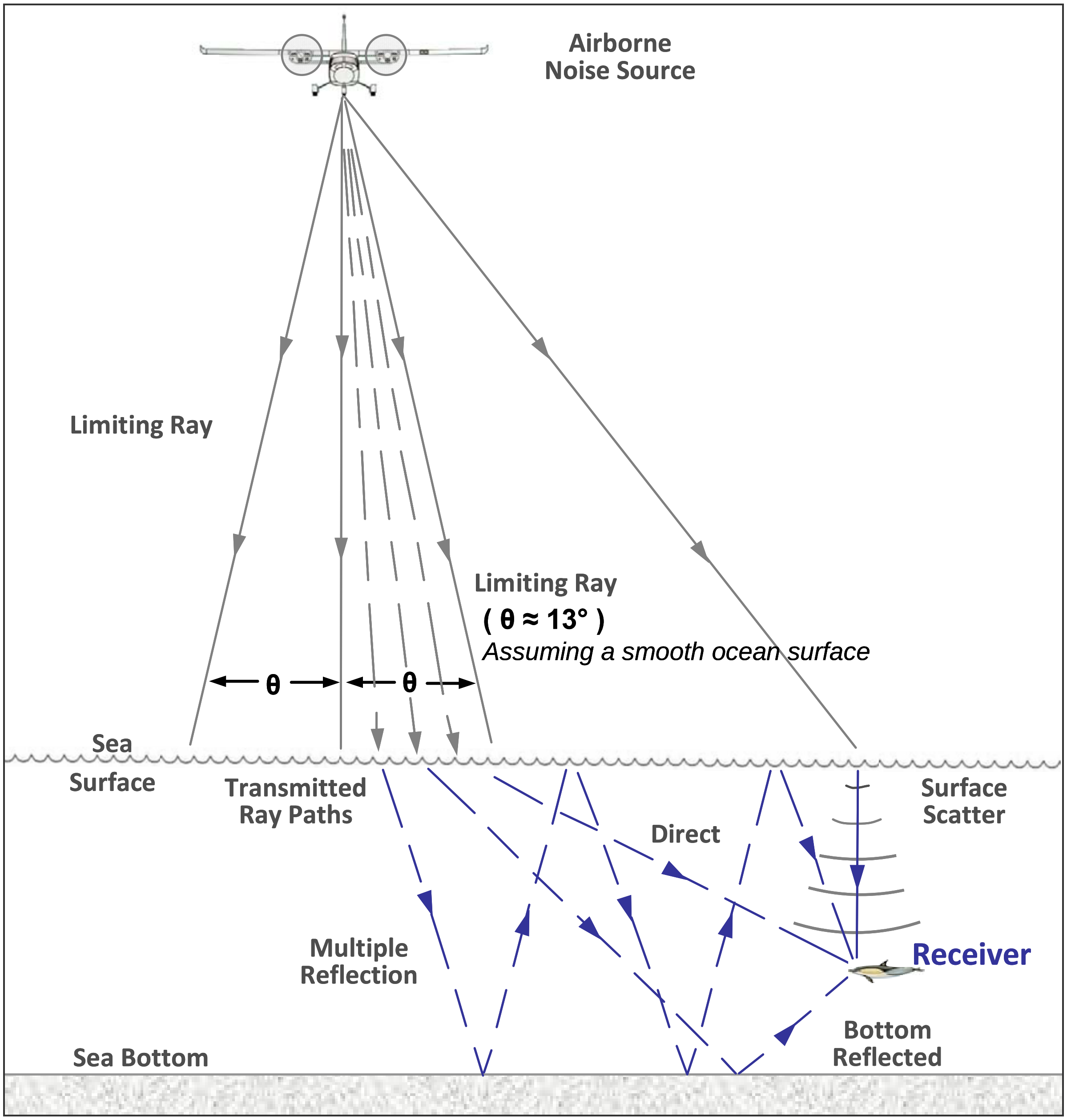

Figure 5. Diagram illustrating the theoretical 26º inverted sound cone (radius 13º) within which the sound ray of an over-flying aircraft is limited at the sea surface under calm flat sea conditions (Beaufort 0-2). Also illustrated are ways in which the transmission of sound rays through the water surface can be influenced by water depth reflection. Increasing disturbance of surface waters (i.e., increasing Beaufort sea state) can increase the size of the radius beyond the theoretical 26-degree sound cone. (Modified from source: Richardson et al. 1995 per Urick 1972).

spills, etc.)(e.g., Richardson et al. 1985a,b, 1986, 1990; Würsig et al. 1985, 1989; Smultea and Würsig 1995; Patenaude et al. 2002).

Our objective was to repeatedly circle the sighting at an altitude of 365-457 m (1200-1500 ft) and a radial distance of ~0.5-1 km and record detailed behavioral observations using the video camera, paper data forms and/or handwritten notes (Tables 2 and 3). Previous studies indicate that bowhead whales (e.g., Richardson et al. 1985a,b; Patenaude et al. 2002), adult humpback whales (e.g., Smultea et al. 1995), and bottlenose dolphins (Smultea and Würsig 1995) show little or no detectable reaction to small fixed-wing aircraft circling at these altitudes and radial distances (also see review in Richardson et al. 1995). These parameters are well outside the Snell's cone theoretical range of air-to-water sound transmission angle associated with over-flying aircraft (see *identify* mode above; also Urick 1972 and Richardson et al. 1995) (Figure 5). Thus, staying outside these parameters was anticipated to avoid the potential for the aircraft to affect the behavior of the observed animals. However, very few systematic studies on the effects of over-flying aircraft on cetaceans have been made, and no studies of the underwater received sound levels of an over-flying Partenavia Observer are known to exist to our knowledge.

While circling the focal animal(s), continuous behavioral sampling, point sampling, and zero-one sampling were implemented as described above.

Aerial Shoreline Survey

The purpose of the aerial shoreline survey was to search for any MM/ST that were dead, injured, and/or stranded on or near the shoreline of SCI after a MTE. Given the range schedule available, a post-MTE aerial shoreline survey could only be conducted over two days in Nov. Because there were many pinnipeds along and near this shoreline as expected (e.g., Carretta et al. 2000), observers concentrated on searching for stranded or near-stranded animals rather than collecting detailed behavior or sighting data. The survey was conducted from an altitude of ~1000 ft and flown in a clockwise direction ~0.2 km (0.1 nm) from the shoreline. Clearance from the aircraft tower on SCI was required prior to the Shoreline Surveys. Data collected during this mode are described in Table 2.

Data Processing

GPS and Palm Pilot data were downloaded separately, saved in an Excel spreadsheet, and backed up each evening after a survey. These two data streams were then merged into one Excel spreadsheet with the time-merge function using time as the common denominator. Data were then imported to a GIS ArcInfo program to plot survey track lines and locations on three-dimensional bathymetry maps obtained online from an SIO website (http://www.sccoos.org/data/bathy/?r=0) and from Google Earth (http://www.googleearth.com). The same program was used to calculate, classify, and summarize kilometers of survey effort and sightings including by Bf, date/time, and leg type effort. Digital photos and video were downloaded and backed up regularly. Behavioral data collected on handwritten forms and/or in a notebook were hand-entered into an Excel custom spreadsheet. Videos were reviewed and both verbal and visual data were entered into the same Excel spreadsheet to supplement and/or verify information. A master Excel spreadsheet contained all the data streams. Summary statistics were run using Excel.

Sighting rates were calculated for straight-line observation effort and thus included only systematic line transect and random observation effort and sightings.

Table 2. Description of the four primary study modes designed to address monitoring goals of the aerial survey.

Mode	Aircraft Speed (kt)	Aircraft Altitude (m)	Flight Pattern	Duration	Data Collected
Search	~100	~305	• Systematic transect lines • Random shorter connecting lines • Transits	Until MM or ST seen, then switch to Identify or Focal Follow Mode	• Time & location of sighting • Species, group size, % calves • Bearing & declination angle to sighting • Behavior state • Initial reaction (yes or no & type) • Status (alive or dead) • Heading of sighting (magnetic) • Dispersal distance (min. & max. in estim. body lengths)
Identify	~85	~305	Circling at ~305 m radius	<5 min	• Photograph to verify species • Estimate group size, % calves • Note any apparent reaction to plane or unusual behavior
Focal Follow	~85	~365-457	Circling at ~1 km radius	≥5– 60+ min	In order of priority every ~1 min: • Time • Focal group heading (magnetic) • Lat./long. (automatic GPS) • Behavior state • Dispersal distance • Aircraft altitude (ft) • Distance of aircraft to MM (declination angle) • Reaction? • Individual aerial behavior events • Bearing & distance to vessels <10 km away or other nearby activity • Surface & dive times (whales) • Individual respirations (whales)
Shoreline Survey	~100	~305	Circumnavigate San Clemente Island in clockwise direction ~0.2 km from shoreline (random effort)	~45 min	• Status (alive, dead or injured) • Species, group size, % calves/young • Bearing & declination angle to sighting • Behavior state & heading • Initial reaction?

Table 3. Roles and responsibilities of the four personnel aboard the monitoring aircraft during *Search*, *Identify*, and *Focal Follow* modes.

Aircraft Seat Position	Role during SEARCH Mode (1000 ft Altitude)	SEARCH Mode Responsibilities	Role during FOCAL Mode (Circling) (365-457 m Alt & 0.5-1.0 km radial distance)	IDENTIFY & FOCAL Mode Responsibilities
Pilot (Left front)	Pilot	• Locate & follow transect lines • Maintain ~305 m altitude & ~100 kt speed • Communications with civilian and Naval flight controllers	Pilot	• Circle sighting clockwise @ ~365-457 m Alt & 0.5-1.0 km radial distance as directed • Keep animal(s) in middle of circle • Avoid flying directly overhead animals • Keep track of sighting location
Right front	Recorder/ Back-up Observer	• Record data • Search for MM/ST • Keep "big picture" perspective • Guide pilot to MM/ST location(s) • Photograph to verify/identify spp.	Videographer	• Videotape focal group through open porthole window
Left center	Observer	Search for MM/ST	Note taker/Recorder	Note behavior data and record with time: • MM heading when parallel w/ plane heading • Aircraft altitude & distance to MM (w/ clinometer) once per circling as possible when plane level Call out overall big picture description when behavior observer not talking
Right center	Observer	Search for MM/ST	Primary Behavioral Observer	• Keep track of focal group • Call out ~1 min as possible/when changes: focal behavior & other data (see Table 1)

[1/] MM = marine mammal; ST = sea turtle; SCI = San Clemente Island

Table 4. Definitions of behavioral states and individual behaviors (events) used during focal animal/group follows. Behavior states are determined based on what >50% of the group is doing.

Behavior State	Code	Definition
REST	rest	>50% of group exhibiting little or no forward movement (<1 km/hr) remaining at or near the surface in the same location or drifting
MILL	mill	>50% of group swimming with no obvious consistent orientation (non-directional) characterized by asynchronous headings, circling, changes in speed, and no surface activity
TRAVEL	trav	>50% of group swimming with an obvious (e.g., wake-producing) consistent orientation (directional) and speed, no surface activity
SURFACE-ACTIVE MILL	sac mill	While milling, occurrence of aerial behavior that creates a conspicuous splash (includes all head, tail, pectoral fin, and leaping/porpoising behavior events—see below)
SURFACE-ACTIVE TRAVEL	sac trav	While traveling, occurrence of aerial behavior that creates a conspicuous splash (include all head, tail, pectoral fin, and leaping/porpoising behavior events—see below)
Individual Behavior Event		
Breach	BR	Leap out of water with a twisting motion at >45º landing on water surface with large splash
Porpoise	PO	Leap fast out of water in forward motion at <45º creating splashes
Spin	SP	Leap clear of water and spin horizontally >1 time (dolphins only)
Bowride	BOW	Swims in front of vessel riding bow wave
Head Slap	HS	Leap out of water with forward thrust at >45º and slap ventral surface on water creating large splash
Feeding	FE	Seen chasing fish or prey and/or zigzag pursuit swimming
Social	SOC	Two or more animals in physical contact
Tail Slap	TS	Slap water surface with ventral or dorsal side of tail flukes
Pectoral Fin Slap	PS	Slap water surface with pectoral fin
Inverted Swim	IS	Inverted swim, ventral side visible
Other Behavior	OB	Behavior not listed above: describe
Whales Only		
Blow	BL	Visible respiration
No Blow Rise	NB	Surface with no visible blow/respiration
Peduncle Arch	PA	Arching of back without lifting tail/flukes
Fluke up	FU	Arching of back followed by lifting tail flukes into air (fluke facing up or down) usually before an extended dive
Unidentified Large Splash	US	Large splash associated with an unidentified/unseen behavior

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Section 3 Results

Results are described below in the following sections: effort, sightings, sighting rates, behavior, focal follows, unusual observations, shoreline surveys, and video/photographs. Results are discussed separately for Oct (*during* MTE period) vs. Nov (*after* MTE period) in each section followed by a comparison of the two periods. Results are summarized in Tables 5-7, illustrated in Figures 3 and 6-16, and provided in detail in Appendices A-D. Appendix D provides some example photographs of sightings, including whales and dolphins tracked below the water surface.

Effort

A total of 8717 km (4707 nm) and 48.9 hr of aerial track line was conducted during the Oct and Nov aerial survey in the SOCAL (Tables 5 and 6)(this includes *all* kilometers flown including periods when weather obscured observations). More effort (4753 km or 2566 nm) was flown from 17-21 Oct *during* the MTE period than from 15-18 Nov *after* the MTE period (3964 km or 2140 nm). However, more flight days (*n* = 5) and hours (27.5 hr, mean 5.5 hr/day) occurred in Oct than Nov (4 days, 21.4 hr, mean 5.4 hr/day).

Based *only* on periods when observations occurred (i.e., excluding cloud-obscured weather periods), most (74%) of the total 4535 nm of *observation* effort consisted of systematic line-transect (1654 nm) and random (1691 nm) effort; the remaining 26% or 1868 nm consisted of circling to take photos/identify species and follow focal groups (Table 5). The proportion of systematic effort was 36% for both Oct and Nov (Table 5). Random effort consisted primarily of transits to and from systematic survey lines but also in Nov included two circumnavigations of SCI searching for potential stranded animals (Figure 3).

During the Oct MTE period, effort occurred primarily between SCI and the mainland coast as our observation plane was not permitted to fly on the active SOAR range due to airspace conflicts (Figure 3). On the last three Oct survey days, we were restricted to a small area between SCI and Santa Catalina Island to avoid potential airspace conflicts (Figure 3).

In Nov, after the MTE had ended, systematic surveys occurred within the SOAR range when there were no airspace conflicts on Nov 14 and 15 (Figure 3). On the remaining two survey days (Nov 16 and 17), systematic transect lines were flown S of SCI to avoid airspace conflicts. Therefore, the only area of overlapping effort between Oct and Nov occurred between SCI and the mainland coast.

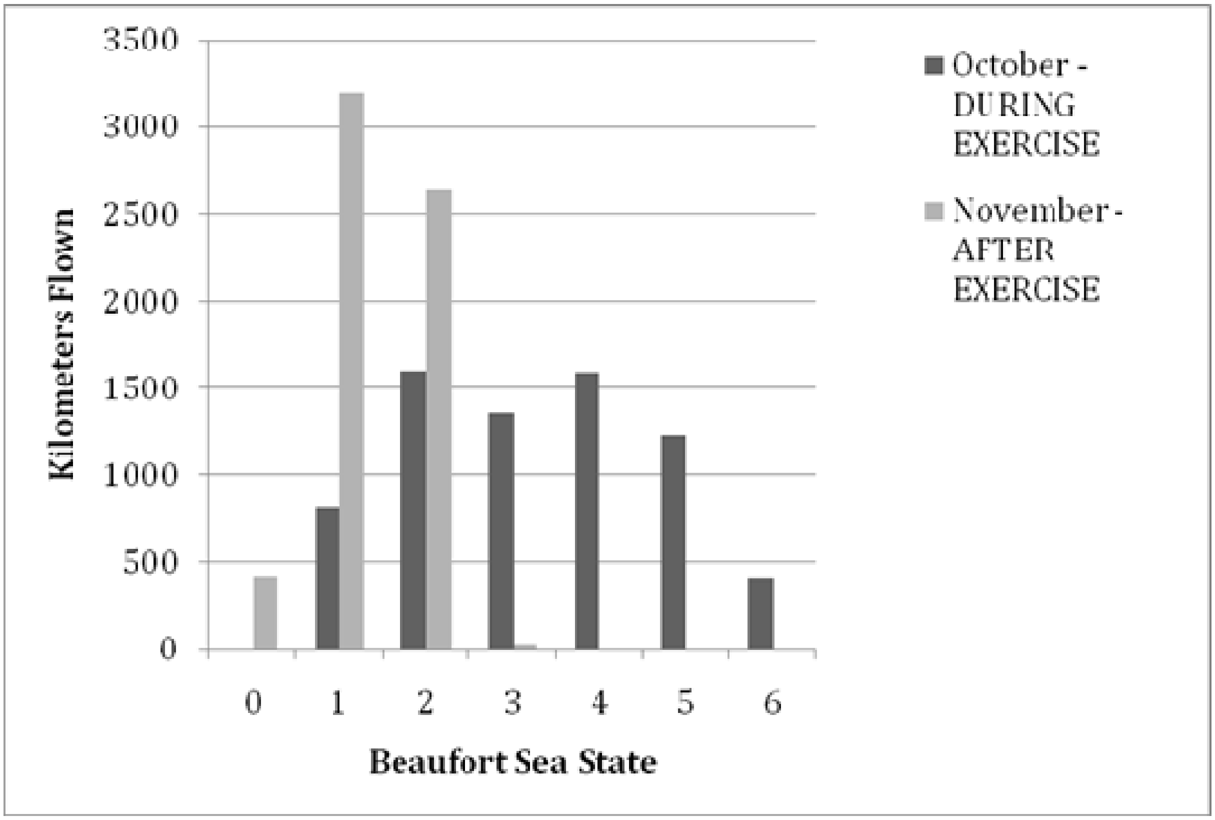

Figure 6. Beaufort sea state during aerial survey monitoring effort (in km) during (Oct) and after (Nov) the SOCAL 2008 MTE period.

Sightings

A total of 300 sightings of ~18,319 individual marine mammals was seen: 115 groups and ~12,587 individuals during Oct and 185 groups and ~5732 individuals during Nov based on all observation effort in Oct (2464 nm) and Nov (2072 nm)(Tables 5 and 6, Appendices A and B). Of the total 300 sightings, 74% were identified to species (*n* = 170) or genus (*n* = 53) (Table 7). Twelve different species were verified including nine species during Oct and nine during Nov. This included four confirmed whale species (blue, fin, Bryde's and humpback), five dolphin species (bottlenose, short- and long-beaked common, Pacific white-sided, and Risso's), and three pinniped species (California sea lion, harbor seal and northern elephant seal) (Table 6).

Overall, the common dolphin was the most frequently identified cetacean species and genus (24% of 300 total groups) in terms of both number of groups (*n* = 73) and individuals (*n* >14,476). This was true for both Oct and Nov (Table 7). Most (79%) of the total 24 common dolphin sightings identified to species (based on examination of photos) were short-beaked commons; the remaining 21% (*n* = 5 groups) were confirmed or probable (>90% certainty) long-beaked common dolphins (Table 6). California sea lions (*n* = 92 groups) were by far the most commonly seen pinniped species (70% of 128 pinniped groups). One sighting of a rare lone Bryde's whale was photo-verified in Oct (Table 7). There were seven mixed-species sightings: six in Oct and one in Nov (Table 7). The seven mixed species groups included six different species of both pinniped-delphinids and mixed delphinids.

Estimated mean group sizes were highest for common dolphins both in Oct and Nov; the mean was higher during Oct than Nov (397 and 89 indiv/group, respectively) (Figure 11). Mean group sizes for other delphinid species (*n* = 60 groups) were considerably smaller, and were smallest for combined whales (mean group size = 1.6 whales/group, *n* = 29 groups) (Figure 11).

Dead California Sea Lion – 15, 16 Nov

At 11:59 on 15 Nov a dead floating California sea lion (confirmed by photographs) was sighted ~0.3 km off the SW coast of SCI. The carcass was bloated and floating among a kelp bed with sea gulls feeding on it. At 12:44 on 16 Nov a dead floating California sea lion (confirmed by photographs) was sighted ~0.9 km off the central W coast of SCI. The carcass was bloated and floating just outside the surf break among the kelp beds with gulls feeding on it. The two sightings were believed to be the same individual based on location and photographs. See Appendix A for further detail on these sea lion locations.

Dead Blue Whale – 17 Nov

At 14:43 on 17 Nov 2008, a dead subadult male blue whale was seen floating ventral side up ~50 km S of SCI. The carcass was first sighted during a systematic transect line at a distance of 6.5 km in a Bf 0. The plane circled the carcass for ~12 min to get photos and video. Species identification was not verifiable in the field as the animal was very bloated and discolored to a whitish-light-gray hue. There were ~30 large sea gulls perched on the whale's ventrum and two blue sharks (*Prionace glauca)* were seen swimming near its head and peduncle.

Two pink fishing buoys estimated to be ~1 m (3 ft) in diameter were floating close to the whale attached to rope lines: one floating at the water surface and one submerged just below the surface. The rope was loosely draped over the whale's extruded penis and tail stock. The cause of death was not evident, and there was no obvious evidence of a ship strike. The carcass appeared to be intact but only the ventral surface was visible. It was estimated to have been dead for at least several days. The same carcass was seen again at 15:16 while flying an adjacent survey line and more photos were taken. Upon landing, the PI (MS) called the lead regional Navy environmental planner to communicate the position and status of the dead whale. The Navy granted permission to MS to contact local cetacean identification experts in the southern California area to confirm species identification. Two experts verified that the carcass was a blue whale based on the number of visible pleats, the estimated body length (BL), and the mottling and coloration pattern of the whale. BL was estimated to be ~63-68 ft (19-21 m) plus the portion of the fluke that was tilted below the water's surface using the known BL (~60 cm) of the western gulls (*Larus occidentalis*) photographed on the blue whale carcass (email from D. Janiger, 20 Nov 08). The Navy immediately contacted the Southwest Regional Office of NMFS to report the carcass sighting and preliminary identification.

Sighting Rates

Overall, sighting rates for individual MM 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 SCI 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 (Table 7, Appendix C, Figure 12). 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 (Figures 13 and 14). 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 (Table 6, Figure 12). 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)(Table 6, Figure 12). 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 (see Figures 2 and 3 of all effort track lines). 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) (Figures 1, 6a). In Nov, whales (mostly baleen whales) were sighted through much of SOAR but appeared to concentrate between SW SCI and Tanner Bank to the W (Figures 1, 6). In Nov, another small concentration of whale sightings occurred ~20 km NW of San Diego directly W of Montgomery Field 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 (Figures 1 and 6).

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 (Figures 1 and 7). Their distribution generally encompassed a NW-oriented band stretching between San Diego and Santa Catalina Island where the aircraft typically transited from the airport to the small survey grid S of Santa Catalina Island (Figures 1, 2, 7). 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 E of Tanner Bank in W SOAR, and the Coronado Escarpment (Figures 1, 7). Very few dolphins were seen during Nov transects in the S portion of the survey area over the San Clemente Rift Valley and the East Cortez Basin (Figures 1, 7). Pacific white-sided dolphins (seen only in Nov) were sighted most frequently off the SW edge of SCI over steep bathymetric drops (Figures 1, 7).

Pinnipeds were distributed primarily near and between SCI and Santa Catalina Island both in Oct and Nov, with smaller numbers seen in offshore waters (Figures 1, 8). During the circumnavigation of SCI on two days in Nov, most pinniped sightings occurred along the NW and NE SCI shoreline, particularly the central W shoreline (Figures 1, 8).

Behavior

Four species or genus had sample sizes considered large enough ($n \geq 8$) 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 (Figure 13), with just one group engaged in surface-active travel, in Oct (Figure 13). All fin whale groups were first seen headed 46-315° magnetic; none were first seen headed generally N or S (Figure 13). Seven of eight fin whale groups with ≥2 individuals were initially observed ≤6 BL apart (Figure 13c). The largest mean dispersal distance of >15 BL 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 (Figure 14). The most frequently first-observed heading for common dolphins was bimodal in the opposite directions of NE/E and SE/W (Figure 14). Inter-individual dispersal tended to be ≤3 BL, particularly in Nov (Figure 14).

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 (Figure 15). Risso's were only occasionally first observed milling or surface-active traveling. The most frequently observed headings among Risso's were NE/E, SW/W, and NW/N (Figure 15). Overall, and for Nov, mean distance between individual Risso's tended to be ≤3 BL (Figure 15). This distance was considerably higher (10.5 BL) 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 BL (Figure 16). 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 1200-1500 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 C). 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)(Appendices C and D). The latter encounters included unusually long observations and video of whales below the water surface during calm Bf 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 SOW. 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 SOW 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 the dead floating blue whale carcass and two dead California sea lion sightings discussed above, we did not observe 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).

Our observations based on aerial survey effort are necessarily limited only to those animals we saw. 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 (Appendix C). 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 project survey region (see *Discussion*).

Photography/Videography

Both digital photos and digital video were taken when possible to verify species and document behavior. Over 2,330 digital photos were taken during 88 of the total 300 sightings, 37 of which were focal follows (Appendix C). No photos were taken during the remaining 212 sightings because the animals were too far away and/or the sighting was too brief. Appendix D includes selected photos of various species of cetaceans seen during the surveys, including photos of whales and dolphins tracked for extended periods below the water surface.

A total of ~95 min of digital video was taken during 9 of the 42 focal follows: two fin whale groups, two humpback groups, two common dolphin groups, and three Risso's dolphin groups (Appendix C). Video included footage of apparent courting humpback and fin whales and extended video of underwater behaviors, as well as footage of a mother-calf fin whale (Appendix C).

Table 5. Aerial survey flight times, total flight hours, and number of marine mammal sightings by date and survey period *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE.

Date 2008	Flight Times (wheels up/down)	Total Flight Time (hr)	Total # Marine Mammal Sightings	Description
October (PHASE I) - AFTER MTE				
17 Oct	08:42–12:37 13:53–17:17	7.3		Line transects E of SCI. Re-fueled at Palomar mid-day. Returned to Montgomery in time to maintain pilot's 8 hr/day FAA flying limit.
18 Oct	07:54–11:36 12:30–15:29	6.7		Line transects E of SCI. Flew over HARP (Hildebrand/SIO—see Fig. 2). Searched near SIO *R/V Flip* off N end SCI to try and coordinate sightings & obtain local weather info. Re-fueled at Palomar mid-day.
19 Oct	10:10-14:27	4.3	9	Delayed departure due to low marine fog. Marine layer obstructed view during transit. Limited to short-line transects between SCI/Santa Catalina Isld due to airspace conflicts. Communicated with/searched near *R/V Flip* off N end SCI to try and coordinate sightings & obtain local weather info. Photo-documented rare Bryde's whale.
20 Oct	11:11-16:20	5.2	33	Delayed departure to allow *R/V Flip* time to set up, to facilitate coordination of sightings and to avoid early morning marine layer. Communicated with/searched near *R/V Flip* off N end SCI to try and coordinate sightings & obtain local weather info. Limited to short-line transects between SCI/Santa Catalina Isld due to airspace conflicts.
21 Oct	09:58-13:57	4.0		Delayed departure due to low marine fog. Limited to short-line transects between SCI/Santa Catalina Isld due to airspace conflicts.
Subtotal October		***27.5***	***112***	
November (PHASE II) - AFTER MTE				
15 Nov	11:03-16:24	5.4		Circumnavigated SCI to search for strandings: 1 dead floating CA sea lion seen near SCI; reported to Navy POC upon landing. Line transects in SOAR.
16 Nov	11:29-16:38	5.2		Circumnavigated SCI to search for strandings: 1 dead floating CA sea lion seen near SCI near where one seen yesterday; reported to Navy POC upon landing. Line transects in SOAR
17-Nov	10:45–16:07	5.4		Line transects S of SOAR E & S of SCI near boundary. Dead blue whale seen: reported to Navy POC upon landing.
18-Nov	11:03-16:24	5.4		Line transects S of SOAR E & S of SCI near boundary. Low clouds and hot areas (i.e., range in use by Navy) required aborting full survey there so returned to survey line transects NE of SCI.
Subtotal November		***21.4***		
GRAND TOTAL OCT & NOV		***48.9***		

Table 6. Summary of aerial survey effort (km) by leg type and Beaufort sea state *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE.

Effort Type (# km)	October – PHASE I *DURING* MTE	Nov - PHASE II *AFTER* MTE	Total
Leg Type			
Systematic	1667.0	1397.5	3064.4
Random	1948.1	1183.8	3131.9
Circling	947.7	1256.3	2204.0
Subtotal Effort	***4562.8***	***3837.5***	***8400.3***
No Effort	190.5	126.7	317.2
Total km Flown	***4753.3***	***3964.2***	***8717.4***
Beaufort sea state			
0		260.4	260.4
1	509.8	1985.4	2495.2
2	993.0	1637.7	2630.7
3	845.2	17.2	862.4
4	987.3		
5	764.6		
6	256.4		
Subtotal	***4356.2***	***3900.8***	***8257.0***
Bf recorded due to poor visibility	397.1	63.4	460.5
Total km Flown (with and without observations)	***4753.3 (2564.7 nm)***	***3964.2 (2139.1 nm)***	***8717.4 (4703.9 nm)***

Table 7. Summary of marine mammal sightings by species and study period *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE.

	OCTOBER - *During* MTE				NOVEMBER - *After* MTE				TOTAL (Oct & Nov)			
Species	**# Grp**	**# Indiv**	**Mean Group Size**	**Sighting Rate (# Indiv/ km)**	**# Grp**	**# Indiv**	**Mean Grp Size**	**Sighting Rate (# Indiv/km)**	**# Grp**	**# Indiv**	**Mean Group Size**	**Sighting Rate (# Indiv/km)**
Blue whale	1	2	2.0	<0.01					1	2	2.0	<0.01
Blue whale (dead)					1	1	1.0	<0.01	1	1	1.0	<0.01
Fin Whale	6	10	1.7	<0.01	5	12	2.4	<0.01	11	22	2.0	<0.01
Fin or Sei whale					1	1	1.0	<0.01	1	1	1.0	<0.01
Bryde's whale	1	1	1.0	<0.01					1	1	1.0	<0.01
Humpback whale					3	7	2.3	<0.01	3	7	2.3	<0.01
Unid. baleen whale					1	1	1.0	<0.01	1	1	1.0	<0.01
Unid. large whale					8	8	1.0	<0.01	8	8	1.0	<0.01
Unid. medium whale					1	2	2.0	<0.01	2	4	2.0	<0.01
Bottlenose dolphin	5	34	6.8	0.01					5	34	6.8	<0.01
Common dolphin sp.	22	8731	396.9	1.73	27	2395	88.7	0.57	49	11126	227.1	1.25
Long-beaked common dolphin	2	80	40.0	0.02					2	80	40.0	0.01
Short-beaked common dolphin	5	1395	279.0	0.65	5	1380	276.0	0.53	10	2775	277.5	0.60
Possible. common dolphin sp.	1	30	30.0	0.01					1	30	30.0	<0.01
Pacific white-sided dolphin					12	498	41.5	0.01	12	498	41.5	<0.01
Risso's dolphin	18	553	30.7	0.15	1	50	50.0	0.02	19	603	31.7	0.10
Unid. dolphin	10	362	36.2	0.10	13	338	26.0	0.13	23	700	30.4	0.11
CA sea lion	37	126	3.4	0.03	53	132	2.5	0.03	90	258	2.9	0.03
CA sea lion (dead)					2	2	1.0	<0.01	2	2	1.0	<0.01
Harbor seal	1	1	1.0	<0.01	9	15	1.7	<0.01	10	16	1.6	<0.01
N. elephant seal					1	1	1.0	<0.01	1	1	1.0	<0.01
Unid. sea lion					1	7	7.0	<0.01	1	7	7.0	<0.01
Unid. pinniped	3	3	1.0	<0.01	23	26	1.1	<0.01	26	29	1.1	<0.01
Unid. marine mammal					6	26	4.3	0.01	6	26	4.3	0.01
Unid. small marine mammal					6	8	1.3	<0.01	6	8	1.3	<0.01
Common dolphin sp. & bottlenose dolphin	2	1257	637.5	0.35					2	1257	637.5	0.21
Common dolphin sp. & CA sea lion					1	26	26.0	0.01	1	26	26.0	<0.01
Common dolphin sp. & Pacific white-sided dolphin					1	300	300.0	0.12	1	300	300.0	0.05
Short-beaked common & Pacific white-sided dolphin					1	400	400.0	0.15	1	400	400.0	0.06
Short-beaked common dolphin & CA sea lion					1	60	60.0	0.02	1	60	60.0	0.01
Pacific white-sided dolphin & CA sea lion					1	22	22.0	0.01	1	22	22.0	<0.01
Unid. dolphin & CA sea lion					1	14	14.0	0.01	1	14	14.0	<0.01
Total	**115**	**12587**	**109.4**	**2.71**	**185**	**5732**	**31.0**	**1.85**	**300**	**18319**	**61.0**	**2.35**

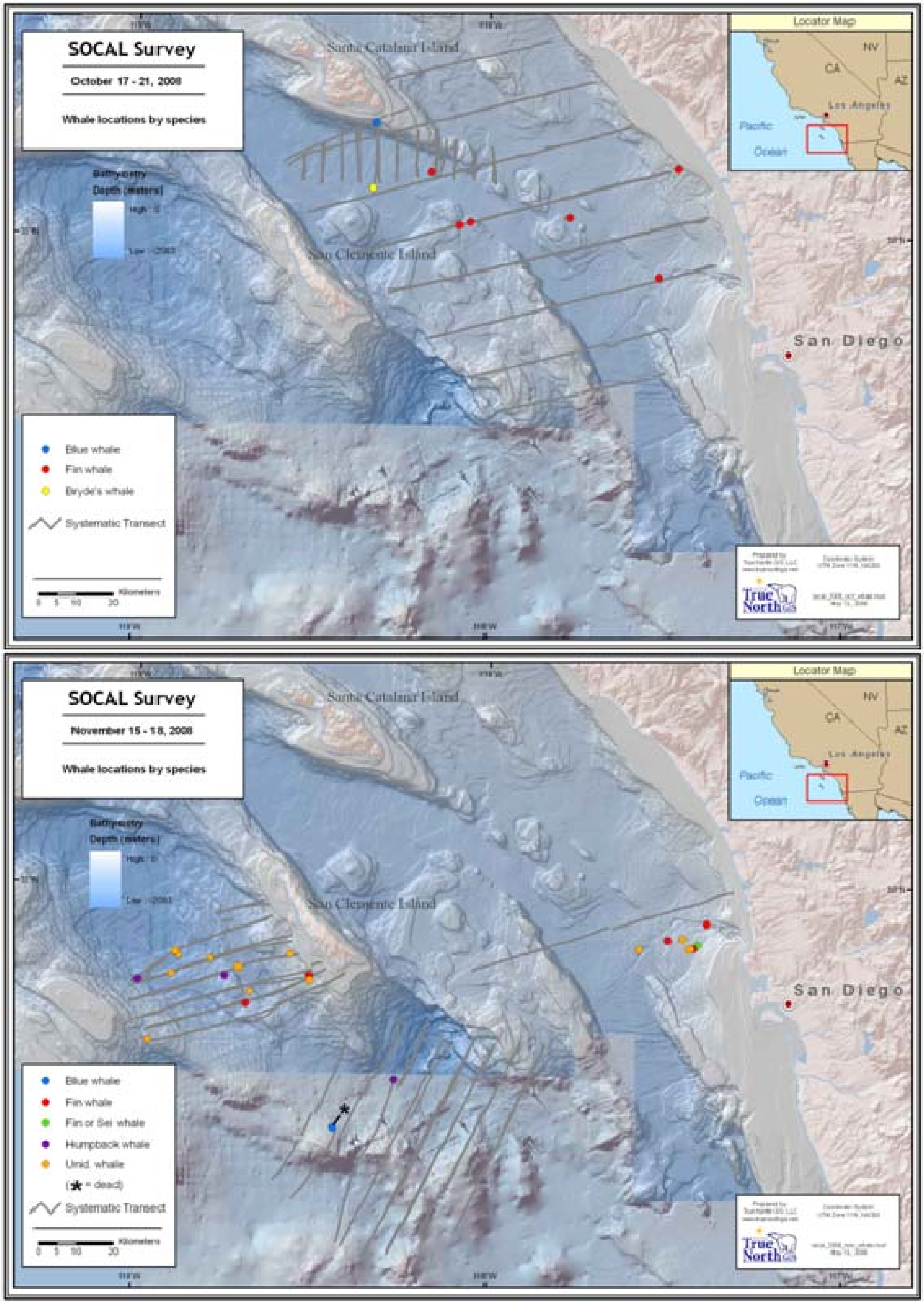

Figure 7. Upper panel 17-21 Oct 2008: Whale sightings in the SOCAL *during* MTE. Only systematic track lines shown but all sightings shown. Lower panel 15-21 Nov 2008: Whale sightings *after* MTE (See Figure 3 for all track line effort).

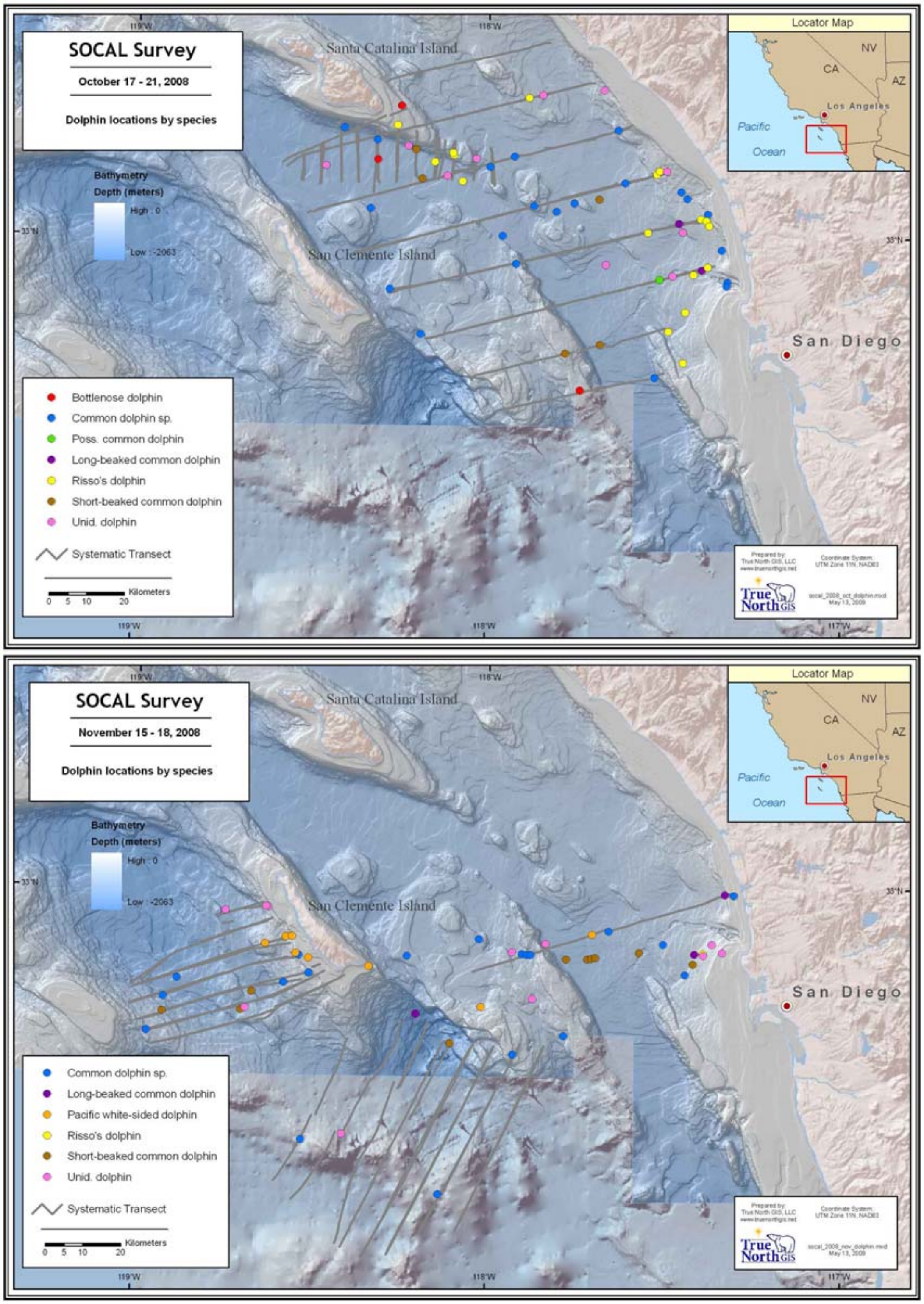

Figure 8. Dolphin sightings: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Sightings *after* MTE.

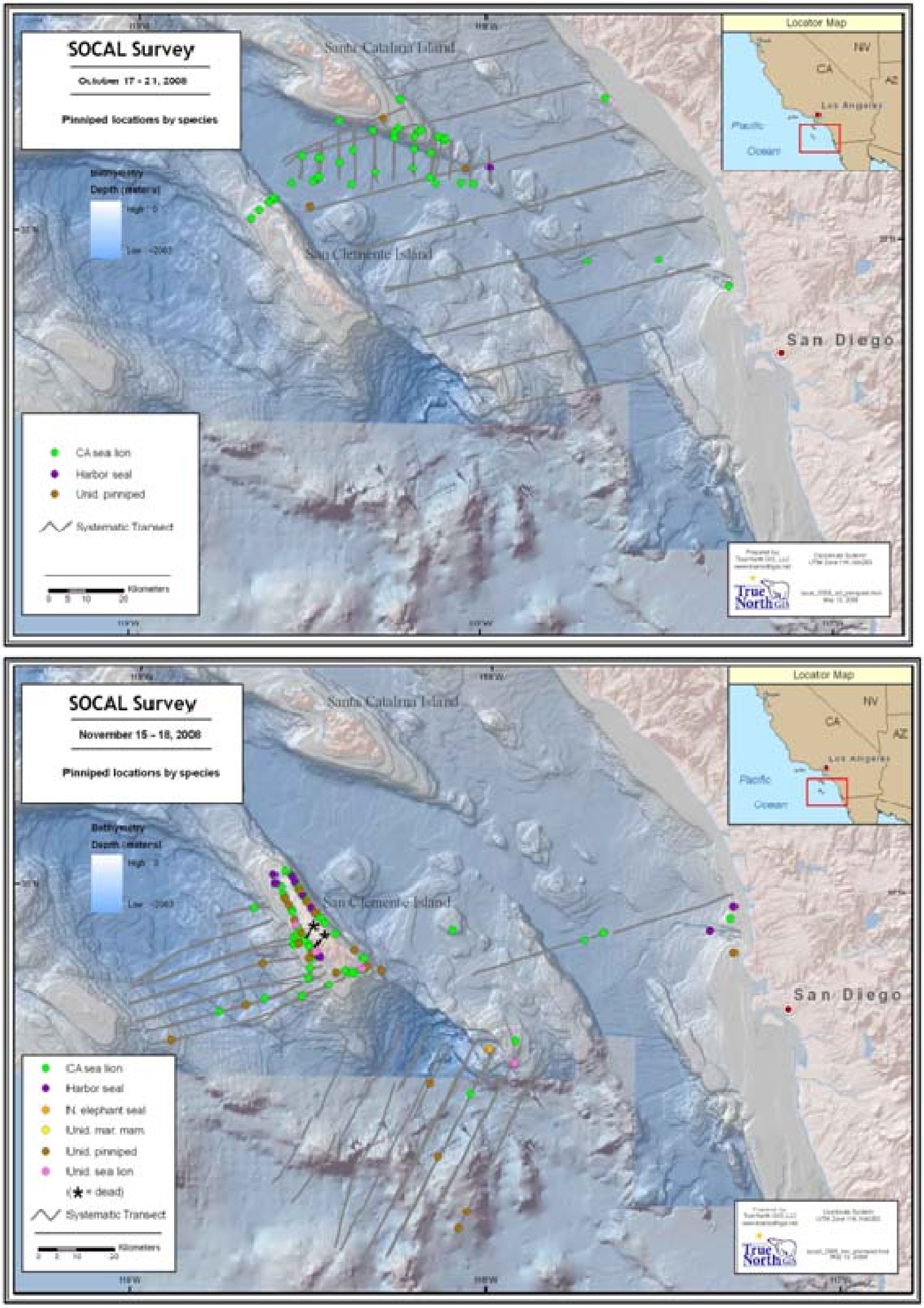

Figure 9. Pinnipeds: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Pinnipeds *after* MTE.

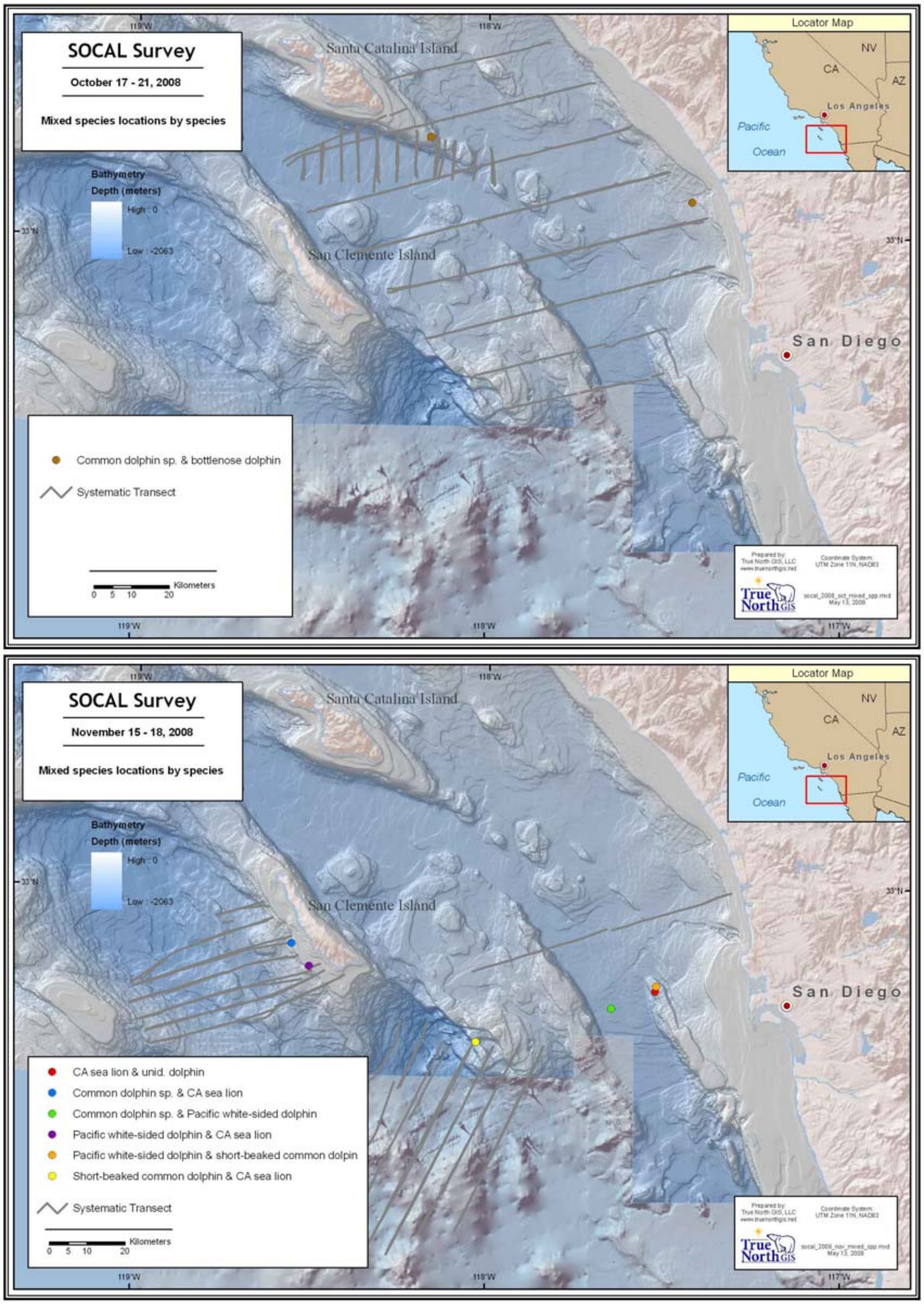

Figure 10. Mixed species: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Mixed-species sightings in the SOCAL *after* MTE.

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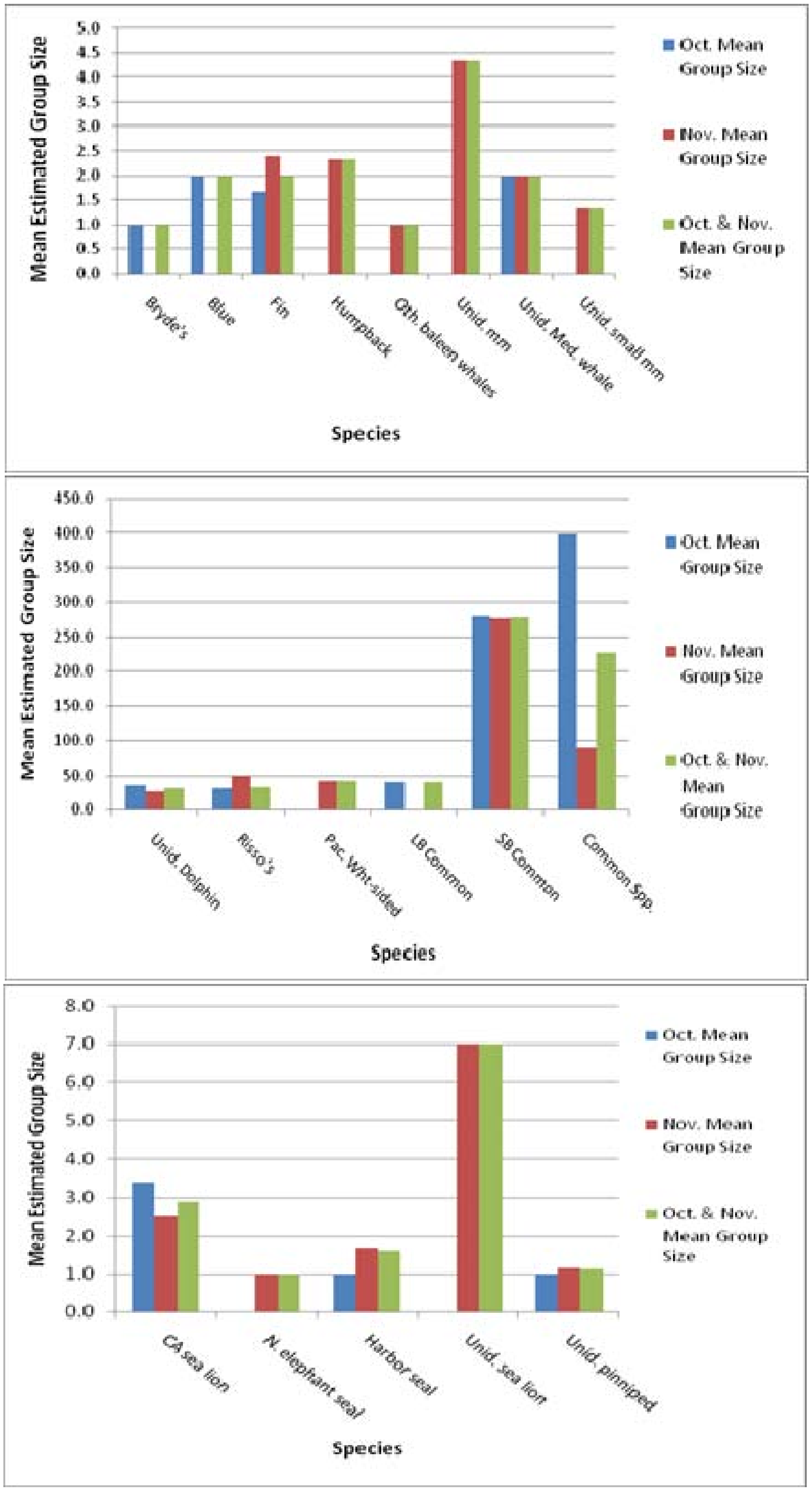

Figure 11. Mean group size by species or group *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period.

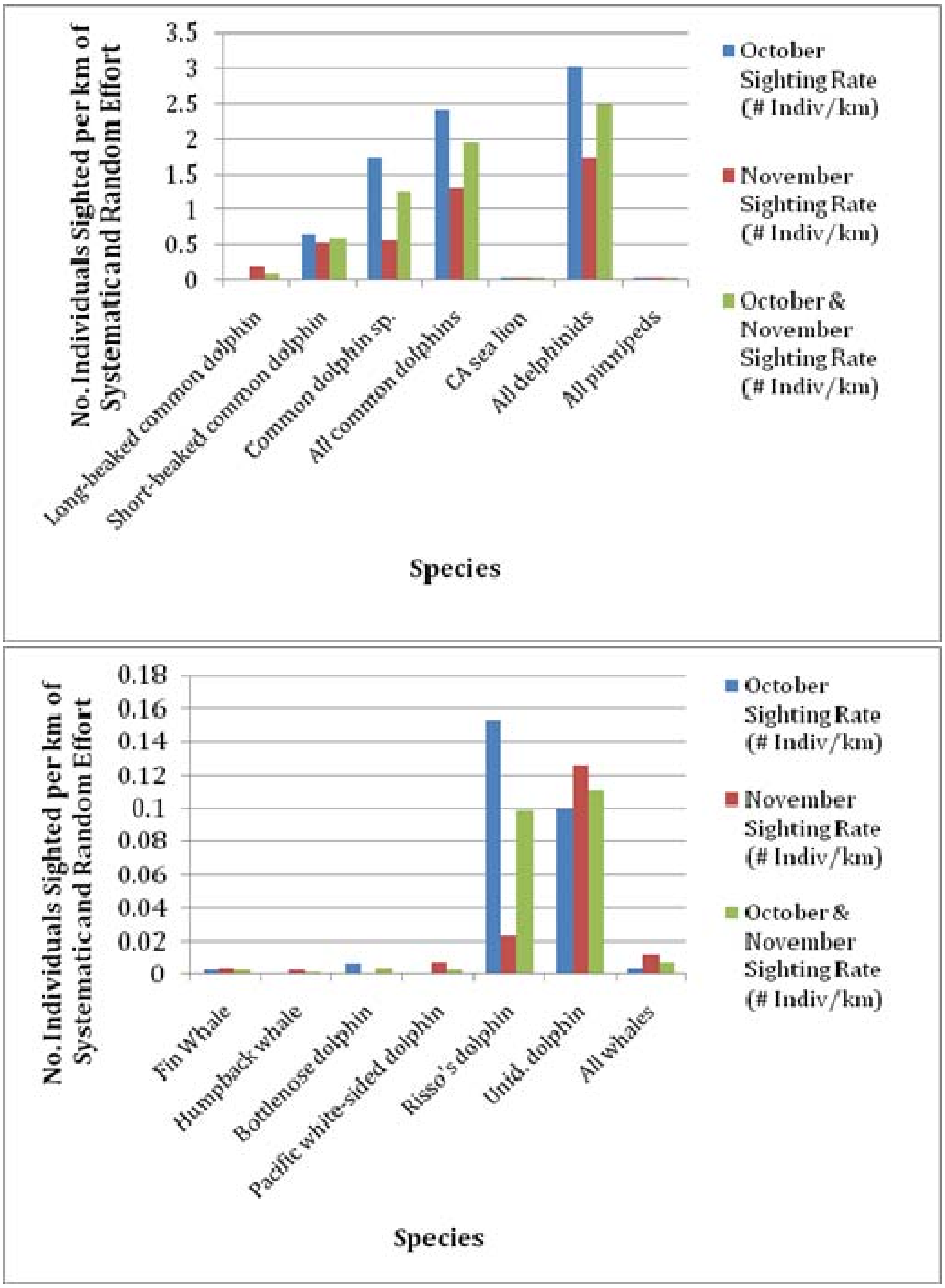

Figure 12. Sighting rates (no. individuals/km) of the most commonly seen (upper panel) and less commonly seen (lower panel) species and groups of marine mammals *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period based only on systematic line transect and random observation data.

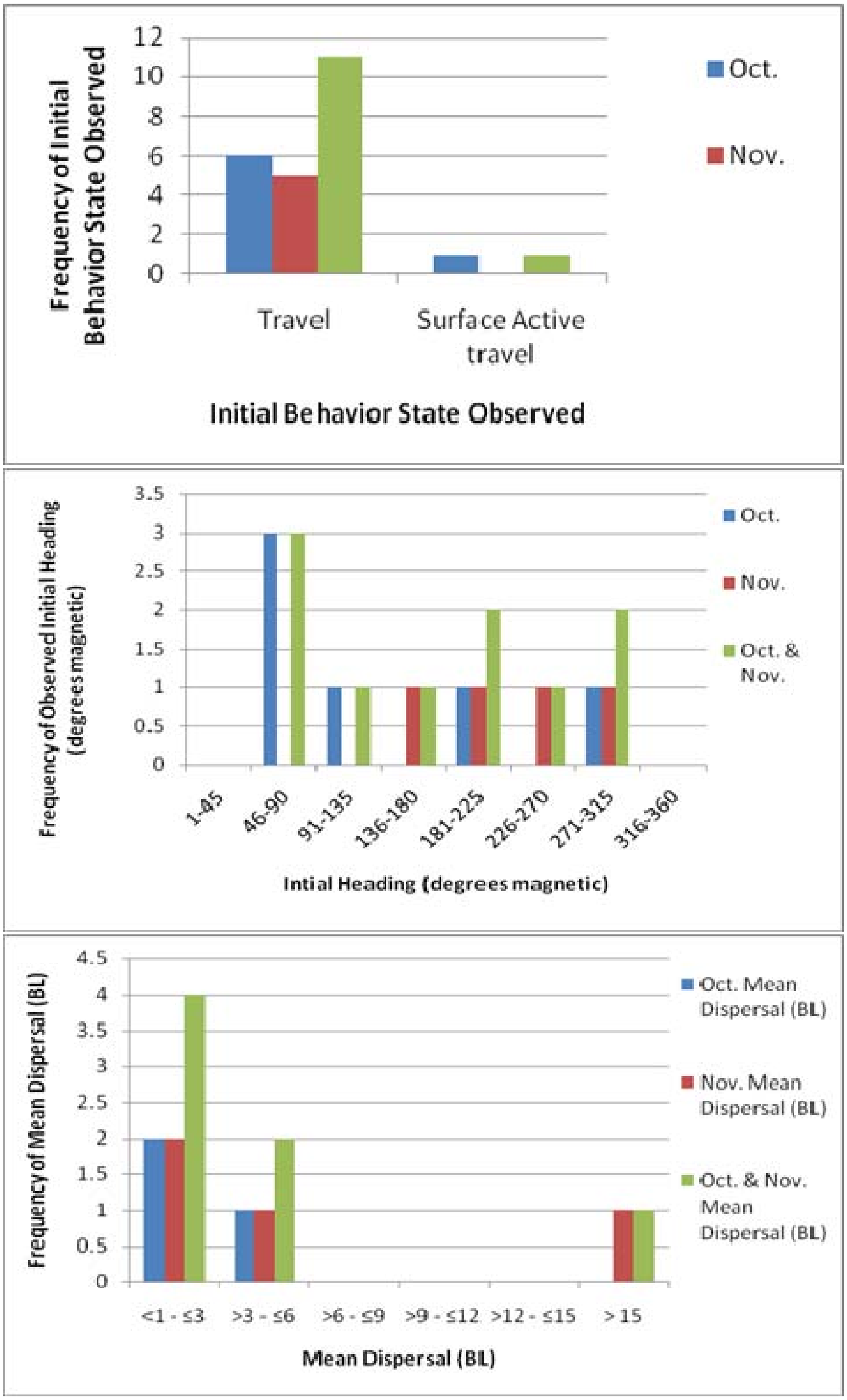

Figure 13. Fin whales. Top panel: frequency of initially observed behavioral states *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Bottom panel: frequency of mean dispersal distance between individuals (in estimated body lengths) *during* (Oct) and *after* (Nov) MTEs.

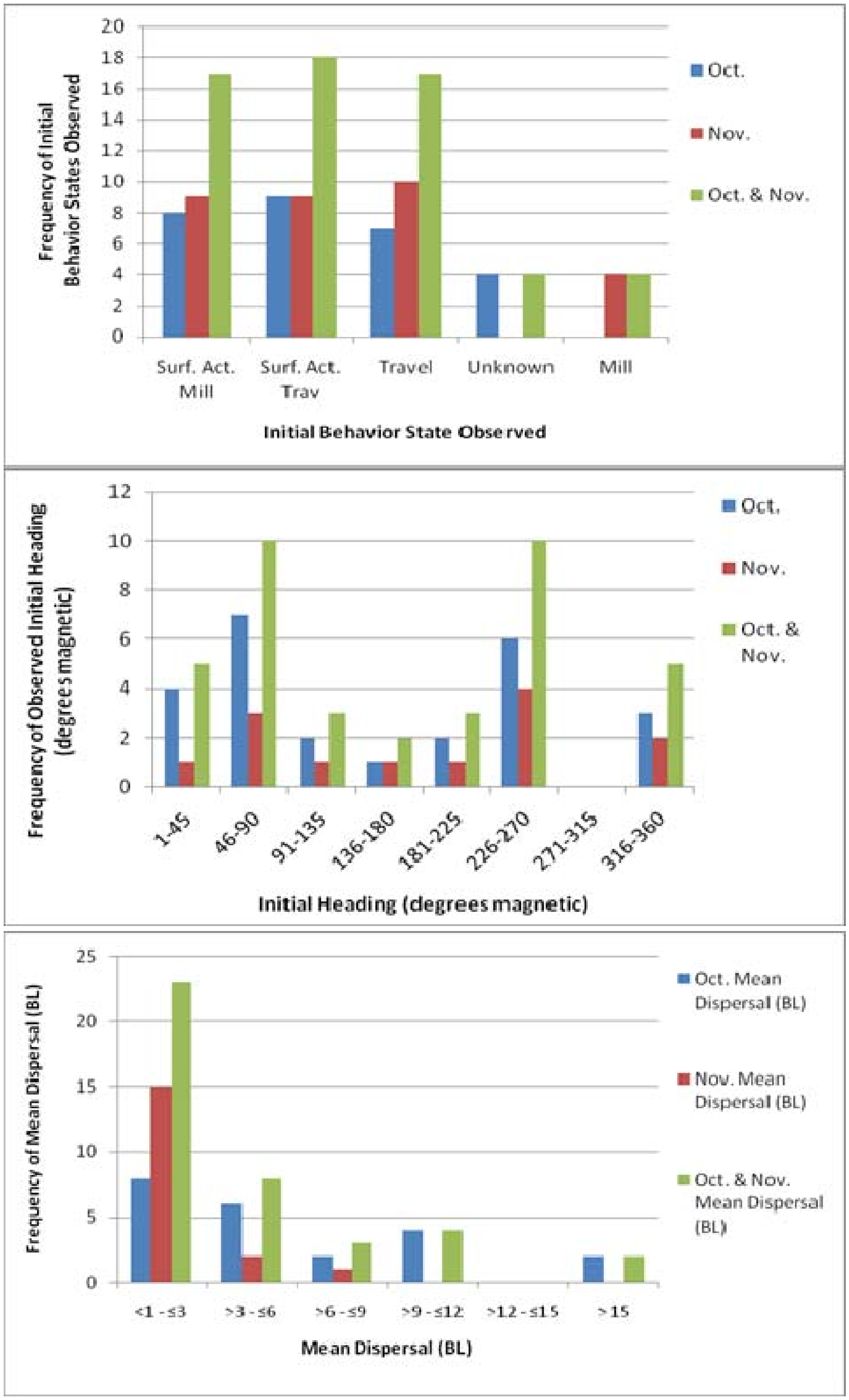

Figure 14. Common dolphins: Upper panel: frequency of initially observed behavioral states *during* (Oct) and *after* (Nov) the SOCAL2008 MTE. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Bottom panel: frequency of mean dispersal distance between individuals (in estimated body lengths) *during* (Oct) and *after* (Nov) MTEs.

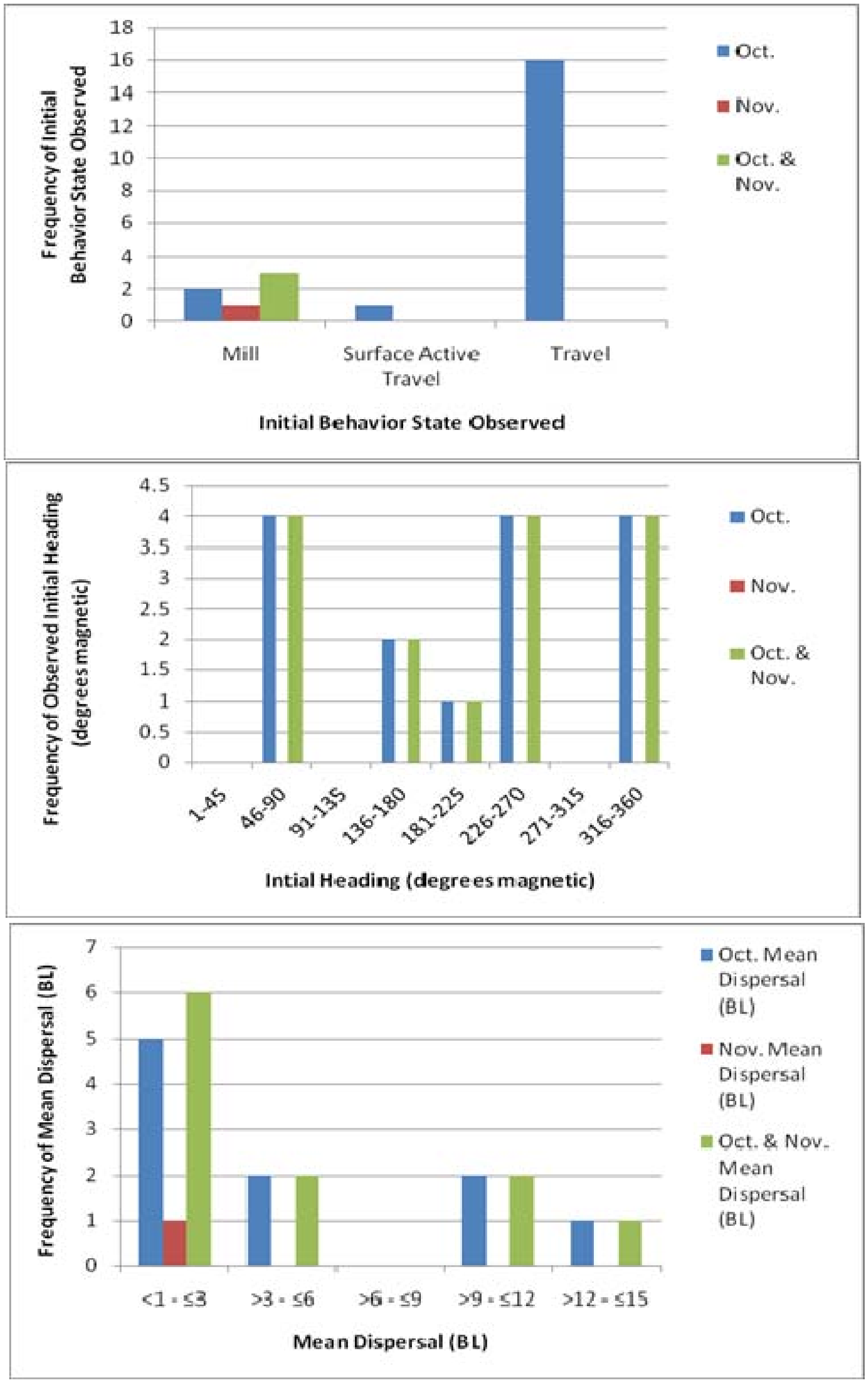

Figure 15. Risso's dolphins: Upper panel: frequency of initially observed behavioral states *during* (Oct) and after (Nov) the SOCAL2008 MTE. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Lower panel: frequency of mean dispersal distance between individuals (in estimated body lengths) *during* (Oct) and *after* (Nov) MTEs

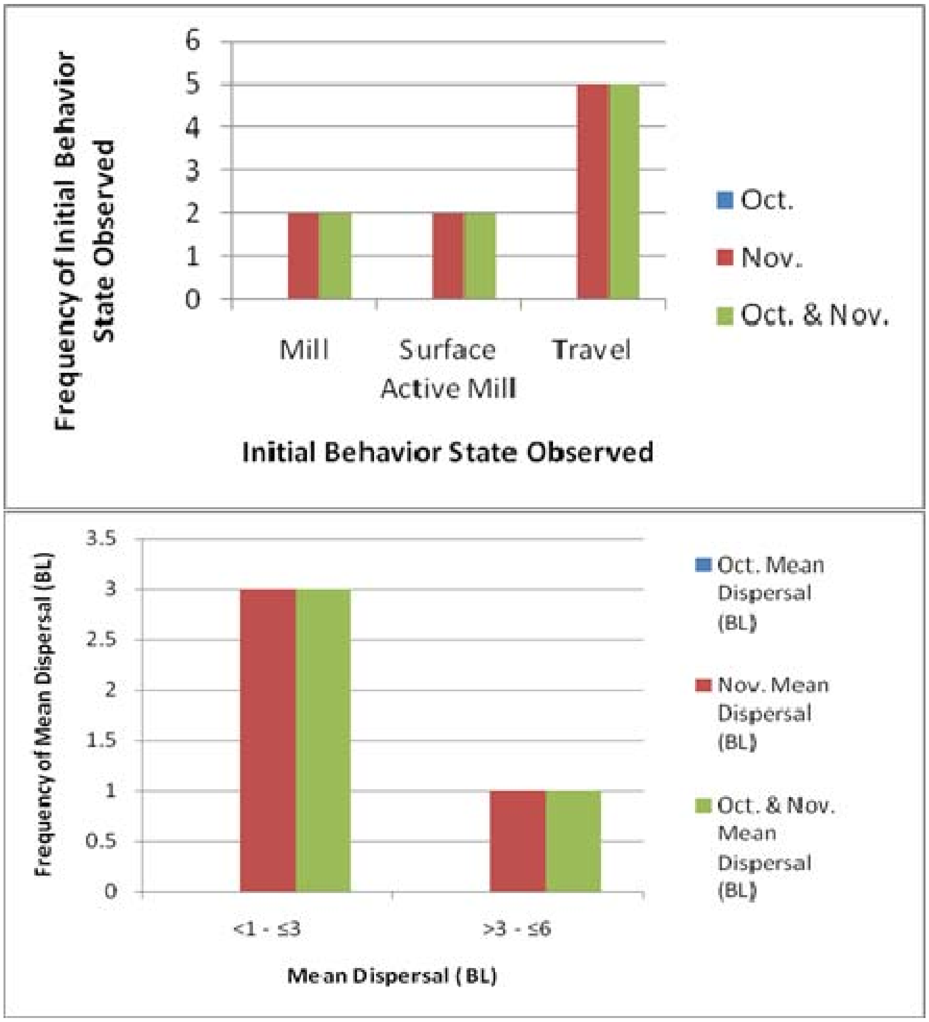

Figure 16. Pacific white-sided dolphins: upper panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) the SOCAL 2008 MTEs. Lower panel: frequency of mean dispersal distance between individuals (in estimated body lengths) *during* (Oct) and *after* (Nov) MTEs.

Section 4 Discussion

Results Relative to Project Questions and Hypotheses

This section discusses results in the context of the US Navy Marine Mammal Monitoring Program (M3P) (DoN 2009) questions and the project hypotheses and predictions outlined in Table 1. In this respect, the survey was successful as it demonstrated that in addition to systematically collecting cetacean occurrence and distribution data, selected behavioral variables can also be collected and quantified for most species. Aerial surveys were also shown to be useful in locating and identifying dead floating marine mammals. The survey successfully gathered current baseline data on species in this region.

What was Learned or Confirmed?

Given the caveats identified in the *Introduction*, this study contributes the following information relevant to the goals identified in the SOW and the Navy's SOCAL M3P (DoN 2009).

- 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 MM was 2.71 vs. 1.85 MM/km in Nov (per systematic/random effort excluding Nov SCI 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) (see *Results*). 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 SCI shoreline surveys where this species aggregates (Carretta et al. 2000).

- Three sightings of floating carcasses were located and photo-documented. This included shoreline surveys around SCI 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 MM 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 SW edge of SCI characterized by steep bathymetric relief, especially Pacific-white-sided dolphins (Figures 6 and 7). In Nov, whales (mostly baleen whales) were sighted through much of SOAR but appeared to concentrate between SW SCI and Tanner Bank to the W (Figure 6). In both months, cetaceans were frequently seen ~20 km NW of San Diego directly W 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 SCI 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 (e.g., reviewed in Richardson et al. 1995; also see Malme et al. 1983, 1984; Richardson et al. 1985, 1986a,b, 1987, 1990a,b, 1991; Smultea and Würsig 1992; Smultea et al. 1995; Patenaude et al. 2002; Smultea et al. 2008). 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 NE/E and SW/W 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 (Table 1). It also addressed goals of the SOCAL M3P (DoN 2009).

- 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. in prep.). Assessing "the efficacy and practicality of monitoring" techniques in this manner meets goals of the M3P (DoN 2009: p. 3). 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 M3P and the Navy-wide Integrated Comprehensive Monitoring Program (ICMP)(DoN 2009: p. 3).

- Sample sizes of some species (mainly common dolphins) may be sufficiently large 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 ~365-457 m (1200-1500 ft) similar to previous studies, including videotaping (e.g., bottlenose dolphins: Smultea and Würsig 1991; bowhead whales: Richardson et al. 1985a,b, 1986, 1990, Würsig et al. 1985, 1989; humpback whales: Smultea et al. 1995). 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, Figure 5). 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 (e.g., reviewed in Richardson et al. 1995; also see paragraph above). Survey results successfully demonstrated that extended focal sessions can be conducted on priority ESA-listed and "surrogate" deep-diving species (DoN 2009) 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 08 training 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 our Navy-experienced aircraft pilots 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, Hawaiian Range Complex (HRC), and Atlantic Range Complex M3Ps and ICMP (DoN 2008, 2009). As such, the survey contributes to the "overall knowledgebase of marine species", a goal of the SOCAL M3P and ICMP (DoN 2009: p. 3).

- Information gathered herein can be used to continue developing effective monitoring approaches and to gather behavioral data on the potential effects of Navy activities on marine resources as required under the SOCAL M3P and ICMP.

- This survey helped to identify both limitations of and recommendations for future SOCAL and other monitoring-related efforts as discussed in the *Recommendations* Section.

Feasibility Assessments

A number of feasibility assessments were conducted during aerial monitoring to identify and develop suitable protocol and to identify study limitations considering the species and conditions of the survey as summarized below.

- A prominent limitation of the study approach with respect to Navy monitoring is the potential for airspace conflict with naval aircraft operations. This is a particular challenge within the SOCAL due to the significant amount of controlled airspace during a MTE. For safety reasons, this potentially limits the ability to fly aerial surveys in the actual MTE area during a MTE, as occurred in Oct 2008. This compromises the ability to observe marine mammals near MFAS sources and necessitates that survey areas differ *during* and in this case, *after*, the MTE. However, the *after*-MTE Nov survey, conducted within 1 day after the MTE ended in this case, provides useful data on potential geographical redistribution, an issue identified in the SOCAL M3P (see Table 1; DoN 2009).

- Survey results herein show that MM were observed in the MTE area soon after MFAS operations. A limitation is that we cannot ascertain from the aircraft whether or not these same animals occurred within the area *before* or *during* the MTE using the current protocol. Tracking radio-tagged animals from an aircraft before, during and/or after an MTE could provide these data. An aircraft provides an ideal high-elevation platform from which tagged animals could be tracked for many miles to the horizon (see *Recommendations* section). Furthermore, radio-tracking equipment is significantly less costly than satellite tags; as a result, more animals can potentially be tagged facilitating larger, more representative samples sizes. Other tagging and photo-identification from vessels allows individual identification and tracking.

- The longest focal follows purposefully were conducted on ESA-listed priority species. Given the relatively low encounter rates of such species, focal follows were also conducted on "surrogate species" (i.e., secondary species of interest—see *Methods* section). It was quickly discerned that conducting consistent focal follows on the typically large groups of common dolphins encountered was not feasible given the difficulty in tracking so many animals at once and the difficulty in maintaining a consistent radial distance. However, it was quickly noted that Risso's dolphins were relatively easy to track given their whitish coloration and thus visibility at and near the water surface, their generally more cohesive and smaller group sizes, and the preliminary opportunistic/anecdotal apparent indifference to the aircraft even during inadvertent close passes. Subsequent focal follows of delphinids were consequently focused on this species in addition to the ESA-listed whales.

- Another survey goal was to assess the feasibility of seeing and tracking cetaceans below the water surface from the research aircraft. Results documented with video show that this can be done from a circling aircraft at ~357-365 m (~1200-1500 ft) altitude and ~0.5-1.0 km radial distance. Bf <4 conditions are best for this approach as more frequent whitecaps associated with higher Bf make it difficult to consistently track animals. Risso's dolphins in particular were relatively easy to track from the air including below the water surface, given their light body coloration and their relatively large body size (up to 3.8 m [Jefferson et al. 2008]).
- No beaked whales, a priority species per the SOCAL M3P (DoN 2009), were sighted during this survey, even during calm conditions, though they are known to occur regularly in the SOAR region (e.g., Carretta et al. 2000; Hildebrand 2005, 2007; Falcone et al. 2009a, b). Several sightings of unidentified medium-sized whales or unidentified whales that observers believed were not baleen whales and were thus likely beaked whales could not be confirmed. The animals dove before we could get a close look, were seen at a distance, and/or observation conditions were marginal. Beaked whales are known to have relatively long dive times (>90% of their time below surface), tend to spend relatively short periods at the surface, and have an inconspicuous diving profile and thus are difficult to sight (e.g., Barlow 1999, Baird et al. 2006, Barlow and Gisiner 2006, Ferguson et al. 2006, Tyack et al. 2006, McSweeney et al. 2007, Jefferson et al. 2008).
- A newly developed data-event recorder system was tried out during these surveys utilizing a small (~5 X 11 cm) Palm Pilot with a customized software program to collect sighting, survey (e.g., leg type), and environmental conditions data. This set up has the advantage of small size relative to a larger laptop and has touch-screen category and numerical/alphabetical input features. Using this system sped up data collection in the field and reduced post-field analysis time and thus project costs. Since this survey, behavioral data collection software has been recently developed for the iPhone and has been tested out and improved upon during aerial survey monitoring in Feb 2009 in Hawaii and June and July 2009 in SOCAL (Smultea et al. *in prep*). The latter includes both a sighting program and a behavioral data collection program for focal follows.

Advantages and Limitations of Aerial Surveys

Aerial surveys provide some specific advantages over vessel surveys, tagging studies, and acoustic studies in addressing the questions and hypotheses of interest and concern to the Navy per the SOCAL M3P and the ICMP (see Table 1; DoN 2009). While aerial surveys cannot address all these questions alone, they provide advantages and contributions listed below. Combined with other methodologies, aerial surveys are an important and unique platform from which to address Navy M3P questions relative to Navy MTEs involving MFAS (and underwater detonations).

Advantages of Aerial Surveys:

1. Provides a systematic "snapshot" over a large area in a short time period. This "snapshot" can be compared before, during, and/or after a MTE to monitor potential large-scale changes in numbers, distribution, behavior, geographical distribution, etc.
2. Typically results in higher sighting rates than vessels per time effort and at considerably reduced cost (vs. large survey vessels)(e.g., Dawson et al. 2008).
3. Reaches far areas fast on short notice.
4. Useful for live or post- ground-truthing of acoustic detections and locating and observing tagged animals, studies which are ongoing in the SOCAL (e.g., DoN 2009).
5. Can observe behavior for extended periods offshore (<6 hours current aircraft fuel range) with potential for no confounding disturbance by aircraft observation platform (vs. vessels that are heard underwater and to which some marine mammals are known to change their behavior in response to).
6. Can observe MM below water for long periods for some species/conditions (vs. vessel cannot).
7. Can provide data on the potential time lag until animals *redistribute* in the area post MTE. Best addressed when done *within the MTE area* before, during and after the MTE. Photo-identification or tagging studies needed to identify known individual movements.
8. Provides visual detection and confirmation of marine mammals that have stranded, are dead or injured and floating at the surface, or that are behaving very abnormally due to severe trauma.

Limitations of Aerial Surveys:

1. Low detection rate of long-diving and/or cryptic species such as beaked whales (e.g., Barlow 1999, Barlow and Gisiner 2006).
2. Cannot track individuals over periods of days or more (vs. tagging and vessel-based photo-identification). However, *can locate, track and ground truth animals tagged with radio and satellite tags* with the appropriate tracking equipment onboard the aircraft.

Past Cetacean Studies in and Near SOAR

Sighting data were compared to aforementioned results of SWFSC systematic, line-transect aerial surveys conducted in 1998-99 in the same region, from the same aircraft type (twin-engine Partenavia with bubble windows), and at the same groundspeed (100 kt) (Carretta et al. 2000). However, we surveyed from an altitude of ~309 m (1000 ft) vs. 213 m (700 ft) by Carretta et al. (2000). We used two observers and a recorder while they used three observers (one belly-window observer) and a recorder. Although Carretta et al. (2000) conducted aerial surveys 1-2 times per month over a period of ~1.5 yr in 1998 and 1999, we limit our comparison here to their 1998 surveys conducted in the same months of Oct and Nov in their "offshore" survey area. Carretta et al. (2000) conducted a total of 525 nm of systematic line transect effort in Oct and 410 nm in Nov in SOAR and around SCI; we conducted 2,462 nm in Oct, and 2,070 nm in Nov in the same general survey area.

- Carretta et al. (2000) reported that common dolphin abundance was 2.5 times greater from May-Oct vs. Nov-April. This is similar to our observations that common dolphin sighting rates were nearly twice as high in Oct vs. Nov.
- We saw Pacific white-sided dolphins only in Nov which is consistent with Carretta et al.'s (2000) findings that this species occurs in the region only during the cold-water months of Nov-April.
- In contrast to Carretta et al. (2000), we saw many more Risso's dolphins in Oct (*n* = 18 groups) vs. Nov (*n* = 1 group) (Table 7), while they reported that Risso's were 3x higher in the cold-water vs. the warm-water periods.
- Changes in the occurrence and abundance of fin and humpback whales appear to differ from 1998-99 when Carretta et al. (2000) did their surveys. We saw three humpback groups in Nov and none in Oct, while they saw humpbacks only twice in the 1.5 yr of survey and only in April. We saw 11 groups of 22 fin whales in ~4,533 nm of total effort in Oct-Nov, while they saw a total of 21 groups throughout the ~1.5 yr and 4,172 nm of surveys (it is not possible to directly cross-compare sighting rates between the two studies using readily available data). Carretta et al. (2000) saw blue whales primarily in spring and summer, with just one seen in Nov; we saw a pair of blues in Oct and a dead blue in Nov. They saw four Cuvier's beaked whales from Nov-April while we did not sight any beaked whales. However, Carretta et al. (2000) saw northern right whale dolphins in Nov while we saw none. They saw many more California sea lions at sea (*n* = 2100) during offshore transects while we sighted ~250 individuals of this species at sea.
- Over 40% off all aerial effort occurred with calm Bf 0-2 during the Carretta et al. (2000) study vs. 32% Bf 0-2 during our Oct-Nov survey.

Section 5 Recommendations

As requested in the SOW, this section provides recommendations for future monitoring efforts relative to what was learned during this survey. Recommendations focus on experiences during this survey and those from recent similar past monitoring surveys we have conducted in the HRC (e.g., Norris et al. 2005; Mobley 2008a,b; Smultea et al. 2007, 2008; Smultea and Mobley 2009), as well as other relevant professional experience. The recommendations are briefly summarized below.

- Continue to build a behavioral database using the *focal follow* approach to quantify behavioral indices of disturbance described herein, including building baseline behavior data sets.
- Consider replicating the SCC OPS Exercise monitoring protocol (Smultea and Mobley 2009 and *in prep.)* in SOCAL where sighting rates are significantly higher in Navy ranges. This approach involves conducting localized, opportunistic "before, during, after" studies from the observer aircraft flying loop search patterns while accompanying a Navy vessel that intermittently transmits MFAS. This has been successfully implemented in MTEs off Hawaii.
- Apply protocol approaches that facilitate collection of multiple before-during-after exposure conditions. This is ideally performed by observing the same group before, during and after exposure for at least 10 different groups for ≥30-60 min each (e.g., reviewed in Richardson et al. 1995; also see Mobley et al. 1988; Smultea et al. 1995). Repeated measures analyses can then be conducted to control for inter-group/individual variability, which in turn typically requires a much smaller sample size and provides greater statistical power to determine significance (e.g., Zar 1984; Mobley et al. 1988; Maybaum 1990, 1993; Frankel and Herman 1993; Smultea et al. 1995).
- Continue to conduct post-MTE aerial surveys in the area, including circumnavigation of SCI ***and Santa Catalina and San Nicholas Island shorelines*** to search for potential severely stressed, injured, or dead floating MM/ST.
- Conduct *a priori* power analyses of baseline behavioral data collected on priority and surrogate species herein. Combine data with future similar data to determine sample sizes required to identify a statistically significant change in behavioral parameters proposed to be monitored relative to potential effects of Navy MFAS and underwater detonation activities (see Table 1).
- Continued developmental support of recent customized software (e.g., BioObserver) for the iPhone is highly recommended. No other marine mammal research groups are known to use this type of system and it increases the efficacy of field data collection and reduces data analysis time.
- Conduct exploratory summary statistical analyses of detailed continuous sampling of focal behavioral sessions on priority and surrogate cetacean species as collected on video recordings.
- Continue to collect video of cetacean behavior during focal follows. We successfully collected extended video footage of four cetacean groups, contributing to baseline behavioral data for these species in the SOCAL. These data may be useful for comparison with future monitoring assessments. Detailed transcription of video-taped behavior provides a more-detailed database on the behavior of cetaceans in this area for which there are very few previous data. The greater detail and accuracy facilitated by recording behavior to videotape may reveal subtle changes in behavior that are not evident during *in situ* observations and from associated field notes, as found in studies of other cetaceans relative to anthropogenic activities (e.g., Malme et al. 1983, 1984; reviewed in Richardson et al. 1995). Videotape also reduces the potential for observer error and bias during field behavioral observations, as taped sessions can be reviewed repeatedly. Examination of videotape also allows for more accurate measure and quantification of some behavioral variables that can be indicative of

stress, including inter-individual body lengths and respiration rates; the former variable can be measured relatively from the video tape using calipers (Smultea and Würsig 1995).

- Purchase *Noldus* video analysis software customized for field data collection and analyses of behavioral data. This system will reduce analysis time and thus reduce analysis costs for analyses of video recordings of focal follow behavioral sessions. It will also minimize the potential for bias and errors during manual videotape transcription and data analyses of focal follow behavioral data.

- Design and conduct studies to assess potential effects of the observer aircraft on focal follow species. It is strongly suggested that systematic studies be conducted to assess potential effects of the aircraft on priority and surrogate species in the SOCAL. This is prudent to confirm results of other studies demonstrating that a small aircraft flying at 365-457 m (1200-1500 ft) altitude and ~0.5-1.0 km radial distance, does not significantly change or affect behavior of those species that have been studied, e.g., bowhead and humpback whales and bottlenose dolphins (reviewed in Richardson et al. 1995; also Richardson et al. 1991; Smultea et al. 2008). This type of study was begun opportunistically and systematically during the June and July 2009 SOCAL aerial monitoring conducted for the Navy (Smultea et al. *in prep*). Assessing potential effects of the circling observer aircraft could be done a number of ways.
    - The aircraft could begin circling at a large radial distance (e.g., 2-3 km) and at a select altitude, gradually closing in on the focal group until a reaction is observed and/or until the aircraft is directly overhead. This could be repeated at different altitudes and for different species, etc.
    - The ideal non-intrusive approach would be to track animals from land using a theodolite before, during and after an aircraft circled overhead (e.g., see Smultea et al. 1995). This approach uses the A-B-A study method and thus typically requires a relatively small sample size to detect a statistically significant effect and/or sufficient statistical power to conclude no effect.

- Conduct controlled overflights by the survey aircraft of an underwater hydrophone such as a sonobuoy to determine received levels (dB) at various depths. This protocol should systematically assess the influence of various pre-selected factors that influence underwater received sound levels. These factors include water depth, aircraft altitude and radial distance, flight pattern (e.g., straight-line passbys, circling), and Bf sea states. This will allow measurement of received underwater sound levels of the aircraft at various frequencies and distances relative to the known frequencies used by marine mammals of concern. These data can then be used to estimate received levels of underwater aircraft sounds near marine mammal sightings. Similar studies have been conducted in the Arctic relative to bowhead whales though with very different aircraft (e.g., a Twin Otter and a Bell 212 helicopter) and in very different water conditions and temperatures, which affect the transmission of underwater sounds (e.g., reviewed in Urick 1972; Richardson et al. 1995).

- Conduct a literature review and summary of parameters successfully used to identify and quantify significant behavioral and stress reactions in MM/ST in response to stimuli. Considerable literature is available on the reactions of MM/ST to various anthropogenic stimuli such as underwater sounds, predators, etc. However, much of these data are limited to "gray" literature such as permit reports, government reports, etc., and thus are difficult to locate and are often not peer-reviewed. Quantifying behavioral data and collecting sufficient such data to measure significant changes in various behavioral parameters (e.g., respiration and dive patterns, inter-individual spacing, orientation, etc.) is challenging. Selecting and using parameters that have been shown in past studies to be indicative of stress and/or that result in what could be considered MMPA/ESA Level B take is critical to solid protocol development. Given the size of the related literature database available, a thorough up-to-date review of this literature is important to support the choice of behavioral parameters used to study and quantify potential effects of Navy activities on MM/ST.

- Conduct a cost-effectiveness and safety analysis of monitoring approaches. This analysis would objectively evaluate, quantify, and qualify the cost-effectiveness and observer safety of various monitoring techniques to address the Navy's monitoring objectives/questions related to training events. For example, the utility vs. cost of photo-ID vs. various tagging techniques could be evaluated to assess which approaches and in what combination would be most cost-effective but could also feasibly and reasonably address Navy monitoring goals. A similar comparison could be made between vessel-based and aerial surveys, etc.

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Section 8 Appendices

Appendix A. 17-21 Oct 2008: Summary of all individual marine mammal sightings, including location latitudes and longitudes, made during aerial monitoring surveys *during* the SOCAL 2008 MTE period off San Diego, California.

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
17-Oct	38	Risso's dolphin	8:54	32.7035	117.4438
17-Oct	1200	Common dolphin sp.	9:15	32.6678	117.5246
17-Oct	6	Bottlenose dolphin	9:33	32.6368	117.7357
17-Oct	20	Prob. short-beaked common dolphin	9:54	32.7250	117.7776
17-Oct	40	Prob. short-beaked common dolphin	10:13	32.7469	117.6800
17-Oct	40	Risso's dolphin	10:24	32.7793	117.4850
17-Oct	31	Risso's dolphin	10:33	32.8255	117.4379
17-Oct	10	Unid. dolphin	10:47	32.9125	117.4738
17-Oct	30	Poss. common dolphin	10:52	32.9035	117.5109
17-Oct	2	Fin whale	10:57	32.9085	117.5161
17-Oct	600	Common dolphin sp.	11:28	32.7697	118.1893
17-Oct	1100	Common dolphin sp.	11:50	32.9405	117.9191
17-Oct	11	Risso's dolphin	12:09	33.0170	117.5444
17-Oct	55	Prob. long-beaked common dolphin	12:22	33.0385	117.4557
17-Oct	8	Risso's dolphin	12:30	33.0495	117.3931
17-Oct	40	Common dolphin sp.	13:56	33.0605	117.3736
17-Oct	11	Risso's dolphin	14:07	33.0458	117.3774
17-Oct	1200	Common dolphin sp. & bottlenose dolphin	14:09	33.0905	117.4190
17-Oct	1	Fin whale	14:19	33.1696	117.4610
17-Oct	27	Risso's dolphin	14:25	33.1568	117.5192
17-Oct	125	Common dolphin sp.	14:31	33.1359	117.6093
17-Oct	2	Fin whale	14:53	33.0307	118.0850
17-Oct	5	Unid. dolphin	15:26	33.1516	118.1170
17-Oct	600	Prob. common dolphin sp.	15:36	33.1980	117.9248

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
17-Oct	3	CA sea lion	16:42	33.2607	118.2501
17-Oct	25	Prob. long-beaked common dolphin	17:07	32.9260	117.3904
18-Oct	1	Common dolphin sp.	8:03	32.9747	117.3333
18-Oct	85	Risso's dolphin	8:09	33.0338	117.3702
18-Oct	1	Common dolphin sp.	8:13	33.0985	117.4326
18-Oct	51	Risso's dolphin	8:19	33.1645	117.5115
18-Oct	25	Prob. CA sea lion	8:53	33.3322	118.2460
18-Oct	12	Bottlenose dolphin	9:07	33.3182	118.2500
18-Oct	1	Unid. pinniped	9:10	33.2866	118.2944
18-Oct	50	Risso's dolphin	9:42	33.3393	117.8852
18-Oct	1	Unid. dolphin	9:51	33.3465	117.8454
18-Oct	14	Unid. dolphin	9:56	33.3587	117.6711
18-Oct	1	CA sea lion	9:59	33.3393	117.6546
18-Oct	100	Common dolphin sp.	10:06	33.2629	117.6298
18-Oct	1	Unid. pinniped	10:23	33.1668	118.0570
18-Oct	1	Unid. pinniped	11:02	33.0721	118.5008
18-Oct	75	Unid. dolphin	12:37	33.1644	117.4908
18-Oct	5	CA sea lion	13:17	33.0379	118.6696
18-Oct	3	Fin whale	13:34	33.0387	118.0506
18-Oct	300	Common dolphin sp.	13:48	33.0804	117.8690
18-Oct	80	Common dolphin sp.	14:04	33.1144	117.4494
18-Oct	50	Common dolphin sp.	14:38	32.8773	118.2786
18-Oct	18	Risso's dolphin	15:10	32.9337	117.3739
19-Oct	110	Common dolphin sp.	10:41	33.0717	118.3350
19-Oct	1	CA sea lion	10:59	32.9452	117.7031
19-Oct	200	Unid. dolphin sp.	11:00	32.9395	117.6644
19-Oct	400	Short-beaked common dolphin	12:06	33.1439	118.1887
19-Oct	700	Prob. short-beaked common dolphin	12:35	33.2135	118.2072
19-Oct	1	Bryde's whale	12:56	33.1184	118.3312

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
19-Oct	250	Common dolphin sp.	13:18	33.2643	118.4122
19-Oct	50	Common dolphin sp.	13:50	33.0073	117.9585
19-Oct	120	Risso's dolphin	14:06	32.9155	117.4148
20-Oct	1	CA sea lion	11:17	32.8868	117.2967
20-Oct	0	Common dolphin sp.	11:19	32.8983	117.3171
20-Oct	1	CA sea lion	11:26	32.9490	117.4998
20-Oct	9	Common dolphin sp.	11:35	33.0664	117.8043
20-Oct	1	Harbor seal	11:49	33.1699	117.9867
20-Oct	1	Risso's dolphin	11:57	33.1383	118.0739
20-Oct	6	Risso's dolphin	12:00	33.2002	118.0993
20-Oct	5	CA sea lion	12:03	33.2337	118.1181
20-Oct	18	Risso's dolphin	12:06	33.1845	118.1529
20-Oct	1	Fin whale	12:08	33.1580	118.1641
20-Oct	1	CA sea lion	12:38	33.1663	118.2089
20-Oct	3	CA sea lion	12:41	33.2120	118.2050
20-Oct	5	CA sea lion	12:43	33.2561	118.1919
20-Oct	0	CA sea lion	12:46	33.2506	118.2614
20-Oct	1	CA sea lion	12:58	33.2547	118.3253
20-Oct	1	CA sea lion	13:09	33.1794	118.4192
20-Oct	1	CA sea lion	13:17	33.1887	118.4776
20-Oct	1	CA sea lion	13:23	33.1930	118.5278
20-Oct	1	CA sea lion	13:27	33.1259	118.5569
20-Oct	1	CA sea lion	13:31	33.1243	118.3824
20-Oct	1	CA sea lion	13:37	33.1293	118.1401
20-Oct	25	Prob. common dolphin sp.	13:43	33.1726	117.9951
20-Oct	2	Unid. dolphin	14:00	33.1925	118.0344
20-Oct	7	Risso's dolphin	14:10	33.2061	118.1012
20-Oct	23	Risso's dolphin	14:26	33.2719	118.2600
20-Oct	6	Bottlenose dolphin	14:28	33.1887	118.3157

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
20-Oct	2	Blue whale	14:44	33.2767	118.3237
20-Oct	5	CA sea lion	15:16	33.0879	118.6035
20-Oct	500	Common dolphin	15:48	33.0863	117.7541
20-Oct	1200	Prob. short-beaked common dolphin	15:57	33.0968	117.6835
20-Oct	6	Unid. dolphin	16:06	33.0175	117.4449
20-Oct	8	Risso's dolphin	16:06	33.0175	117.4449
20-Oct	300	Common dolphin sp.	16:11	32.8882	117.3196
21-Oct	75	Bottlenose dolphin & common dolphin sp.	10:30	33.2439	118.1655
21-Oct	4	CA sea lion	10:33	33.2553	118.1844
21-Oct	1	CA sea lion	11:05	33.2797	118.4207
21-Oct	1	CA sea lion	11:21	33.1297	118.4931
21-Oct	2	CA sea lion	11:41	33.1305	118.0693
21-Oct	1	CA sea lion	11:42	33.1295	118.0331
21-Oct	1	CA sea lion	11:57	33.2388	118.1179
21-Oct	3	CA sea lion	11:57	33.2417	118.1341
21-Oct	1	CA sea lion	12:01	33.1434	118.1569
21-Oct	1	CA sea lion	12:06	33.2412	118.2055
21-Oct	2	CA sea lion	12:09	33.2379	118.2611
21-Oct	1	CA sea lion	12:15	33.1548	118.3160
21-Oct	900	Common dolphin sp.	12:18	33.2361	118.3176
21-Oct	1	CA sea lion	12:45	33.1409	118.4777
21-Oct	7	CA sea lion	12:54	33.0900	118.6070
21-Oct	16	CA sea lion	13:01	33.0616	118.6474
21-Oct	18	CA sea lion	13:02	33.0789	118.6191
21-Oct	9	Unid. dolphin	13:07	33.1728	118.4644
21-Oct	2	CA sea lion	13:14	33.2082	118.3788
21-Oct	40	Unid. dolphin	13:18	33.2218	118.2284
21-Oct	1	CA sea lion	13:20	33.2040	118.1555
21-Oct	2	Fin whale	13:32	33.0506	117.7705

Appendix B. 15-21 Nov 2008: Summary of all individual marine mammal sightings, including location latitudes and longitudes, made during aerial monitoring surveys *after* the SOCAL 2008 MTE period off San Diego, California.

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
15-Nov	1	Harbor seal	11:09	32.91	117.37
15-Nov	2	Fin whale	11:11	32.91	117.38
15-Nov	22	Unidentified dolphin	11:35	32.85	117.93
15-Nov	1	Unid. pinniped	11:51	32.81	118.3
15-Nov	1	California sea lion	11:56	32.84	118.49
15-Nov	1	Harbor seal	11:56	32.84	118.48
15-Nov	1	California sea lion	11:57	32.85	118.5
15-Nov	1	Unid. sea lion	11:57	32.85	118.49
15-Nov	1	California sea lion (dead)	11:59	32.85	118.49
15-Nov	1	Unid. pinniped	11:59	32.84	118.5
15-Nov	1	California sea lion	12:00	32.86	118.51
15-Nov	1	California sea lion	12:01	32.88	118.52
15-Nov	1	California sea lion	12:01	32.9	118.54
15-Nov	1	Unid. sea lion	12:02	32.92	118.55
15-Nov	1	California sea lion	12:03	32.95	118.56
15-Nov	1	California sea lion	12:04	32.97	118.58
15-Nov	1	California sea lion	12:05	33.01	118.59
15-Nov	1	Harbor seal	12:05	33.01	118.61
15-Nov	1	Harbor seal	12:06	33.03	118.61
15-Nov	1	California sea lion	12:07	33.04	118.58
15-Nov	1	California sea lion	12:08	33.04	118.57
15-Nov	1	California sea lion	12:08	33.03	118.56
15-Nov	2	California sea lion	12:09	33	118.54
15-Nov	1	California sea lion	12:09	32.98	118.53
15-Nov	1	California sea lion	12:09	32.98	118.52
15-Nov	1	California sea lion	12:11	32.93	118.48
15-Nov	1	California sea lion	12:18	32.84	118.36
15-Nov	3	California sea lion	12:20	32.8	118.38
15-Nov	1	California sea lion	12:22	32.77	118.45
15-Nov	1	California sea lion	12:24	32.74	118.53
15-Nov	1	Unid. small mar. mammal	12:27	32.7	118.61
15-Nov	2	Unid. small mar. mam.	12:35	32.67	118.73

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
15-Nov	12	Unid. dolphin	12:55	32.71	118.69
15-Nov	13	Prob. short-beaked common dolphin	12:58	32.71	118.7
15-Nov	1	Fin whale	13:02	32.72	118.69
15-Nov	12	California sea lion	13:19	32.81	118.51
15-Nov	22	Pacific white-sided dolphin & California sea lion	13:19	32.81	118.51
15-Nov	650	Short-beaked common dolphin	13:32	32.75	118.67
15-Nov	1	Unid. large baleen whale	13:33	32.75	118.68
15-Nov	90	Short-beaked common dolphin	13:49	32.7	118.92
15-Nov	2	Humpback whale	14:06	32.78	118.75
15-Nov	1	Unid. large whale	14:16	32.84	118.56
15-Nov	19	California sea lion	14:25	32.87	118.54
15-Nov	0	California sea lion	14:29	32.88	118.56
15-Nov	4	Pacific white-sided dolphin	14:30	32.88	118.57
15-Nov	2	Pacific white-sided dolphin	14:30	32.88	118.56
15-Nov	1	California sea lion	14:34	32.89	118.55
15-Nov	2	Pacific white-sided dolphin	14:37	32.87	118.63
15-Nov	1	Unid. large whale	14:43	32.82	118.79
15-Nov	3	Humpback whale	14:52	32.77	118.99
15-Nov	1	Unid. dolphin	15:18	32.95	118.63
15-Nov	2	California sea lion	15:19	32.95	118.67
15-Nov	5	California sea lion	15:31	32.83	118.5
15-Nov	0	Unid. pinniped	15:31	32.83	118.51
15-Nov	75	Pacific white-sided dolphin	15:32	32.83	118.51
15-Nov	5	California sea lion	15:38	32.8	118.4
15-Nov	1	Unid. marine mammal	15:38	32.8	118.38
15-Nov	2	California sea lion	15:39	32.81	118.36
15-Nov	2	Pacific white-sided dolphin	15:39	32.81	118.34
15-Nov	120	Common dolphin sp.	15:44	32.84	118.23
15-Nov	17	Common dolphin sp.	15:55	32.85	117.9
15-Nov	4	Common dolphin sp.	15:55	32.84	117.89
15-Nov	6	Common dolphin sp.	15:55	32.84	117.88
15-Nov	0	Short-beaked common dolphin	16:00	32.83	117.78

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
15-Nov	22	Short-beaked common dolphin	16:02	32.83	117.72
15-Nov	20	Short-beaked common dolphin	16:02	32.84	117.7
15-Nov	15	Short-beaked common dolphin	16:02	32.84	117.69
15-Nov	1	Fin or Sei whale	16:12	32.86	117.41
16-Nov	3	Fin whale	11:38	32.88	117.49
16-Nov	1	Unid. baleen whale	12:01	32.88	117.45
16-Nov	1	Unid. large whale	12:07	32.85	117.57
16-Nov	200	Prob. short-beaked common dolphin	12:09	32.85	117.57
16-Nov	2	Unid. small mar. mam.	12:27	32.82	118.13
16-Nov	1	California sea lion	12:33	32.81	118.36
16-Nov	5	California sea lion	12:36	32.81	118.41
16-Nov	1	Unid. pinniped	12:37	32.8	118.43
16-Nov	2	California sea lion	12:41	32.85	118.5
16-Nov	1	California sea lion	12:41	32.86	118.51
16-Nov	1	California sea lion (dead)	12:44	32.87	118.52
16-Nov	1	California sea lion	12:45	32.91	118.54
16-Nov	1	Unid. pinniped	12:45	32.9	118.53
16-Nov	1	Unid. pinniped	12:45	32.93	118.55
16-Nov	3	California sea lion	12:46	32.94	118.56
16-Nov	1	Unid. pinniped	12:46	32.96	118.57
16-Nov	1	California sea lion	12:47	32.98	118.59
16-Nov	1	California sea lion	12:47	32.99	118.59
16-Nov	1	Unid. pinniped	12:47	32.98	118.58
16-Nov	1	Harbor seal	12:51	33.03	118.56
16-Nov	3	California sea lion	12:53	33.01	118.55
16-Nov	1	Harbor seal	12:53	33.02	118.55
16-Nov	1	Unid. pinniped	12:53	33	118.54
16-Nov	3	California sea lion	12:54	32.99	118.54
16-Nov	3	Harbor seal	12:54	32.98	118.53
16-Nov	1	Harbor seal	12:55	32.95	118.5
16-Nov	1	Unid. pinniped	12:55	32.97	118.52
16-Nov	1	Unid. pinniped	12:56	32.94	118.49
16-Nov	2	California sea lion	12:57	32.92	118.47
16-Nov	1	California sea lion	12:58	32.9	118.44

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
16-Nov	1	Unid. pinniped	13:00	32.85	118.38
16-Nov	1	Unid. pinniped	13:02	32.82	118.35
16-Nov	1	Unid. sea lion	13:02	32.81	118.36
16-Nov	1	California sea lion	13:03	32.8	118.38
16-Nov	2	Unid. marine mammal	13:12	32.67	118.67
16-Nov	1	Unid. pinniped	13:20	32.63	118.9
16-Nov	1	Unid. whale	13:21	32.63	118.96
16-Nov	23	Common dolphin sp.	13:22	32.65	118.97
16-Nov	1	California sea lion	13:33	32.7	118.76
16-Nov	1	Unid. pinniped	13:37	32.72	118.69
16-Nov	1	California sea lion	13:39	32.74	118.63
16-Nov	1	Fin whale	13:42	32.79	118.51
16-Nov	1	Unid. large baleen whale	13:47	32.77	118.51
16-Nov	2	California sea lion	13:51	32.79	118.51
16-Nov	120	Common dolphin sp.	13:51	32.8	118.51
16-Nov	65	Common dolphin sp.	14:07	32.77	118.58
16-Nov	2	Unid. small mar. mam.	14:20	32.7	119.02
16-Nov	220	Common dolphin sp.	14:25	32.74	118.92
16-Nov	1	Unid. large whale	14:34	32.8	118.71
16-Nov	1	Unid. pinniped	14:48	32.82	118.64
16-Nov	0	Unid. pinniped	14:51	32.87	118.54
16-Nov	8	California sea lion	14:52	32.87	118.56
16-Nov	6	California sea lion	14:52	32.86	118.55
16-Nov	26	Common dolphin sp. & California sea lion	14:52	32.87	118.56
16-Nov	1	Unid. baleen whale	15:09	32.79	118.9
16-Nov	40	Common dolphin sp.	15:09	32.78	118.88
16-Nov	1	Unid. small whale	15:22	32.84	118.89
16-Nov	2	Unid. medium whale	15:23	32.83	118.88
16-Nov	10	Unid. dolphin	15:41	32.96	118.63
16-Nov	1	Unid. dolphin	15:47	32.95	118.75
16-Nov	16	Common dolphin sp.	15:56	32.84	118.54
16-Nov	9	Pacific white-sided dolphin	15:57	32.84	118.55
16-Nov	18	Unid. marine mammal	16:09	32.88	118.05

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
16-Nov	150	Common dolphin sp.	16:11	32.88	118.02
16-Nov	25	Unid. dolphin	16:16	32.87	117.84
16-Nov	200	Common dolphin sp.	16:24	32.87	117.5
16-Nov	1	Unid. large whale	16:29	32.86	117.43
17-Nov	1	Unid. pinniped	10:49	32.85	117.3
17-Nov	2	Unid. dolphin	10:50	32.85	117.33
17-Nov	50	Short-beaked common dolphin	10:53	32.82	117.42
17-Nov	500	Common dolphin sp.	10:54	32.8	117.44
17-Nov	400	Pacific white-sided dolphin & short-beaked common dolpin	11:00	32.77	117.52
17-Nov	14	California sea lion & unid. dolphin	11:01	32.76	117.52
17-Nov	300	Common dolphin sp. & Pacific white-sided dolphin	11:10	32.72	117.65
17-Nov	1	Unid. marine mammal	11:13	32.68	117.73
17-Nov	1	Unid. marine mammal	11:14	32.66	117.76
17-Nov	1	Unid. pinniped	11:33	32.23	118.06
17-Nov	1	Unid. pinniped	11:33	32.19	118.08
17-Nov	1	California sea lion	11:56	32.64	117.92
17-Nov	1	California sea lion	12:08	32.51	118.05
17-Nov	1	Unid. pinniped	12:13	32.36	118.14
17-Nov	60	Short-beaked common dolphin & California sea lion	12:47	32.63	118.03
17-Nov	1	N. elephant seal	12:48	32.62	118
17-Nov	300	Short-beaked common dolphin	12:58	32.63	118.1
17-Nov	2	Humpback whale	13:39	32.54	118.26
17-Nov	2	Unid. marine mammal	14:14	32.63	118.19
17-Nov	2	Unid. marine mammal	14:28	32.54	118.33
17-Nov	250	Unid. dolphin	14:43	32.41	118.41
17-Nov	1	Blue whale (dead male)	14:44	32.42	118.44
17-Nov	60	Common dolphin sp.	15:09	32.4	118.53
17-Nov	35	Long-beaked common dolphin	15:28	32.7	118.2
17-Nov	6	Pacific white-sided dolphin	15:36	32.72	118.02
17-Nov	1	Unid. dolphin	15:40	32.74	117.87
17-Nov	60	Risso's dolphin	15:53	32.85	117.39

Date 2008	Group Size	Species	Time	Latitude (º N)	Longitude (º W)
17-Nov	1	Unid. dolphin	15:53	32.84	117.39
18-Nov	200	Prob. long-beaked common dolphin	10:44	32.85	117.41
18-Nov	18	Common dolphin sp.	10:59	32.65	117.78
18-Nov	30	Common dolphin sp.	11:33	32.27	118.14
18-Nov	50	Common dolphin sp.	11:51	32.6	117.93
18-Nov	8	Unid. sea lion	11:52	32.59	117.92
18-Nov	1	Unid. pinniped	12:46	32.54	118.16
18-Nov	9	California sea lion	13:21	32.91	118.1
18-Nov	1	California sea lion	13:39	32.88	117.73
18-Nov	5	Pacific white-sided dolphin	13:40	32.89	117.7
18-Nov	1	California sea lion	13:41	32.9	117.67
18-Nov	70	Common dolphin sp.	13:42	32.9	117.66
18-Nov	300	Long-beaked common dolphin	13:56	32.99	117.32
18-Nov	0	Common dolphin sp.	14:01	32.99	117.3
18-Nov	1	Harbor seal	14:01	32.97	117.3
18-Nov	1	California sea lion	14:02	32.94	117.31
18-Nov	1	Unid. dolphin	14:06	32.87	117.36
18-Nov	4	Fin whale	14:07	32.86	117.42

Appendix C. Summary of the focal observation sessions conducted *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE aerial survey marine mammal monitoring effort off San Diego, CA.

Date	Species	Bf Sea State	Initial Time	End time	Time with Sighting (min)	Estim. Group Size	Min # of Calves Seen	Initial Behav. State (Other Beh. States)	Photos?	Video?	Comments
16-Oct	Unid. Dolphin	4	9:33	unknown	≥ 3	6	0	TR	Yes	No	Traveled in tight group < 0.5 BL dispersal.
16-Oct	Unid. dolphin	4	9:54	10:10	16	24	0	TR	Yes	No	Small unidentified dolphin, under 6 ft in length, dark gray in color, traveling 1-8 BL dispersal, reaction to aircraft = change in behavior. Further description: white front, back and gray in the middle, short beak, very streamline body. Count of 24 +calf. Video > 9 min.
16-Oct	Common dolphin	4	10:13	unknown	≥ 3	40	0	TR	Yes	Yes	Line abreast group formation, group reacted by changing direction, separated by 8 BL dispersal
16-Oct	Risso's dolphin	3	10:24	unknown	≥ 3	40	0	TR	Yes	Yes	Consistent line abreast group formation.
16-Oct	Fin Whale	2	10:57	unknown	≥ 3	2	20	TR	Yes	Yes	Travel E
16-Oct	Common dolphin	2	11:50	11:55	5	1100	0	SAC MILL	Yes	Yes	Surface active mill. Three boats present: speed vessel moved in and out of group, vessel stopped, group dispersed between two boats, group very divided. Third boat approached, group moved back together. Change in dispersion observed, most traveled NW. Observed porpoising. Boat pursued group, clear reaction to vessel.
16-Oct	Risso's dolphin	2	12:10	12:19	9	11	0	TR	Yes	Yes	Travel at slow/medium speed in NE direction, diving, travel below surface, traveling line abreast. Initially 1-3 BL dispersal, observed again at 8 BL dispersaland then 1-5 BL dispersal. Visible when below surface.
16-Oct	Common dolphin	1	12:23	12:29	6	55	0	SAC MILL	No	No	Surface active mill. 1-10 BL dispersal. Birds diving near group, 3 pelicans present.
16-Oct	Common dolphin	2	13:55	14:01	6	40	1	SAC MILL	Yes	No	Surface active mill, no clear direction of travel, numerous subgroups, inverted swimming. 1-5 BL dispersal
16-Oct	Common dolphin	3	14:05	14:14	9	1200	0	SAC MILL	Yes	No	Milling, inverted swimming, social, appear to be feeding, birds present. Risso's in vicinity, we circled common dolphins. Group spread over 1/3 mile. Individuals turning sharply in circle where birds dove as well as inverted swimming.
16-Oct	Fin whale	3	14:19	14:23	4	1	0	TR	Yes	No	Slow travel E, respirations and dives observed.

Date	Species	Bf Sea State	Initial Time	End time	Time with Sighting (min)	Estim. Group Size	Min # of Calves Seen	Initial Behav. State (Other Beh. States)	Photos?	Video?	Comments
16-Oct	Common dolphin	3	14:33	14:38	5	125	0	SAC MILL	Yes	No	Surface active mill, feeding, widely dispersed, birds circling, zigzag heading, several subgroups.
16-Oct	Fin whale	6	14:55	15:04	9	2	0	TR	Yes	No	Traveling in line astearn formation 1-4 BL dispersal. Both at surface for ~2 min, 4 blows. 2 BL dispersal, 1 animal hanging, travel SW
17-Oct	Fin whale	6	13:36	13:41	5	3	0	TR	No	No	Possible reaction, dove when plane shadow passed over. Traveling, white chevron visible on right side of jaw. 1-5 BL dispersal when first sighted. Traveling, 2 visible, one smaller (not calf size). 2 animals dove almost immediately, possible reaction to aircraft. During last dive, one whale was directly under aircraft.
17-Oct	Common dolphin	6	13:47	13:51	5	300	10	TR (SAC)	No	No	Travel, surface active. Nursery group and other subgroups. <1 BL dispersal for M/C pairs. Max 6 BL dispersal overall. 2 subgroups dove quickly on 2 different occasions when the aircraft shadow was directly over group. When separated by 3 BL dispersal individual dove immediately when plane shadow passed it, other did not (no shadow on 2nd dolphin).
17-Oct	Risso's dolphin	4	15:12	15:21	9	18	9	TR	Yes	Yes	Collected 1-min behavioral scan samples of dispersal: 1-5 BL, breach, surface-active mill, swimming on side; dispersal 1-7 BL, cohesive travel; 1-4 BL dispersal, line formation; 1-3 BL dispersal, plank group formation; 1-2 BL dispersal, line abreast, traveling N; 1-3 BL dispersal, staying line abreast.
18-Oct	Bryde's whale	5	12:56	unknown		1	0	TR	Yes	No	Circled 3 times at declination angle ~40º. Photos verified was a Bryde's whale, 3 visible ridges on rostrum, no distinct white demarcation on jaw. Blow was relatively small.
18-Oct	Risso's dolphin	2	14:06	14:18	12	120	8	TR	Yes	No	Collected 1-min scan samples of behavior state. Aircraft shadow passed over 1 Risso's dolphin that was below the water surface--no reaction observed/no change in behavior. Group spread out over ~2 miles. Aircraft circled a trailing subgroup for ~3 circles to observe for reaction to aircraft shadow, could not position shadow over group. General 1-20 BL dispersal. 5 subgroups at 1-8 BL dispersal
19-Oct	Fin whale	2	12:07	12:35	28	1	0	SAC TR	Yes	No	Photos confirmed as fin whale, white on jaw on right side, 5 min down time. Surface active: breach. Travel at medium speed to NW. 50-60 ft long body.
19-Oct	Common Dolphin	2	13:42	13:56	14	25	15	SAC TR	Yes	No	Surface active travel. Group appeared to react by going below surface when plane circled. Travel NW, then NE, then NW, then NE – apparent reactoin by changing heading and dive/respiration pattern. Surface-active travel, porpoising, <10 BL dispersal

Date	Species	Bf Sea State	Initial Time	End time	Time with Sighting (min)	Estim. Group Size	Min # of Calves Seen	Initial Behav. State (Other Beh. States)	Photos?	Video?	Comments
19-Oct	Blue whale	2	14:44	unknown	≥ 3	2	0	SAC TR	Yes	No	Traveling just south of Catalina Island, slow travel, no change in reaction or behavior. Traveling E.
20-Oct	Fin whale	1	13:32	unknown	≥ 3	2	50	TR	Yes	No	Traveling, animals turned and mom-calf decreased body spacing from 1.5 to 0.5 BL while we circled, possible reaction to aircraft, change in dispersion
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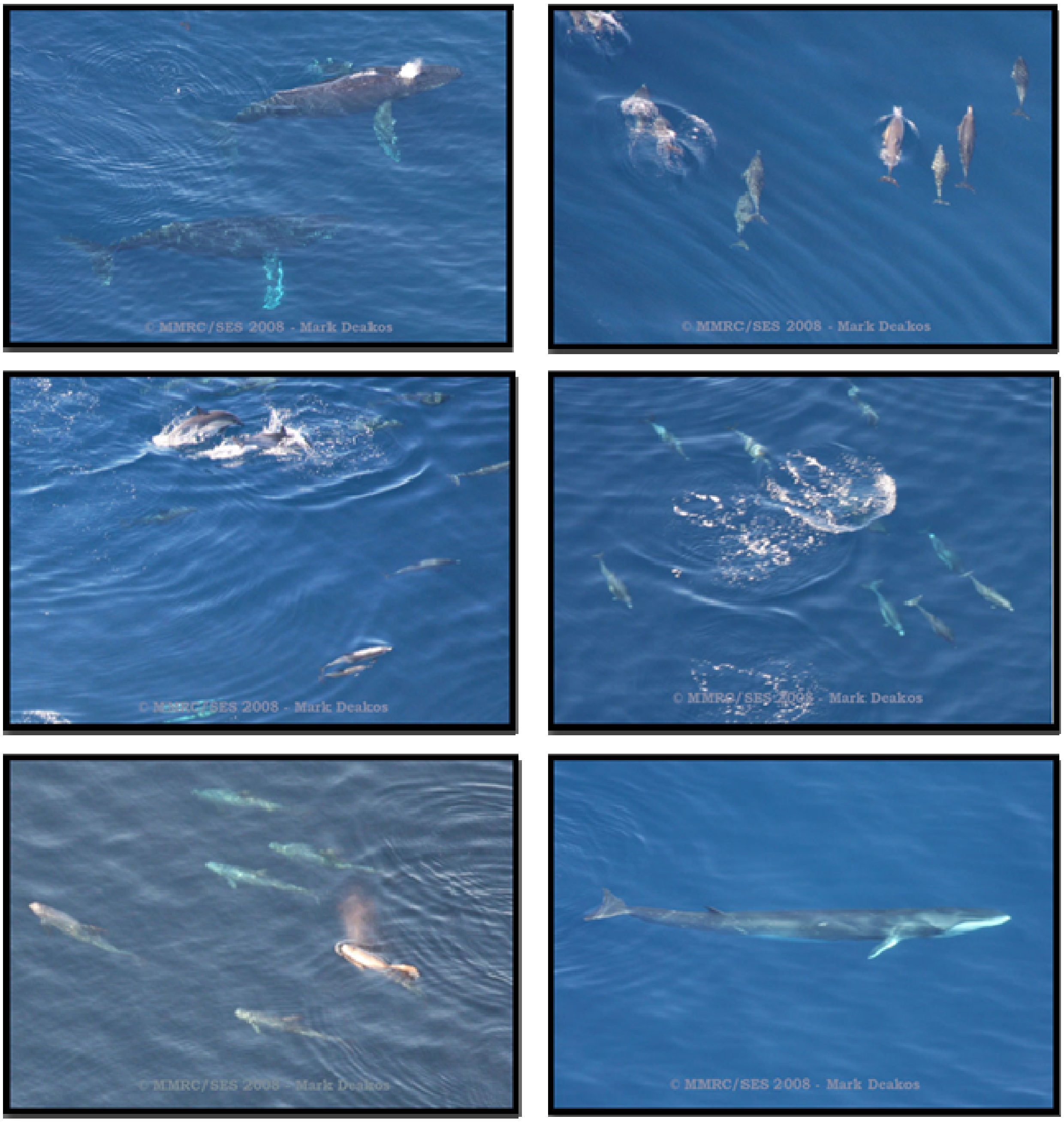
14-Nov	Fin whale	2	11:10	11:23	13	2	0	TR	Yes	No	2 fin whales traveling W, observed logging below the surface, traveling at slow pace, no obvious reaction to aircraft.
14-Nov	Unid. dolphin	2	11:34	11:44	9	18	unknown	SAC TR	No	No	Unidentified dolphin, traveling W, porpoising, possible common dolphin, dark bodies, small in size, line abreast group shape. Consistent 2-6 BL dispersal, count 18-25 dolphins
14-Nov	Fin whale	2	13:02	unknown	≥ 3	1	0	TR	Yes	No	Slow travel, <1 minute down times.
14-Nov	Pac white-sided dolphin	2	13:19	13:26	7	22	0	TR	Yes	No	2-4 BL dispersion, many singletons/individuals. 1 observed inverted swimming. White on 50% of dorsal fin , most traveling 90º heading, some logging, spread out over ~1 mile, no calves observed.
14-Nov	Common dolphin	2	13:30	13:35	5	800	0	SAC MILL	Yes	No	Surface active mill, probably feeding, birds following and circling group, large group tightly clumped, tight grouping initially, became more spread-out throughout sighting, broke into subgroups.
14-Nov	Common dolphin	2	13:47	13:56	9	90	unknown	SAC TR	Yes	No	Surface active travel, large group of common dolphins, one observed inverted swimming, spread out into many subgroups. 4-5 body-length dispersion, 1-2 BL dispersion in subgroups, fast travel 270º heading, aircraft passed over, did not observe any dramatic changes in behavior.
14-Nov	Humpback whale	2	14:04	14:21	17	2	0	TR (SAC)	Yes	No	2 humpbacks sighted, initial behavior state unknown, appeared to be traveling. Observed fluke up, lob-tailing, resting, logging, and inverted tail slap. Traveled at < 1 body length apart.
14-Nov	Pac White-sided dolphin	2	14:25	14:31	6	18	1	TR	Yes	No	Seen directly below the aircraft, 1 calf observed.
14-Nov	Humpback whale	2	14:52	15:06	14	3	0	TR	No	Yes	Initially 2 whales observed, traveling 180º heading, < 1 body length apart, Later 3 humpbacks observed, one smaller, all fairly small. Center animal had white pectoral fins. Consistent slow travel

Date	Species	Bf Sea State	Initial Time	End time	Time with Sighting (min)	Estim. Group Size	Min # of Calves Seen	Initial Behav. State (Other Beh. States)	Photos?	Video?	Comments
14-Nov	Common dolphin	2	15:43	15:47	4	90	unknown	SAC TR	Yes	No	Throughout observation spread out into numerous subgroups, main subgroup ~75 dolphins.
15-Nov	Fin whale	1	11:40	12:01	21	4	0	TR	Yes	No	2 fin whales, 4 body lengths apart, traveling NW, later 3rd fin whale approached, possibly affiliation. No change in behavior, continued slow travel.
15-Nov	Fin whale	1	13:43	13:48	5	2	0	TR	Yes	No	Fin whale traveling 150º heading. Slow travel, no reaction, Clear white jaw, 2nd animal 1/4 mile behind, 2 vessels 0.5 mile away, slow travel below surface.
15-Nov	Common dolphin	1	13:51	13:58	7	120	unknown	SAC MILL	Yes	No	Porpoising, milling, dispersed 1-5 body lengths apart.
15-Nov	Common dolphin	1	14:07	14:29	22	65	0	SAC TR	Yes	No	Circled back to observe larger pod of common dolphin *n* =~120, observed no calves 1-5 body-length dispersion, 2 subgroups, circled a few times, still saw no calves, subgroups followed the main groups, change in behavior, possible reaction
16-Nov	Common dolphin	1	12:58	13:04	6	350	8	SAC TR	Yes	No	Traveling fast, 8 calves observed, vessel passing, moving toward dolphins, passed directly in area of dolphin group, no change in group shape/dispersion.
16-Nov	Humpback whale	1	13:42	14:12	30	2	0	TR	Yes	Yes	2 humpbacks traveling slow, small bubble cloud, unusual behavior. Consistent slow travel
16-Nov	Risso's dolphin	1	15:53	unknown	≥ 3	50	unknown	MILL (SAC MILL, TR)	Yes	No	Mill, sac mill, travel, bird activity. HS (head slap), possible change in behavior state, started at mill, sac mill, trav. Aircraft circled 3 times and then returned to land due to fuel.
17-Nov	Common dolphin	3	11:52	11:57	5	50	unknown	TR	Yes	No	Circled for photos, appear to be traveling, large group 30-50 animals. 2 subgroups, 1-2 body-lengths spacing, traveling 340º heading
17-Nov	Common dolphin	3	13:43	13:48	5	70	0	TR (SAC MILL)	Yes	No	No visible reaction first flight over them but began surface active mill when aircraft circled at 800 ft and approx. 30º declination. 2 subgroups observed.
17-Nov	Fin whale	0	14:07	15:07	60	4	0	SAC, TR	Yes	Yes	Breaching occurred shortly after approach, seemed to be related to affiliate whales: two whales joined by third whale, and later a fourth whale appeared in area. Animals visible for long periods underwater. Observed much socializing: apparent courting behavior, rolling, turning on side. Extensive video footage with clear subsurface shots.

Appendix D. Aerial photographs of cetaceans using a telephoto lens from the aircraft during the 2008 SOCAL aerial survey monitoring effort off San Diego, California. These photographs demonstrate the ability to track various species of cetaceans below the water surface. (A) humpback whale, (B) common dolphin sp. (*Delphinus* sp.) with Pacific white-sided dolphin, (C) common dolphin sp., (D) common dolphin sp., (E) Risso's dolphin, (F) fin whale (completely submerged). Photos by Mark Deakos.



Appendix D-2. Humpback whale (*Megaptera novaeangliae*) dive sequence as observed from the aircraft during the 2008 SOCAL marine mammal monitoring survey off San Diego, California, demonstrating the ability to observe cetaceans and behavior sub-surface during an aerial survey. During this focal session humpbacks were observable below the surface for extended periods. Video was also taken of this and other focal groups to document surface/sub-surface behavior.

APPENDIX H SOCAL MTE AERIAL MONITORING JUNE AND JULY 2009

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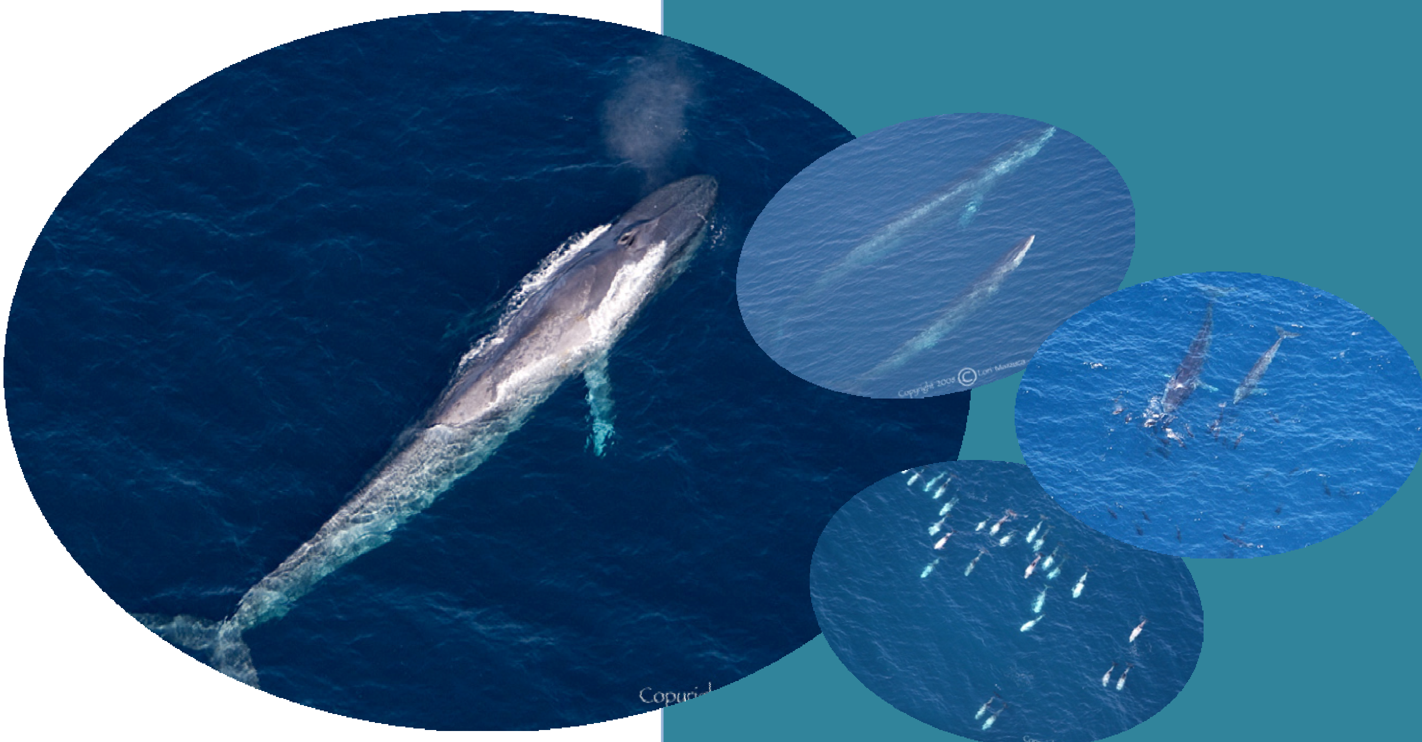
June 5-11 and July 20-29, 2009 - *Final Field Report*

Aerial Survey Monitoring for Marine Mammals off Southern California in Conjunction with US Navy Major Training Events



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Cover Photo: Blue whale (*Balaenoptera musculus*), fin whale mother & calf (*B. physalus),* fin whale with Northern right whale dolphins (*Lissodelphis borealis*), & Risso's dolphins (*Grampus griseus*) photographed with a telephoto lens from the aircraft during the SOCAL June 09 aerial monitoring survey. Photos courtesy of Lori Mazzuca and Mark Deakos.

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Section 1 Introduction

In support of the U.S. Navy's (Navy) Marine Mammal Monitoring Plan (M3P) in the Southern California Range Complex (SOCAL) (DoN 2009), aerial surveys were conducted by Marine Mammal Research Consultants (MMRC) and Smultea Environmental Sciences (SES) to monitor marine mammals and sea turtles (MM/ST) during June and July 2009 in the SOCAL area. Monitoring occurred in conjunction with several Navy Major Training Events (MTEs) involving mid-frequency-active sonar (MFAS). Portions of these MTEs took place in the offshore waters near San Clemente Island (SCI) off San Diego, California. Naval training has been conducted within SOCAL for over 40 years, and marine mammals are also known to be abundant there (e.g., summarized in Carretta et al. 2000, 2008; DoN 2008, 2009). As part of SOCAL, the Navy operates the Southern California Anti-submarine Warfare Range (SOAR) W of San Clemente Island (Figure 1).

The contracted work involved considerable pre-survey planning via email and telephone with the Navy Technical Representative (NTR) given the logistical complexity of the MTEs. In particular, coordinating multiple Navy activities on the SOCAL range was logistically challenging and time-consuming for Navy personnel given the high degree of safety planning. Protocol was similar to that implemented for aerial surveys in SOCAL in Fall 2009 (see Smultea et al. 2009)

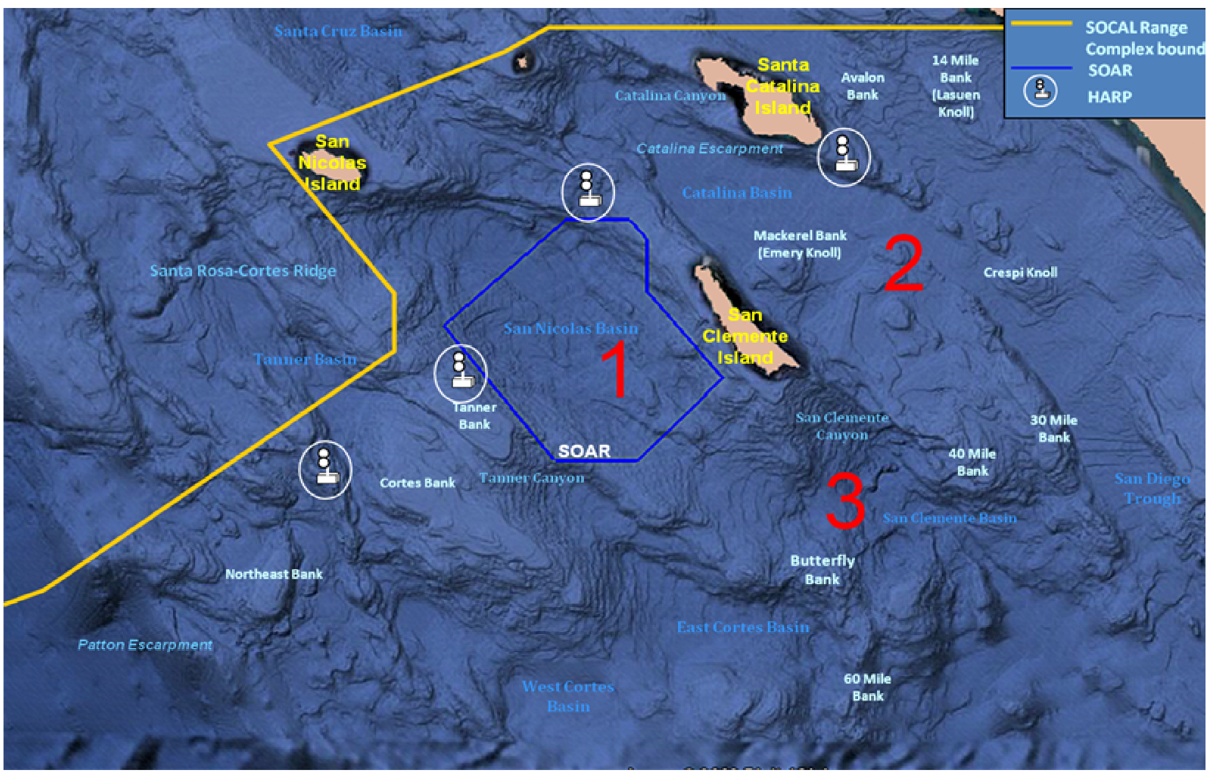

Figure 1. Location of the aerial survey monitoring area and underwater topographic features within the Navy's Southern California Range Complex (SOCAL). Numbers indicate survey areas of interest to the Navy in order of priority; orange line designates the SOCAL boundary; blue lines designate the Southern California Offshore Anti-submarine Warfare Range (SOAR); icons are approximate locations of Navy-funded bottom-mounted passive- acoustic high-frequency acoustic recording packages (HARPs).

Project Planning

Meetings and communications with Navy personnel identified the actual survey areas, periods, and communications protocols to be used. This was required to coordinate logistics and ensure safety and open communication between the Navy and the aerial monitoring team during the surveys given the complexity of multiple naval aircraft and vessel operations involved with the MTEs and other missions. Clearance from various Navy commands was obtained by Navy environmental planners on behalf of MMRC/SES prior to the research aircraft flying in the SOCAL. In addition, pre-planning sessions with the NTR and other Navy staff and local researchers, including at Scripps Institution of Oceanography (SIO), La Jolla, California were conducted. These communications were needed to coordinate survey efforts with others conducting marine mammal research in the same region and period including the Naval Undersea Warfare Center (NUWC), SIO and Cascadia Research Collective (CRC). Other ongoing studies involved passive acoustics, tagging, photo-identification, and behavioral studies from small and large vessels (including the R/V *Sproul* and a CRC vessel), some of which were funded by the Office of Naval Research (ONR) and N45 funds (e.g., Falcone et al. 2009a,b). Communications identified ways the various research groups and platforms could collaborate and assist one another in obtaining complimentary data and thus maximizing the utility of simultaneously operating studies. Of particular focus was conducting simultaneous aerial and vessel (*Sproul*, SIO) line transect surveys while NUWC and SIO researchers conducted passive acoustic monitoring studies and CRC conducted tagging and photo-identification studies on July 25-26, west of SCI.

For the July 2009 aerial survey M. Smultea and J. Mobley (co-Principal Investigators for the SOCAL aerials) were officially added (through coordination with the Office of Protected Resources and Southwest Fisheries Science Center [SWFSC]) for the period of the survey to an existing Federal Permit issued to National Marine Fisheries Service (NMFS)/SWFSC to fly aerial surveys and obtain photographs at altitudes ≥500 ft.

Project Questions and Hypotheses

Project questions and hypotheses were developed by SES/MMRC based on the five questions identified in the Navy's SOCAL M3P designed to assess potential effects of MFAS and underwater detonations on MM/ST during Navy MTEs (DoN 2009; see Smultea et al. 2009). See the 2008 SOCAL aerial survey report (Smultea et al. 2009) for more related information.

An important factor limiting the ability to assess potential effects of MFAS in this report is that the Navy did not disclose MFAS transmission times and locations for national security reasons. Thus, it is not possible for us herein to compare data from specific operational MFAS "on" and "off" periods during MTEs, nor data on distance and relative location of MFAS sources *vs.* sightings.

Approach

The approach implemented to address SOCAL M3P requirements was to conduct fixed-wing aircraft-based surveys to monitor the occurrence and behavior of MM/ST in the SOCAL relative to MFAS transmission periods. The primary survey areas were SOAR W of SCI and the NAOPA range between SCI and the mainland coast (Figure 1). The study approach involved implementing search, verify, and focal follow modes as described in Smultea et al. (2009). Two sets of surveys were conducted: one in June and one in July 2009. Notably, sea turtles were considered unlikely to be seen in the MTE based on available data (reviewed in DoN 2008). See Smultea et al. (2009) for a detailed list of primary monitoring goals of the aerial surveys.

As described in Smultea et al. (2009), priority species were (1) MM/ST exhibiting unusual or distressed behavior, (2) near-stranded, stranded, or dead MM/ST, (3) MM/ST species listed as endangered or threatened under the ESA, (4) beaked whales, and (5) Risso's dolphins, dwarf/pygmy sperm whales (*Kogia* sp.), and other deep-diving odontocetes considered potential "surrogate" representatives for deep-diving beaked whales (see DoN 2009).

Section 2 Methods

Methods implemented during this study generally followed those described in the report for the fall 2008 aerial monitoring surveys conducted in SOCAL off San Diego, see Smultea et al. (2009). Survey tracks for the June and July events are shown in Figures 2 and 3.

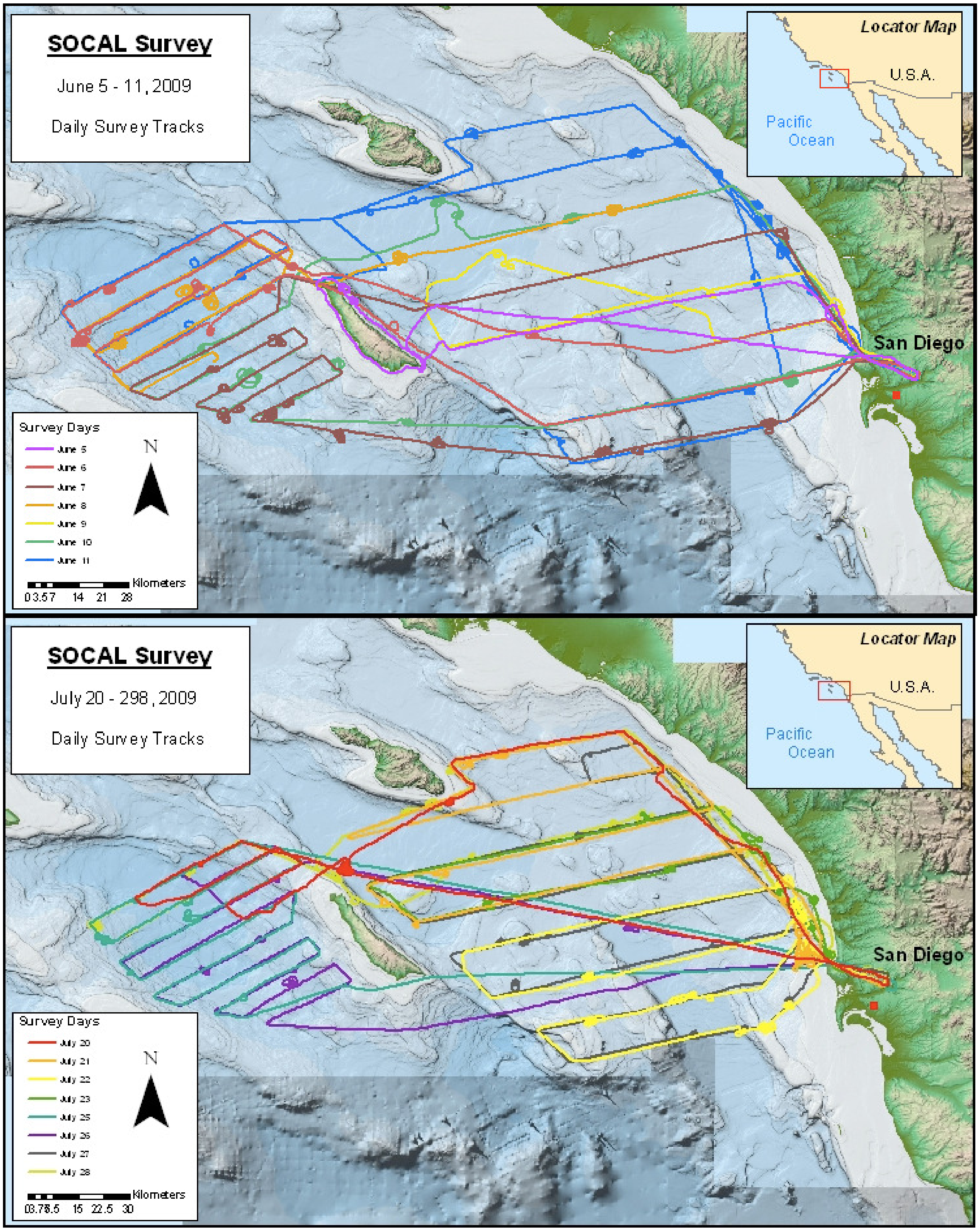

Figure 2. Aerial survey track lines and observation effort in the SOCAL during a Major Training Event (MTE) (5 – 11 June 2009 - top panel), and after the MTE (20-29 July 2009 - bottom panel).

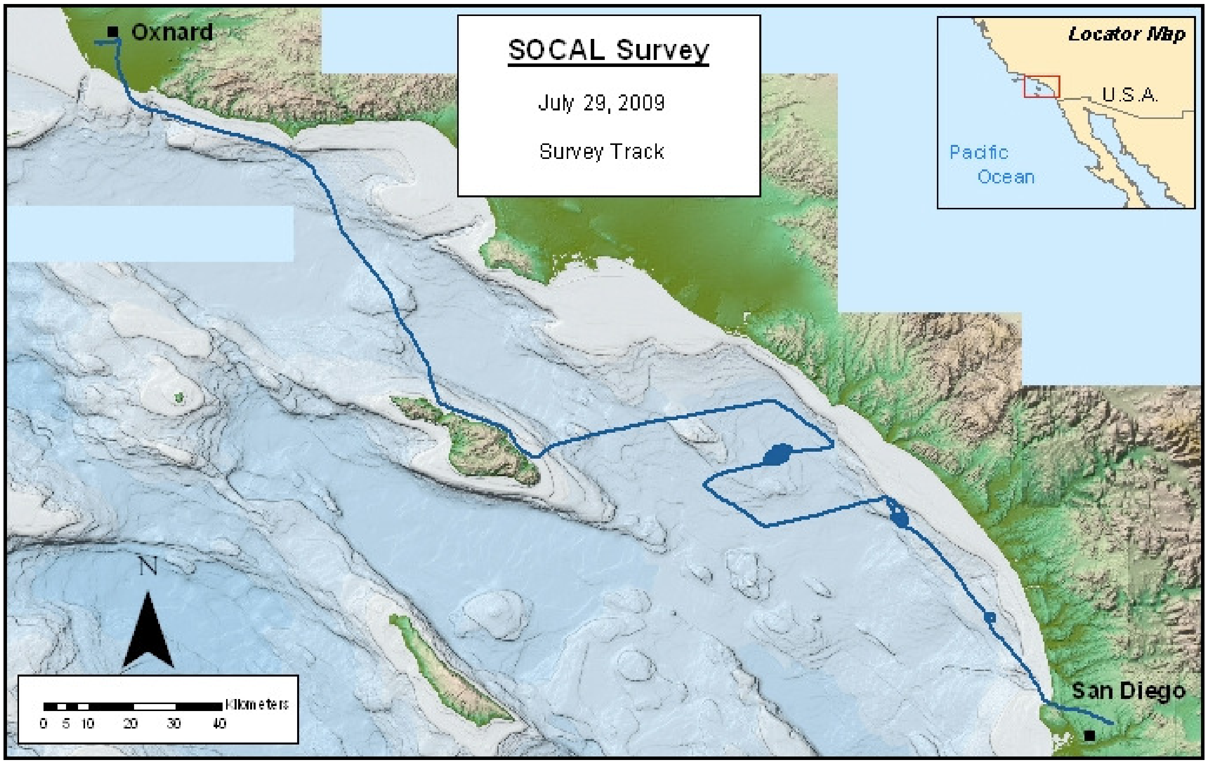

Figure 3. Aerial survey track line during the last day (July 29) of the July 2009 SOCAL aerial survey en route to return the observation aircraft to Oxnard, California.

Section 3 Results

This section closely follows the format of the Fall 2008 SOCAL aerial survey monitoring report (Smultea et al. 2009). Results are summarized in Tables 1-4, Figures 2-13, and Appendices A and B. Some unconfirmed species in this report may be confirmed after photographs are reviewed by species experts, which had not been completed at the time of this report.

Effort

A total of 63.8 hr of flight hours and ~13,769 km of flight time were conducted during the June and July SOCAL aerial survey between aircraft "wheels up" off the ground to "wheels down" when the plane landed (Tables 1 and 2). More of this flight time occurred in July (7386 km) than June (6382 km). However, more flight days (*n* = 8) and hours (33.9 hr, mean 4.2 hr/day) occurred in July than June (6 days, 29.9 hr, mean 5.0 hr/day). Surveys were flown on every day except July 23 when heavy low fog persisted all day and thus surveys could not be flown safely in the project area (Table 1).

Observers were on full watch during 92% or 12,640 km of the total 13,769 km of flight time (Table 2). Observations for marine mammals did not occur during the remaining 8% (1129 km) of total flight time due to poor weather (e.g., heavy fog and/or low clouds) that partially or fully obscured the observers' views or while transiting over land (Table 2). Overall, most (44%) of the total 12,640 km of observation effort in June and July consisted of circling sightings for focal follows and/or species identification; this was followed by systematic line-transect (29%), transit (20%), and random effort (7%) (Table 2). The proportion of systematic observation effort was 29% for June and 28% for July (Table 2). Random effort consisted primarily of transits to and from systematic survey lines but also in June included two circumnavigations of SCI totaling 76 km searching for potential stranded animals (Figure 2 and Table 2).

Overall, Bf ranged from 1-6 during both June and July, and Bf 3 predominated (43%) during both months (Figure 4). Bf was 0-3 during most of June (64%) and July (72%).

During both June and July, effort was fairly equally divided between the SOAR grid west of SCI and the NAOPA survey grid E of SCI (Figure 2).

Sightings

A total of 401 sightings of ~32,208 individual marine mammals was seen: 161 groups and ~9489 individuals during June and 240 groups and ~22,719 individuals during July based on periods with observation effort in June (6140 km) and July (6500 km)(Table 2). Of the total 401 sightings, 72% were identified to species (*n* = 224) or genus (*n* = 65) (Appendices A and B). At least 14 different species were verified including 11 species in June and 10 during July (most of which were the same species across months) (Table 3). This included at least five baleen whales (blue, fin, Bryde's or sei, humpback and minke whales), Cuvier's beaked whale, six dolphin species (bottlenose, short- and long-beaked common, Pacific white-sided, Risso's, and Northern right whale dolphin), and two pinniped species (California sea lion and harbor seal)(Table 3). Unidentified sightings usually occurred when there was no time to circle.

Overall, the Risso's dolphin was the most frequently identified species group (23% or 93 of 401 total groups) followed by common dolphins of the genus Delphinus (16% or 63 groups) (Table 3). In terms of number of individuals seen, the common dolphin was the most abundant (*n* = ~16,772 or 52% of the total 32,208 individuals seen). This was true for both June and July, though more individual common dolphins were seen in July (*n* = 12,020) vs. June (*n* = 4572) (Table 4). Numbers of blue whales were higher during July than June (Figure 10) while the opposite was true for fin whale numbers (Figure 11 and Table 3). California sea lions (*n* = 49 groups of 102 individuals) were the most commonly identified pinniped species (77% of 64 pinniped groups, including unidentified pinnipeds). The one sighting of ~4

Cuvier's beaked whales, a lone minke whale, and a Bryde's/fin/ or sei whale were seen in July (Table 3). Species identification of the minke whale was confirmed by the CRC vessel.

Only two mixed-species sightings were made: a mother-calf fin whale with a large group of Northern right whale dolphins in June (see photo on report cover page), and in July a group of short-beaked common dolphins with California sea lions (Appendices A and B).

Estimated mean group sizes were highest for common dolphins in both June and July, with a somewhat higher mean during June vs. July (297 vs. 256 individuals/group, respectively) (Figure 9). Mean group sizes for other delphinid species (n = 168 groups) were considerably smaller. For example, overall mean group size for 93 Risso's dolphin sightings was 15.9 individuals/group (Figure 9). Whales had the smallest observed group sizes (mean group size for all whales except Cuvier's = 1.3 whales/group, n = 106 groups).

Two dead, floating unidentified sea lions (probable California sea lions) were seen separately on July 25. The first was seen at 14:46 approximately 70 km W of SCI; the second was seen at 17:23 approximately 40 km W of San Diego (Figure 7). Photographs were taken of both sightings. Both carcasses were bloated. See Appendix B for further detail on these pinniped locations.

Distribution

In both June and July 2009 line-transect surveys were conducted only E and W of SCI and effort was similarly distributed in both months (see Figure 2). Transect lines E of SCI in NAOPA were the same as those followed in Oct and Nov 2008 (see Smultea et al. 2009). Survey lines W of SCI in SOAR in June-July 2009 were in the same area as Oct-Nov 2008, but were spaced slightly farther apart during June-July (~7 km apart) vs. Oct-Nov (~5 km apart). Lines were farther apart in SOAR during June-July to maximize coverage of the Navy-identified survey area within the ~5-hr limit of the aircraft's fuel tank.

In both June and July 2009 blues whales were seen primarily along the edge of the coastal continental, shelf drop-off and the continental slope off San Diego and Los Angeles (Figure 5). In June, fin whale sightings were limited largely to the NW quarter of the survey area in SOAR W of SCI along the NE edge of Tanner Bank (Figures 1 and 5). Fins, unlike blue whales, did not appear to be strongly associated with steep bathymetric relief. Rather, fin whales were most commonly sighted across the San Nicolas Basin/SOAR between SCI and Tanner Bank, primarily in June (Figure 5). In contrast, during July, fin whale sightings were more spread-out across the study area.

On July 25, a group of ~4 Cuvier's beaked whales was seen in San Nicolas Basin/SOAR in the vicinity of the CRC small tagging vessel (Figures 1 and 5). In that same area and time period, several other species were documented by the aircraft and CRC observers (see Unusual Observations below and Figure 5).

In June, the distribution of Risso's and common dolphins appeared to be segregated. Risso's were seen predominantly in offshore waters along and west of 30- and 40-Mile Banks and over 50 km W of San Diego (Figure 6). In particular, Risso's sightings were concentrated along the steep eastern edge of SCI. In contrast, in June, common dolphins were seen mostly along the coast within ~35 km of the shoreline. However, in July, both Risso's and common dolphins were most frequently seen concentrated along the continental slope, with very few sightings made W of SCI in SOAR.

In June, pinnipeds (comprised primarily of California sea lions) were seen nearly exclusively along the coast of SCI during the two circumnavigations of that coastline (Figure 7). In contrast, in July, many more such sightings were made at sea spread-out across the survey area.

Behavior

Four species or genus had sample sizes considered large enough ($n \geq 10$) to warrant summarizing initially observed behavior state, heading, and estimated mean dispersal distance between individuals: blue whales (n = 29), fin whales (n = 29), common dolphins (n > 70), and Risso's dolphins (n = 85)(Figures 10-13).

In both June and July blue and fin whales were nearly always initially observed traveling (Figures 10 and 11). In both months, blue whales were first seen headed a variety of directions with slight trends for some animals to head mostly SSW/NNE magnetic (Figure 10). Fin whales exhibited a more distinct directional trend, heading predominantly to the WSW magnetic (Figure 11).

Common dolphins were surface active and/or traveling when first seen in both June and July (Figure 12). In contrast, Risso's dolphins were rarely seen engaged in surface-active behaviors; rather, they predominantly traveled and also exhibited rest and milling more frequently than common dolphins (Figure 13). The most frequently observed heading among common dolphins was to the WSW (Figure 12). Inter-individual spacing (i.e., dispersal) for both common and Risso's dolphins was usually ≤3 body lengths, though spacing was sometimes as much as 12-15 body lengths (Figures 12 and 13).

Focal Follows

Approximately 76 (19%) of the 401 sightings were circled for at least 5 min by the aircraft to photo-verify species and make group-size estimates as needed/feasible. Fifteen of these sightings were circled for at least 10 min and up to 48 min to conduct "extended focal follows" (defined in Smultea et al. 2009)(Table 4). For extended follows, altitude was increased to 1200-1500 ft and radial distance maintained as possible at 0.5-1.0 km. The total 15 extended focal follows most frequently involved fin whales (n = 5) or common dolphins (n = 4).

Detailed analyses of focal follow behavioral data (e.g., re-orientation and respiration rates, dive times, etc.) were not conducted given the inability to know MFAS transmission times, the small sample sizes, budget limitations, and goals of the SOW. 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

Our observations based on aerial survey effort are necessarily limited only to those animals we saw and most of those observations were brief in duration, restricting the ability to make a more informed assessment. We did not observe any animals or behavior that appeared distinctly "unusual" and potentially related to exposure to MFAS. We did, however, observe a few noteworthy events as follows.

- Two dead floating probable California sea lions were seen on the same date (June 25 as described above).
- On June 6, for ~48 min, we circled a fin whale mother and calf to collect behavioral data using the video and photographs. The whales appeared to closely follow a large group of ~1000 Northern right whale dolphins, and were always seen at the tail end of the dolphin group. The dolphins appeared to interact with the fin whale mother and calf by swimming between and around them, while the fin calf often rolled on its mother's back/rostrum, meandering while traveling slowly.
- On June 11, from ~10:00-10:45, we circled a lunge feeding blue whale. Our goal was to collect detailed continuous behavioral data from different aircraft altitudes and a lateral distance of ~1.0 km to systematically assess whether the aircraft might affect the whale's behavior. The blue whale continued lunge feeding throughout the observations and did not appear to be disturbed by the aircraft circling for ~5 min at ~1.0 km lateral distance at each altitude of ~2000 ft then ~1500 ft then ~1000 ft. This was the first and only lunge feeding blue whale we saw during the entire June-July survey period. The whale was located within ~20 km of the Los Angeles coastline region. Extensive behavioral data were collected using the iPhone and handwritten notes. However, analysis of these detailed behavioral data was outside the scope of the SOW.
- On July 25 from ~15:00-15:50, up to four different cetacean species were seen in the same small (~4-6 km^2) area in SOAR W of SCI. These sightings included at least 5 fin whales, 1 minke whale, ~4 Cuvier's beaked whales, and a possible Bryde's/sei or fin whale (Figure 5). We found it unusual that

such a diverse array of species would occur in such a small area. The CRC tagging vessel was in the area when we first arrived but they appeared to be following different animals than we were circling. The Cuvier's whales were seen ~2-3 km from the CRC vessel; however, this vessel later indicated that they had not seen the Cuvier's. All three of the aircraft observers saw the Cuvier's, sometimes more than once, but were unable to obtain photographs. As we departed the area we saw surface-water disturbance created by the vortex of several whale tail beats near the CRC vessel and we also saw a medium-sized animal nearby. We did not confirm species in the field, but upon return to land, a CRC vessel observer indicated that they had been following a minke whale at that time. The vessel observers had also seen fin whales, but they had not seen the Cuvier' beaked whales.

Photography/Videography

Over 3400 digital photos were taken during ~113 (28%) of the total 401 sightings (Table 4). No photos were taken during the remaining 288 sightings because the animals were too far away and/or the sighting was too brief.

A total of ~2.2 hr of video was taken during focal follows that was considered useable for behavioral analyses (Table 4). Video included footage of systematic observations of the behavior of Risso's dolphins, common dolphins, fin and blue whales, and Northern right whale dolphins.

Table 1. Aerial survey flight times and total flight hours by date and survey period during the June and July SOCAL 2009 MTE aerial surveys.

2009 Date	Wheels Up Time	Wheels Down Time	Total Hours	Comments
4-Jun				Aspen commutes plane from Oxnard to Montgomery
5-Jun	16:23	18:27	2.1	Delayed departure due to thunderstorms & 4 hot spots around SCI then had to depart SOAR before 18:00 given restricted access. Circumnavigated SCI: no strandings seen. Surveyed 1 systematic leg & 1 transit leg NAOPA.
6-Jun	12:38	16:59	4.3	Surveyed N half SOAR & 1.5 systematic line NAOPA. Navy communications required adjusting survey plans. Extended focal behavior session on fin whale mother/calf with N right whale dolphins.
7-Jun	12:42	17:27	4.7	Fuel truck arrived late to fuel plane. Surveyed S half SOAR & 2 systematic lines NAOPA. Navy communications required adjusting survey plans. Two extended focal behavior sessions on 1 humpback then 2 blue whales.
8-Jun	8:21	12:55	4.6	Surveyed N half SOAR & 2 systematic lines NAOPA. Low clouds & Navy communications required adjusting survey in some areas. Circled fin whale entangled in long ~300 ft fishing line & buoy 09:49-10:04 at N latitude 33 05.045 / W longitude 118 24.692. Informed passing Coast Guard plane about entangled whale. Departed SOAR before 12:00. Reported entangled whale to NTR upon landing at Montgomery Field.
9-Jun	8:09	9:58	1.8	Surveyed 1.5 systematic lines NAOPA then returned to airport (low ceilings persisted all day). Attempted to relocate entangled fin whale seen yesterday but Navy communications & low clouds required adjusting survey.

2009 Date	Wheels Up Time	Wheels Down Time	Total Hours	Comments
10-Jun	8:21	13:02	4.7	Surveyed S half of SOAR & 2 partial systematic lines NAOPA. Navy communications required restricted flight pattern in parts of NAOPA. Departed SOAR <12:00. Extended focal session (fin whale & Risso's dolphins).
11-Jun (#1)	8:41	13:25	4.7	Two flights today. Surveyed N half SOAR & N & S ends NAOPA. Extended focal behavior session on two groups of feeding blue whales. Navy communications required restricted flight pattern in parts of NAOPA.
11-Jun (#2)	16:00	18:57	2.9	
12-Jun				Aspen commutes plane from Montgomery Field to Oxnard (no observers onboard).
TOTAL			**29.9**	

2009 Date	Wheels Up Time	Wheels Down Time	Total Hours	Comments
20-Jul	12:17	14:57	2.7	Had to end early due to heavy marine fog layer.
21-Jul	12:29	16:47	4.3	Heavy fog near SOAR and equipment malfunction. NAOPA: spotty fog off & on, hot airspace. 1 controlled circling of Risso's dolphins at 500/1000/1500/2000 but tankers nearby. 6 blue, 1 fin, commons, Risso's, CA sea lions
22-Jul	12:56	17:34	4.1	Late start due to fog. Intermittent fog & hot spots near SCI. Focal follows on Risso's dolphins.
23-Jul	NA	NA	0	No flight due to weather, heavy marine fog layer.
24-Jul	16:14	19:09	2.9	SOAR off limits due to Navy exercise.
25-Jul	13:30	17:41	4.2	Flew SOAR; modified last line due to low fuel.
26-Jul	13:05	17:25	4.5	Completed all SOAR lines except 1&2 due to heavy clouds.
27-Jul	13:49	18:16	4.5	Completed nearly all NAOPA lines.
28-Jul	14:10	18:28	4.3	Heavy fog over SOAR prevented completion of SOAR.
29-Jul	13:21	15:45	2.4	Completed 3 N. NAOPA lines then transited to Oxnard (Aspen) with observers on watch.
TOTAL			**33.9**	**33 of 33.9 hr within the SOCAL survey area.**

Table 2. Summary of aerial survey effort (km) by survey period, effort type, and Beaufort sea state during the June and July SOCAL 2009 aerial surveys.

Effort Type (# km)	June	July	Total
Systematic	1737	1865	3602
Random	369	474	844
Transiting	1451	1060	2511
Circling	2507	3101	5608
Circumnavigating coast of San Clemente Island	76	0	76
Opportunistic effort during fog	0 (no fog)	520	520
Over land	225	202	427
Off effort (not observing due to poor weather obscuring visibility)	17	164	181
Total km flown	**6382**	**7386**	**13,769**
Total km effort with observers on full watch	**(6140)**	**(6500)**	**(12,640)**
Beaufort Sea State			
1	347	508	855
2	713	1866	2578
3	2750	3082	5832
4	1689	1175	2864
5	619	516	1135
6	22	11	33
N/A (not recorded/applicable)	242	229	471
Total km flown	**6382**	**7386**	**13,769**

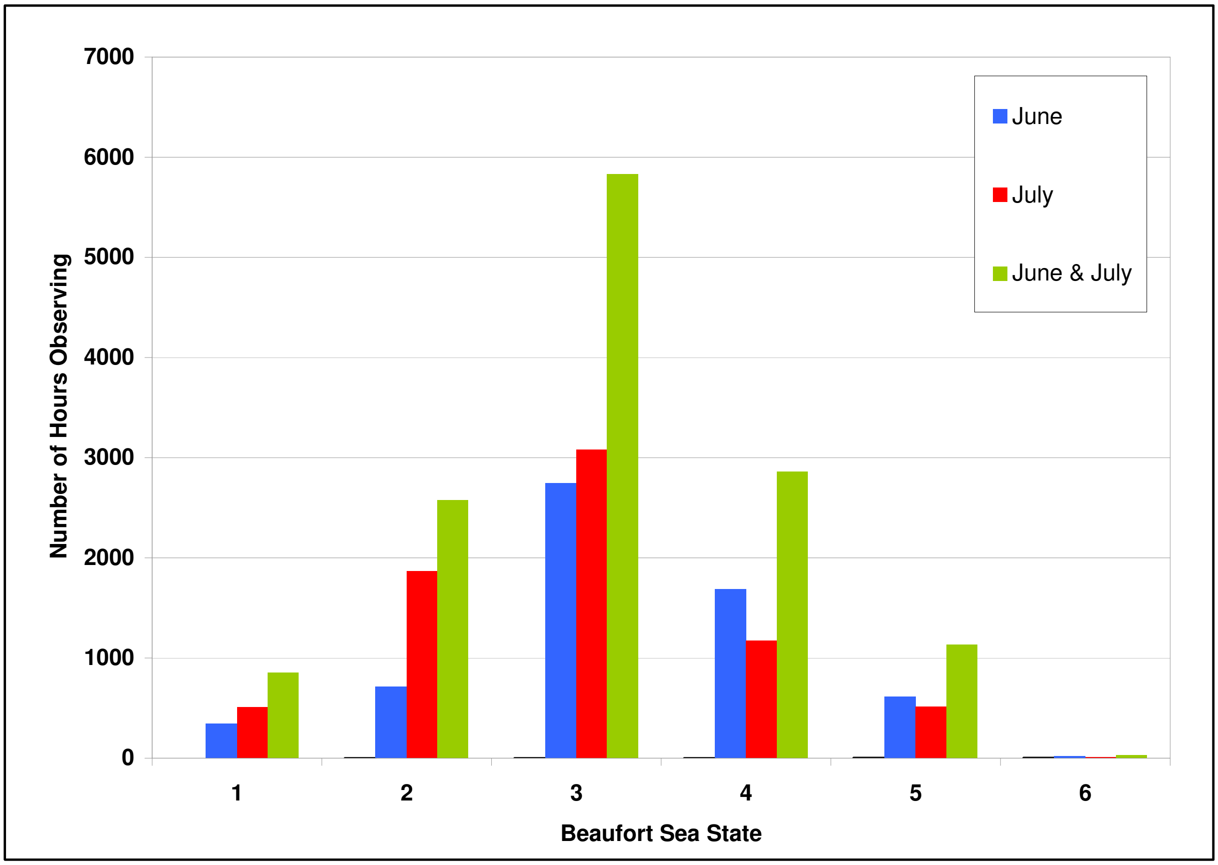

Figure 4. Beaufort sea state during aerial survey monitoring effort (km) during the June and July SOCAL 2009 aerial surveys.

Table 3. Summary of marine mammal sightings by species and survey month during the SOCAL 2009 aerial surveys.

Species Identification	Scientific Name	JUNE			JULY			JUNE & JULY		
		Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size
Blue Whale	*Balaenoptera musculus*	9	11	1.2	20	26	1.3	29	37	1.3
Fin Whale	*B. physalus*	23	34	1.5	6	7	1.2	29	41	1.4
Probable Fin Whale	*B. physalus*	1	2	2.0	0	0	0	1	2	2.0
Fin or Sei Whale	*B. physalus or B. borealis*	0	0	0	1	4	4	1	4	4.0
Fin, Sei or Bryde's Whale	*B. physalus, B. borealis, or B. edenii*	0	0	0	1	1	1	1	1	1.0
Minke Whale	*B. acutorostrata*	0	0	0	1	1	1	1	1	1.0
Humpback Whale	*Megaptera novaeangliae*	2	2	1.0	0	0	0	2	2	1.0
Unidentified Baleen Whale	Balaenopteridae sp.	13	14	1.1	3	3	1	16	17	1.1
Unidentified Medium-sized Whale	Cetacea	0	0	0	1	1	1.0	1	1	1.0
Cuvier's	*Ziphius cavirostris*	0	0	0	1	4	4.0	1	4	4.0

Table 3. Summary of marine mammal sightings by species and survey month during the SOCAL 2009 aerial surveys. (cont'd)

		JUNE			JULY			JUNE & JULY		
Species Identification	**Scientific Name**	**Total No. of Sightings**	**Total Estimated No. Individuals Observed**	**Mean Group Size**	**Total No. of Sightings**	**Total Estimated No. Individuals Observed**	**Mean Group Size**	**Total No. of Sightings**	**Total Estimated No. Individuals Observed**	**Mean Group Size**
Beaked Whale										
Bottlenose Dolphin	*Tursiops truncatus*	1	11	11.0	1	15	15	2	26	13.0
Common Dolphin sp.	*Delphinus sp.*	16	4752	297.0	47	12,020	255.7	63	16,772	266.2
Long-beaked Common Dolphin	*D. capensis*	1	400	400.0	5	1057	211.4	6	1457	242.8
Short-beaked Common Dolphin	*D. delphis*	0	0	0	5	1355	271	5	1355	271.0
Short-Beaked Common Dolphin & California Sea Lion	*D. delphis* & *Zalophus californianus*	0	0	0	1	230	230	1	230	230.0
Unidentified Dolphin: Common Dolphin sp. or Bottlenose Dolphin	Delphinidae sp.	0	0	0	1	9	9	1	9	9.0
Probable	*Delphinus* sp.	3	475	158.3	3	1260	420	6	1735	289.2

Table 3. Summary of marine mammal sightings by species and survey month during the SOCAL 2009 aerial surveys. (cont'd)

Species Identification	Scientific Name	JUNE			JULY			JUNE & JULY		
		Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size
Common Dolphin sp.										
Pacific White-sided Dolphin	*Lagenorhynchus obliquidens*	0	0	0	1	35	35	1	35	35.0
Risso's Dolphin	*Grampus griseus*	40	701	17.5	53	779	14.7	93	1480	15.9
Unidentified dolphin: possible Risso's Dolphin	Delphinidae sp.	0	0	0	1	300	300	1	300	300.0
Unidentified Dolphin	Delphinidae sp.	16	1503	93.9	51	5554	108.9	67	7057	105.3
Northern Right Whale Dolphin	*Lissodelphis borealis*	3	1500	500.0	0	0	0	3	1500	500.0
California Sea Lion	*Zalophus californianus*	23	69	3.0	26	33	1.3	49	102	2.1
Harbor Seal	*Phoca vitulina*	1	1	1.0	1	1	1	2	2	1.0
Unidentified Sea Lion	Pinnipedia	0	0	0	1	1	1	1	1	1.0
Unidentified Pinniped: Probable CA	Pinnipedia	0	0	0	1	1	1	1	1	1.0

Table 3. Summary of marine mammal sightings by species and survey month during the SOCAL 2009 aerial surveys. (cont'd)

Species Identification	Scientific Name	JUNE			JULY			JUNE & JULY		
		Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size	Total No. of Sightings	Total Estimated No. Individuals Observed	Mean Group Size
Sea Lion										
Unknown Pinniped	Pinnipedia	6	9	1.5	3	6	2	9	15	1.7
Dead Pinniped	Pinnipedia	0	0	0	2	2	1.0	2	2	1.0
Unidentified Marine Mammal	Cetacea or Pinnipedia	1	3	3.0	1	1	1.0	2	4	2.0
Unidentified Small Marine Mammal	Cetacea or Pinnipedia	1	1	1.0	2	13	6.5	3	14	5.0
Unidentified Whale	Cetacea	1	1	1.0	0	0	0	1	1	1.0
TOTAL		**161**	**9489**	**58.9**	**240**	**22,719**	**94.6**	**401**	**32,208**	**80.3**

Table 4. Summary of survey results for the October and November 2008 and June and July 2009 aerial surveys for marine mammals in the SOCAL off San Diego, California.

Parameter	Oct-08	Nov-08	Jun-09	Jul-09	Total
Survey Dates	17-21 Oct	15-18 Nov	5-11 June	20-29 July	**Oct-Nov, June-July**
No. Days Flown	5	4	6	9	**24**
Major Training Exercise (MTE) Period?	Yes	No	Yes	No	**Yes & No**
Total Flight Hours (Wheels Up/Down)	27.5	21.4	29.9	33.9	**112.7**
Total Observation Effort in km (nm) *(excludes poor weather, over land, etc.)*	4561 km (2462 nm)	3834 km (2070 nm)	6140 km (3316 nm)	6500 km (3507 nm)	**21,035 km** **(11,355 nm)**
No. Navy-directed Survey Changes	~9	~7	~12	~10	**~38**
No. Coastline Surveys for Strandings (around San Clemente Island)	0	2	1	0	**3**
No. Sightings	115	185	161	240	**701**
Estimated No. Individuals	12,587	5732	9489	22,719	**~50,527**
Mean Group Size	109.4	31.0	58.9	94.7	**72.1**
No. Dead Sightings	0	3 (2 CA sea lions, 1 blue whale)	0	2 (2 probable CA sea lions)	**5**
No. Species	9	9	11	10	**13**
No. Focal Groups Circled 5-9 min	22	20	24	37	**103**
No. Extended Focal Groups Circled >10 min	5	7	7	8	**27**
Longest Focal Follow Duration (min)	28 min (fin whale)	60 min (fin whale)	48 min (fin whale)	38 min (long-beaked common dolphin)	**60 min**
No. Photos Taken	1050	1280	1099	2301	**5730**
Estimated Useable Video (min)	53	41	83	50	**227**

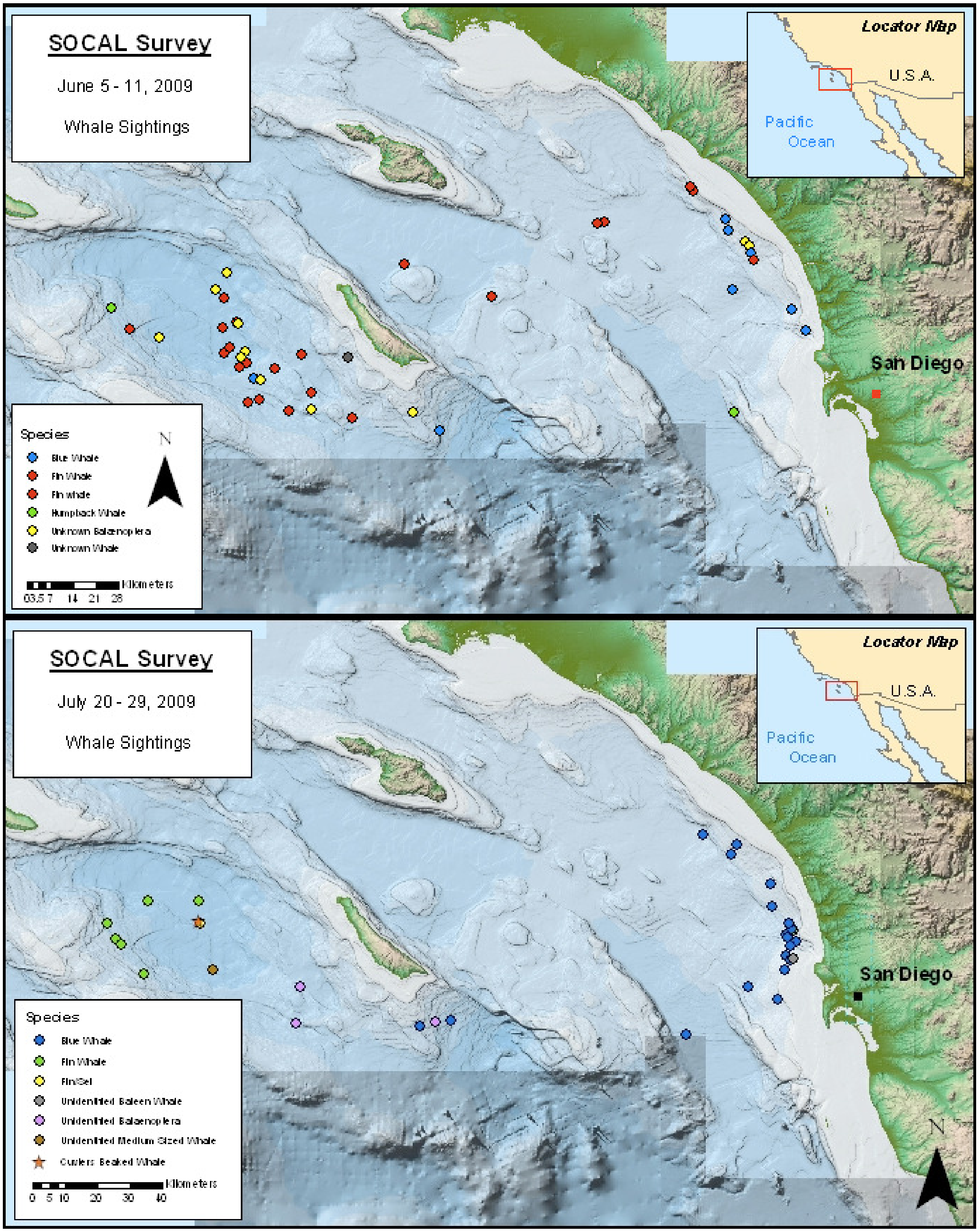

Figure 5. June and July 2009: Whale sightings in the SOCAL aerial survey study area. (See Figure 2 for all track line effort).

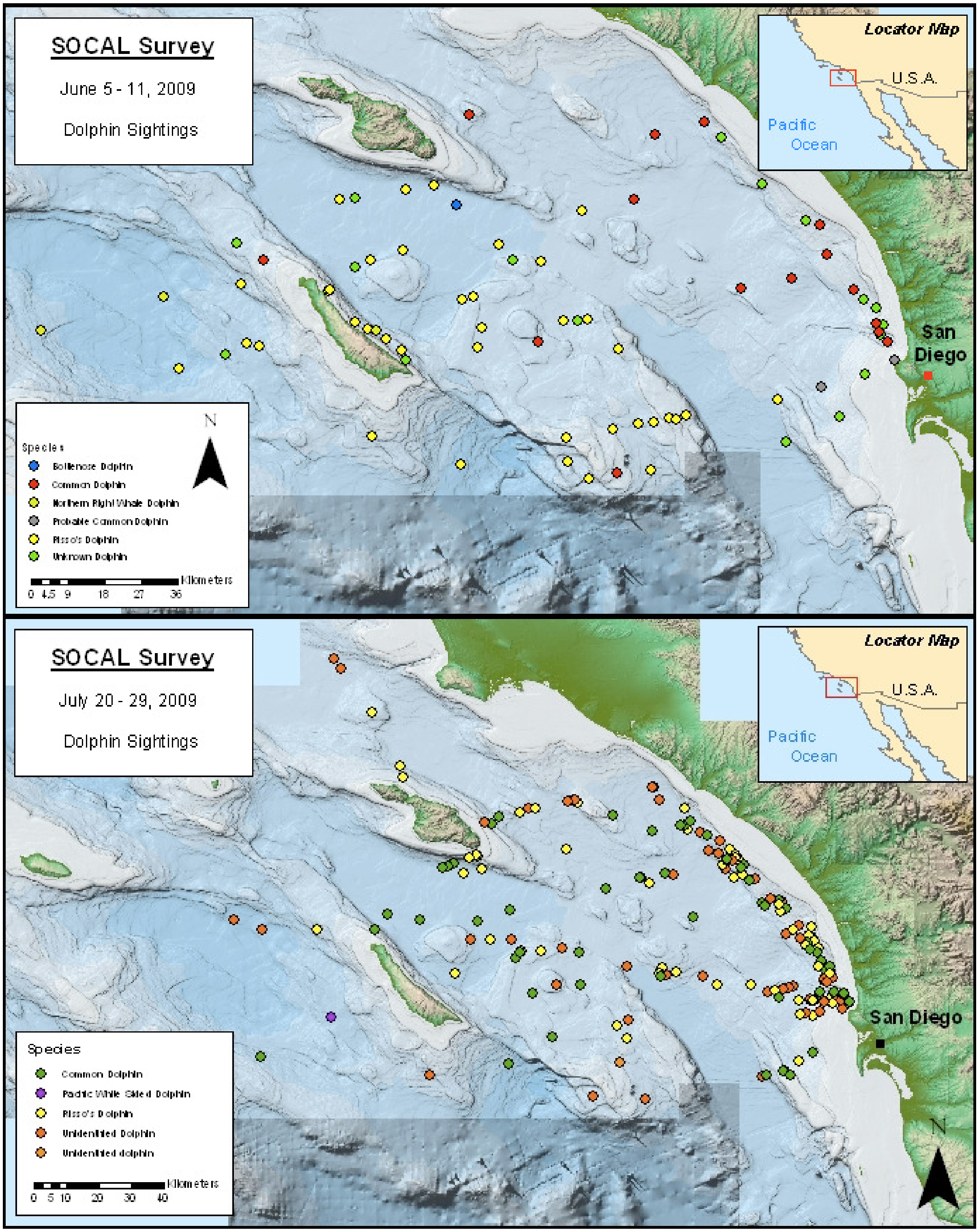

Figure 6. June and July 2009: Dolphin sightings in the SOCAL aerial survey study area. (See Figure 2 for all track line effort).

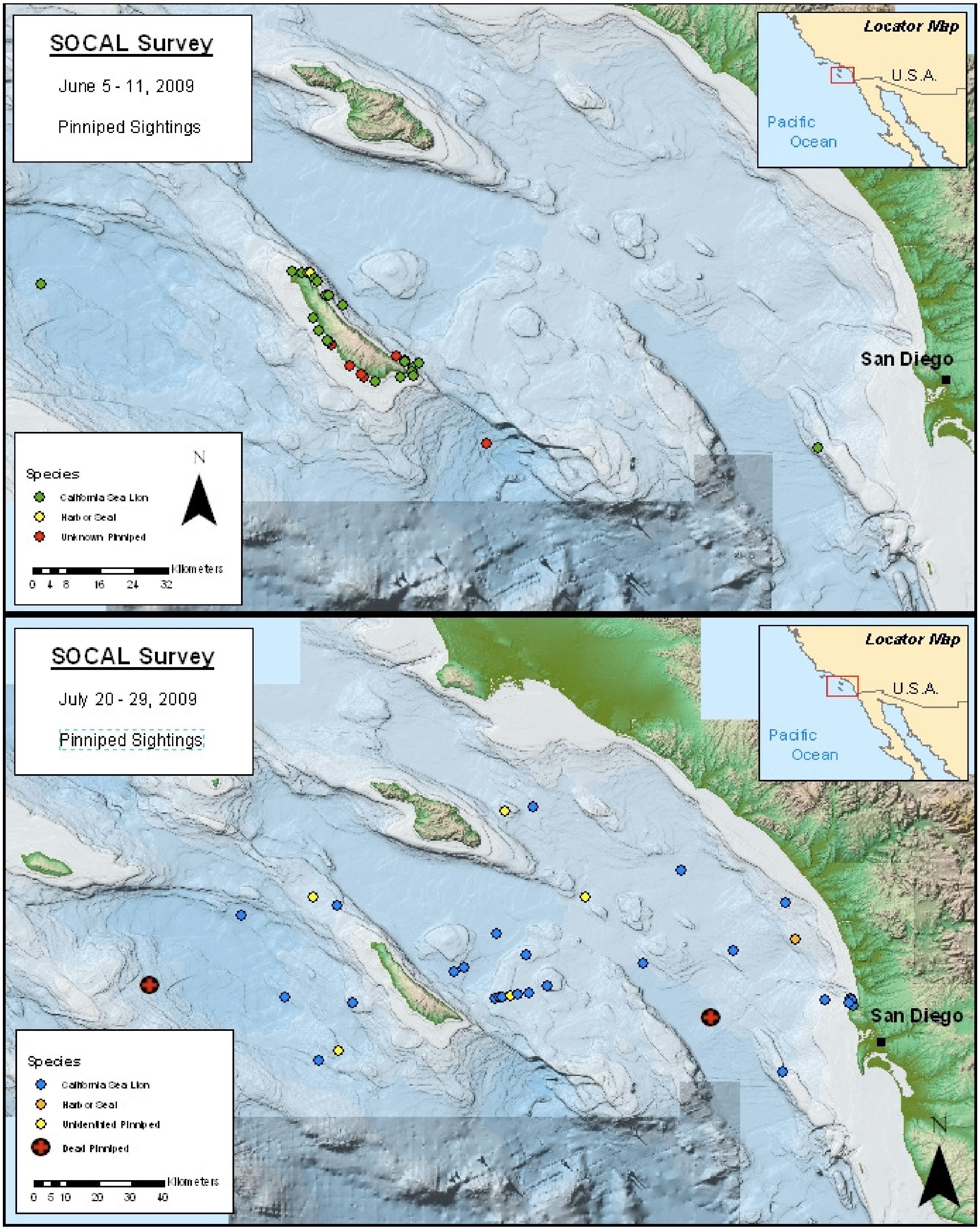

Figure 7. June and July 2009: Pinniped sightings in the SOCAL aerial survey study area. (See Figure 2 for all track line effort).

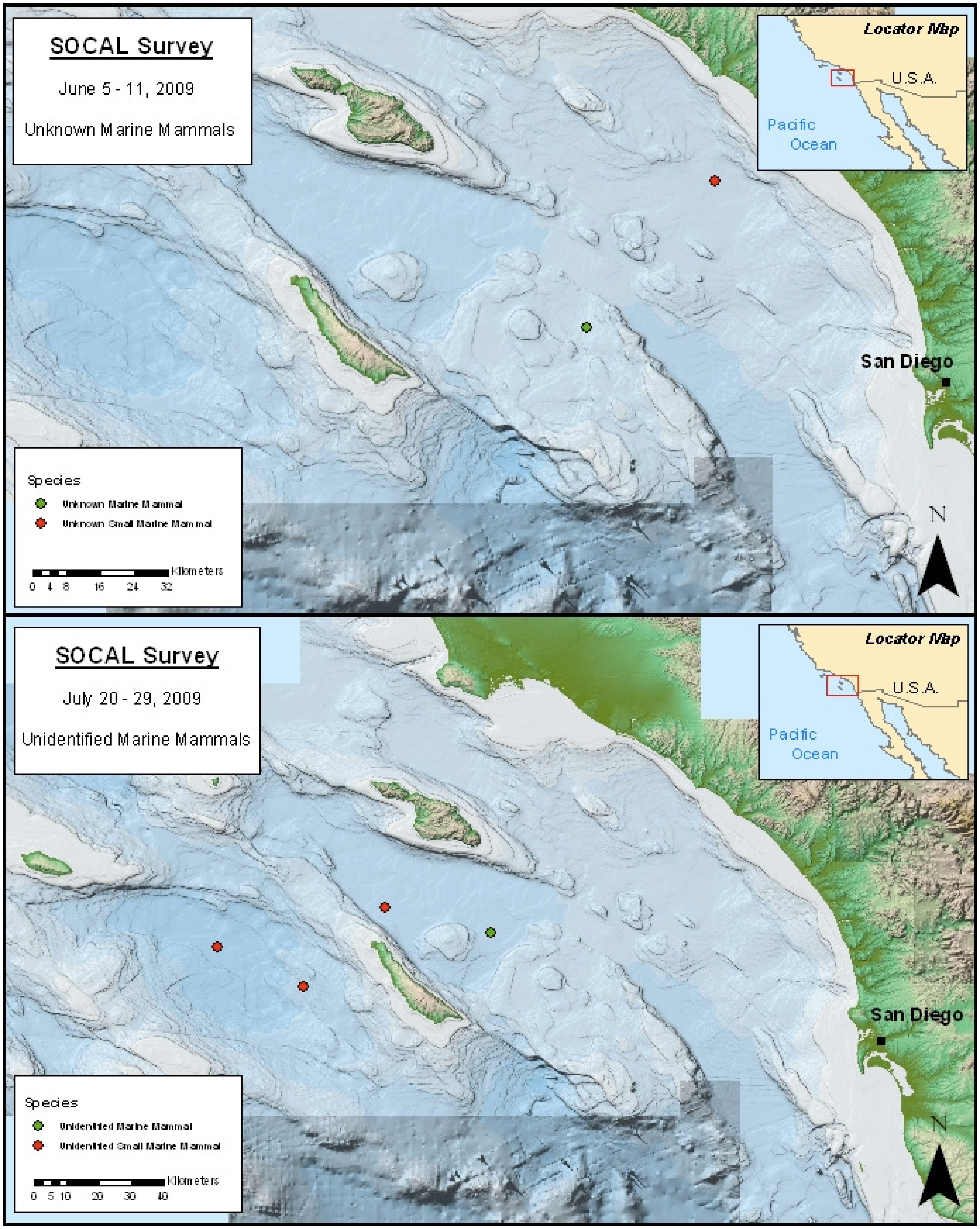

Figure 8. June and July 2009: Unidentified marine mammal sightings in the SOCAL aerial survey study area. (See Figure 2 for all track line effort).

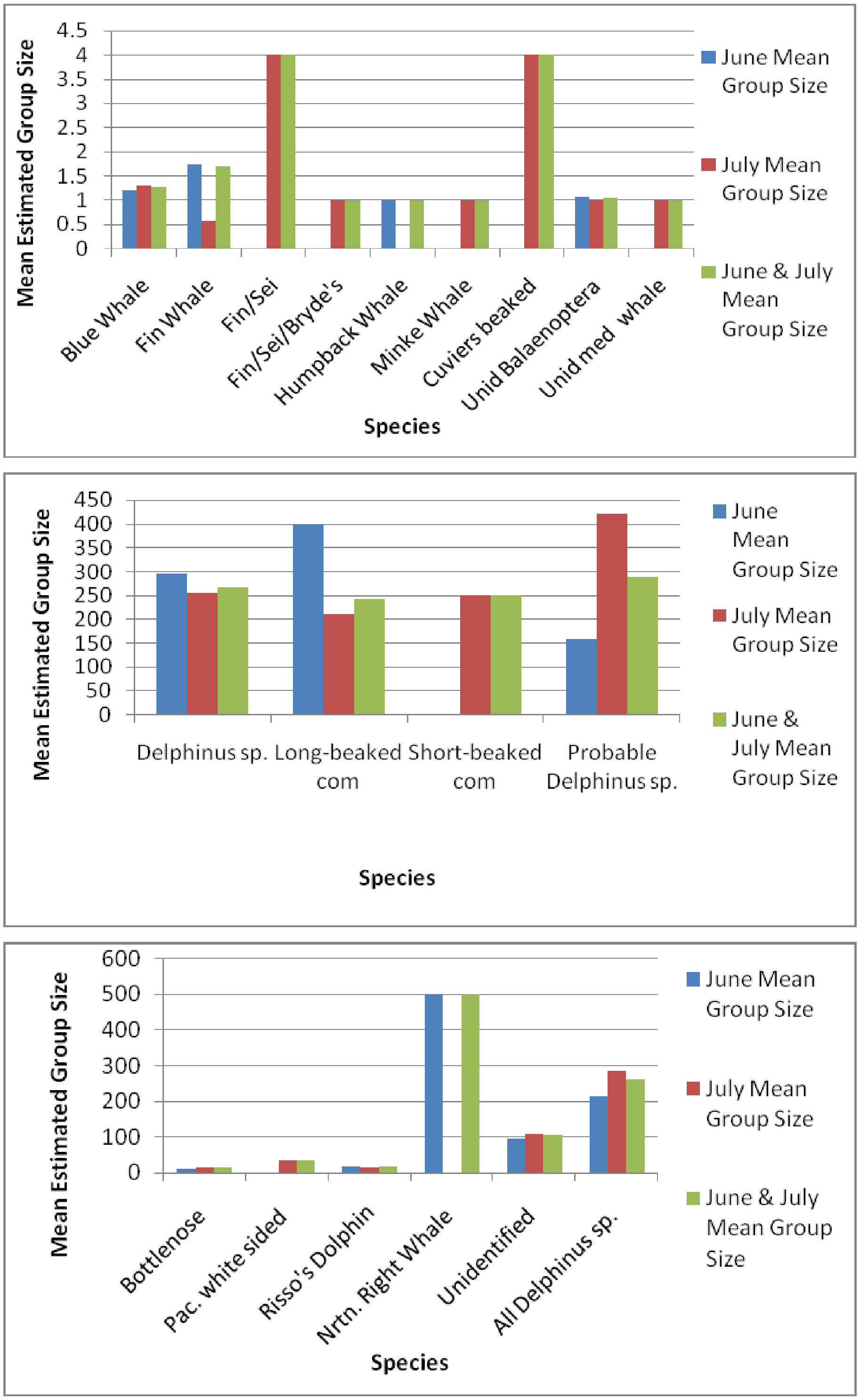

Figure 9. Mean group size by species or species group during the June and July 2009 SOCAL aerial survey periods. Upper panel: whales; middle panel: common dolphins; bottom panel: dolphins.

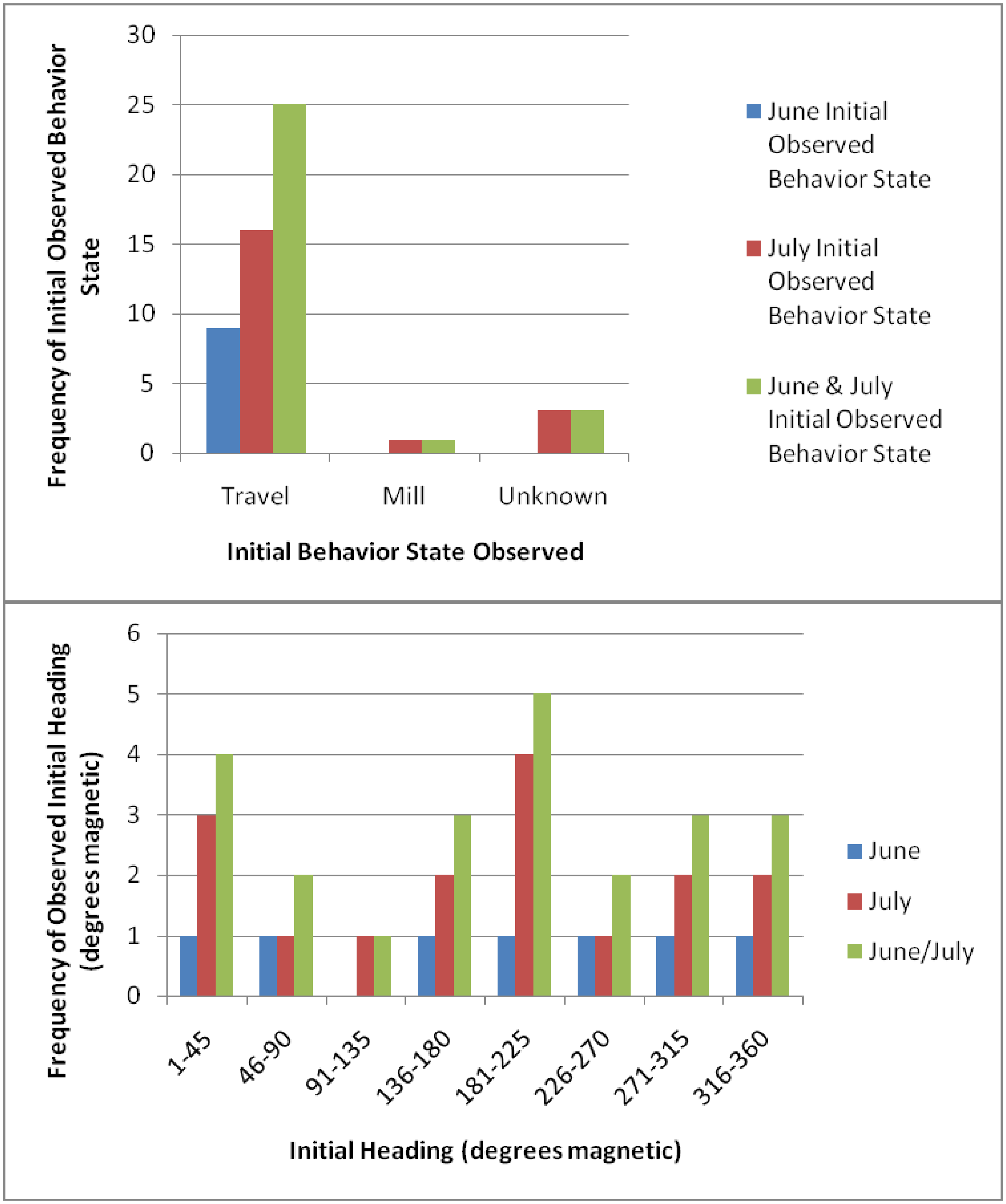

Figure 10. Blue whales during the June and July SOCAL 2009 survey periods. Top panel: frequency of initially observed behavioral states. Bottom panel: frequency of initially observed headings (degrees magnetic).

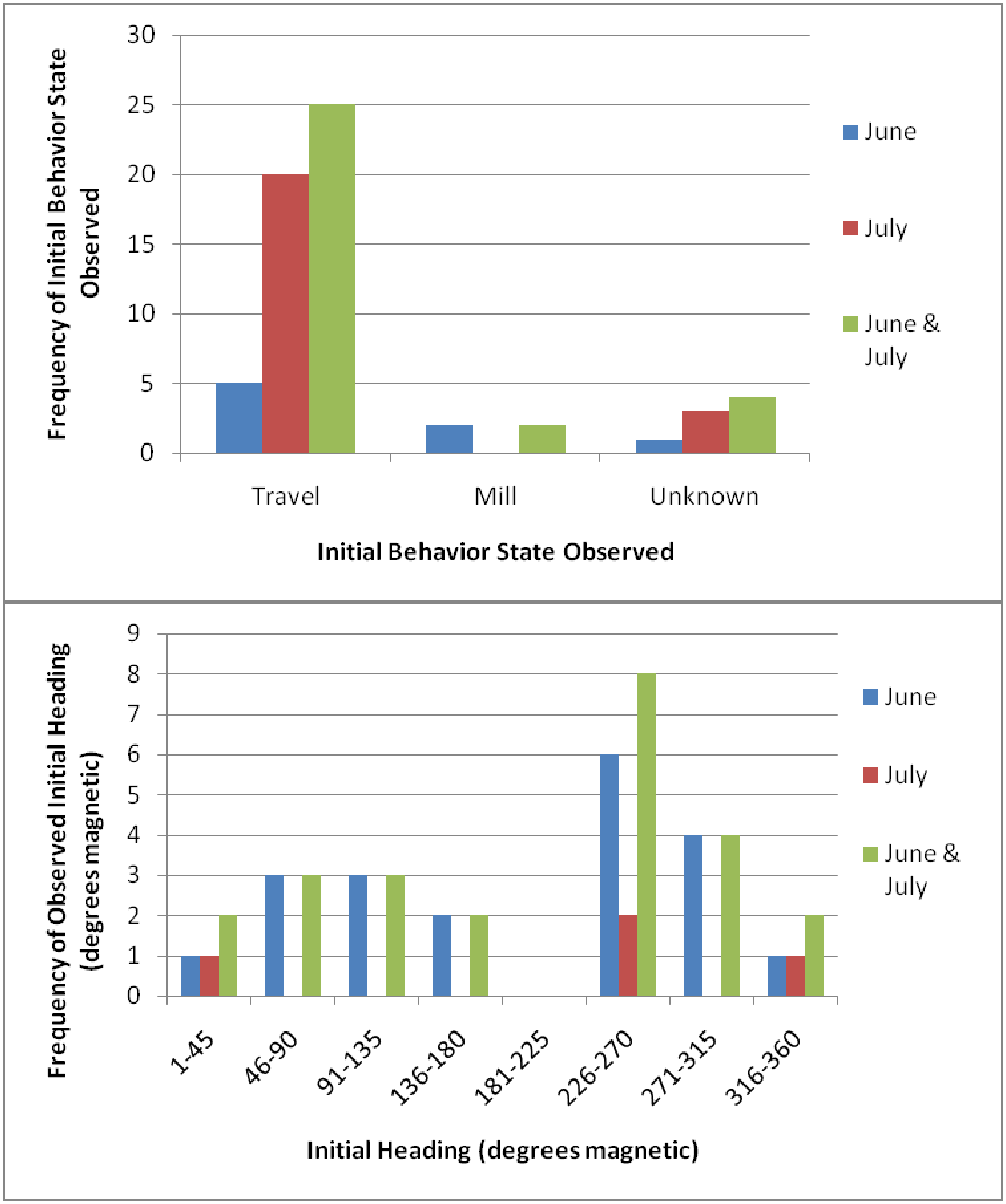

Figure 11. Fin whales during the June and July SOCAL 2009 survey periods. Top panel: frequency of initially observed behavioral states. Bottom panel: frequency of initially observed headings (degrees magnetic).

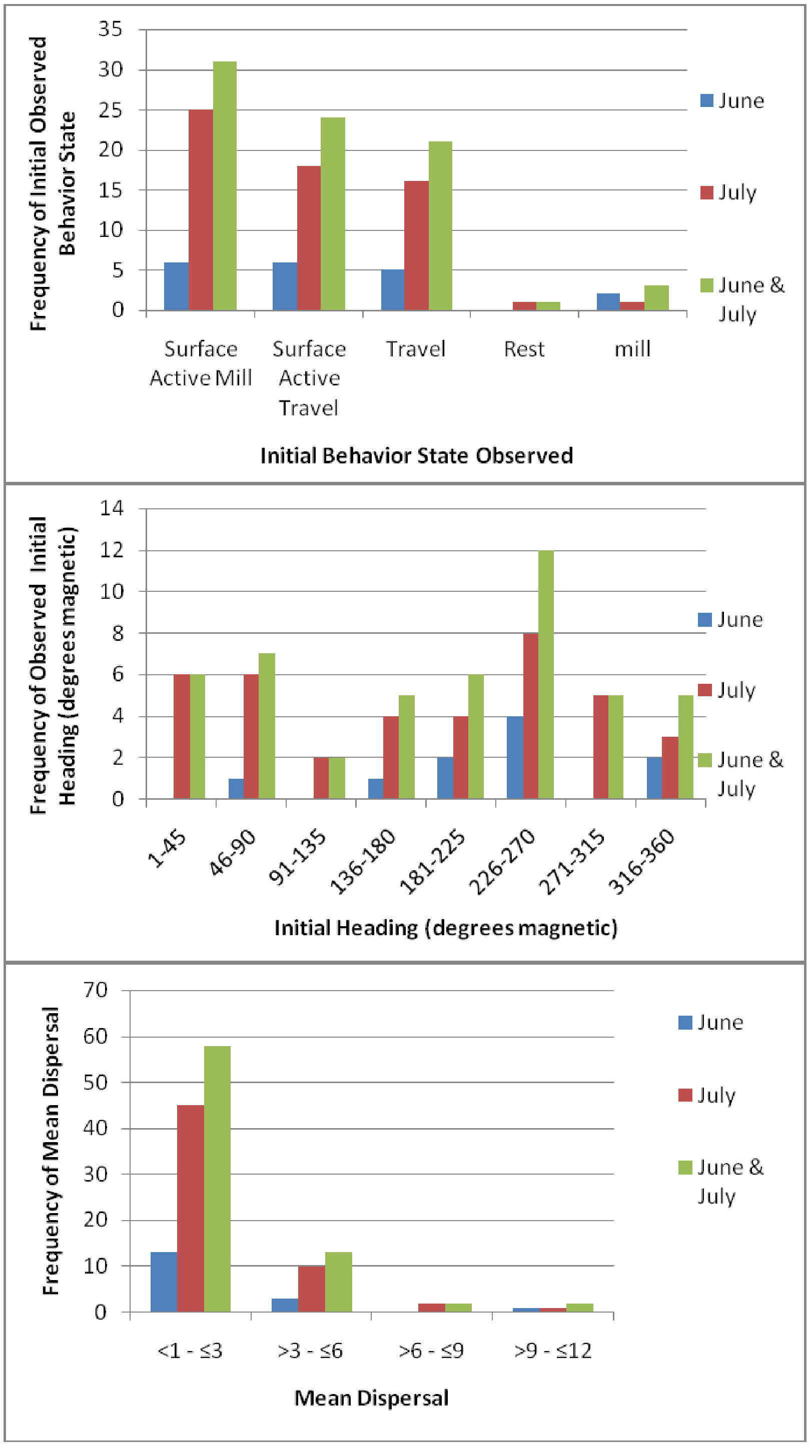

Figure 12. Common dolphins during the June and July SOCAL 2009 survey periods: Upper panel: frequency of initially observed behavioral states. Middle panel: frequency of initially observed headings (degrees magnetic). Bottom panel: frequency of mean dispersal distance between individuals (in estimated body lengths).

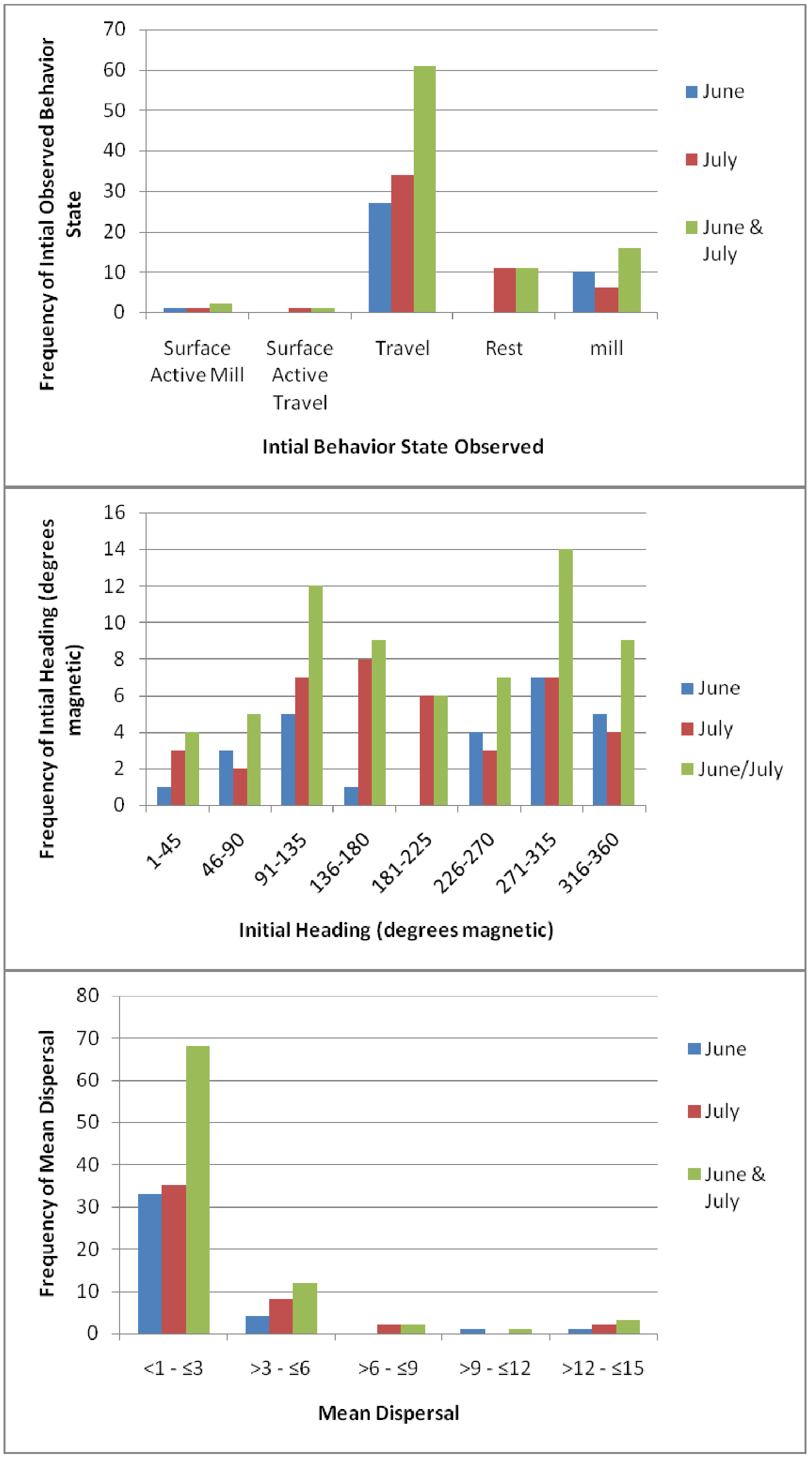

Figure 13. Risso's dolphins during the June and July SOCAL 2009 survey periods: Upper panel: frequency of initially observed behavioral states. Middle panel: frequency of initially observed headings (degrees magnetic). Bottom panel: frequency of mean dispersal distance between individuals (in estimated body lengths).

Section 4 Discussion

Key Role of Aerial Surveys

Survey results provide further support of the key and unique roles that aerial surveys play in addressing Navy monitoring plan goals (see review in Smultea et al. 2009). These include:

(1) providing the advantage of surveying key Navy areas of interest (e.g., areas W and E of SCI) *within one day, providing a "snapshot" of marine mammal numbers, presence, distribution and behavior* before, during and after MTEs,

(2) *collecting quantifiable behavioral data* known to be indices of stress/disturbance,

(3) *conducting focal follows* of priority cetacean species including video-documentation of underwater behavior,

(4) providing a platform from which the *behavior and potential reactions of cetaceans to MTEs may be studied without confounding results* (vs. from vessels), and

(5) locating and identifying dead floating and stranded animals.

Results Highlights

The relative importance and contextual contribution and significance of specific key results are listed below.

- Over ~20,000 km of aerial survey observations and over 700 sightings of marine mammals were obtained during the Oct-Nov 2008 (Smultea et al. 2009) and June-July 2009 SOCAL aerial surveys. This effort represents the most up-to-date and comprehensive visual survey from the SOCAL/SOAR vicinity since the SWFSC aerial surveys there in 1998-99 (Carretta et al. 2000).

- On July 25-26, W of SCI, aerial and vessel (R/V *Sproul*, SIO) line-transect surveys for marine mammals were successfully conducted simultaneously to passive acoustic monitoring studies by NUWC and SIO researchers, and satellite tagging and photo-identification surveys by 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 the 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 goals of the SOCAL Marine Monitoring Plan (DoN 2009).

- The aerial survey grids W and E of SCI were each surveyed *within one day* on several different days. This demonstrates the unique ability of aerials to *obtain a "snapshot"* of a large area providing information on the numbers, occurrence, (re-) distribution, species, behavior, and disposition of marine mammals in high-priority Navy areas within a short (<1 day) time. This ability provides information for the area *before, during and after* MTEs. These data cannot be obtained from a vessel or from passive acoustics within one day in such a large area.

- A live fin whale dragging ~100 m of fishing rope and a buoy was observed E of SCI in June. Sighting information was immediately communicated to a passing US Coast Guard helicopter and to the Navy NTR. The Navy contacted the NMFS. In addition, two dead probable California sea lions were observed in July: one E and one W of SCI over the middle of underwater basins. These sightings show that the aircraft is an effective way to *quickly identify dead and injured/stranded MM*. This was similarly demonstrated in Oct-Nov 2008 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).

- Sample sizes of species sightings collected during June and July 2009, especially when combined with our 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. We are currently working in collaboration with the Navy to produce such preliminary estimates. This will facilitate comparison with abundance and density estimates derived from aerial surveys conducted in the same region by the SWFSC in 1998-1999 (Carretta et al. 2000)

- Marine mammals were seen *in* and *near* the active area W of SCI *during* the June MTE period as well as *in* and *near* this area in July *after* the MTE. This is similar to results of the Oct (*during*) and Nov (*after*) SOCAL aerial surveys (Smultea et al. 2009).

- Seven systematic assessments of the potential effect of our aircraft circling at different altitudes and ~1 km lateral distance were undertaken on Risso's and common dolphins and fin and blue whales. Preliminary analyses indicate that flying at altitudes of ~1500 ft and in some cases ~1000 ft and lateral distance of ~1 km did not result in obvious changes in behavior, heading, or dispersal. One blue whale continued lunge feeding and Risso's dolphins continued resting at the surface throughout the ~40-min observation periods. 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. The only other similar systematic assessments of potential observation aircraft effects were conducted on bowhead whales in the Arctic (e.g., reviewed in Richardson et al. 1995) and on Hawaiian humpback whales (Bowles 1995, Smultea et al. 1995).

- 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 W of SCI. In July, fin whales were seen more frequently in the NW section of this basin vs. in the central basin in June. These results indicate that fin and blue whales are more common in the region than during the 1998-1999 SWFSC aerial surveys (Carretta et al. 2000).

- Overall, Risso's dolphins were the most frequently sighted species followed by common dolphins. In contrast, in Oct-Nov, commons were by far the most frequently seen species (Smultea et al. 2009). Risso's dolphins were common in both June and July while common dolphins were more common in July.

- In June, Risso's dolphins were distributed widely in offshore waters, with a concentration along the steep drop-off on the E side of SCI. In contrast, commons 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). Relatively few sightings of either species occurred in waters W of SCI within SOAR, 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 W of SCI.

- In June, California sea lions were frequently seen along the coast of SCI during the two circumnavigations of SCI with few seen at sea. In contrast, California sea lions were frequently seen at sea in July. This pattern is related to the June haul-out period on SCI and the subsequent dispersal of the species at sea in July (e.g., Carretta et al. 2000).

- Mean group size, behavior state, heading, and dispersal distance were similar in Oct, Nov, June and/or July within the cetacean species examined: blue whale, fin whale, common dolphin, Risso's dolphin, Pacific white-sided dolphin. However, common dolphins appeared to head predominantly NE/E and SW/W in both June and July, similar to data from Oct and Nov (Smultea et al. 2009). Risso's tended to head most frequently to the W 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 (see Smultea et al. 2009). It also addressed goals of the SOCAL M3P (DoN 2009).
- 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 M3P 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 M3P and ICMP and other Navy range M3Ps (DoN 2008, 2009). As such, the survey contributes to the "overall knowledgebase of marine species", a goal of the SOCAL M3P and ICMP (DoN 2009: p. 3).

Section 5 Recommendations

A comprehensive list of recommendations to improve data collection techniques, analyses, interpretations, and applications was provided in the SOCAL 2008 aerial survey report (Smultea et al. 2009). Below are a few recommendations in addition to those.

1. Sighting data from 2008 and 2009 SOCAL aerial surveys should be preliminarily analyzed using free DISTANCE software (Buckland et al. 2001) to ascertain whether existing samples sizes are sufficiently large to calculate reasonable abundance and density estimates for some marine mammal species. This requires additional data analysis and preparation beyond the scope of this study. This is important to assess whether changes in abundance can be statistically linked to *before, during and after MFAS activity periods*. Additional DISTANCE analyses can be conducted if preliminary results are promising.

2. Preliminary and follow-up statistical analyses of behavioral indices successfully collected and summarized herein should be analyzed using a behavioral analysis program. Because data were collected using BioSpectator Go software, their current format is most amenable to analyses that can be run in that software program. This analysis was beyond the scope of our study. Such information is important to statistically identify minimum sample sizes required to identify statistically significant changes in attributes that could be related to MFAS activities, in consultation with a professional statistician.

3. Video of behavioral data collected during this study should be analyzed using NOLDUS video analysis software (www.noldus.com). Analysis of video data is typically a tedious and time-consuming process. However, Noldus has developed video data analysis software that increases analysis efficiency and helps to standardize the process. Such results provide the most detailed and accurate method for objectively quantifying measurable behavioral data (e.g., inter-animal dispersal distances, respiration rates, relative changes in orientation, frequency of behaviors, etc.) because videotape can be re-reviewed, etc. The most effective approach is to combine the video data with a recorded vocal narration of behavior, notes taken using a behavioral software program, e.g., BioSpectator Go, and/or handwritten notes on forms, all of which we did during the study. This approach has been successfully used to quantify and identify subtle and other significant changes in measurable behavioral variables of bowhead, gray and humpback whales, that in turn were statistically shown to be influenced by anthropogenic underwater sound and other stimuli (reviewed in Richardson et al. 1995). However, the above analyses were beyond the scope of the current study.

4. Formal **Pre-Planning Meetings** should be conducted and attended **by all key** research and Navy representatives. This allows coordinating and maximizing the ability of various simultaneously operating platforms to collect data useful to assess potential effects of Navy training activities on marine mammals. This helps to reduce data-collection costs through multi-use of platforms. It also increases efficiency and safety of field operations and provides the opportunity for team building, data sharing, and collaboration.

5. A formal post-field **Information Transfer Meeting** should be held ~2-3 months after the fiscal monitoring year has been completed. This allows the various researchers and Navy representatives to share data and techniques, to identify additional future collaborative efforts, and to build relationships between researchers and Navy representatives involved in the activities. This could include Navy personnel explaining the challenges faced when trying to coordinate and obtain approval for the monitoring research, and identifying ways in which researchers can assist in this process. It also gives both research and Navy representatives the opportunity to question one another about results and goals, and to identify ways to improve and smooth related endeavors, and to assist one another in data collection and meeting study goals.

Section 6 Acknowledgements

We are grateful to Navy personnel from U.S. Pacific Fleet Environmental and Naval Facilities Engineering Command Pacific for their support, coordination and facilitation in implementing these surveys. We thank Dr. John Hildebrand, Paula Hodgkiss, Linda Sawyer, and other assisting staff at the Scripps Institution of Oceanography and the California Institute of Technology for facilitating this contract. Many thanks also to the hard working survey crew and technical assistants including observers M. Deakos and L. Mazzuca, and graphics/document/data management support from Jenelle Black. We thank Rick Throckmorton and Barry Hansen and our astute and enthusiastic pilot Kathleen Veatch of Aspen Helicopters for providing us with our aircraft and pilots.

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Appendix A List of All June Sightings

Appendix A. 5-11 June 2009: Summary of all individual marine mammal sightings, including location latitudes and longitudes, made during the SOCAL 2009 aerial monitoring surveys off San Diego, California.

Date 2009	Estim. Group Size	SOCAL June 09 Species List Species Identification	Initial time	Latitude ˚N	Longitude ˚W
5-Jun	1	Unidentified Dolphin	16:48:02	32.937	117.988
5-Jun	3	Risso's Dolphin	16:48:44	32.938	118.016
5-Jun	3	Unidentified Dolphin	17:02:44	32.85	118.368
5-Jun	1	California Sea Lion	17:03:02	32.848	118.364
5-Jun	1	California Sea Lion	17:03:43	32.835	118.347
5-Jun	1	California Sea Lion	17:05:16	32.814	118.372
5-Jun	2	California Sea Lion	17:07:30	32.803	118.428
5-Jun	1	Unidentified Pinniped	17:08:32	32.813	118.451
5-Jun	1	Unidentified Pinniped	17:08:48	32.818	118.458
5-Jun	1	Unidentified Pinniped	17:10:02	32.837	118.48
5-Jun	4	Unidentified Pinniped	17:12:27	32.881	118.521
5-Jun	1	California Sea Lion	17:12:50	32.888	118.526
5-Jun	1	California Sea Lion	17:12:59	32.891	118.529
5-Jun	4	California Sea Lion	17:13:54	32.913	118.547
5-Jun	1	California Sea Lion	17:15:11	32.94	118.559
5-Jun	4	California Sea Lion	17:19:48	33.038	118.604
5-Jun	1	California Sea Lion	17:20:32	33.037	118.583
5-Jun	1	California Sea Lion	17:20:48	33.036	118.572
5-Jun	1	Harbor Seal	17:20:59	33.035	118.567
5-Jun	1	California Sea Lion	17:21:27	33.024	118.556
5-Jun	1	California Sea Lion	17:21:44	33.017	118.55
5-Jun	4	California Sea Lion	17:21:45	33.017	118.55
5-Jun	12	Risso's Dolphin	17:22:21	33.005	118.541
5-Jun	4	California Sea Lion	17:27:22	32.987	118.532
5-Jun	10	Risso's Dolphin	17:36:16	32.936	118.481
5-Jun	11	Risso's Dolphin	17:37:19	32.919	118.453
5-Jun	1	Unidentified Pinniped	17:40:21	32.857	118.383
5-Jun	5	California Sea Lion	17:40:59	32.845	118.365
5-Jun	2	California Sea Lion	17:41:44	32.824	118.348

SOCAL June 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
5-Jun	2	California sea Lion	17:42:13	32.815	118.347
5-Jun	2	California sea Lion	17:44:09	32.844	118.335
5-Jun	6	Risso's dolphin	17:48:45	32.878	118.209
5-Jun	3	Unidentified marine mammal	17:55:37	32.925	117.977
5-Jun	1	Blue whale	18:14:47	32.965	117.343
6-Jun	1	Blue whale	12:45:48	32.905	117.304
6-Jun	400	Unidentified dolphin	12:49:58	32.908	117.314
6-Jun	24	Risso's dolphin	13:08:06	32.874	117.894
6-Jun	75	Common dolphin sp.	13:13:22	32.89	118.073
6-Jun	27	Risso's dolphin	13:20:28	32.923	118.198
6-Jun	175	Common dolphin sp.	13:36:05	33.073	118.684
6-Jun	40	Unidentified dolphin	13:43:00	33.11	118.743
6-Jun	1	California sea lion	13:56:32	33.013	119.141
6-Jun	1	Humpback whale	14:06:17	32.969	119.233
6-Jun	2	Fin whale	14:12:06	32.91	119.182
6-Jun	1000	Northern right whale dolphin	15:01:51	32.917	119.18
6-Jun	300	Northern right whale dolphin	15:26:14	32.992	118.905
6-Jun	2	Fin whale	15:51:35	32.927	118.886
6-Jun	1	Unidentified baleen whale	15:51:46	32.925	118.881
6-Jun	38	Risso's dolphin	16:01:21	33.021	118.733
6-Jun	3	California sea lion	16:14:50	32.987	118.527
6-Jun	25	California sea lion	16:15:46	32.965	118.497
6-Jun	200	Northern right whale dolphin	16:18:01	32.916	118.433
6-Jun	4	Risso's dolphin	16:20:54	32.899	118.411
6-Jun	25	Risso's dolphin	16:21:55	32.873	118.377
6-Jun	15	Risso's dolphin	16:35:55	32.697	117.909
6-Jun	6	Risso's dolphin	16:40:28	32.728	117.745
7-Jun	1	Humpback whale	12:55:41	32.677	117.502
7-Jun	1	California sea lion	12:57:12	32.663	117.484
7-Jun	130	Unidentified dolphin	13:27:26	32.67	117.522
7-Jun	60	Risso's dolphin	13:36:43	32.606	117.823
7-Jun	52	Common dolphin sp.	13:42:16	32.599	117.899
7-Jun	23	Risso's dolphin	13:53:33	32.588	117.961
7-Jun	3	Risso's dolphin	14:02:11	32.618	118.247

SOCAL June 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
7-Jun	2	Blue whale	14:04:19	32.629	118.32
7-Jun	2	Fin whale	14:19:32	32.661	118.564
7-Jun	2	Fin whale	14:40:56	32.683	118.739
7-Jun	2	Fin whale	14:57:07	32.733	118.677
7-Jun	1	Fin whale	15:17:42	32.714	118.821
7-Jun	2	Fin whale	15:22:04	32.704	118.853
7-Jun	3	Fin whale	15:27:40	32.707	118.854
7-Jun	1	Blue whale	15:35:43	32.771	118.838
7-Jun	2	Unidentified baleen whale	15:41:35	32.767	118.818
7-Jun	4	Risso's dolphin	15:51:13	32.888	118.723
7-Jun	19	Risso's dolphin	15:53:45	32.882	118.693
7-Jun	1	Unidentified dolphin	16:01:12	32.863	118.768
7-Jun	1	Fin whale	16:04:21	32.816	118.856
7-Jun	1	Fin whale	16:05:05	32.805	118.878
7-Jun	1	Fin whale	16:21:19	32.843	118.92
7-Jun	18	Risso's dolphin	16:35:46	33.007	118.538
7-Jun	28	Risso's dolphin	16:43:55	32.985	118.242
7-Jun	50	Risso's dolphin	16:44:37	32.991	118.217
7-Jun	1	Fin whale	16:45:43	33	118.175
7-Jun	350	Common dolphin sp.	17:05:09	33.152	117.449
7-Jun	15	Unidentified dolphin	17:16:22	32.984	117.349
8-Jun	22	Risso’s dolphin	8:27:33	33.211	117.876
8-Jun	25	Common dolphin sp.	8:29:38	33.214	117.879
8-Jun	1	Unidentified baleen whale	8:50:34	33.091	118.403
8-Jun	400	Common dolphin sp.	8:59:26	33.077	118.403
8-Jun	1	Blue whale	9:05:44	33.08	118.409
8-Jun	35	Risso's dolphin	9:12:33	33.023	118.618
8-Jun	2	Fin whale	9:19:27	33.128	118.788
8-Jun	500	Common dolphin sp.	9:25:12	33.043	118.948
8-Jun	1	Risso's Dolphin	9:48:11	32.891	119.118
8-Jun	1	Fin whale	9:49:38	32.875	119.097
8-Jun	1	Unidentified baleen whale	10:38:33	32.843	119.053
8-Jun	1	Fin whale	10:59:42	32.831	118.871
8-Jun	1	Unidentified baleen whale	11:02:57	32.831	118.871

SOCAL June 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
8-Jun	1	Unidentified baleen whale	11:49:42	32.831	118.871
8-Jun	1	Unidentified baleen whale	11:59:26	32.831	118.871
8-Jun	1	Unidentified baleen whale	12:26:11	32.831	118.871
8-Jun	2	Unidentified baleen whale, probable fin whale	12:29:00	32.831	118.871
8-Jun	25	Risso's dolphin	12:33:22	32.831	118.871
9-Jun	15	Unidentified dolphin	8:16:33	32.967	117.322
9-Jun	60	Common dolphin sp.	8:35:15	33.011	117.623
9-Jun	15	Risso's dolphin	8:51:18	32.942	117.966
9-Jun	50	Risso's dolphin	9:18:29	33.108	118.16
9-Jun	220	Unidentified dolphin	9:23:46	33.073	118.131
9-Jun	5	Risso's dolphin	9:27:00	33.071	118.068
10-Jun	150	Unidentified dolphin, probable common dolphin sp.	8:34:22	32.852	117.282
10-Jun	11	Unidentified dolphin	8:36:16	32.82	117.347
10-Jun	125	Unidentified dolphin, probable common dolphin sp.	8:39:26	32.79	117.445
10-Jun	1	Unidentified pinniped	9:13:16	32.671	118.188
10-Jun	1	Unidentified baleen whale	9:19:27	32.676	118.396
10-Jun	6	Risso's dolphin	9:26:55	32.68	118.443
10-Jun	1	Unidentified baleen whale	9:34:22	32.685	118.677
10-Jun	1	Unidentified whale	9:45:56	32.831	118.576
10-Jun	1	Fin whale	10:12:25	32.798	118.78
10-Jun	1	Fin whale	10:42:01	32.838	118.706
10-Jun	2	Fin whale	11:06:56	32.86	118.905
10-Jun	2	Risso's dolphin	11:34:18	33.239	118.307
10-Jun	11	Bottlenose dolphin	11:43:51	33.196	118.255
10-Jun	37	Risso's dolphin	12:02:52	33.184	117.976
10-Jun	2	Fin whale	12:32:44	33.203	117.882
10-Jun	1	Unidentified small marine mammal	12:37:39	33.238	117.704
10-Jun	1	Unidentified dolphin	12:45:55	33.162	117.478
10-Jun	1	Unidentified baleen whale	12:46:21	33.153	117.471
10-Jun	1	Unidentified baleen whale	12:46:50	33.141	117.46
10-Jun	3	Unidentified dolphin	12:54:54	32.93	117.306
11-Jun	60	Common dolphin sp.	8:47:28	32.914	117.315
11-Jun	15	Common dolphin sp.	8:48:06	32.934	117.322

SOCAL June 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
11-Jun	500	Common dolphin sp.	8:54:09	33.085	117.433
11-Jun	1	Blue whale	8:59:04	33.119	117.454
11-Jun	100	Common dolphin sp.	9:44:59	33.38	117.703
11-Jun	140	Common dolphin sp.	10:09:00	33.396	118.227
11-Jun	1	Risso's dolphin	10:29:05	33.206	118.515
11-Jun	1	Unidentified baleen whale	11:06:03	33.065	118.912
11-Jun	1	Fin whale	11:45:32	32.914	118.924
11-Jun	125	Unidentified dolphin	12:01:09	33.058	118.48
11-Jun	7	Risso's dolphin	12:02:39	33.073	118.445
11-Jun	8	Unidentified dolphin	12:10:54	33.21	118.481
11-Jun	15	Risso's dolphin	12:16:14	33.229	118.367
11-Jun	400	Common dolphin sp.	12:32:50	33.352	117.816
11-Jun	200	Unidentified dolphin, probable common dolphin sp.	12:45:48	33.345	117.666
11-Jun	1	Fin whale	12:48:02	33.294	117.618
11-Jun	1	Fin whale	12:50:46	33.303	117.622
11-Jun	300	Unidentified dolphin	12:55:00	33.242	117.577
11-Jun	1	Fin whale	13:00:46	33.099	117.45
11-Jun	400	Long-beaked common dolphin	13:06:20	33.009	117.374
11-Jun	1200	Common dolphin sp.	13:13:49	32.892	117.298
11-Jun	230	Unidentified dolphin	16:09:58	32.725	117.402
11-Jun	25	Risso's dolphin	16:32:07	32.625	118.01
11-Jun	8	Risso's dolphin	16:37:44	32.679	118.013
11-Jun	8	Risso's dolphin	16:41:55	32.709	117.852
11-Jun	7	Risso's dolphin	16:42:55	32.715	117.817
11-Jun	8	Risso's dolphin	16:43:53	32.722	117.783
11-Jun	3	Risso's dolphin	16:45:51	32.721	117.768
11-Jun	35	Risso's dolphin	16:52:38	32.765	117.542
11-Jun	1	Blue whale	17:14:00	33.02	117.507
11-Jun	700	Common dolphin sp.	17:14:30	33.032	117.509
11-Jun	1	Blue whale	17:32:29	33.216	117.526
11-Jun	2	Blue whale	17:41:18	33.182	117.518

Appendix B List of All July Sightings

Appendix B. 20-29 July 2009: Summary of all individual marine mammal sightings, including location latitudes and longitudes, made during the SOCAL 2009 aerial monitoring surveys off San Diego, California.

SOCAL July 09 Species List					
Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
20-Jul	30	Unidentified dolphin	12:32:39	32.949	117.783
20-Jul	2	Unidentified dolphin	12:35:14	32.971	117.895
20-Jul	13	Risso's dolphin	12:41:01	33.014	118.133
20-Jul	18	Unidentified dolphin	12:45:33	33.046	118.328
20-Jul	1	California sea lion	12:54:25	33.136	118.702
20-Jul	1	Unidentified small marine mammal	13:10:17	33.018	119.033
20-Jul	150	Unidentified dolphin	13:14:15	33.072	118.906
20-Jul	900	Unidentified dolphin, possible common dolphin sp.	13:40:24	33.128	118.567
20-Jul	650	Common dolphin sp.	14:04:32	33.276	118.308
20-Jul	1	Unidentified sea lion	14:17:38	33.398	118.233
20-Jul	200	Unidentified dolphin	14:19:32	33.41	118.169
20-Jul	1	Unidentified dolphin	14:23:13	33.435	118.041
20-Jul	200	Unidentified dolphin	14:45:00	33.084	117.417
21-Jul	1	Blue whale	12:34:58	32.868	117.359
21-Jul	500	Long-beaked common dolphin	12:35:33	32.886	117.36
21-Jul	2	Blue whale	12:36:35	32.928	117.358
21-Jul	2	Blue whale	12:46:09	32.831	117.36
21-Jul	1	Fin whale	12:56:36	32.94	117.337
21-Jul	1	Blue whale	12:56:53	32.944	117.341
21-Jul	2	Blue whale	12:59:20	33.007	117.398
21-Jul	280	Unidentified dolphin	13:04:13	33.063	117.453
21-Jul	1	Blue whale	13:09:31	33.208	117.588
21-Jul	20	Risso's dolphin	13:09:45	33.218	117.596
21-Jul	300	Unidentified dolphin	13:10:40	33.242	117.62
21-Jul	200	Unidentified dolphin	13:12:27	33.293	117.668
21-Jul	30	Risso's dolphin	13:14:31	33.353	117.724
21-Jul	60	Common dolphin sp.	13:14:47	33.364	117.733
21-Jul	50	Unidentified dolphin	13:17:05	33.434	117.804

Date 2009	Estim. Group Size	SOCAL July 09 Species List Species Identification	Initial time	Latitude ˚N	Longitude ˚W
21-Jul	6	Risso's dolphin	13:23:13	33.426	118.03
21-Jul	13	Risso's dolphin	13:26:34	33.41	118.149
21-Jul	1	California sea lion	13:28:46	33.408	118.155
21-Jul	35	Risso's dolphin	14:01:14	33.399	118.19
21-Jul	400	Common dolphin sp.	14:02:45	33.387	118.248
21-Jul	13	Risso's dolphin	14:17:23	33.281	118.314
21-Jul	25	Common dolphin sp.	14:19:20	33.257	118.377
21-Jul	5	Common dolphin sp.	14:19:45	33.251	118.392
21-Jul	3	Risso's dolphin	14:31:05	33.231	118.349
21-Jul	9	Risso's dolphin	14:32:42	33.243	118.297
21-Jul	6	Risso's dolphin	14:39:37	33.298	118.06
21-Jul	9	Risso's dolphin	14:52:31	33.318	117.634
21-Jul	8	Risso's dolphin	14:53:31	33.297	117.61
21-Jul	25	Risso's dolphin	14:54:14	33.282	117.594
21-Jul	50	Risso's dolphin	14:54:44	33.271	117.585
21-Jul	16	Risso's dolphin	14:56:14	33.252	117.628
21-Jul	16	Risso's dolphin	15:01:56	33.202	117.83
21-Jul	1	Unidentified pinniped, probable CA sea lion	15:07:10	33.16	118.009
21-Jul	700	Common dolphin sp.	15:16:06	33.099	118.308
21-Jul	14	Risso's dolphin	15:35:48	32.952	118.37
21-Jul	1	California sea lion	15:37:15	32.952	118.374
21-Jul	1	California sea lion	15:41:19	32.966	118.348
21-Jul	300	Common dolphin sp.	15:45:42	32.997	118.204
21-Jul	1	Blue whale	16:05:16	33.154	117.512
21-Jul	150	Unidentified dolphin	16:10:23	33.151	117.462
21-Jul	60	Unidentified dolphin, possible common dolphin sp.	16:14:55	33.055	117.382
21-Jul	1	Blue whale	16:23:49	32.859	117.344
21-Jul	1	California sea lion	16:24:24	32.873	117.345
21-Jul	1	Unidentified baleen whale	16:25:14	32.861	117.337
21-Jul	28	Common dolphin sp.	16:30:32	32.9	117.358
22-Jul	100	Common dolphin sp.	13:06:11	32.733	117.377
22-Jul	9	Unidentified dolphin, possible common dolphin or bottlenose dolphin	13:14:27	32.683	117.454
22-Jul	4	California sea lion	13:24:48	32.674	117.461

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
22-Jul	40	Common dolphin sp.	13:26:02	32.68	117.461
22-Jul	800	Common dolphin sp.	13:29:15	32.672	117.44
22-Jul	12	Unidentified dolphin	13:37:03	32.667	117.518
22-Jul	300	Unidentified dolphin, possible common dolphin sp.	13:49:51	32.606	117.843
22-Jul	300	Unidentified dolphin, possible Risso's dolphin	13:54:16	32.613	117.988
22-Jul	80	Unidentified dolphin	14:01:00	32.704	117.914
22-Jul	1	Blue whale	14:34:16	32.783	117.464
22-Jul	80	Unidentified dolphin	14:38:12	32.878	117.384
22-Jul	1	Blue whale	14:39:52	32.922	117.352
22-Jul	80	Unidentified dolphin	14:40:11	32.932	117.346
22-Jul	4	Unidentified dolphin	14:41:11	32.961	117.331
22-Jul	2	Blue whale	14:41:54	32.959	117.352
22-Jul	40	Unidentified dolphin	15:00:02	32.916	117.432
22-Jul	175	Unidentified dolphin	15:00:25	32.913	117.444
22-Jul	12	Unidentified dolphin	15:00:53	32.909	117.461
22-Jul	60	Unidentified dolphin	15:02:07	32.9	117.501
22-Jul	39	Risso's dolphin	15:14:32	32.806	117.921
22-Jul	2	Risso's dolphin	16:02:24	33.059	117.387
22-Jul	1	Blue whale	16:06:39	33.069	117.4
22-Jul	3	Risso's dolphin	16:09:10	33.08	117.381
22-Jul	13	Risso's dolphin	16:10:30	33.043	117.372
22-Jul	25	Risso's dolphin	16:11:06	33.024	117.364
22-Jul	70	Common dolphin sp.	16:13:15	32.959	117.343
22-Jul	1	Blue whale	16:21:14	32.907	117.331
22-Jul	2	Blue whale	16:22:15	32.899	117.346
22-Jul	6	Risso's dolphin	16:26:52	32.884	117.327
22-Jul	1	Unidentified dolphin	16:27:29	32.892	117.316
22-Jul	700	Common dolphin sp.	16:47:42	32.902	117.317
24-Jul	40	Unidentified dolphin	16:21:30	32.942	117.324
24-Jul	1400	Common dolphin sp.	16:29:36	32.986	117.353
24-Jul	1200	Common dolphin sp.	16:37:55	33.012	117.366
24-Jul	900	Common dolphin sp.	16:42:30	33.04	117.394
24-Jul	40	Common dolphin sp.	16:49:24	33.133	117.452
24-Jul	1	California sea lion	16:58:50	33.146	117.455

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
24-Jul	18	Common dolphin sp.	16:59:32	33.157	117.473
24-Jul	75	Common dolphin sp.	17:14:03	33.107	117.71
24-Jul	20	Risso's dolphin	17:34:27	33.013	118.188
24-Jul	35	Common dolphin sp.	17:38:43	33.013	118.193
24-Jul	1	California sea lion	17:41:15	33	118.175
24-Jul	9	Unidentified dolphin	18:16:10	33.228	117.766
24-Jul	2	Blue whale	18:30:58	33.18	117.494
24-Jul	14	Common dolphin sp.	18:53:12	32.871	117.279
25-Jul	5	Risso's dolphin	13:36:23	32.869	117.322
25-Jul	300	Unidentified dolphin	13:37:05	32.873	117.347
25-Jul	4	Risso's dolphin	13:37:50	32.879	117.375
25-Jul	15	Unidentified dolphin	13:38:10	32.882	117.385
25-Jul	35	Risso's dolphin	13:41:12	32.904	117.481
25-Jul	35	Risso's dolphin	13:43:19	32.919	117.551
25-Jul	1	Unidentified dolphin	13:47:27	32.944	117.684
25-Jul	10	Risso's dolphin	13:49:43	32.958	117.759
25-Jul	10	Risso's dolphin	13:50:57	32.966	117.796
25-Jul	1	California sea lion	13:52:36	32.976	117.852
25-Jul	200	Common dolphin sp.	13:57:53	33.013	118.026
25-Jul	30	Unidentified dolphin	13:59:19	33.023	118.075
25-Jul	500	Unidentified dolphin	14:03:42	33.048	118.214
25-Jul	1	California sea lion	14:04:58	33.056	118.256
25-Jul	1	Unidentified marine mammal	14:05:28	33.059	118.272
25-Jul	10	Common dolphin sp.	14:11:31	33.103	118.47
25-Jul	5	Common dolphin sp.	14:14:17	33.118	118.558
25-Jul	1	California sea lion	14:27:30	33.108	118.966
25-Jul	2	Fin whale	14:33:24	33.023	119.129
25-Jul	1	Unidentified sea lion, probable California sea lion (Dead)	14:46:44	32.918	119.223
25-Jul	1	Fin whale	14:49:24	32.916	119.22
25-Jul	1	Fin whale	14:53:29	32.903	119.204
25-Jul	1	Fin whale	15:04:44	33.023	118.99
25-Jul	4	Fin or sei whale	15:28:55	32.961	118.986
25-Jul	4	Cuvier's beaked whale	15:35:52	32.967	118.989
25-Jul	1	Minke Whale	15:47:58	32.82	119.14

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
25-Jul	500	Unidentified dolphin	17:17:03	32.825	117.889
25-Jul	1	Unidentified sea lion, probable California sea lion (Dead)	17:23:10	32.825	117.663
25-Jul	8	Risso's dolphin	17:30:39	32.837	117.378
26-Jul	15	Unidentified dolphin	13:10:02	32.853	117.296
26-Jul	1	Unidentified dolphin	13:11:50	32.847	117.358
26-Jul	10	Unidentified dolphin	13:12:56	32.844	117.396
26-Jul	35	Risso's dolphin	13:26:29	32.773	117.895
26-Jul	1500	Common dolphin sp.	13:35:19	32.702	118.222
26-Jul	1	Blue whale	13:37:18	32.691	118.291
26-Jul	1	Unidentified Baleen Whale	13:38:32	32.684	118.331
26-Jul	1	Blue whale	13:39:49	32.675	118.377
26-Jul	80	Unidentified dolphin	13:41:39	32.671	118.441
26-Jul	1	Unidentified baleen whale	13:50:03	32.682	118.719
26-Jul	1	California sea lion	13:52:29	32.706	118.752
26-Jul	1	Unidentified pinniped	13:54:10	32.731	118.696
26-Jul	1	Fin, sei or Bryde’s whale	14:05:01	32.785	118.709
26-Jul	225	Short-beaked common dolphin	14:20:44	32.72	118.912
26-Jul	35	Pacific white-sided dolphin	14:30:45	32.831	118.714
26-Jul	1	California sea lion	14:35:48	32.866	118.656
26-Jul	1	Unidentified medium-sized whale	14:56:29	32.832	118.95
26-Jul	1	California sea lion	15:11:11	32.882	118.845
26-Jul	12	Unidentified small marine mammal	15:12:53	32.909	118.796
26-Jul	1	Unidentified pinniped	16:14:03	33.161	118.765
26-Jul	8	Risso's dolphin	16:28:12	33.075	118.756
26-Jul	5	Risso's dolphin	16:45:31	33.046	118.273
26-Jul	4	Risso's dolphin	16:59:08	32.953	117.804
26-Jul	70	Common dolphin sp.	16:59:42	32.942	117.801
26-Jul	34	Risso's dolphin	17:08:04	32.919	117.642
26-Jul	35	Common dolphin sp.	17:12:53	32.888	117.47
26-Jul	45	Risso's dolphin	17:14:22	32.877	117.418
27-Jul	1	Blue whale	13:57:07	32.748	117.381
27-Jul	30	Risso's dolphin	14:01:22	32.708	117.417
27-Jul	60	Short-beaked common dolphin	14:04:31	32.671	117.506
27-Jul	1	Blue whale	14:11:10	32.65	117.636

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
27-Jul	10	Risso's dolphin	14:44:37	32.839	117.413
27-Jul	20	Risso's dolphin	14:49:25	32.878	117.376
27-Jul	900	Short-beaked common dolphin	15:18:05	32.775	118.102
27-Jul	1	California sea lion	15:30:59	32.878	118.263
27-Jul	1	California sea lion	15:31:14	32.88	118.252
27-Jul	1	California sea lion	15:31:33	32.882	118.24
27-Jul	4	Unidentified Pinniped	15:32:18	32.886	118.217
27-Jul	3	California sea lion	15:32:45	32.889	118.199
27-Jul	1	California sea lion	15:33:33	32.894	118.169
27-Jul	230	Short-beaked common dolphin and California sea lion	15:33:57	32.897	118.157
27-Jul	1	California sea lion	15:38:59	32.914	118.116
27-Jul	25	Unidentified dolphin	15:39:44	32.919	118.088
27-Jul	70	Common dolphin sp.	15:46:41	32.919	118.025
27-Jul	1	California sea lion	16:00:44	33.012	117.601
27-Jul	110	Short-beaked common dolphin	16:13:18	33.15	117.519
27-Jul	60	Short-beaked common dolphin	17:05:17	33.186	117.951
27-Jul	150	Common dolphin sp.	17:21:23	33.265	117.615
27-Jul	10	Risso's dolphin	17:25:03	33.274	117.592
27-Jul	100	Common dolphin sp.	17:31:13	33.365	117.743
27-Jul	200	Common dolphin sp.	17:43:01	33.392	117.934
27-Jul	8	Unidentified dolphin	17:52:08	33.345	117.689
27-Jul	300	Unidentified dolphin	17:54:16	33.283	117.639
27-Jul	1	Harbor seal	18:03:46	33.041	117.427
27-Jul	300	Unidentified dolphin	18:07:41	32.938	117.347
27-Jul	30	Unidentified dolphin	18:08:02	32.929	117.34
27-Jul	40	Unidentified dolphin	18:10:02	32.877	117.3
27-Jul	1	California sea lion	18:11:09	32.857	117.265
28-Jul	200	Unidentified dolphin	14:14:58	32.894	117.29
28-Jul	35	Common dolphin sp.	14:15:10	32.898	117.293
28-Jul	6	Risso's dolphin	14:20:33	33.029	117.397
28-Jul	80	Unidentified dolphin	14:21:30	33.05	117.414
28-Jul	5	Risso's dolphin	14:22:21	33.073	117.431
28-Jul	60	Unidentified dolphin	14:25:51	33.161	117.495
28-Jul	75	Unidentified dolphin	14:28:01	33.169	117.501

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
28-Jul	60	Common dolphin sp.	14:29:24	33.173	117.504
28-Jul	15	Possible bottlenose dolphin	14:30:38	33.177	117.507
28-Jul	1	California sea lion	14:45:10	33.181	117.51
28-Jul	250	Common dolphin sp.	14:48:45	33.185	117.514
28-Jul	25	Common dolphin sp.	14:59:16	33.189	117.517
28-Jul	1000	Common dolphin sp.	14:59:29	33.193	117.52
28-Jul	50	Common dolphin sp.	15:17:12	33.197	117.523
28-Jul	350	Long-beaked common dolphin	15:34:33	33.201	117.527
28-Jul	10	Unidentified dolphin	15:58:28	33.206	117.53
28-Jul	1	Fin whale	16:12:50	33.21	117.533
28-Jul	80	Common dolphin sp.	16:58:07	33.214	117.536
28-Jul	11	Risso's dolphin	17:03:34	33.218	117.539
28-Jul	40	Common dolphin sp.	17:13:11	33.222	117.543
28-Jul	130	Common dolphin sp.	17:41:03	33.227	117.546
28-Jul	25	Common dolphin sp.	17:47:36	33.231	117.549
28-Jul	35	Long-beaked common dolphin	17:55:43	33.235	117.553
28-Jul	7	Risso's dolphin	18:00:06	33.239	117.556
28-Jul	5	Risso's dolphin	18:06:23	33.244	117.56
28-Jul	37	Long-beaked common dolphin	18:08:42	33.248	117.563
28-Jul	3	California sea lion	18:13:15	33.252	117.567
28-Jul	25	Common dolphin sp.	18:13:30	33.257	117.571
28-Jul	1	California sea lion	18:21:21	33.261	117.575
28-Jul	1	California sea lion	18:21:38	33.265	117.58
29-Jul	4	Risso's dolphin	13:28:22	33.269	117.585
29-Jul	100	Common dolphin sp.	13:30:56	33.271	117.591
29-Jul	8	Risso's dolphin	13:39:59	33.269	117.596
29-Jul	95	Common dolphin sp.	13:43:17	33.267	117.602
29-Jul	2	Risso's dolphin	13:44:09	33.263	117.605
29-Jul	75	Common dolphin sp.	13:44:47	33.258	117.604
29-Jul	135	Long-beaked common dolphin	14:12:17	33.255	117.599
29-Jul	30	Common dolphin sp.	14:52:54	33.256	117.592
29-Jul	12	Risso's dolphin	14:54:50	33.261	117.589
29-Jul	100	Common dolphin sp.	14:57:50	33.263	117.594
29-Jul	40	Unidentified dolphin	14:58:06	33.262	117.599

SOCAL July 09 Species List

Date 2009	Estim. Group Size	Species Identification	Initial time	Latitude ˚N	Longitude ˚W
29-Jul	20	Unidentified dolphin	15:04:25	33.264	117.603
29-Jul	70	Unidentified dolphin	15:04:50	33.268	117.603
29-Jul	20	Unidentified dolphin	15:12:01	33.271	117.598
29-Jul	8	Risso's dolphin	15:20:56	33.268	117.593
29-Jul	5	Risso's dolphin	15:22:04	33.264	117.592
29-Jul	4	Risso's dolphin	15:27:39	33.261	117.595
29-Jul	600	Unidentified dolphin	15:31:53	33.261	117.6
29-Jul	50	Unidentified dolphin	15:32:50	33.265	117.602
29-Jul	1	Blue whale	15:34:45	33.269	117.599

APPENDIX I SOCAL HARP DATA SUMMARY SITES M AND N MAY TO JULY 2009

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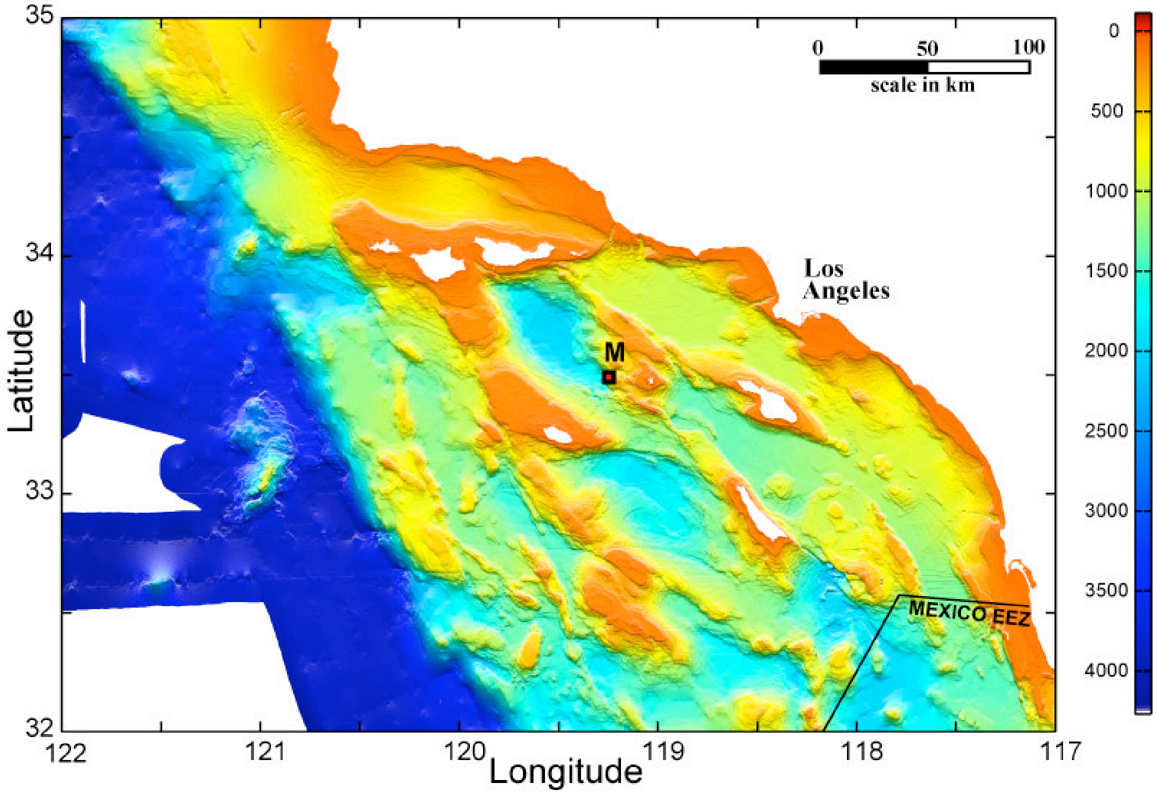
Marine Physical Laboratory of the Scripps Institution of Oceanography University of California, San Diego

SCRIPPS Whale Acoustics

High Frequency Acoustic Recording Package Data Summary Report May 17, 2009 – July 8, 2009 SOCAL 33, Site M



John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell, Amanda Cummins, Sara Kerosky, Karlina Merkens, Lisa Munger, Marie Roch and Sean Wiggins

Marine Physical Laboratory, Scripps Institution of Oceanography
University of California San Diego, LA Jolla, CA 92037-0205

Contract Number: FISC N00244-08-1-0028
Project Title: Southern California Marine Mammal Studies
Location: Site M, Latitude 33-30.580 N, Longitude 119-15.253 W, Depth 1120 m
Deployment Cruise: SOCAL 33, R/V Sproul
Recording Period: May 17, 2009 – July 8, 2009
Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes data analysis for deployment of a High Frequency Acoustic Recording Package (HARP) in the southern California (SOCAL) offshore region. The HARP records broadband (10 Hz – 100 kHz) acoustic data, including both marine animal and anthropogenic sound. This report summarizes initial analysis to detect the presence of marine mammals by species as well as the occurrence of naval sonar and other anthropogenic sound events.

We investigated the temporal occurrence of marine mammal and anthropogenic sound using manual analysis of three frequency bands: 10-1000 Hz (Low); 1000-5000 Hz (Mid); and 5-100 kHz (High). For each of these bands one or more analysts scanned the data using a long-term spectrogram display with approximately one hour of data per display. A MATLAB based software package called *TRITON* was used for data display and event logging. Potential sound events detected in a one-hour or shorter spectrogram were investigated at finer temporal scales to identify the origin of the sound by species or type of anthropogenic sound. Table 1 gives a summary, by species or anthropogenic sound source, of the number of hours and days sounds were detected, as well as the percentage of hours or days they were detected.

Site M is located to the west of Santa Barbara Island, and north of the primary area of naval training activity near San Clemente Island. The HARP at site M was deployed by the R/V Sproul during cruise SOCAL 33, on May 16, 2009 and recovered on the R/V Sproul during cruise SOCAL 34 on July 27, 2009. It recorded acoustic data continuously at a 200 kHz sample rate between 00:00 May 17 and 14:56 July 8, a total of 53 days (1263 hours) of recording.

Detected marine mammals include: blue whale, fin whale, humpback whale, sperm whale, beaked whale, Risso's dolphin, unidentified dolphin, and California sea lion. Anthropogenic sounds include mid-frequency active sonar (3.5 kHz) and broadband (10 Hz – 10 kHz) ship noise. Blue whale D calls, associated with feeding, were present from the beginning of the recording window, whereas blue whale A+B song calls began on about June 10. Fin whales at 20-Hz are present throughout the data, as were Fin whales at 50-Hz, although the latter were more prominent in late June. Humpback whale song only was recorded on a single day in late May. Sperm whales were recorded intermittently throughout the data set. Beaked whales (primarily Cuvier's beaked whales) were recorded throughout the data set, on 40% of the recording days. Risso's dolphins were detected on 57% of recording days, primarily during nighttime hours. Unidentified dolphin whistles and echolocation clicks were recorded throughout the data, but at the highest rates during the beginning and ending sections of the data set. The most probable dolphin species represented by these data are common dolphins (both long and short beaked) as well as bottlenose dolphins. California sea lions were recorded nearly

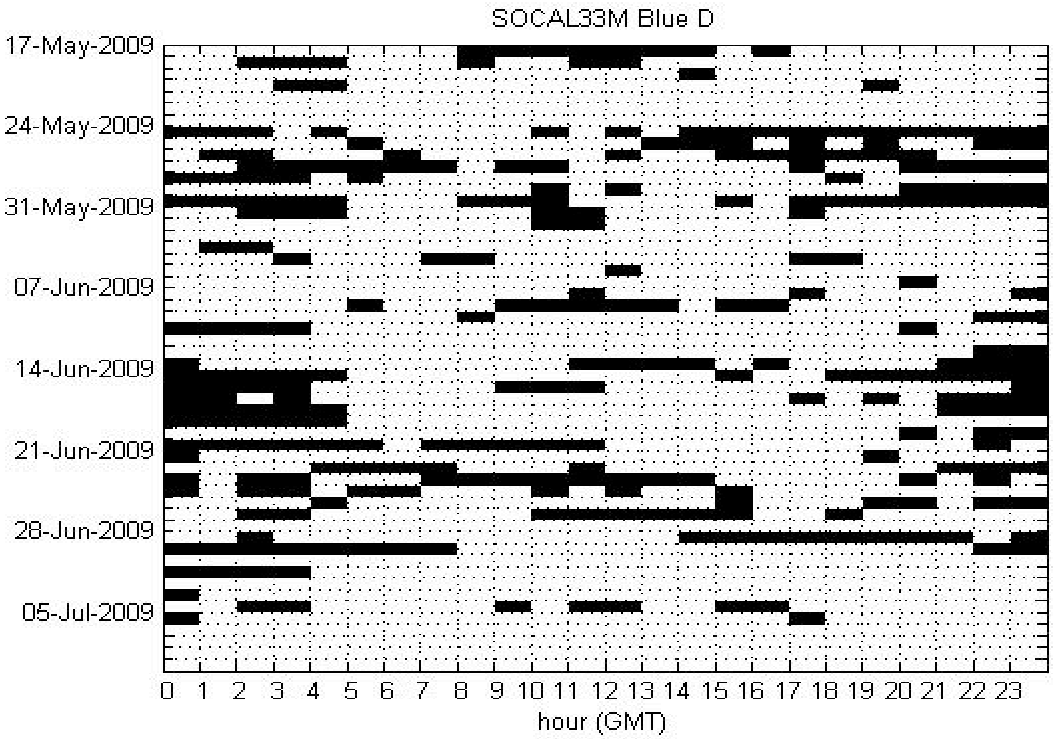
continuously during the later half of the data set, but were absent during the first half of the data set.

Anthropogenic sound sources include mid-frequency active (MFA) sonar (3 – 5 kHz) and broadband (10 Hz – 10 kHz) ship noise. The MFA sonar was recorded primarily in mid-to-late May, and again in late June and early July. Broadband ship noise from nearby vessels was recorded intermittently, primarily in the later half of the data set.

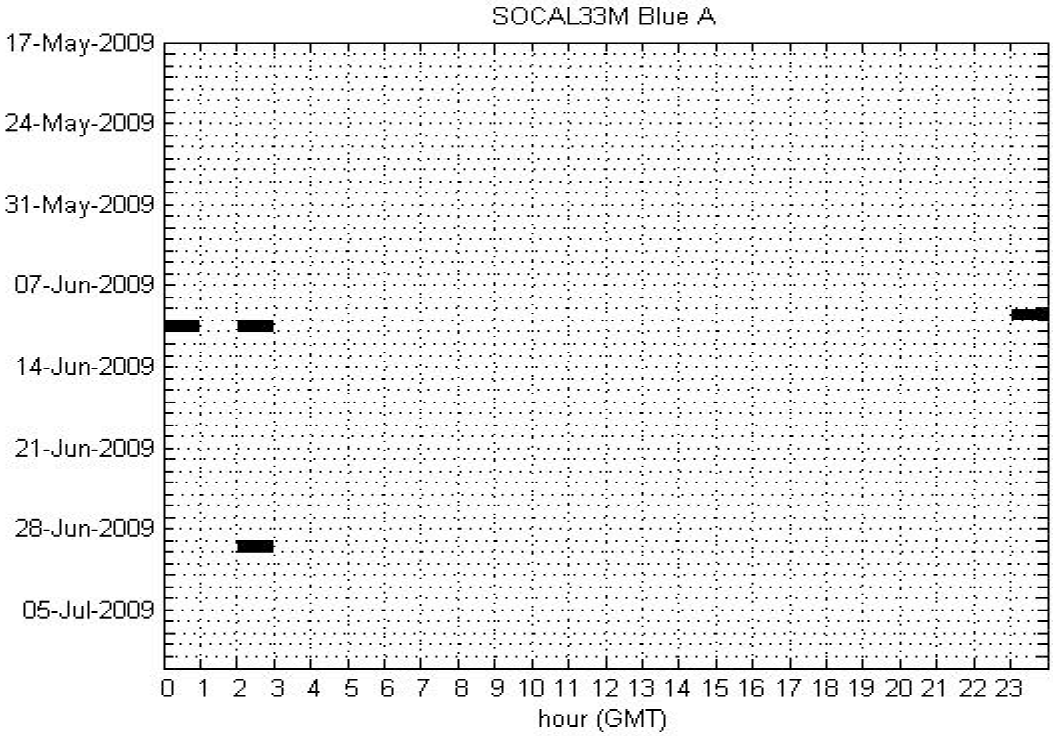
Species/Source	Call Type	# Hour Bins	Percent	# Daily Bins	Percent
Blue Whale	**D**	**276**	**22**	**42**	**79**
Blue Whale	**A**	**4**	**0.3**	**3**	**5.7**
Blue Whale	**B**	**34**	**2.7**	**14**	**26**
Fin Whale	**20 Hz**	**659**	**52**	**53**	**100**
Fin Whale	**50 Hz**	**396**	**31**	**51**	**96**
Humpback Whale	**Song**	**3**	**0.2**	**1**	**1.9**
Sperm Whale	**Echolocation**	**46**	**3.6**	**16**	**30**
Beaked Whale	**Echolocation**	**41**	**3.3**	**21**	**40**
Risso's Dolphin	**Whistles/ Echolocation**	**132**	**10**	**30**	**57**
Un ID Dolphin	**Whistles/ Echolocation**	**403**	**32**	**50**	**94**
CA Sea Lion	**Bark/Whine/ Buzz**	**481**	**38**	**26**	**49**
MFA Sonar	**Ping**	**134**	**11**	**15**	**29**
Ship	**Broadband Noise**	**34**	**2.7**	**17**	**33**

Table 1. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

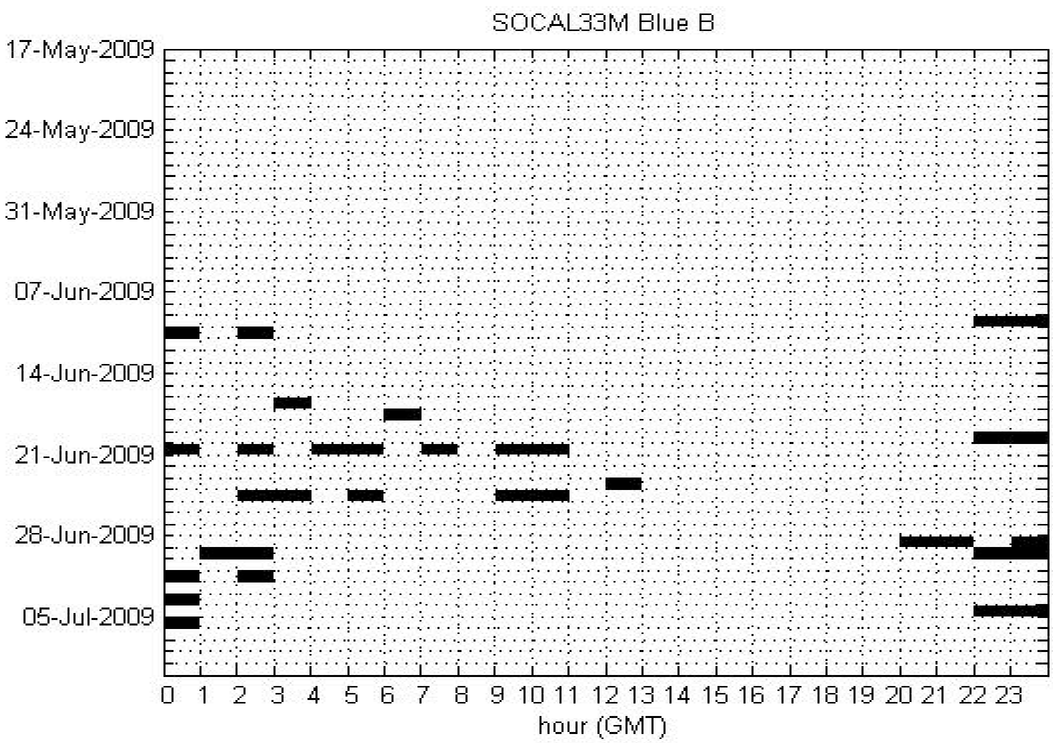
MARINE MAMMAL DETECTIONS BY SPECIES AND CALL TYPE AND ANTHROPOGENIC SOUND BY SOURCE TYPE



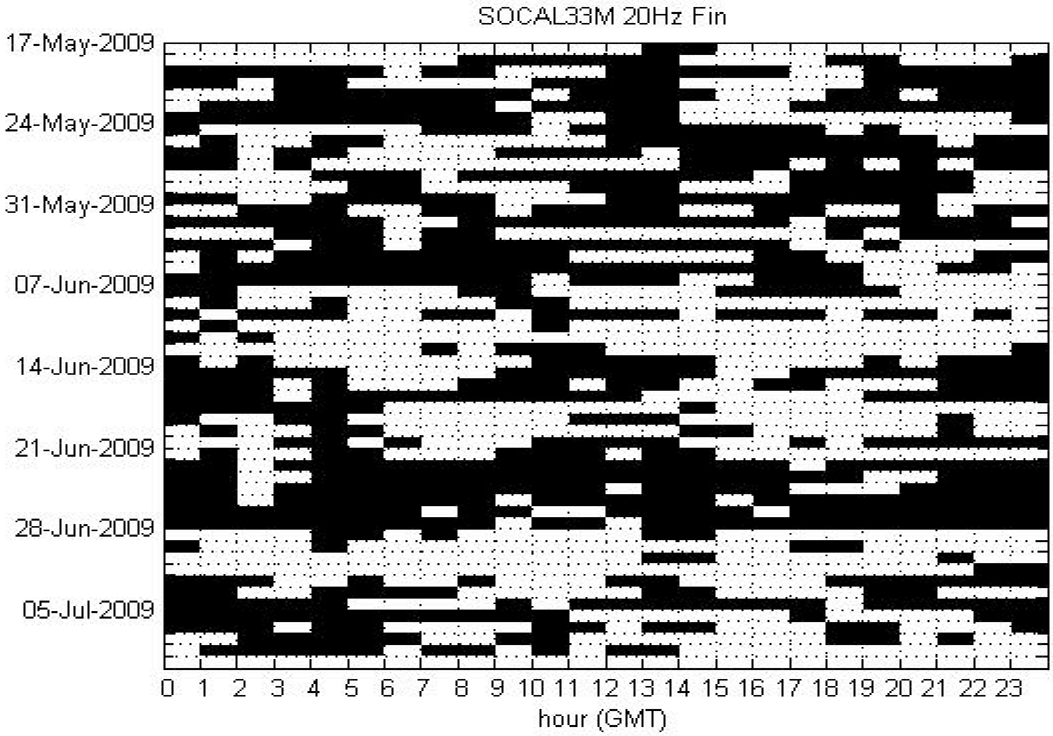
Blue Whale – "D" Call in Hourly Bins



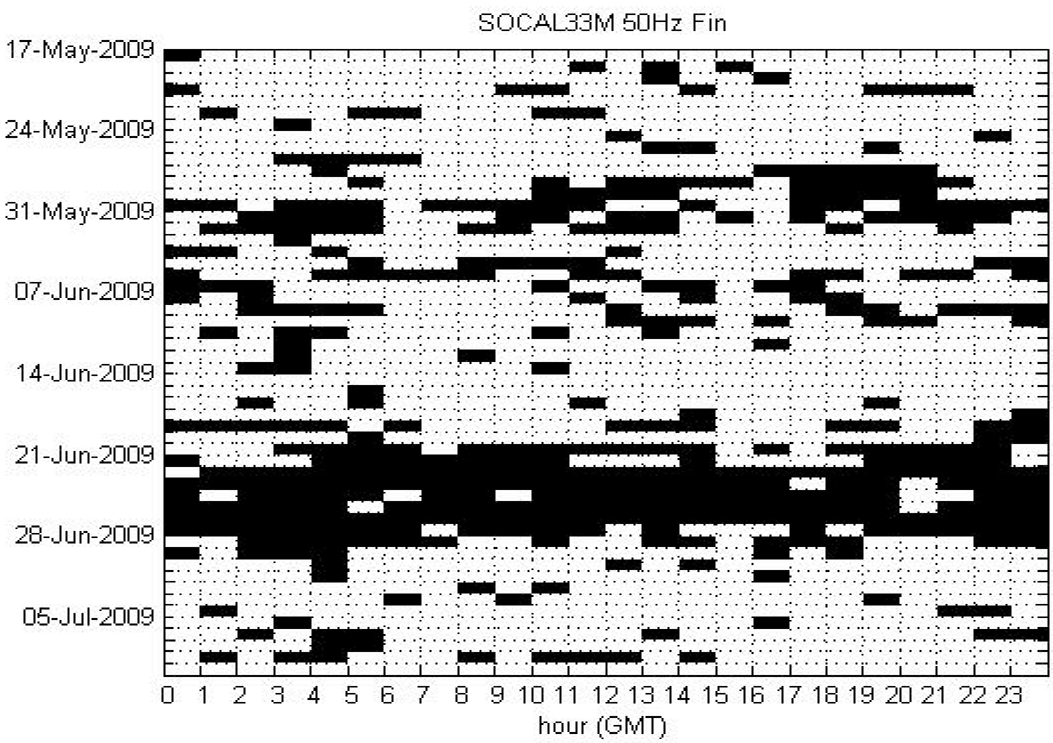
Blue Whale – "A" Call in Hourly Bins



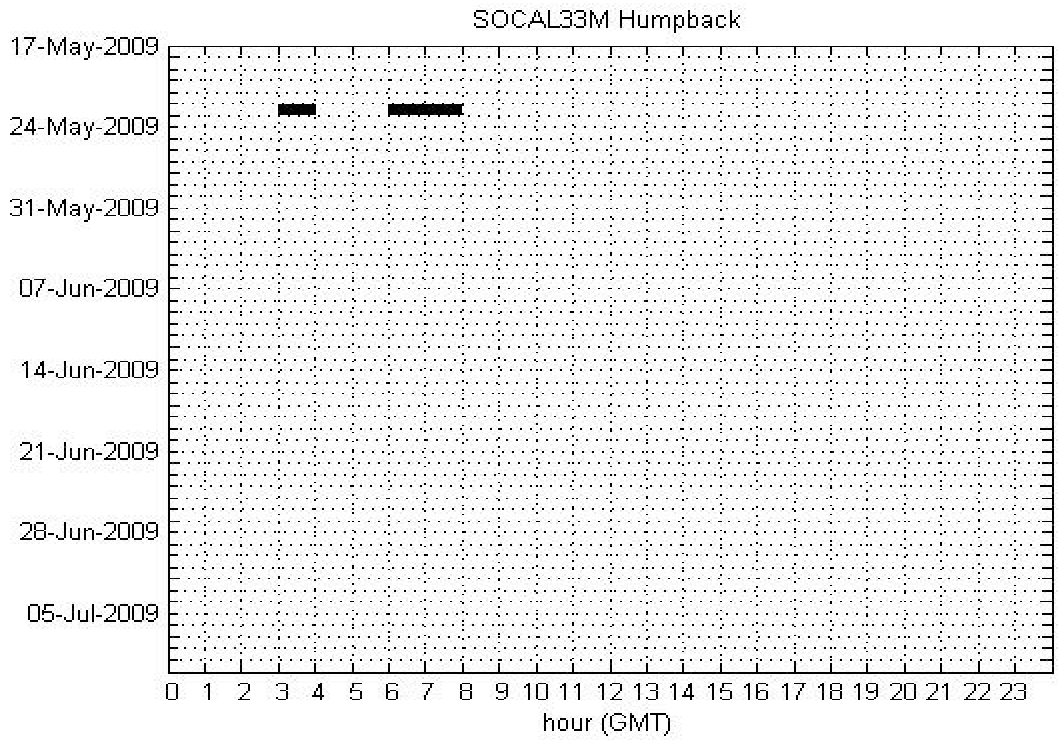
Blue Whale – "B" Call in Hourly Bins



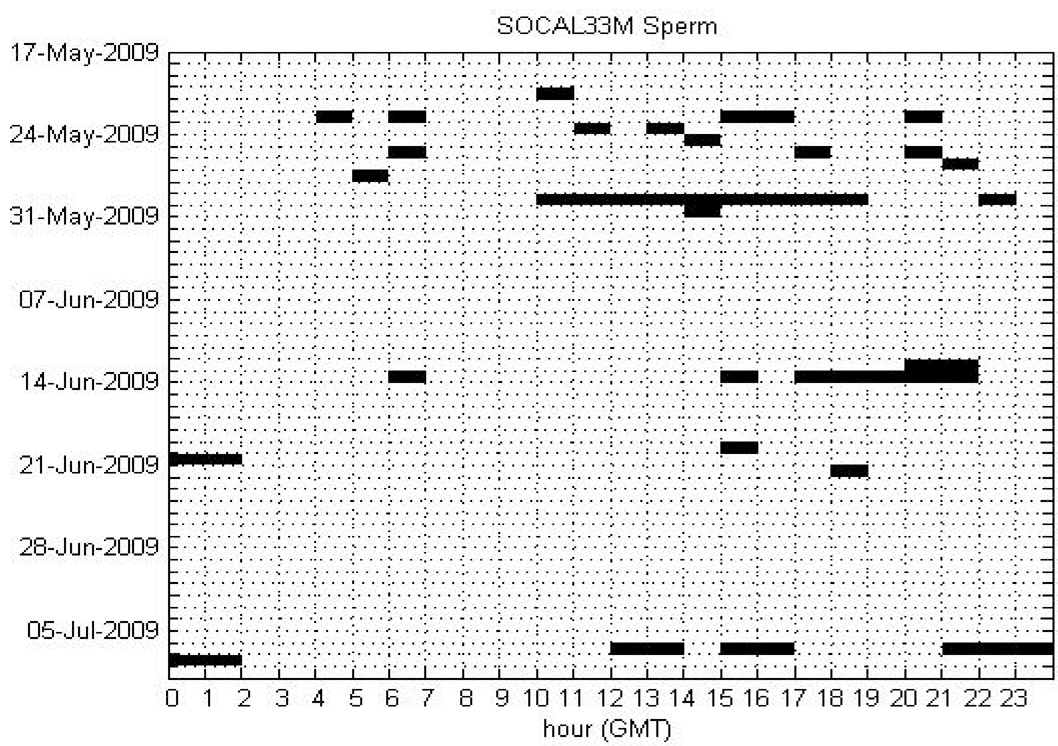
Fin Whale – "20-Hz" Call in Hourly Bins



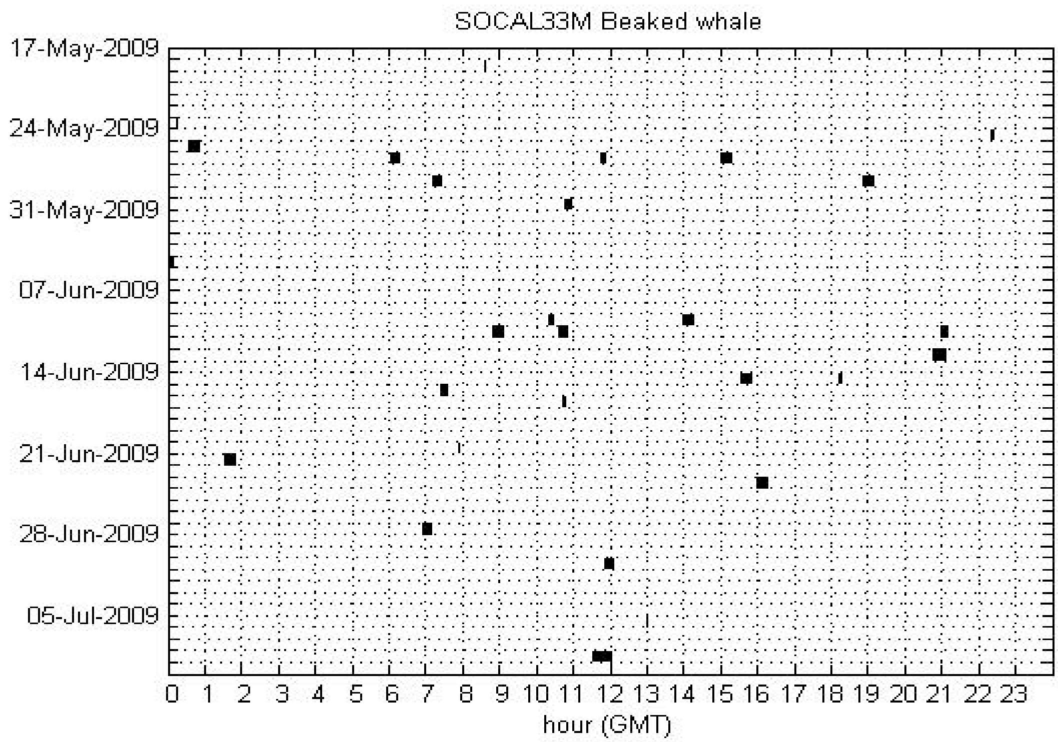
Fin Whale – "50 Hz" Call in Hourly Bins



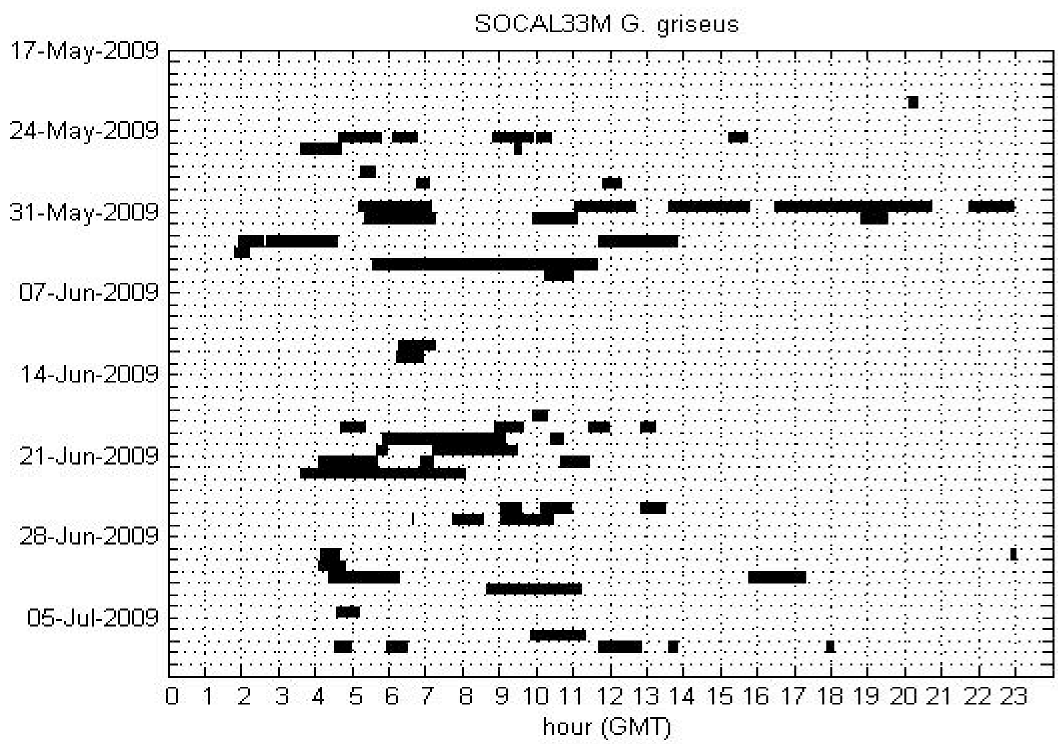
Humpback Whale – Song in Hourly Bins



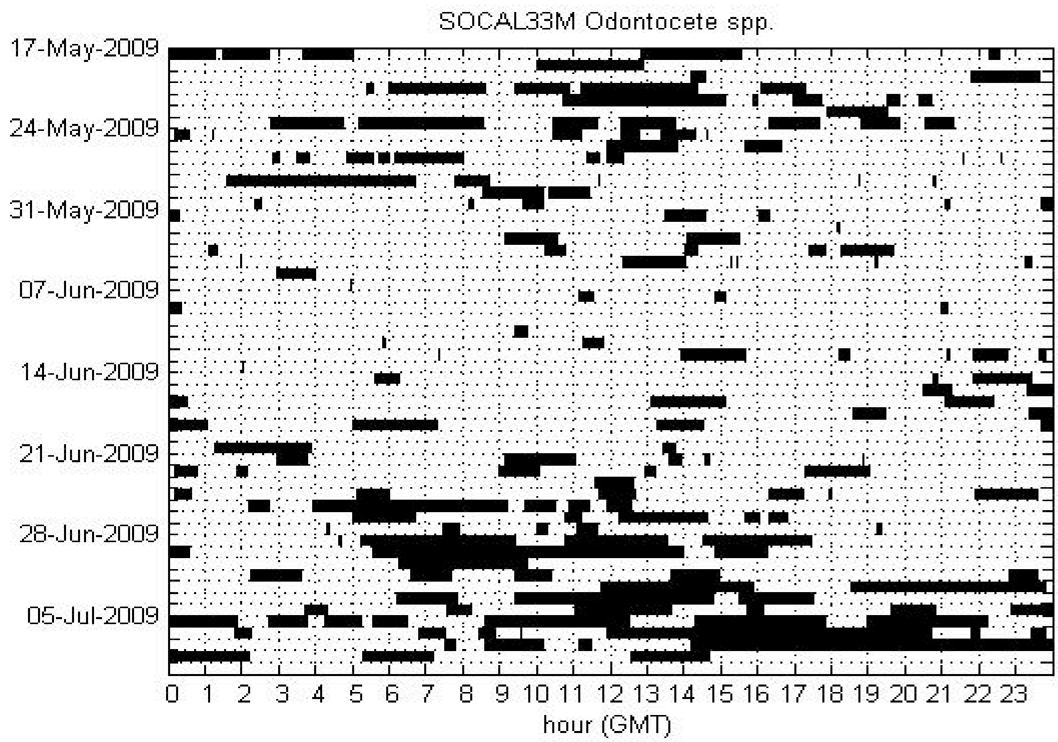
Sperm whales – Echolocation Clicks in Hourly Bin



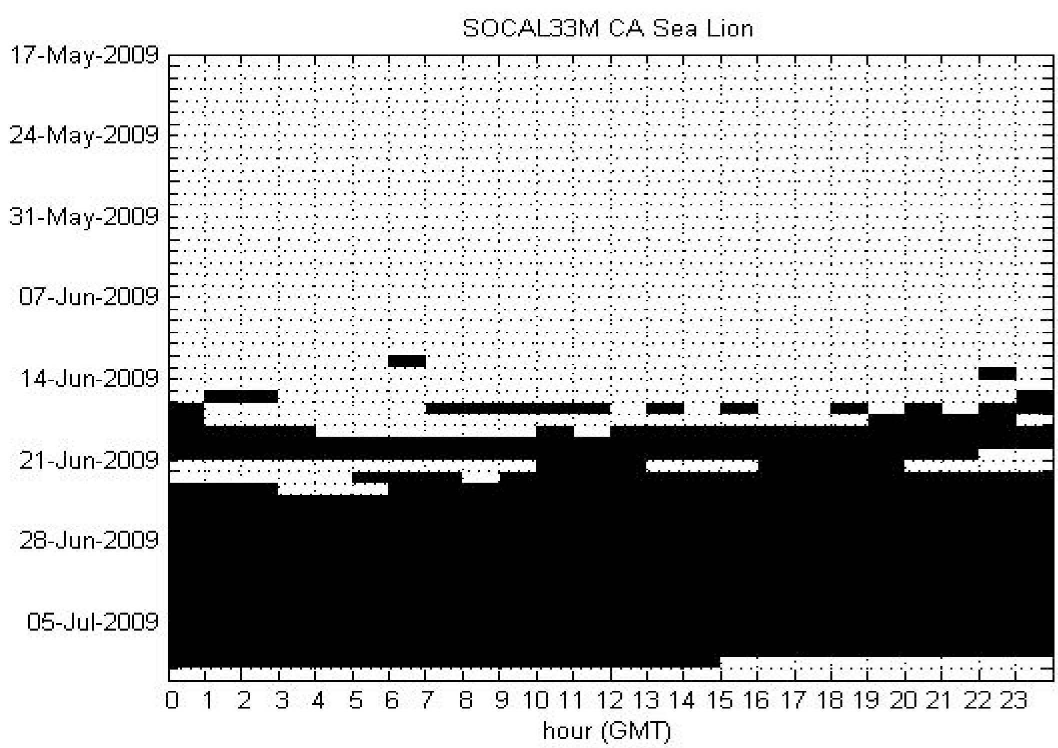
Beaked whales – Echolocation Pulses in One-Minute Bins



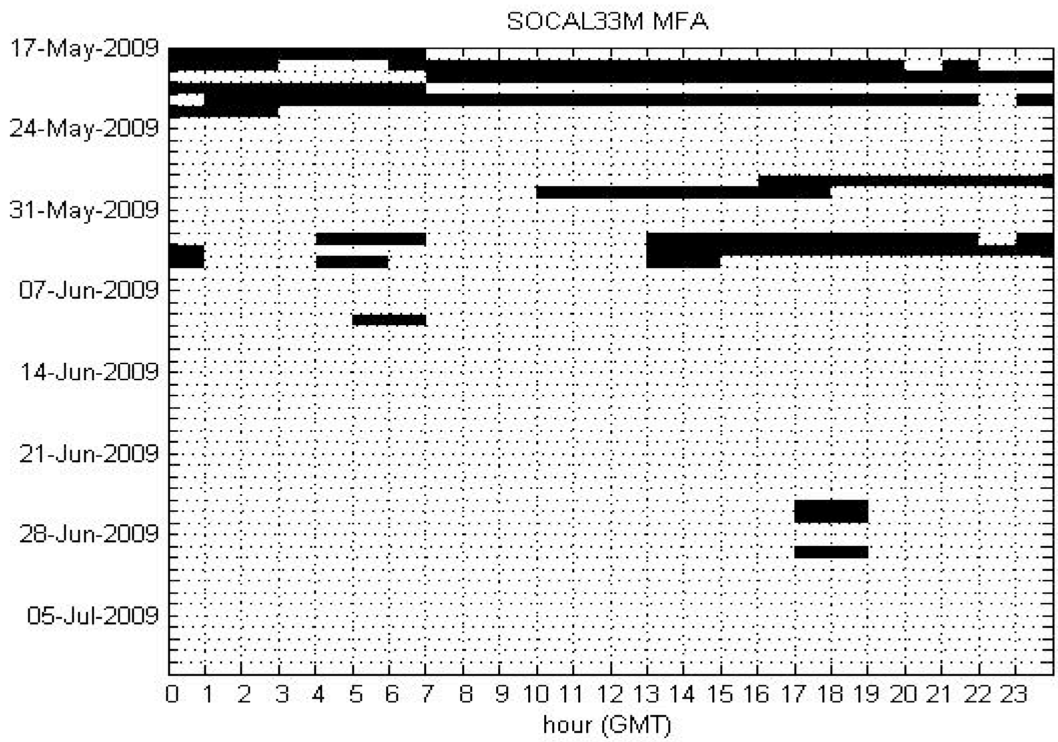
Risso's Dolphin – Echolocation Clicks in One-Minute Bins



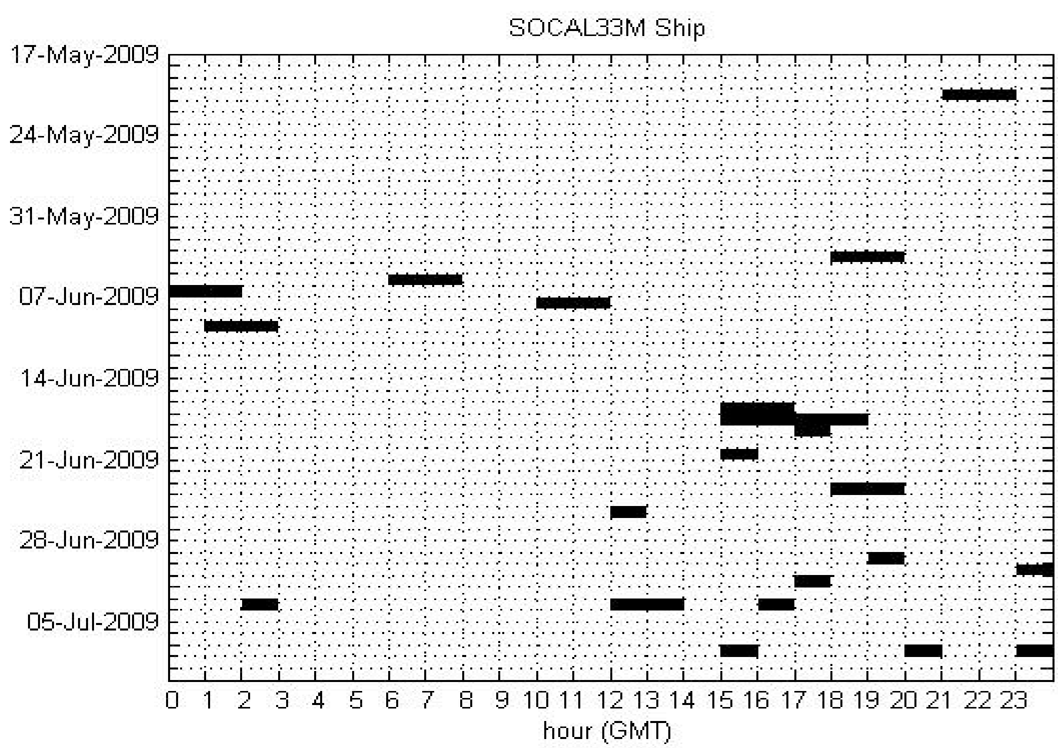
Unidentified Dolphin – Echolocation Clicks and Whistles in One-Minute Bins



California Sea Lion – Calls in Hourly Bins



Mid-Frequency Active Sonar (3 – 5 kHz) in Hourly Bins

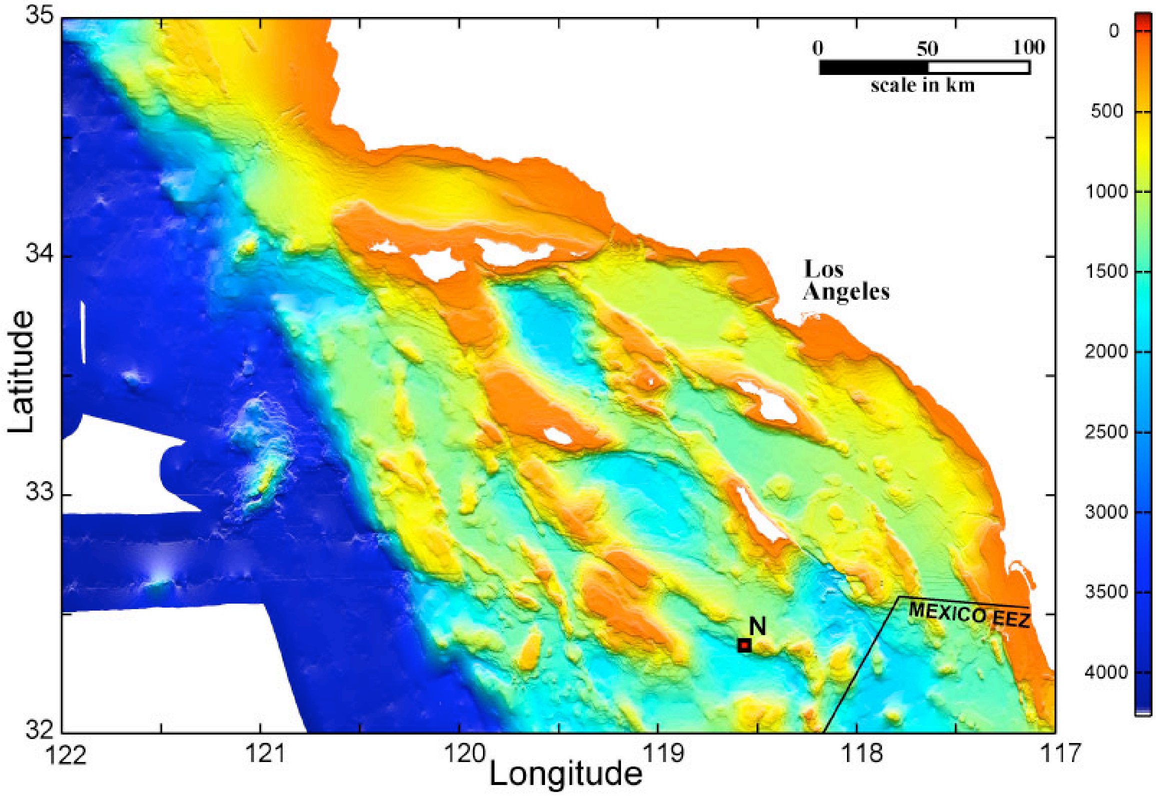


Broadband Ship Noise in Hourly Bins

Marine Physical Laboratory of the Scripps Institution of Oceanography University of California, San Diego

SCRIPPS Whale Acoustics

High Frequency Acoustic Recording Package Data Summary Report May 19, 2009 – July 12, 2009 SOCAL 33, Site N



John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell, Amanda Cummins, Sara Kerosky, Karlina Merkens, Lisa Munger, Marie Roch and Sean Wiggins

Marine Physical Laboratory, Scripps Institution of Oceanography
University of California San Diego, LA Jolla, CA 92037-0205

Contract Number: FISC N00244-08-1-0028
Project Title: Southern California Marine Mammal Studies
Location: Site N, Latitude 32-22.205 N, Longitude 118-33.905 W, Depth 1295 m
Deployment Cruise: SOCAL 33, R/V Sproul
Recording Period: May 19, 2009 – July 12, 2009
Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes data analysis for deployment of a High Frequency Acoustic Recording Package (HARP) in the southern California (SOCAL) offshore region. The HARP records broadband (10 Hz – 100 kHz) acoustic data, including both marine animal and anthropogenic sound. This report summarizes initial analysis to detect the presence of marine mammals by species as well as the occurrence of naval sonar and other anthropogenic sound events.

We investigated the temporal occurrence of marine mammal and anthropogenic sound using manual analysis of three frequency bands: 10-1000 Hz (Low); 1000-5000 Hz (Mid); and 5-100 kHz (High). For each of these bands one or more analyst scanned the data using a long-term spectrogram display with approximately one hour of data per display. A MATLAB based software package called *TRITON* was used for data display and event logging. Potential sound events detected in a one-hour or shorter spectrogram were investigated at finer temporal scales to identify the origin of the sound by species or type of anthropogenic sound. Table 1 gives a summary by species or anthropogenic sound source of the number of hours and days they were detected, as well as the percentage of hours or days detected.

Site N is located south of San Clemente Island, an area of naval training activity. The HARP at site N was deployed by the R/V Sproul during cruise SOCAL 33, on May 19, 2009 and recovered on the R/V Sproul during cruise SOCAL 34 on July 22, 2009. It recorded acoustic data continuously at a 200 kHz sample rate between 15:00 May 19 and 21:19 July 12, a total of 54 days (1302 hours) of recording.

Detected species include: blue whale, fin whale, humpback whale, Minke whale, sperm whale, killer whale, beaked whales, Risso's dolphin, Pacific white-sided dolphin, unidentified dolphin, and California sea lions. Anthropogenic sounds include mid-frequency active sonar (3.5 kHz) and broadband (10 Hz – 10 kHz) ship noise. Blue whale D calls, associated with feeding and A+B song calls began at this site on about June 1, 2009. Fin whales at 20-Hz are present throughout the data. Fin whales at 50-Hz are predominantly present after June 1, 2009. Humpback whale song was recorded sporadically, primarily in the later part of June. A single bout of Minke whale song was recorded in late May, and a single encounter with sperm whales was recorded in mid-June. Two encounters with killer whales were recorded, in early June and late June. Beaked whales (primarily Cuvier's beaked whales) were recorded throughout the data set, on 87% of the recording days. Risso's dolphins were recorded on 9% of recording

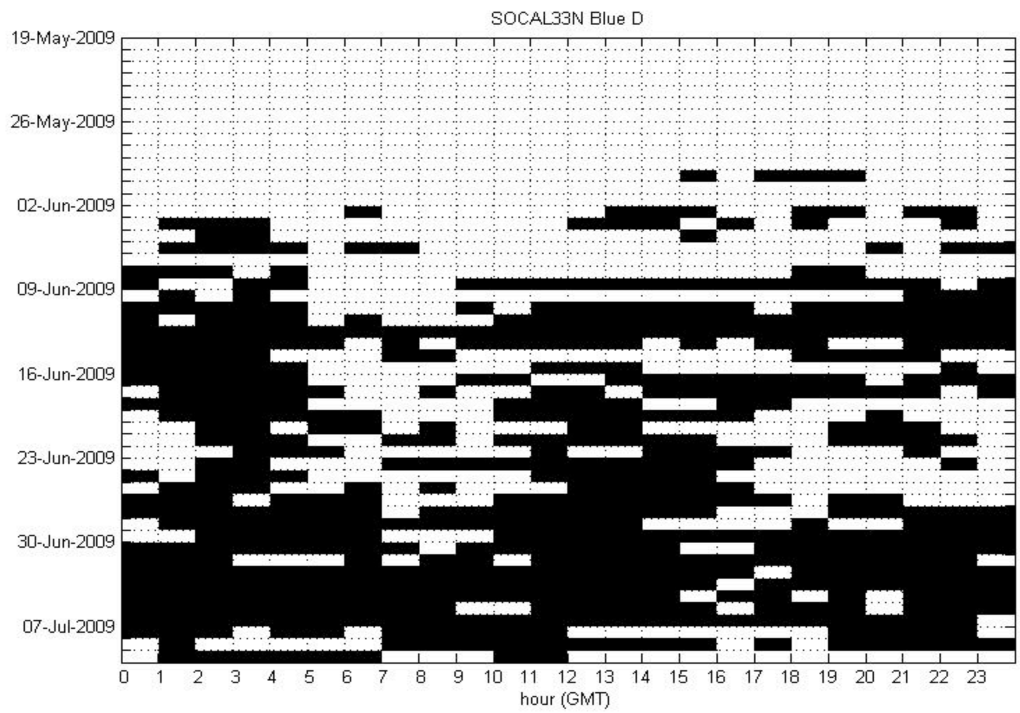
days, and Pacific white-sided dolphins were recorded only during a single encounter. Unidentified dolphin whistles and echolocation clicks were recorded throughout the data, but at the highest rates during the later portion of the data set. The most probable dolphin species represented by these data are common dolphins (both long and short beaked) as well as bottlenose dolphins. California sea lions were recorded during a few encounters in late June and early July.

Anthropogenic sound sources include mid-frequency active (MFA) sonar (3 – 5 kHz) and broadband (10 Hz – 10 kHz) ship noise. The MFA sonar was recorded primarily in mid-to-late May, and again in late June and early July. Broadband ship noise, tabulated from the mid-frequency data set to indicate close approaches, was recorded throughout the data set.

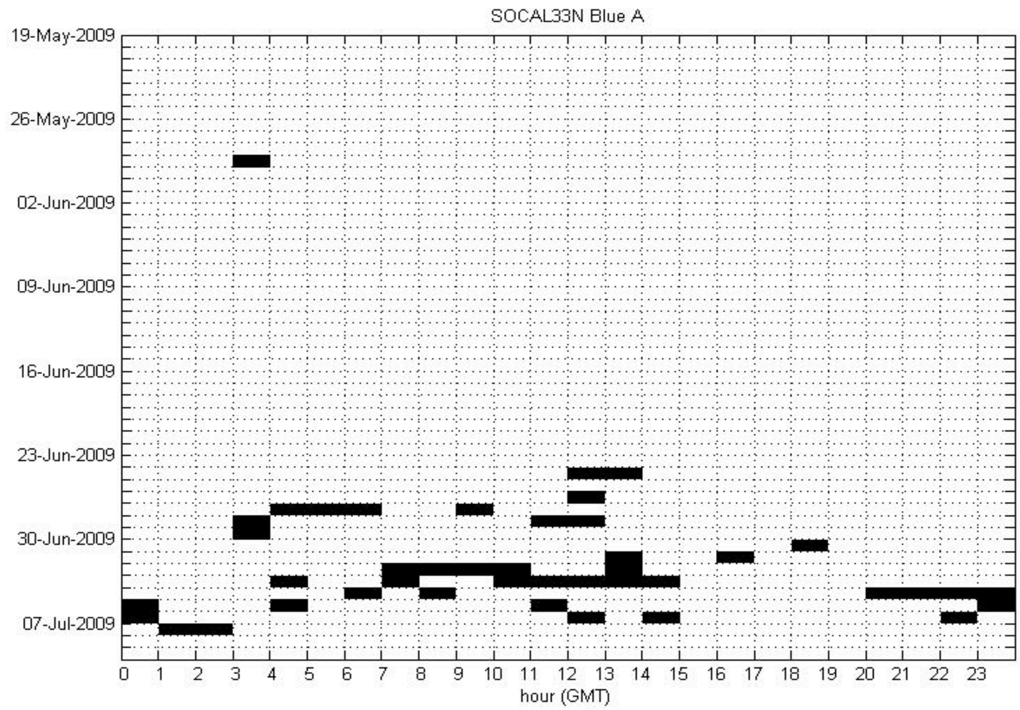
Species/Source	Call Type	# Hour Bins	Percent	# Daily Bins	Percent
Blue Whale	D	543	42	38	70
Blue Whale	A	43	3	14	26
Blue Whale	B	223	17	36	67
Fin Whale	20 Hz	558	43	47	87
Fin Whale	50 Hz	209	16	43	80
Humpback Whale	Song	17	1.3	10	19
Minke Whale	Song	1	0.1	1	2
Sperm Whale	Echolocation	1	0.1	1	2
Killer Whale	Whistles/ Echolocation	11	0.8	6	11
Beaked Whale	Echolocation	213	16	48	88
Risso's Dolphin	Whistles/ Echolocation	15	1.1	5	9
Pacific WS Dolphin	Whistles/ Echolocation	1	0.1	1	2
Un ID Dolphin	Whistles/ Echolocation	781	60	52	96
CA Sea Lion	Bark/Whine/ Buzz	14	1.1	6	11
MFA Sonar	Ping	133	10	21	39
Ship	Broadband Noise	220	17	45	83

Table 1. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

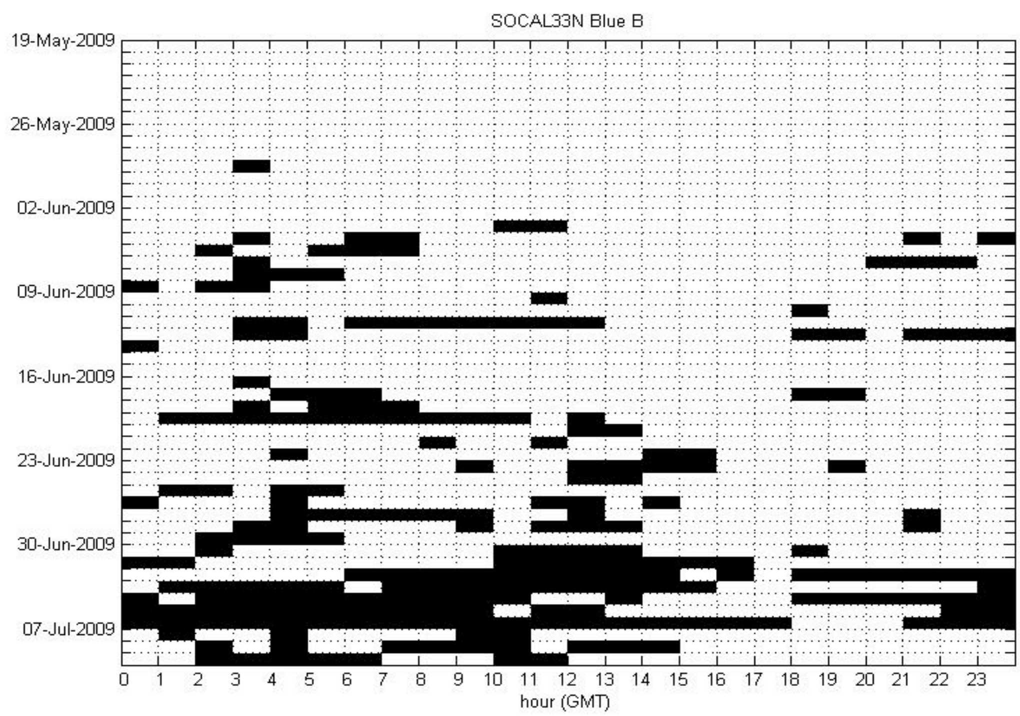
MARINE MAMMAL DETECTIONS BY SPECIES AND CALL TYPE AND ANTHROPOGENIC SOUND BY SOURCE TYPE



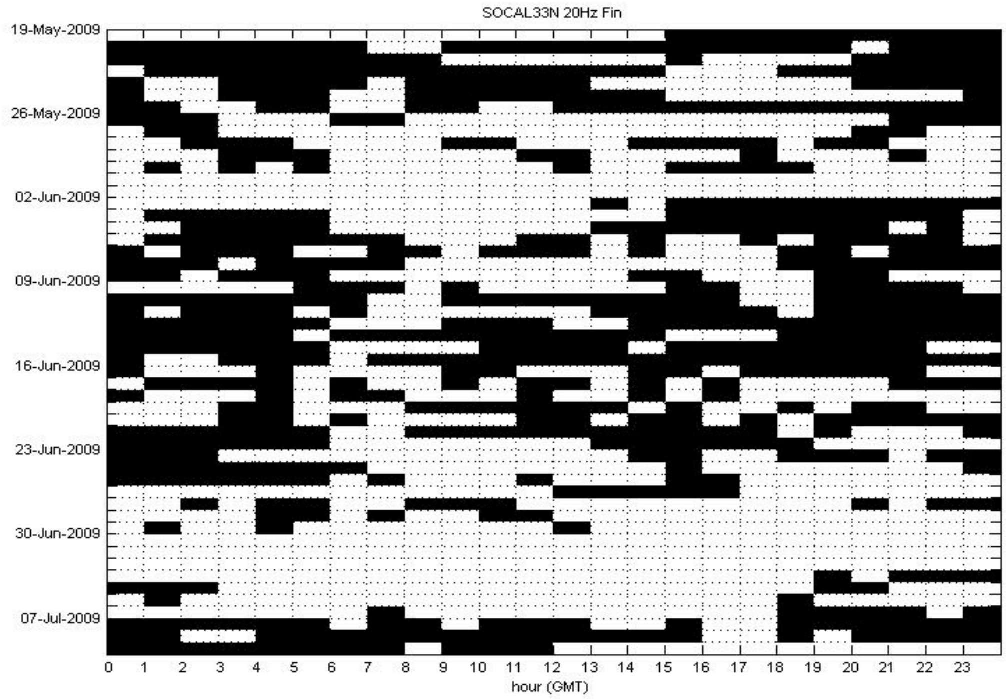
Blue Whale – "D" Call in Hourly Bins



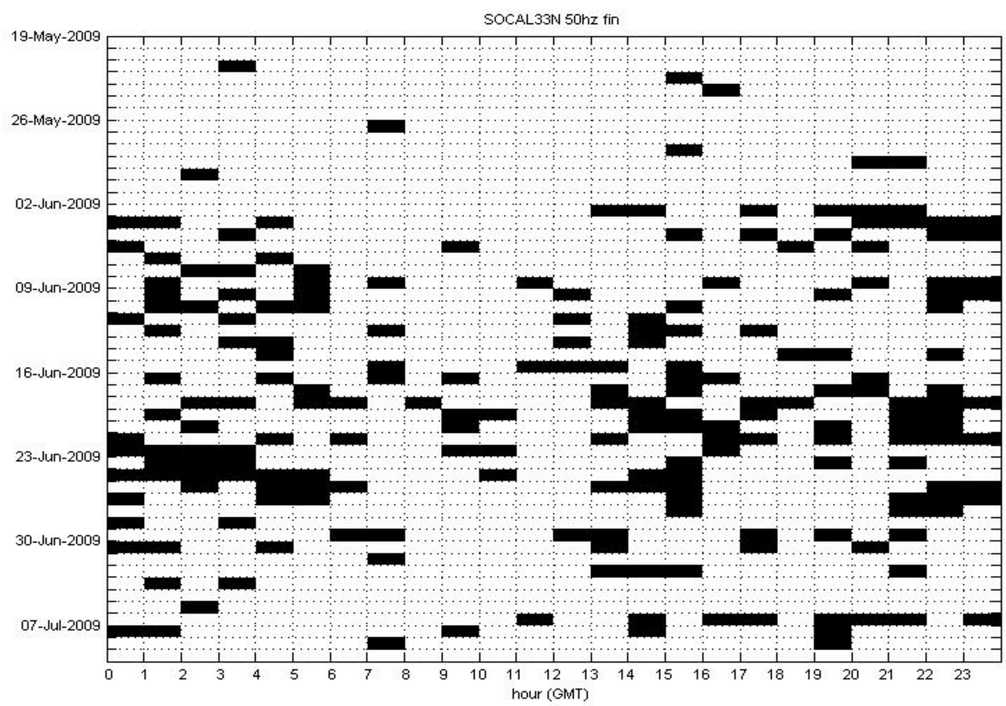
Blue Whale – "A" Call in Hourly Bins



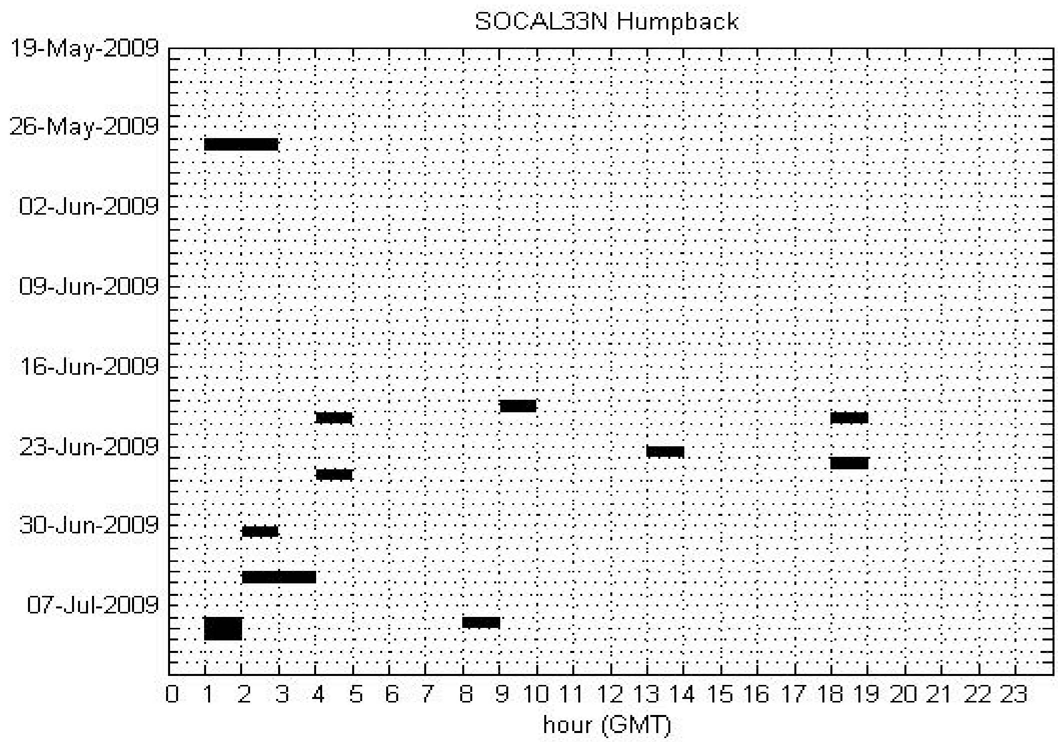
Blue Whale – "B" Call in Hourly Bins



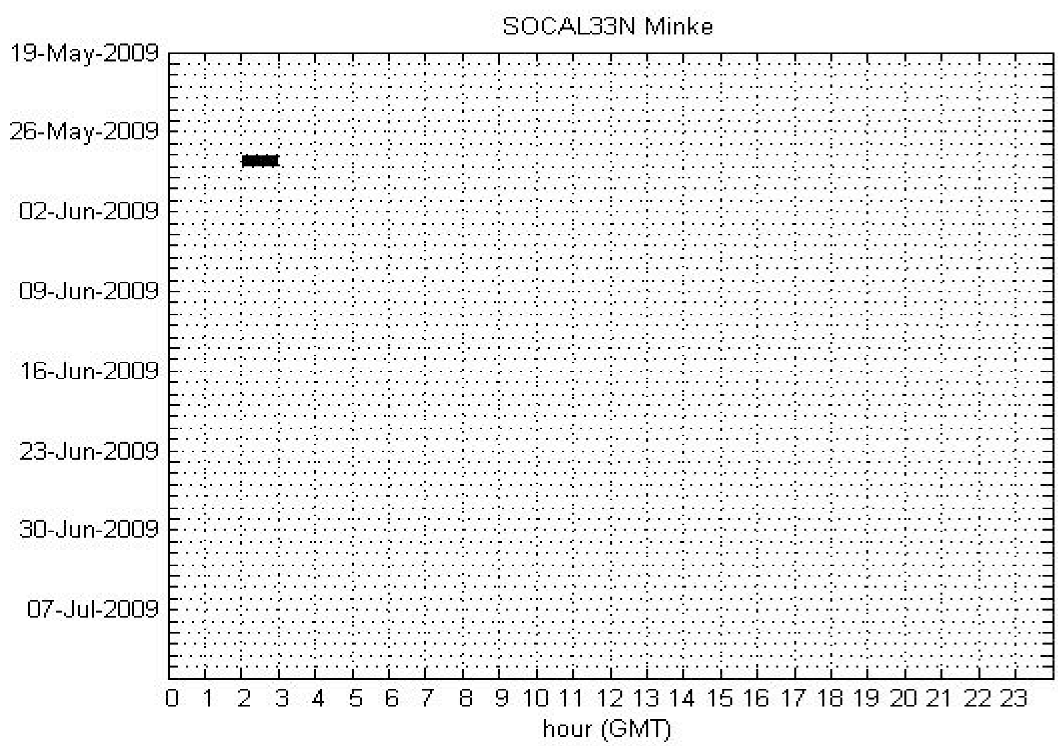
Fin Whale – "20-Hz" Call in Hourly Bins



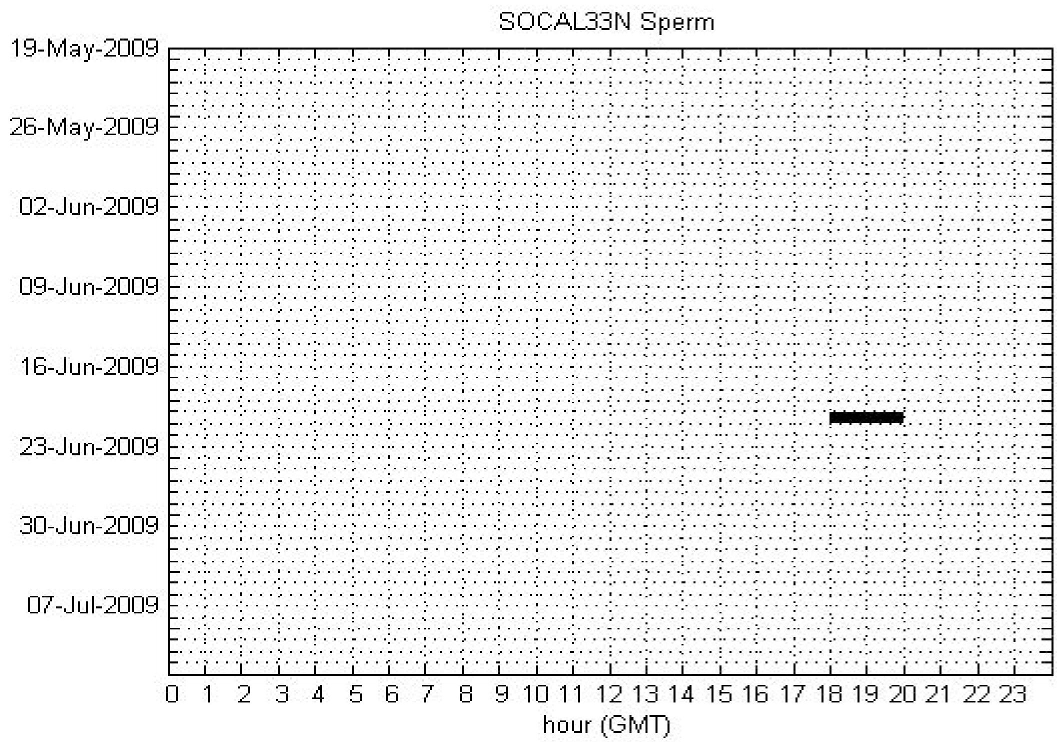
Fin Whale – "50 Hz" Call in Hourly Bins



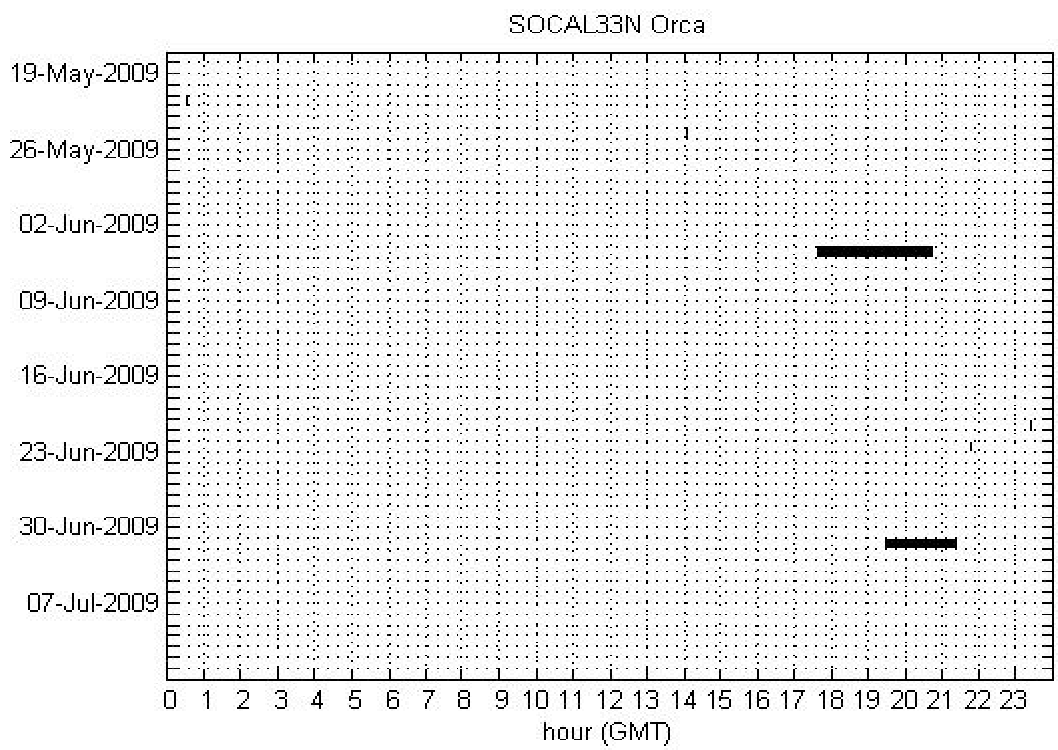
Humpback Whale – Song in Hourly Bins



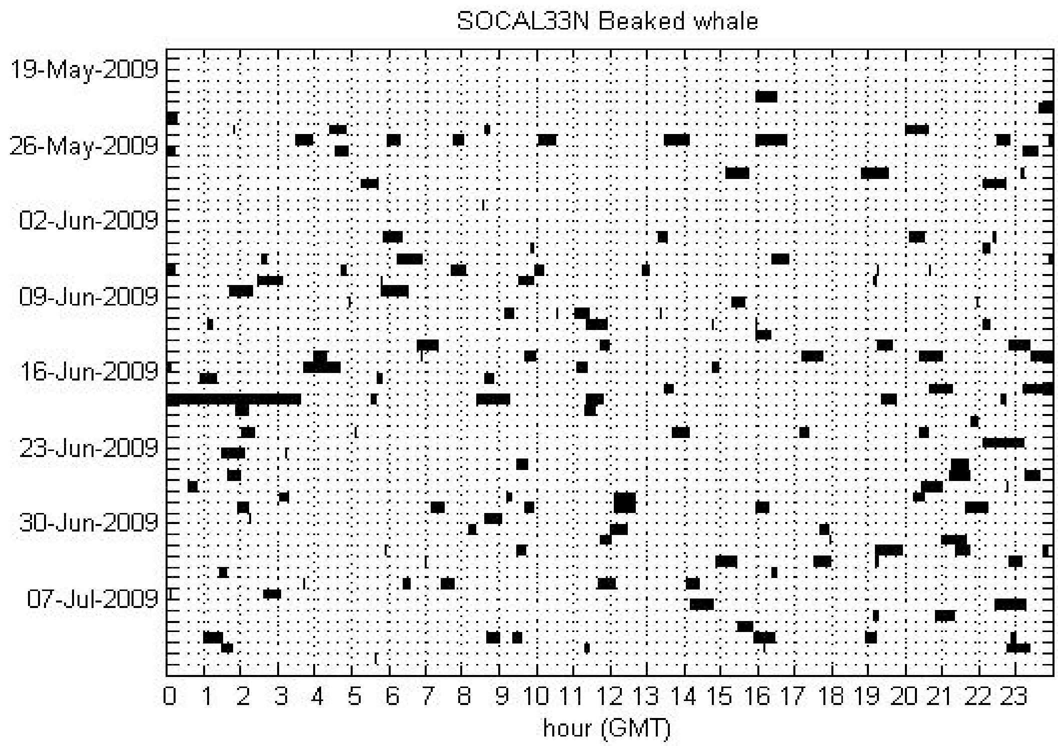
Minke Whale – Song in Hourly Bins



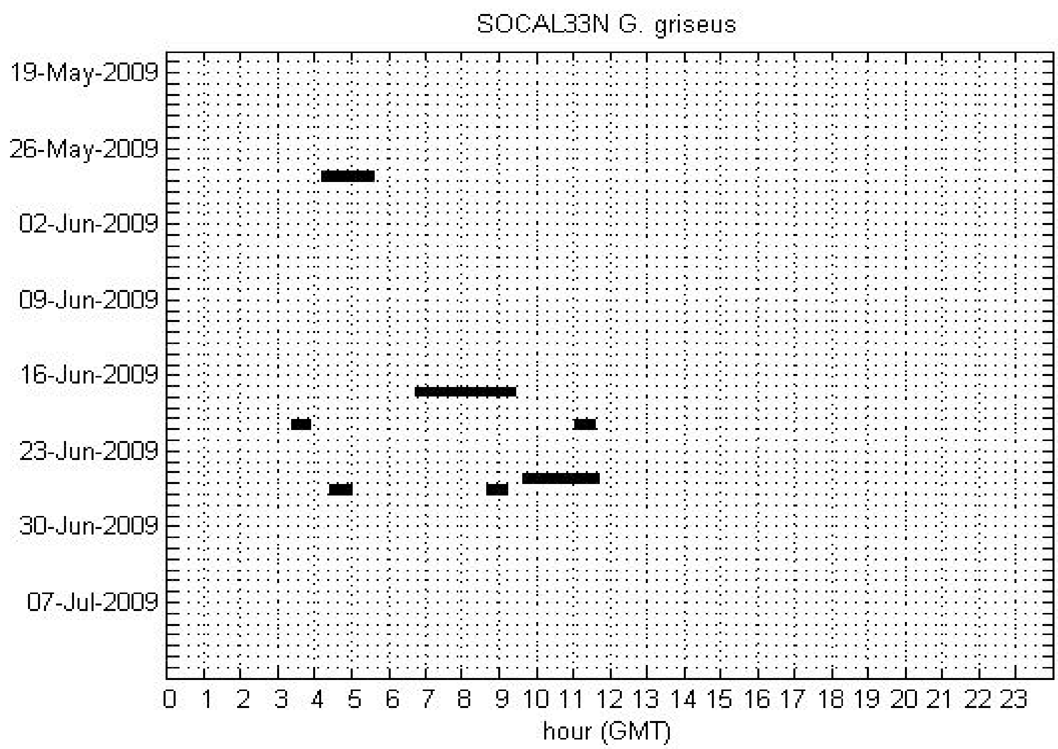
Sperm whales – Echolocation Clicks in Hourly Bin



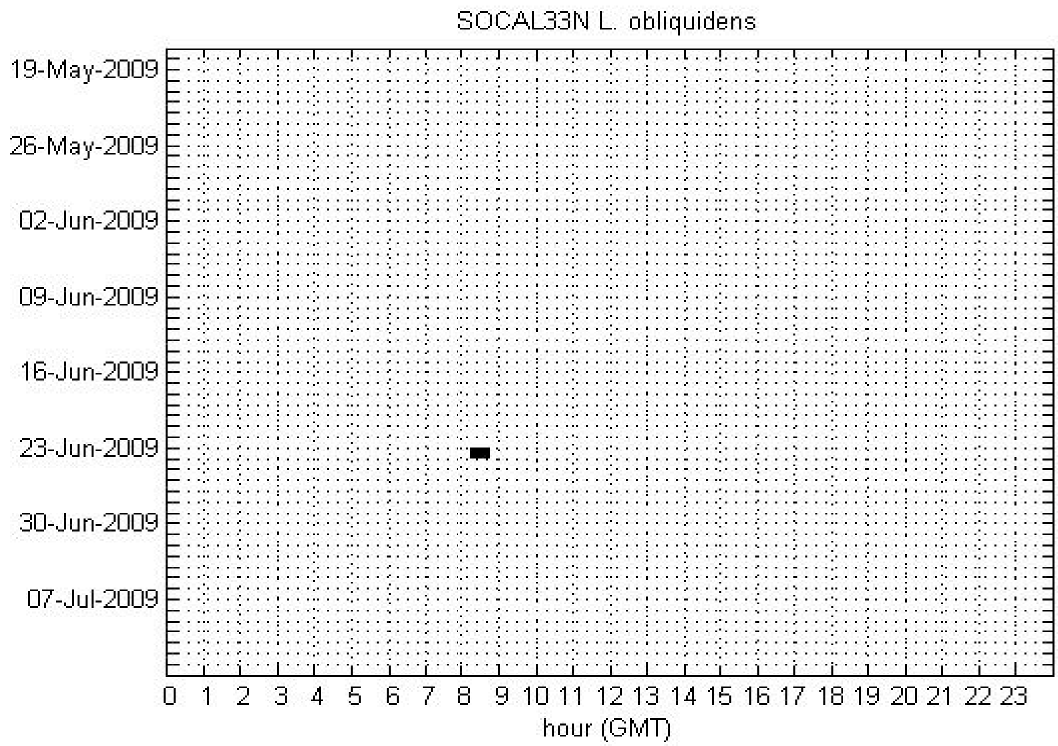
Killer whales – Echolocation Clicks and Whistles in One-Minute Bin



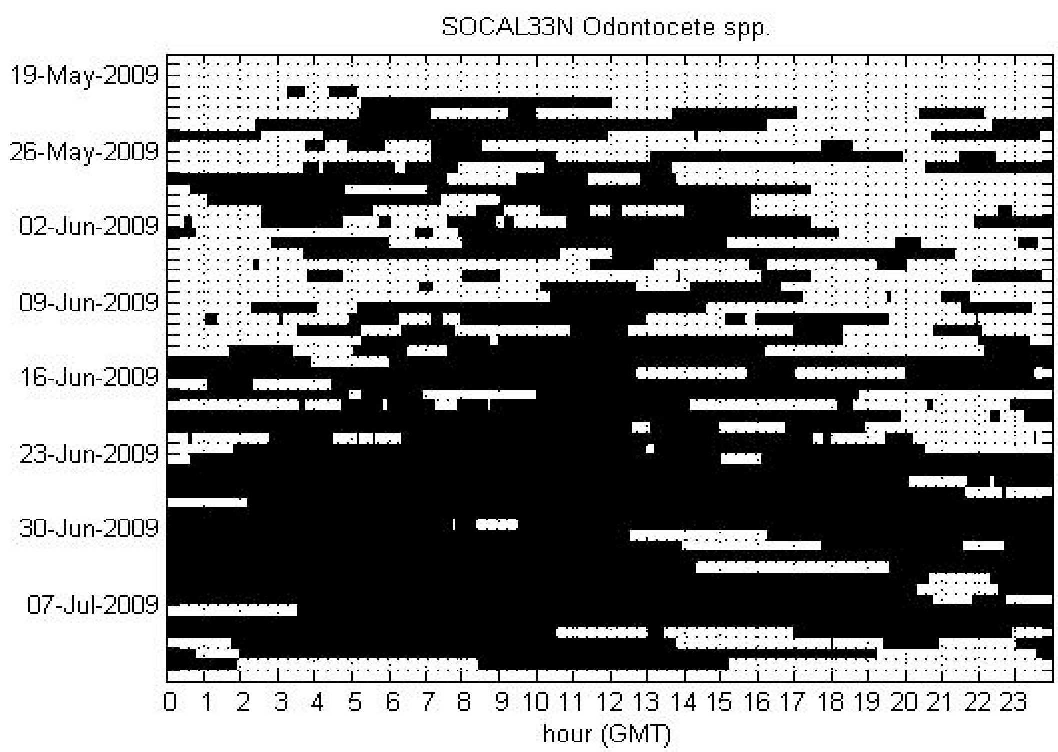
Beaked whales – Echolocation Pulses in One-Minute Bins



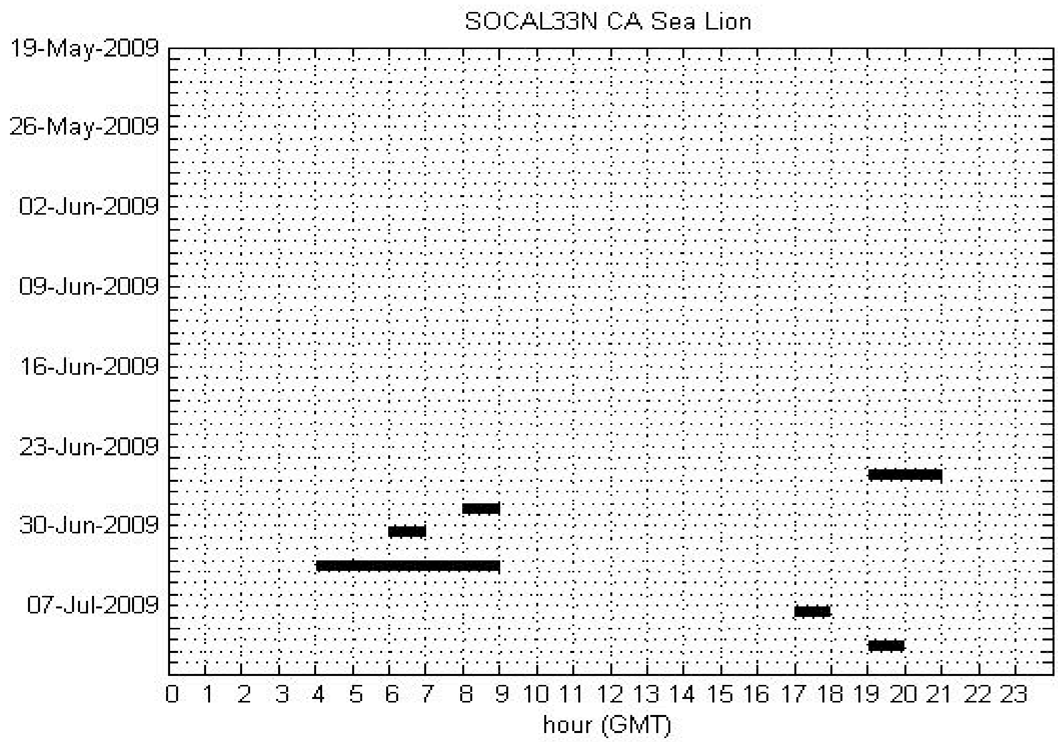
Risso's Dolphin – Echolocation Clicks in One-Minute Bins



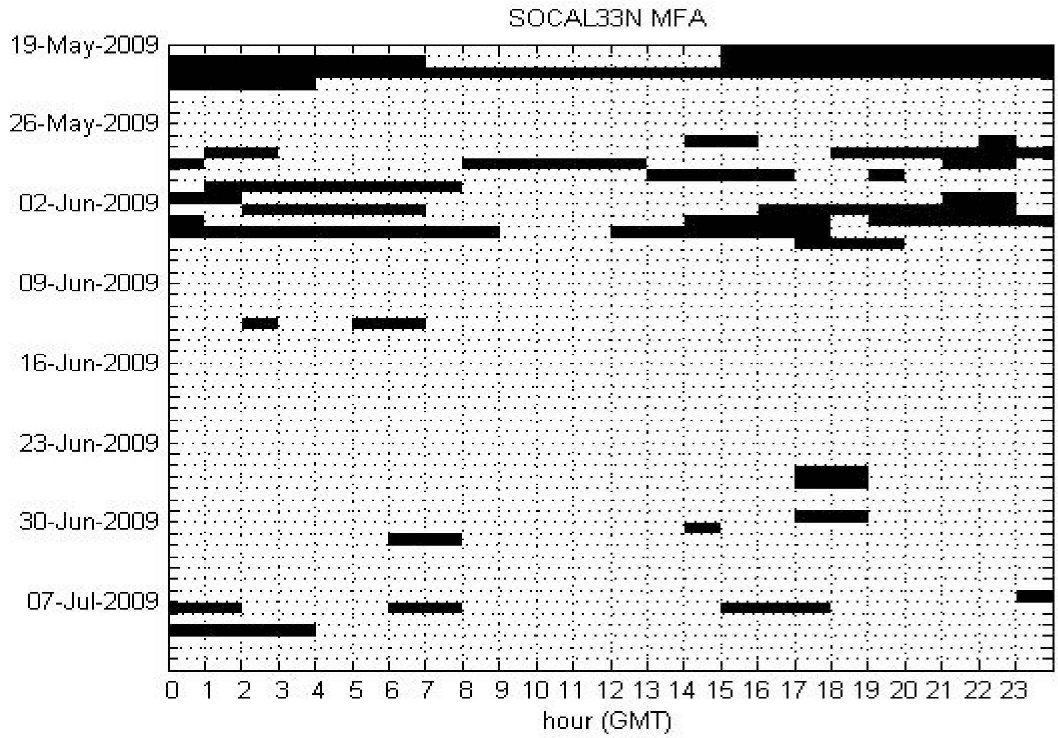
Pacific White-sided Dolphin – Echolocation Clicks in One-Minute Bins



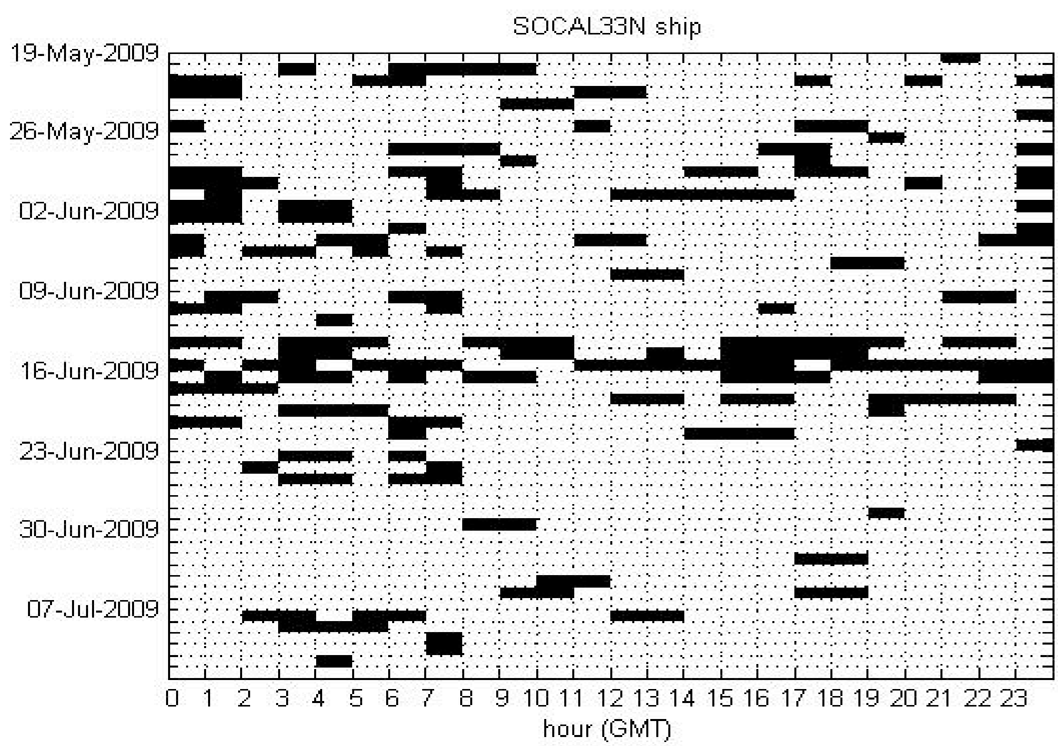
Unidentified Dolphin – Echolocation Clicks and Whistles in One-Minute Bins



California Sea Lion – Calls in Hourly Bins



Mid-Frequency Active Sonar (3 – 5 kHz) in Hourly Bins



Broadband Ship Noise in Hourly Bins