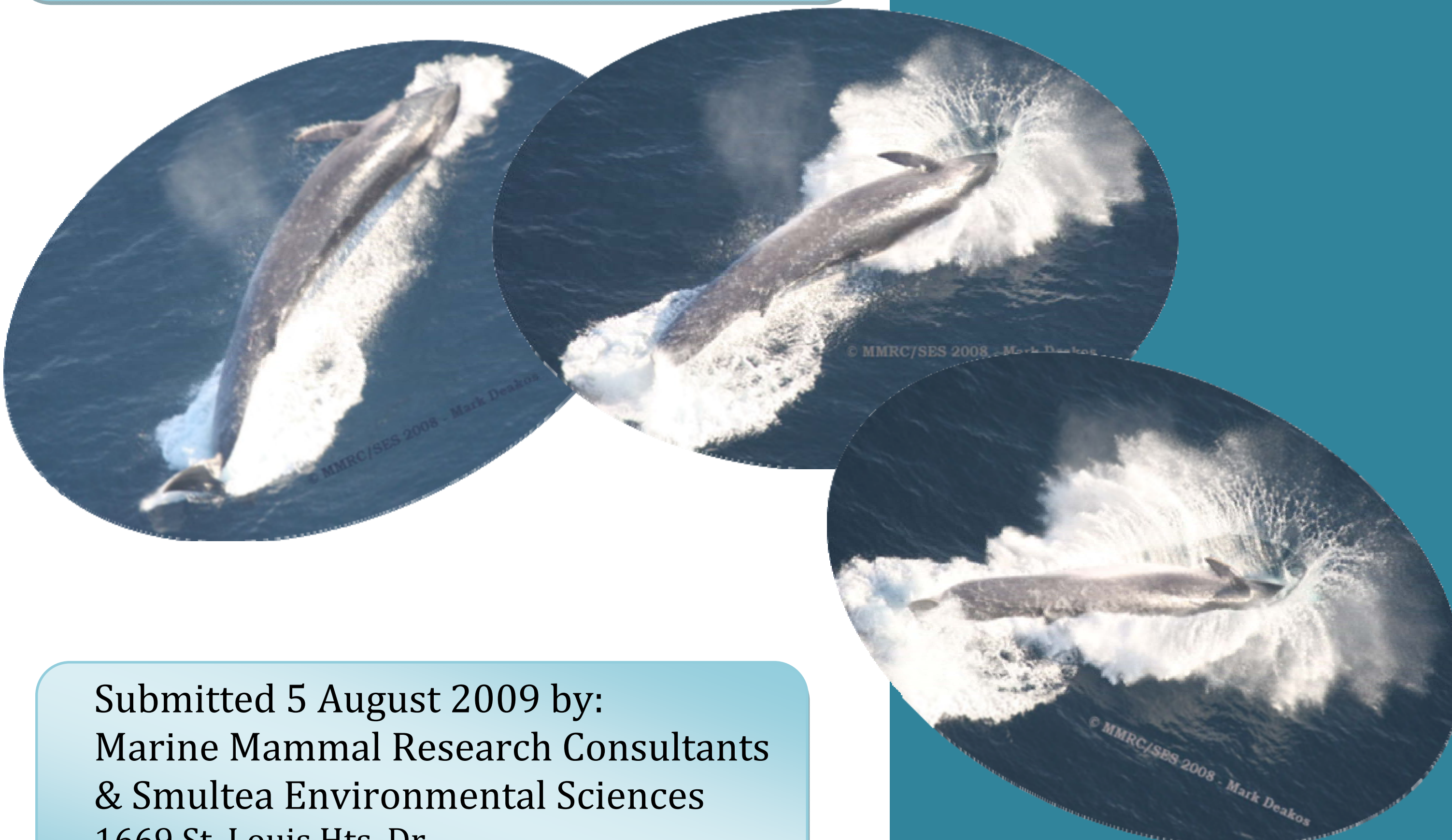
SOCAL October & November 2008 Final Report

Aerial Survey Marine Mammal Monitoring in Conjunction with Navy Exercises



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Marine Mammal Research Consultants
& Smultea Environmental Sciences
1669 St. Louis Hts. Dr.
Honolulu, HI 96816

Authors:

Mari A. Smultea, MSc
Smultea Environmental Sciences, LLC
29333 SE 64th St.,
Issaquah, WA 98027
msmultea@msn.com
www.smultea.com

Dr. Joseph R. Mobley
Marine Mammal Research Consultants
1669 St. Louis Hts. Dr.
Honolulu, HI 96816

Kate Lomac-MacNair
Marine Mammal Research Consultants & Smultea Environmental Sciences, LLC

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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 redistribut e? 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.

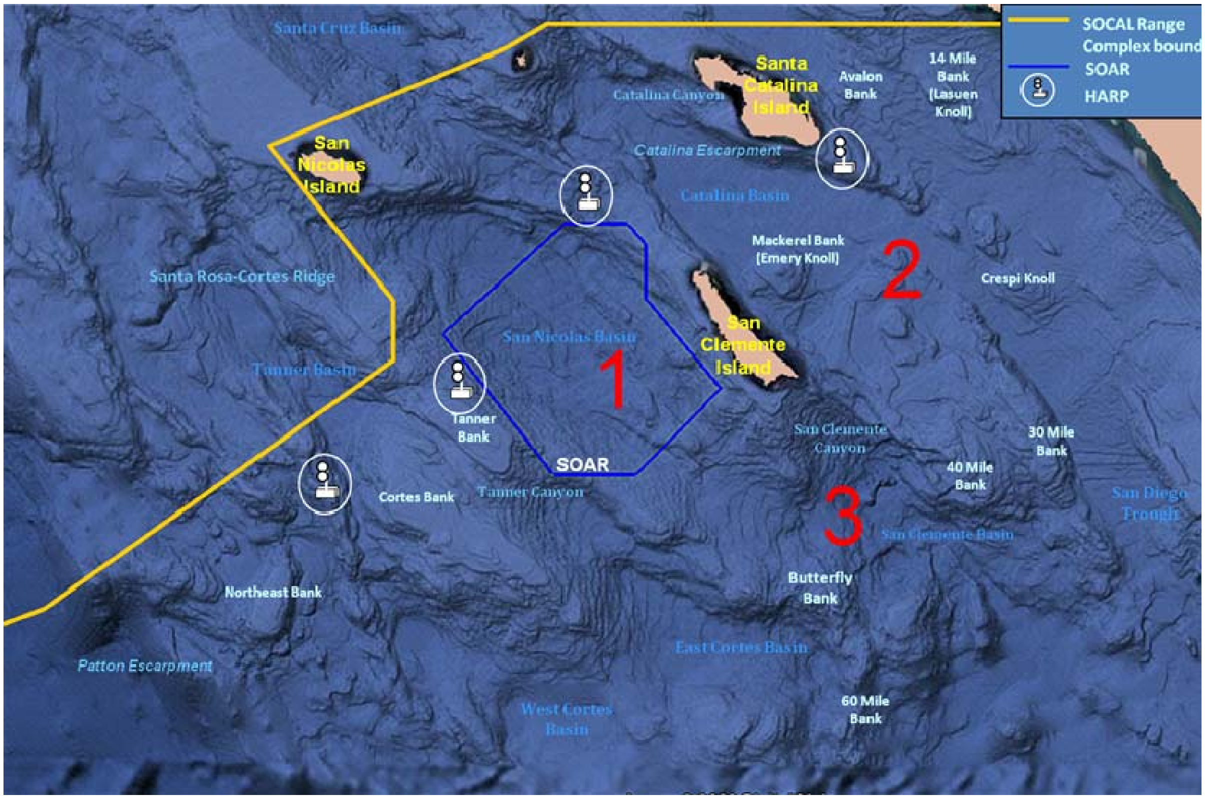

Figure 2. Location of the aerial survey monitoring area and underwater topographic features within the Navy's Southern California Range Complex (SOCAL). Numbers indicate survey areas of interest to the Navy in order of priority; orange line designates the SOCAL boundary; blue lines designate the Southern 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.

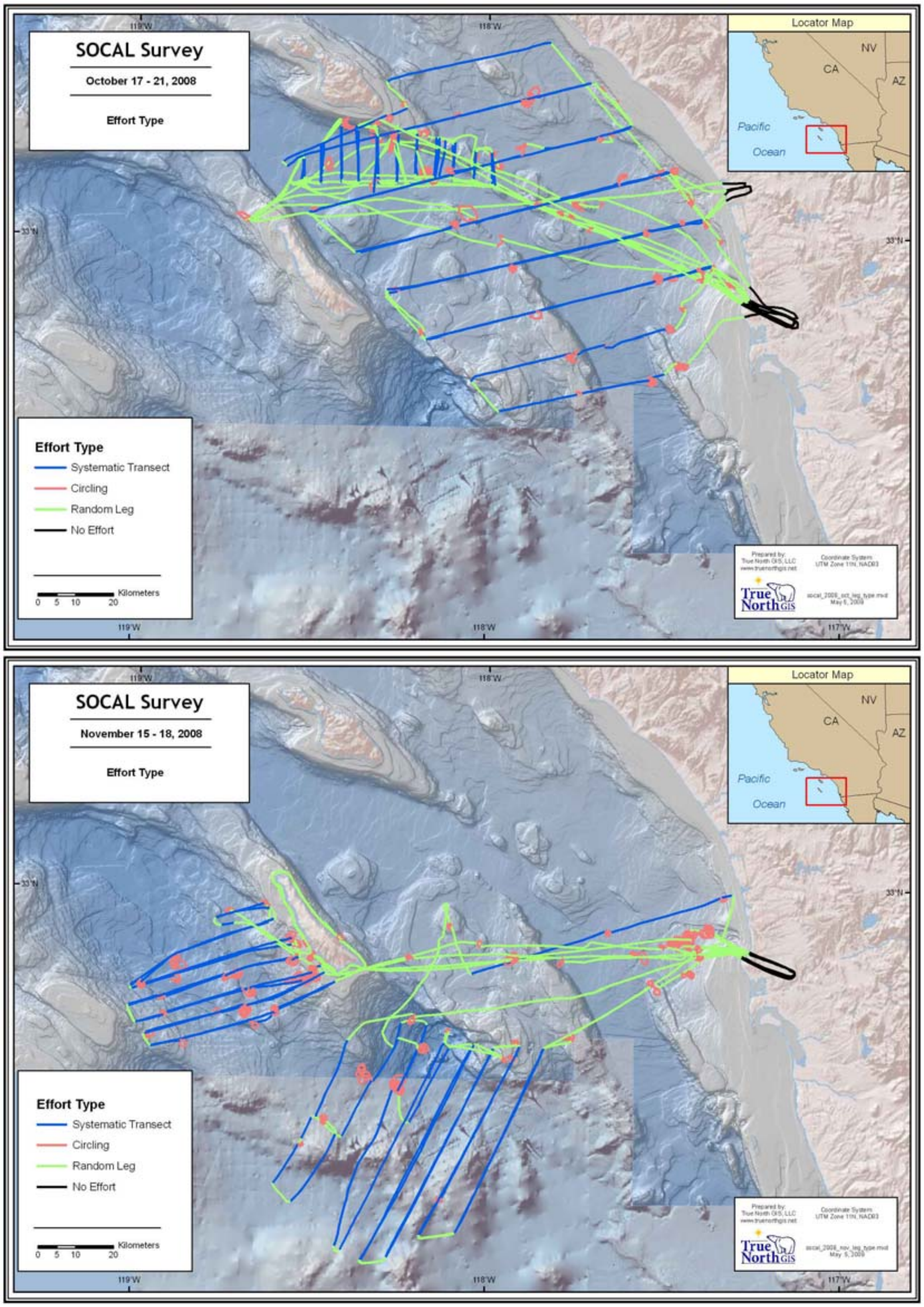

Figure 3. Aerial survey track lines and observation effort in the SOCAL during a Major Training Event (MTE) (15-21 Oct 2008 - top panel), and after the MTE (15-18 Nov - bottom panel).

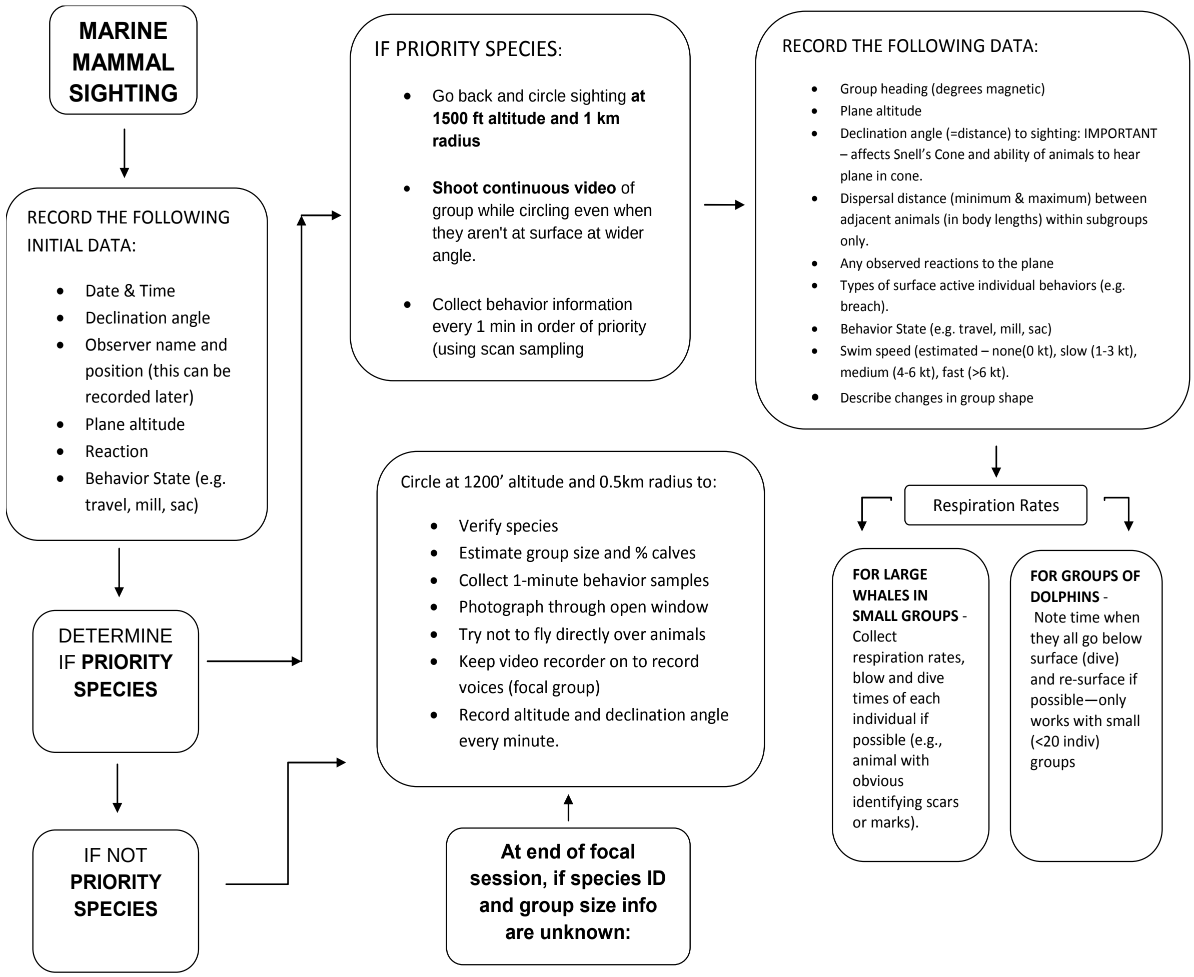

Figure 4. Protocol decision flow chart.

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

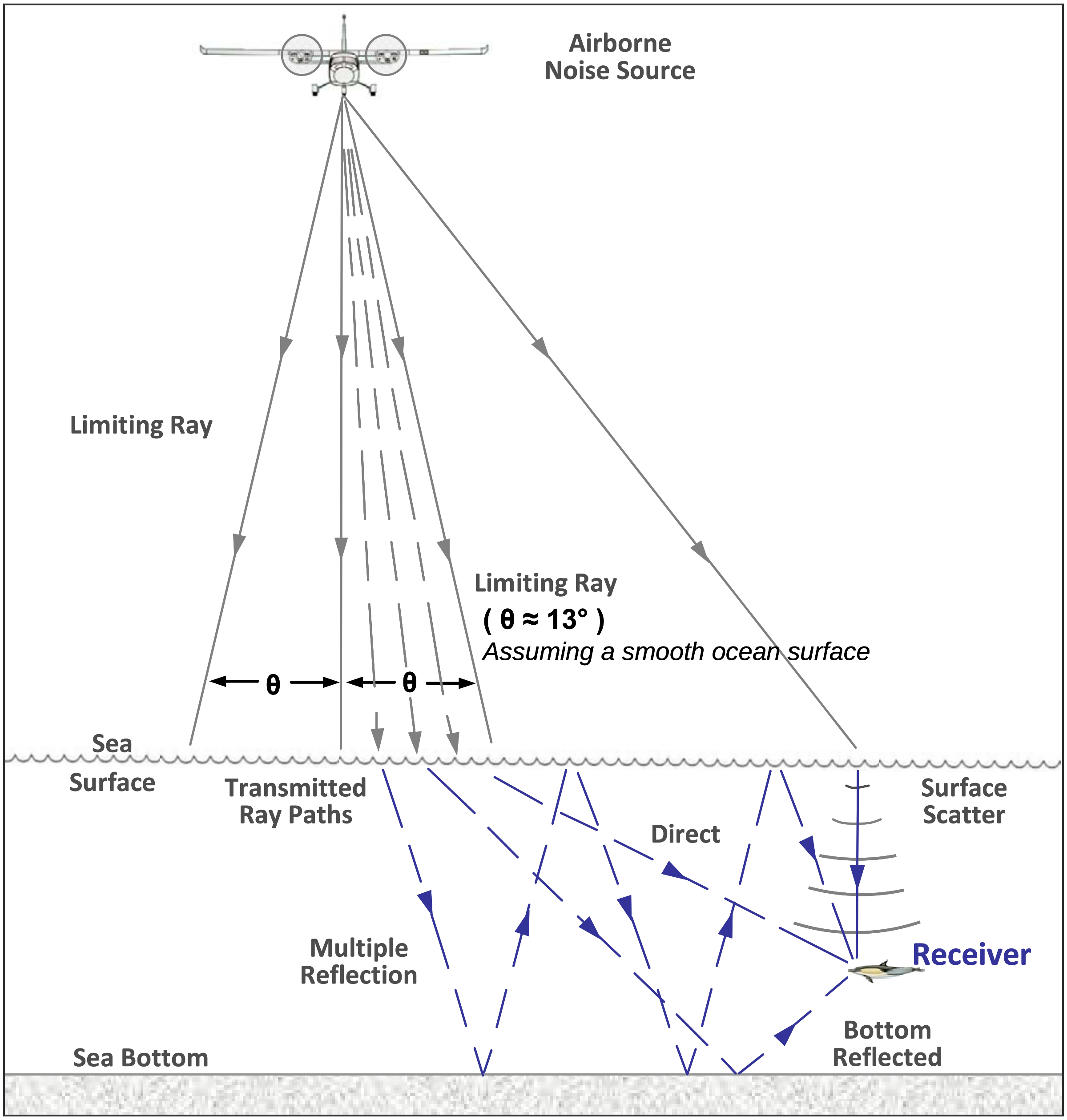

Figure 5. Diagram illustrating the theoretical 26º inverted sound cone (radius 13º) within which the sound ray of an over-flying aircraft is limited at the sea surface under calm flat sea conditions (Beaufort 0-2). Also illustrated are ways in which the transmission of sound rays through the water surface 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.

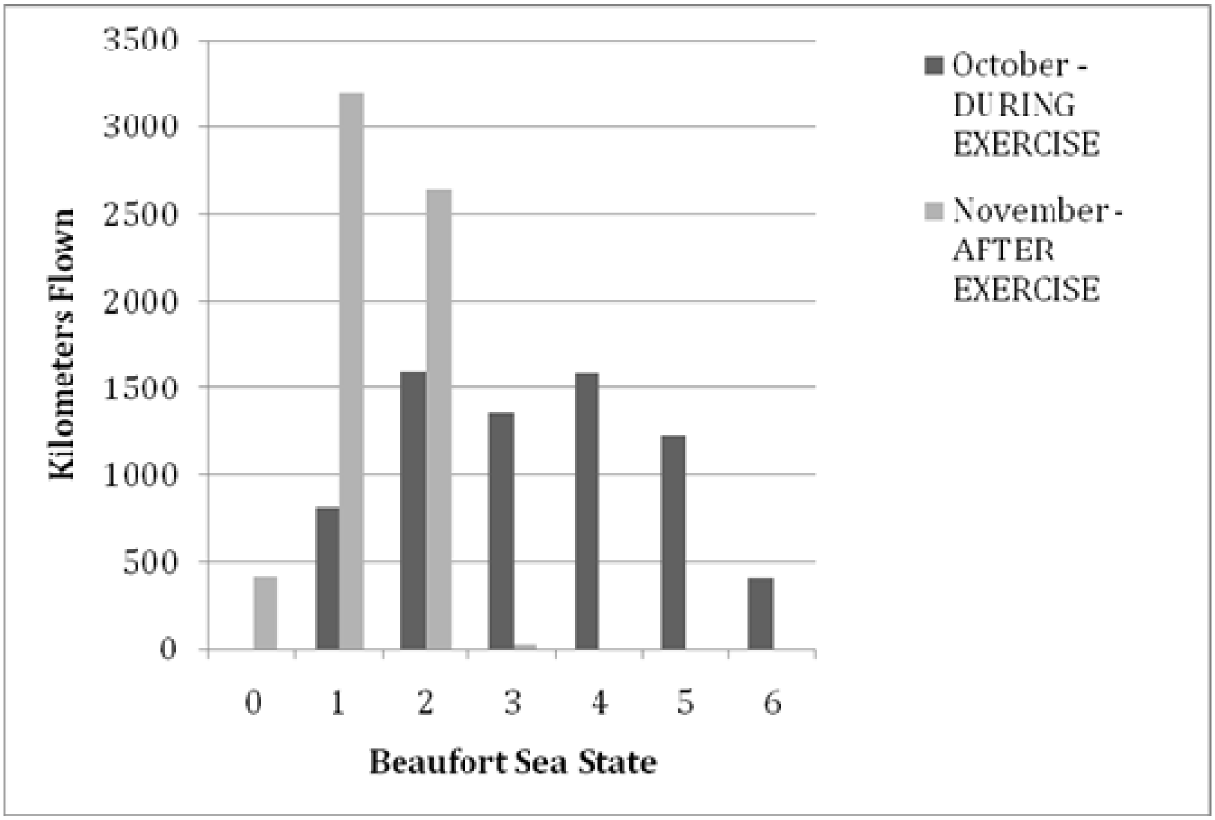


Figure 6. Beaufort sea state during aerial survey monitoring effort (in km) during (Oct) and after (Nov) the SOCAL 2008 MTE period.

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.

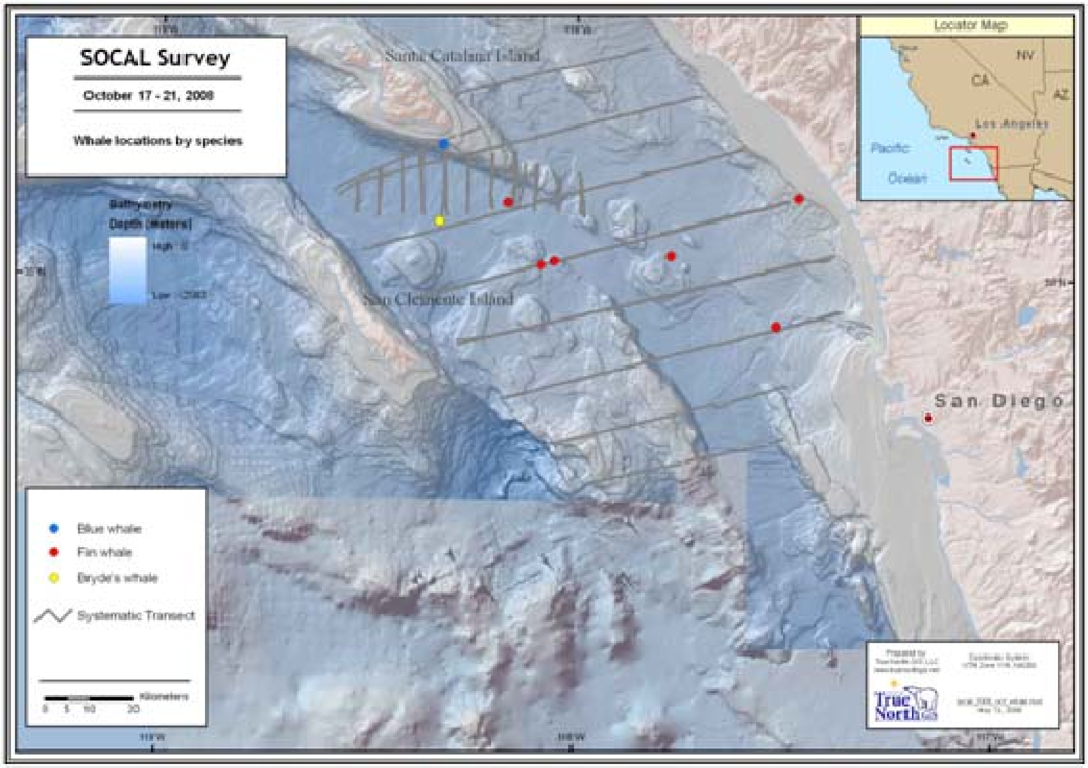
Date 2008	Flight Times (wheels up/down)	Total Flight Time (hr)	Total # Marine Mammal Sightings	Description
October (PHASE I) - AFTER MTE				
17 Oct	08:42–12:37 13:53–17:17	7.3		Line transects E of SCI. Re-fueled at Palomar mid-day. Returned to Montgomery in time to maintain pilot's 8 hr/day FAA flying 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**



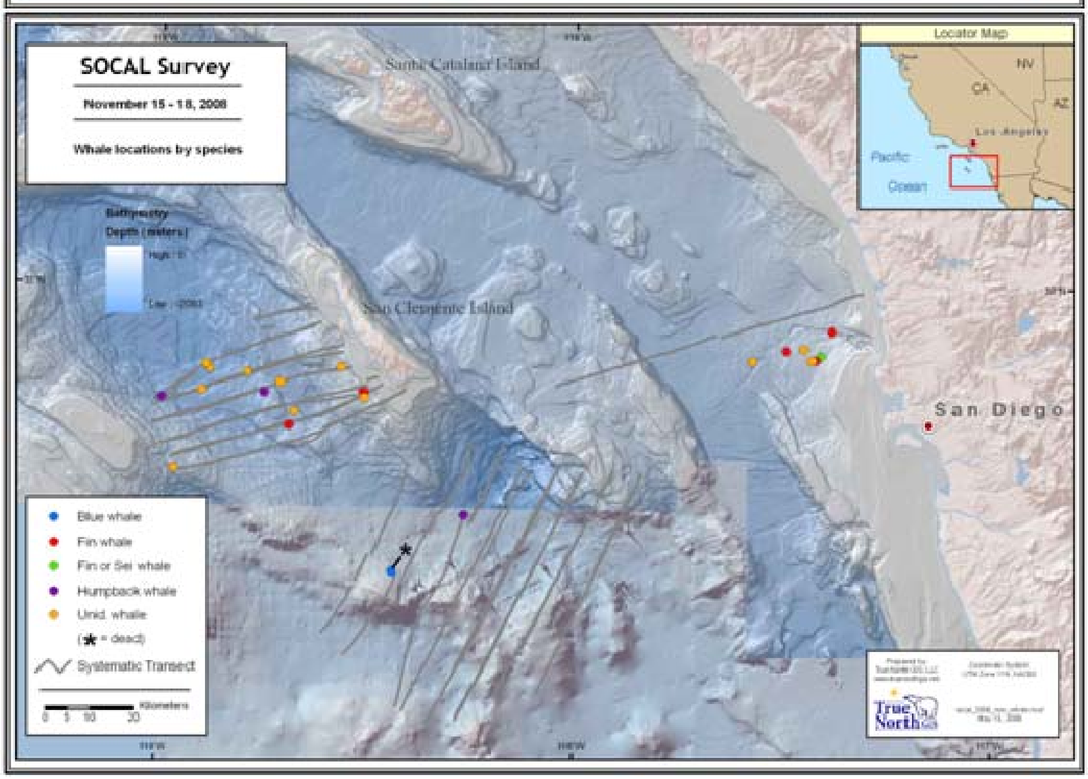


Figure 7. Upper panel 17-21 Oct 2008: Whale sightings in the SOCAL *during* MTE. Only systematic track lines shown but all sightings shown. Lower panel 15-21 Nov 2008: Whale sightings *after* MTE (See Figure 3 for all track line effort).

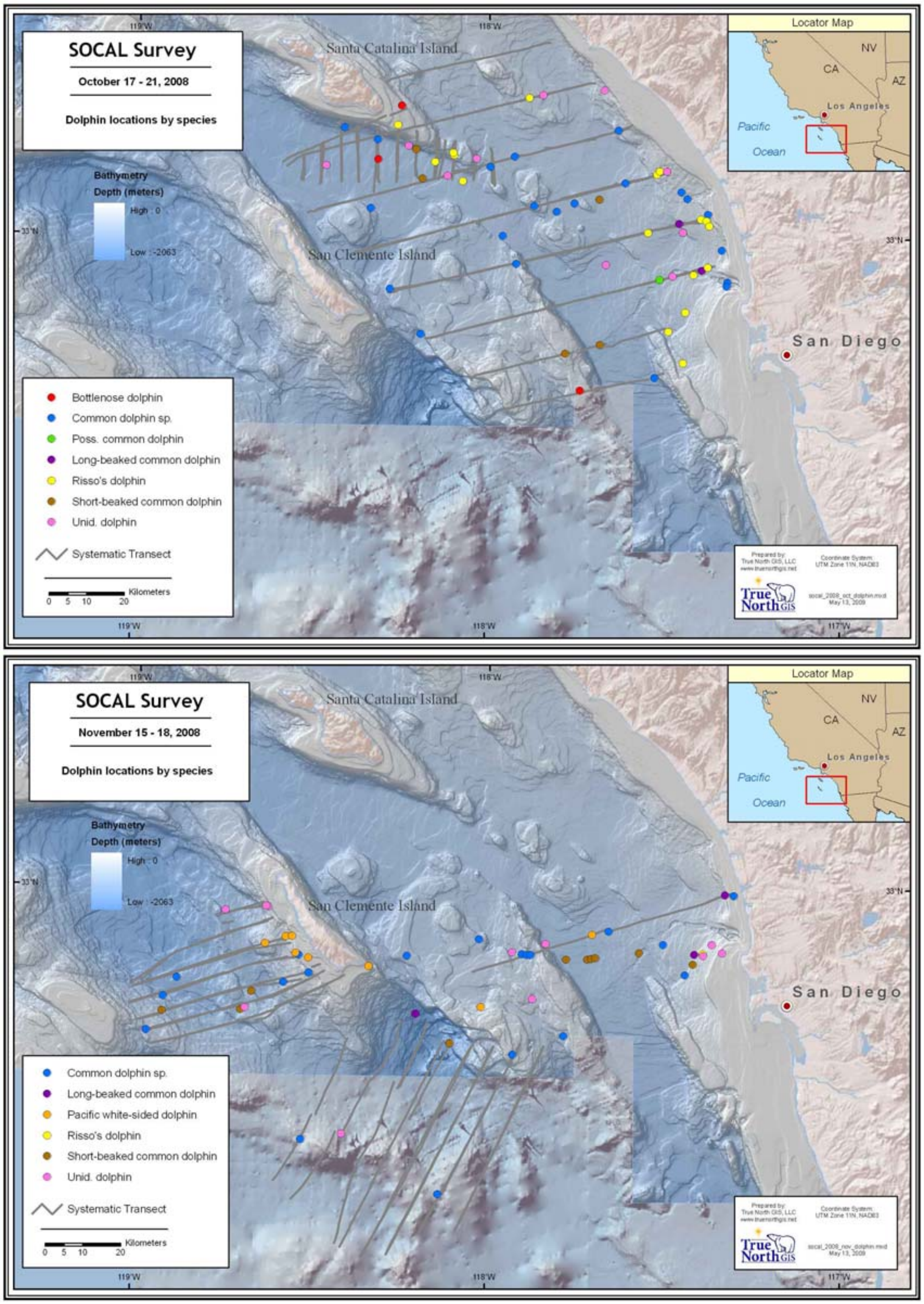


Figure 8. Dolphin sightings: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Sightings *after* MTE.

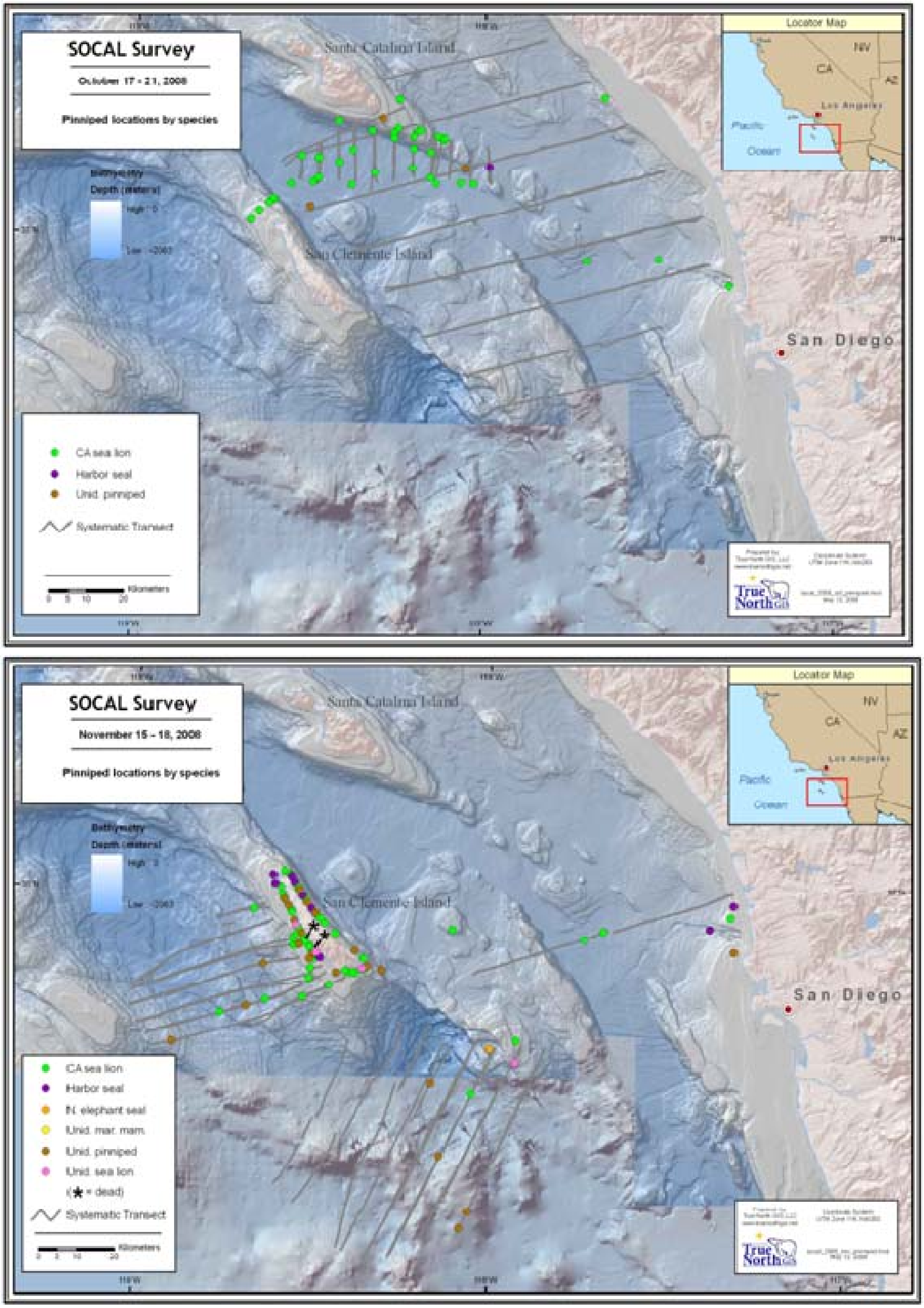


Figure 9. Pinnipeds: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Pinnipeds *after* MTE.

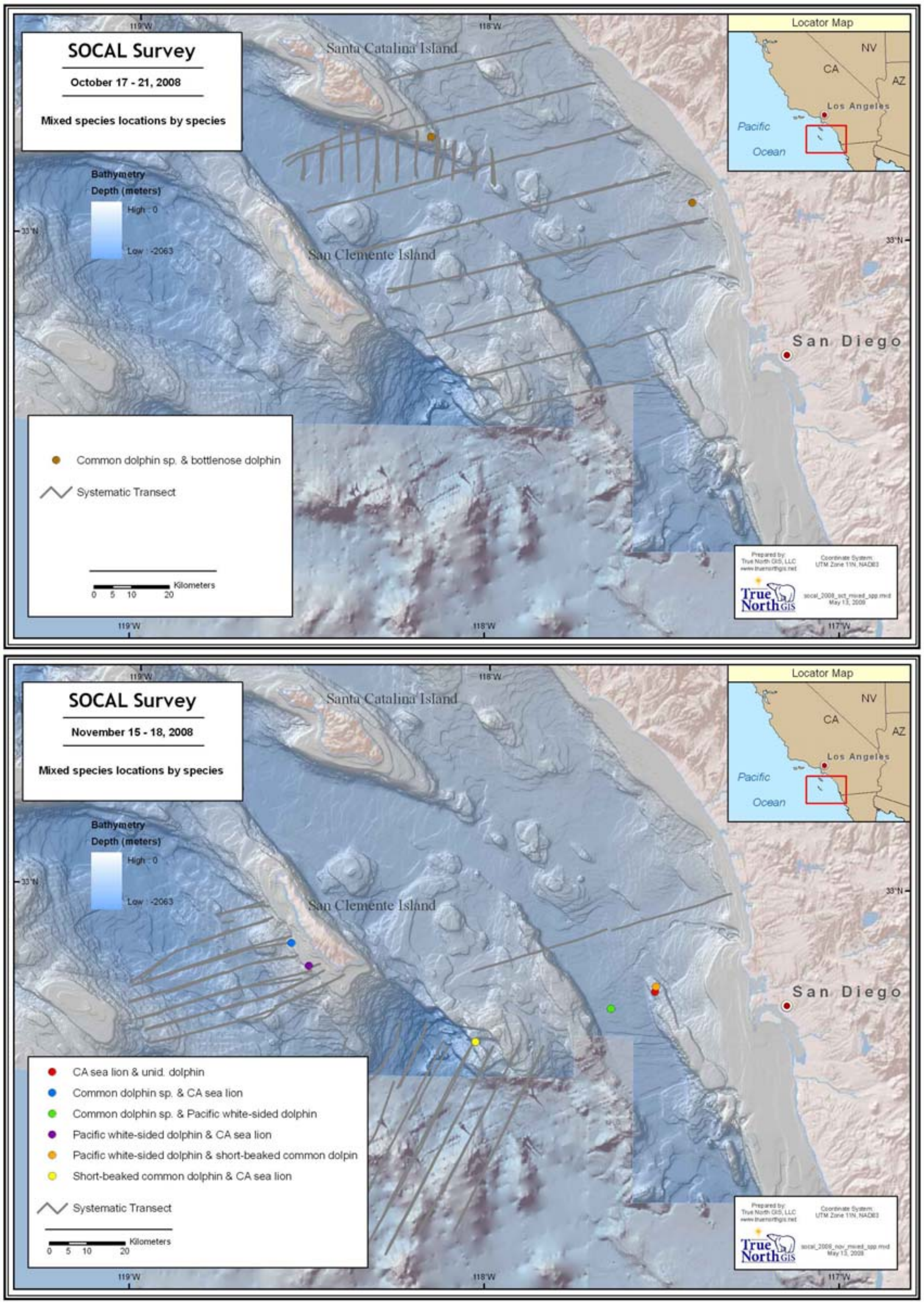


Figure 10. Mixed species: Upper panel 17-21 Oct 2008: Sightings in the SOCAL *during* MTE. Lower panel 15-21 Nov 2008: Mixed-species sightings in the SOCAL *after* MTE.

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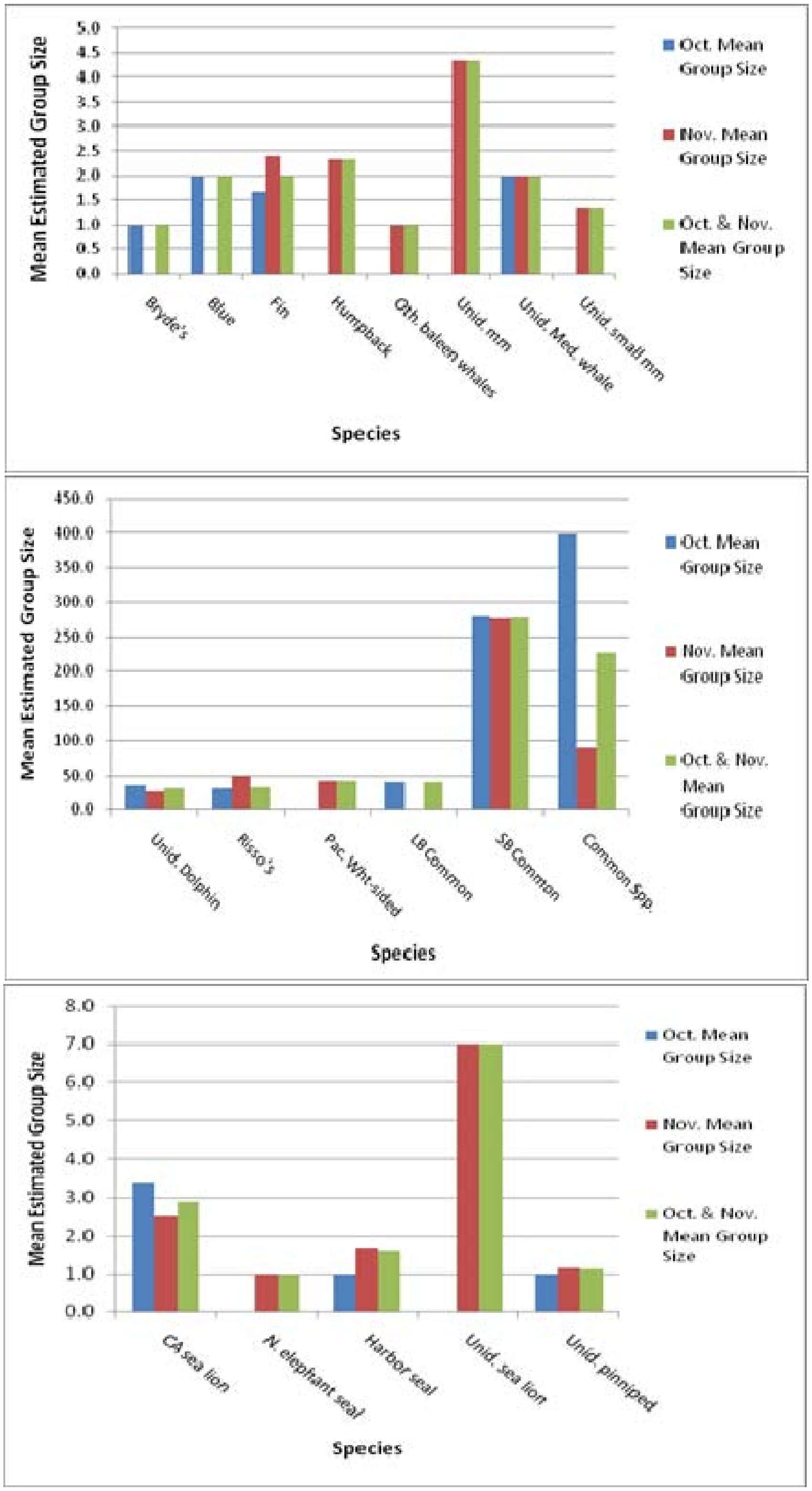

Figure 11. Mean group size by species or group *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period.

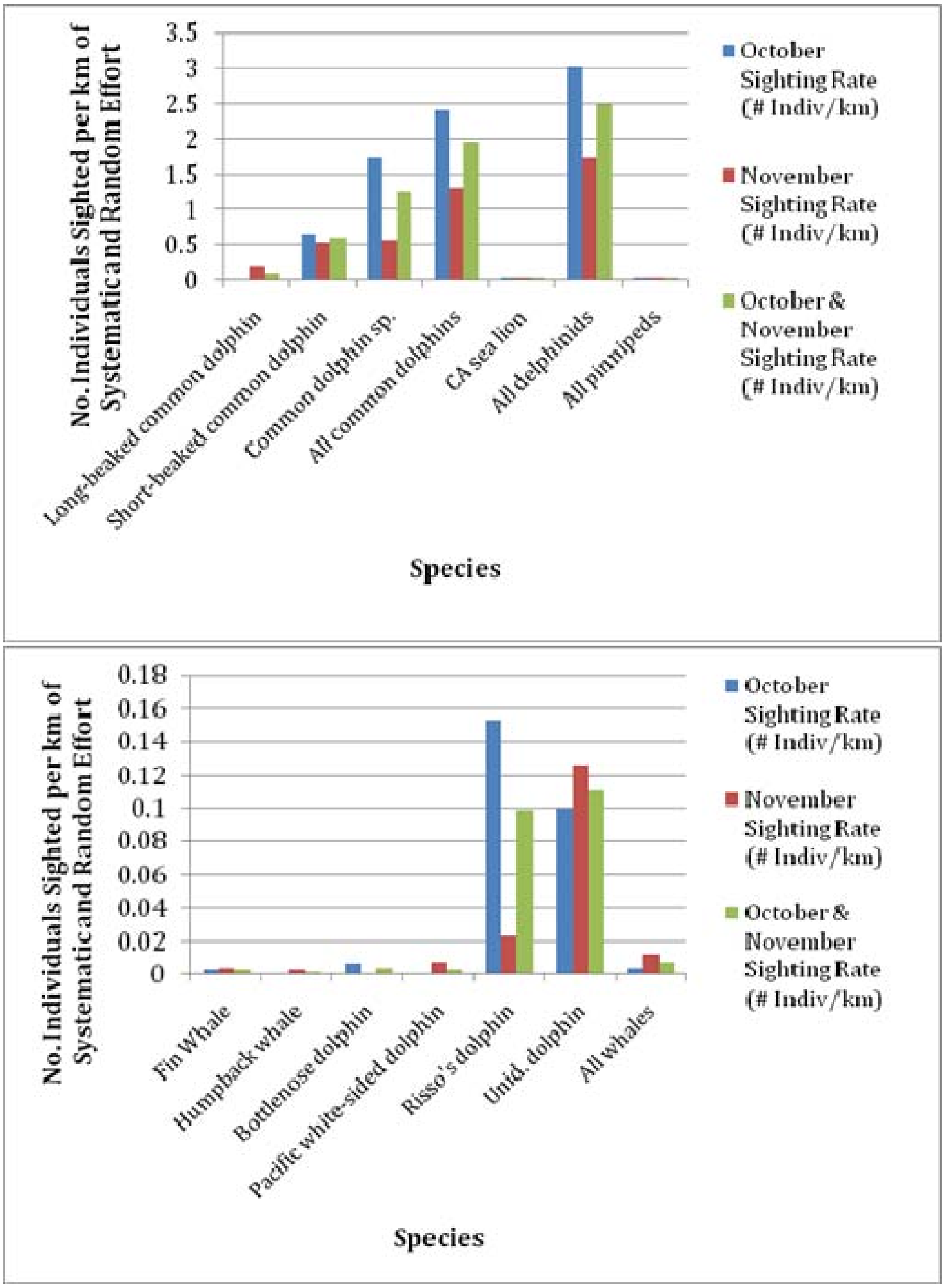

Figure 12. Sighting rates (no. individuals/km) of the most commonly seen (upper panel) and less commonly seen (lower panel) species and groups of marine mammals *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period based only on systematic line transect and random observation data.

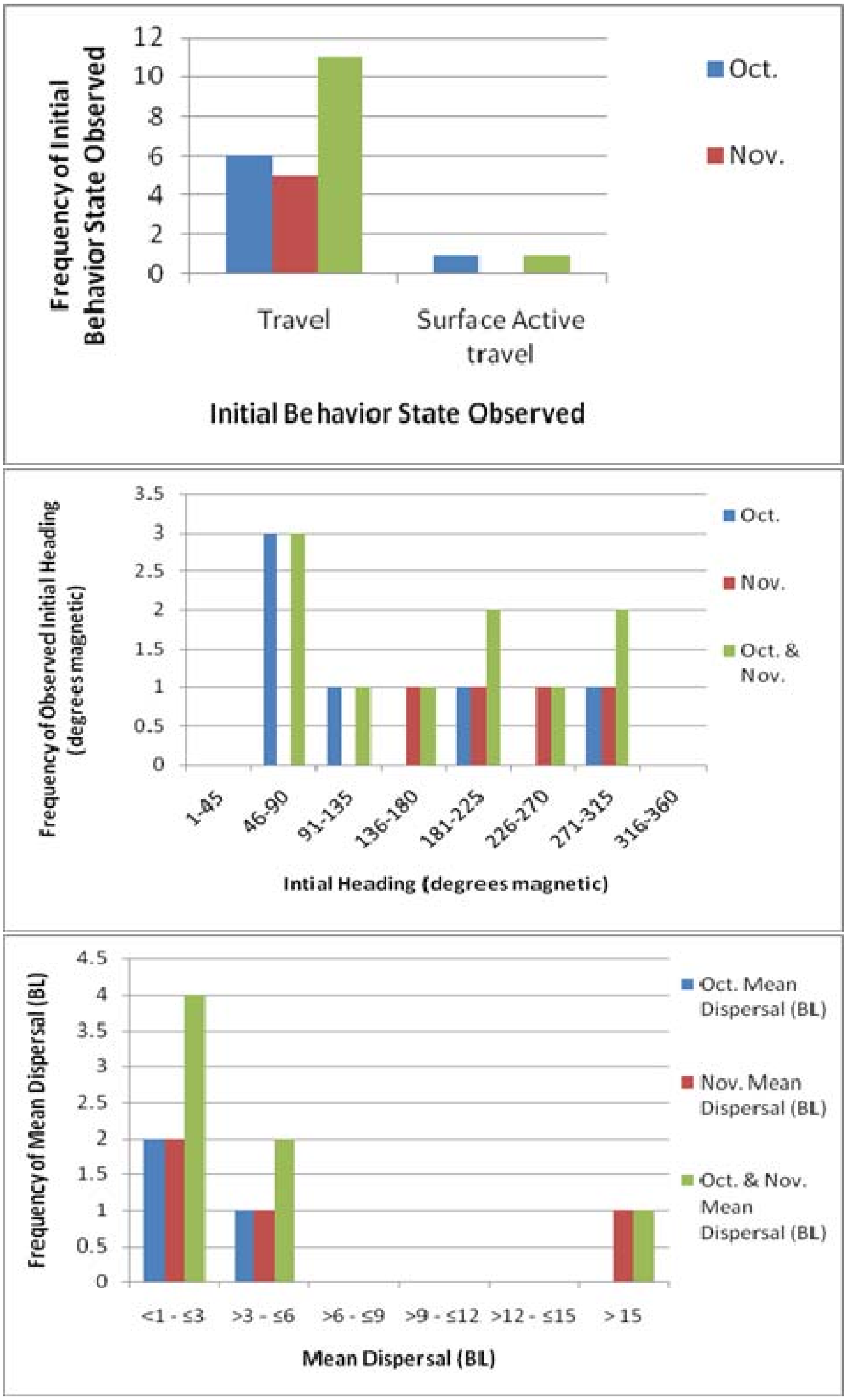

Figure 13. Fin whales. Top panel: frequency of initially observed behavioral states *during* (Oct) and *after* (Nov) the SOCAL 2008 MTE period. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Bottom panel: frequency of mean dispersal distance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

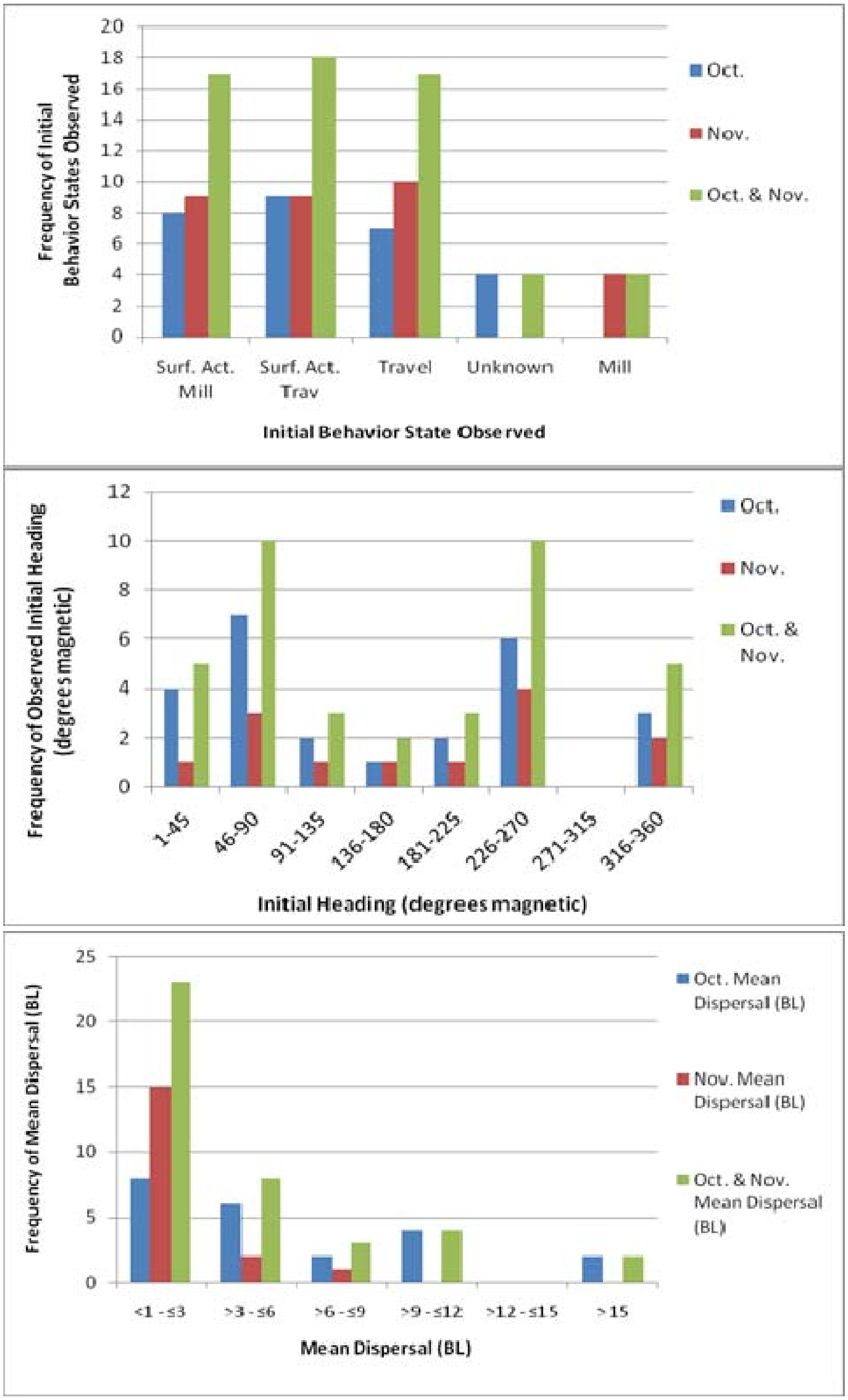

Figure 14. Common dolphins: Upper panel: frequency of initially observed behavioral states *during* (Oct) and *after* (Nov) the SOCAL2008 MTE. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Bottom panel: frequency of mean dispersal distance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

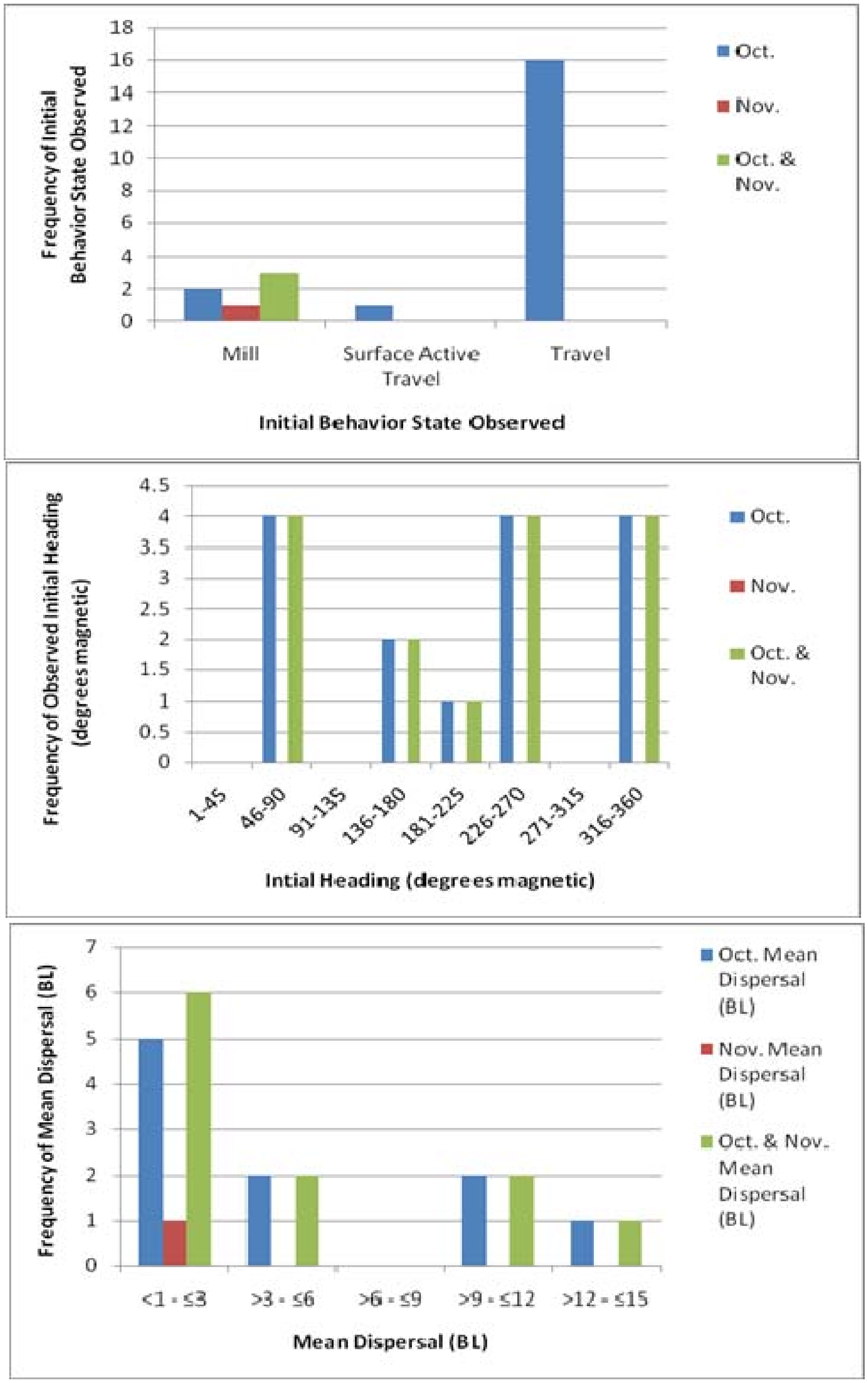

Figure 15. Risso's dolphins: Upper panel: frequency of initially observed behavioral states *during* (Oct) and after (Nov) the SOCAL2008 MTE. Middle panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) MTEs. Lower panel: frequency of mean dispersal distance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

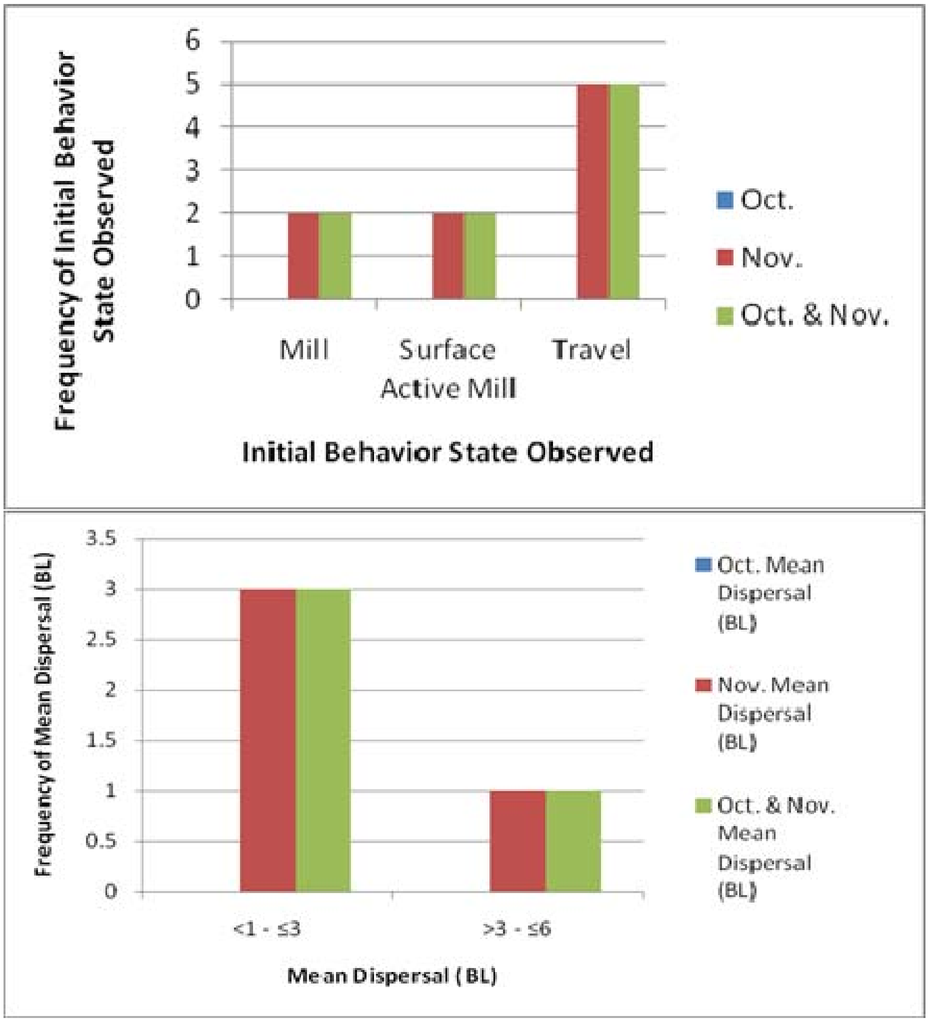

Figure 16. Pacific white-sided dolphins: upper panel: frequency of initially observed headings (degrees magnetic) *during* (Oct) and *after* (Nov) the SOCAL 2008 MTEs. Lower panel: frequency of mean dispersal distance between individuals (in estimated body lengths) *during* (Oct) and *after* (Nov) MTEs.

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 7 Literature Cited

Altmann, J. 1974. Observational study of behavior: Sampling methods. Behaviour 49:227-267.

Baird, R.W., G.S. Schorr, D.L. Webster, S.D. Mahaffy, A.B. Douglas, A.M. Gorgone, and D.J. McSweeney. 2006. A survey for odontocete cetaceans off Kaua'i and Ni'ihau, Hawai'i, during October and November 2005: Evidence for population structure and site fidelity. Prepared for Pacific Islands Fisheries Science Center under Order No. AB133F05SE5197, Honolulu, HI. Available as downloadable pdf file at:
http://www.cascadiaresearch.org/robin/Bairdetal2006odontocetesurvey.pdf

Balcomb III, K C. and D.E. Claridge. 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. Bahamas Journal of Science 8: 2-12. Available as downloadable pdf file at: http://www.bahamaswhales.org/resources/Stranding_Article.pdf

Barlow, J. 1999. Trackline detection probability for long-diving whales. Pages 209–221 *in* G. W. Garner, S. C. Amstrup, J. L. Laake, B. F. J. Manly, L. L. McDonald and D. G. Robertson, eds. Marine mammal survey and assessment methods. A. A. Balkema Publishers, The Netherlands.

Baird, R. W., D. L. Webster, D. J. McSweeney, A. D. Ligon, G. S. Schorr and J. Barlow. 2006. Diving behaviour of Cuvier's (Ziphius cavirostris) and Blainville's (Mesoplodon densirostris) beaked whales in Hawai'i . Canadian Journal of Zoology 84:1120–1128.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22:446-464.

Barlow J. and R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7:239–249.

Barlow, J., T. Gerrodette, and J. Forcada. 2001. Factors affecting perpendicular sighting distances on shipboard line-transect surveys for cetaceans. Journal of Cetacean Research and Management 3:201-212.

Brownell, R.L., Jr., T. Yamada, J.G. Mead, and A.L. van Helden. 2004. Mass strandings of Cuvier's beaked whales in Japan: U.S. Naval acoustic link? IWC Working Document SC/56/E37 presented to the IWC Scientific Committee, 19-22 July. Sorrento, Italy.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling. Oxford University Press, Oxford, UK. 432 pp.

Wilkin, S.M., M. Berman-Kowalewski, F. M. D. Gulland, J. Calambokidis, B. Mate, M. McKenna, P. Collins, S. Dover, D. Rotstein, J. St. Leger, N. Senyk, and J. Cordaro. Blue whale ship strikes off Southern California. Abstract submitted to the 18th Biennial Conference on the Biology of Marine Mammal, Quebec, October 2009. http://www.cascadiaresearch.org/SMM2009abstracts.htm.

Carretta, J. V., M. S. Lowry, C. E. Stinchcomb, M. S. Lynn, and R. E. Cosgrove. Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters: Results from aerial and ground surveys in 1998 and 1998. NOAA/NMFS/Southwest Fisheries Science Center Administrative Report LJ-00-02. 19 pp

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldewell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller,

S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management **7**:177–187

Dawson, S., P. Wade, E. Slooten, and J. Barlow. 2008. Design and field methods for sighting surveys of cetaceans in coastal and riverine habitats. Mamm. Rev. 38:19-49.

DoN (Department of the Navy). 2008a. Marine resources assessment for the Southern California and Point Mugu Operating Areas. In *Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Contract number N62470-02-D09997, CTO 120. Prepared by Geo-Marine, Inc., Plano, Texas.*

DoN. 2008b. Southern California Range Complex Final Environmental Impact Statement (FEIS). Department of the Navy.

DoN. 2009a. Southern California Range Complex monitoring plan. Prepared for National Marine Fisheries Service, Silver Spring, MD. Available as downloadable pdf file at: www.nmfs.noaa.gov/pr/pdfs/permits/socal_monitoringplan.pdf

DoN. 2009b. Hawaii Range Complex monitoring plan. Prepared for National Marine Fisheries Service, Silver Spring, MD. Available as downloadable pdf file at: Available at: http://www.nmfs.noaa.gov/pr/pdfs/permits/hrc_monitoringplan.pdf

Evans, P.G.H. and L.A. Miller (eds.). 2004. Active sonar and cetaceans. Proceedings of workshop held at the ECS 17th Annual Conference, Las Palmas, Gran Canaria, 8th March 2003. European Cetacean Society, Kiel, Germany. 84pp.

Falcone, E.A., G.S. Schorr, E.E. Henderson, M.F. Mckenna, D. Moretti, A.B. Douglas, J. Calambokidis, and J.A. Hildebrand. 2009a. Sighting characteristics and photo-identification of Cuvier's beaked whales (*Ziphius cavirostris*) near San Clemente Island, California: a key area for beaked whales and the military? Submitted to Marine Biology October 2008, in review.

Falcone, E.A., G.S. Schorr, A.B. Douglas, D.L. Webster, J. Calambokidis, J. Hildebrand, R.D. Andrews, M.B. Hanson, R.W. Baird, and D. Moretti. 2009b. Movements of Cuvier's beaked whales in a region of frequent naval activity: Insights from sighting, photo-identification, and satellite tag data. Abstract submitted to the 18th Biennial Conference on the Biology of Marine Mammals, Quebec, October 2009.

Ferguson, M. C., J. Barlow, S. B. Reilly and T. Gerrodette. 2006. Predicting Cuvier's (*Ziphius cavirostris*) and *Mesoplodon* beaked whale population density from habitat characteristics in the eastern tropical Pacific Ocean. Journal of Cetacean Research and Management 7:287–299.

Fernandez, A., J. F. Edwards, F. Rodriguez, A. E. de los Monteros, P. Herraez, P. Castro, J. R. Jaber, V. Martin, and M. Arbelo. 2005. "Gas and fat embolic syndrome" involving a mass stranding of beaked whales (Family Ziphiidae) exposed to anthropogenic sounds. *Veterinary Pathology* 42:446-457.?

Frankel, A.S. and L.M. Herman. 1993. Responses of humpback whales to playback of natural and artificial sounds in Hawaii. Journal of the Acoustical Society of America 4:1848.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature 392:29.

Green, G.A., R.A. Grotefendt, M.A. Smultea, C.E. Bowlby, and R.A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington offshore waters. Contract No. 50ABNF200058. Prepared for the National Marine Mammal Laboratory, National Marine Fisheries Service, Seattle, WA.

Hildebrand, J. 2005. Marine mammal acoustic monitoring and habitat investigation, Southern California Channel Island region – Final Report for Office of Naval Research #N00014-01-D-0043-D12, July 2005. Prepared by Marine Physical Laboratory, Scripps Institute of Oceanography. Prepared for Office of Naval Research, Washington, DC. 166 pp.

Hildebrand, J. 2007. Marine mammal acoustic monitoring and habitat investigation, Southern California offshore region – Technical Report June 2006 – June 2007. Prepared by Marine Physical Laboratory, Scripps Institute of Oceanography. Prepared for Chief of Naval Operations, N45, Washington, DC, and Naval Post-Graduate School, Monterey, CA. NPS-OC-08-002. 42 pp.

Jefferson, T. A., M. A. Webber, and R. L. Pitman. 2008. Marine mammals of the world: A comprehensive guide to their identification. San Diego: Academic Press.

Jensen, A. S. and G. K. Silber. 2004. Large whale ship strike database. NOAA Technical Memorandum NMFS-OPR-25.

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herráez, A. M. Pocknell, F. Rodríguez, F. E. Howie, A. Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham, and A. Fernández. 2003. Gas-bubble lesions in stranded cetaceans. Nature 425:575.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. BBN Report 5366. Report from Bolt Beranek & Newman, Inc., Cambridge, MA, for Minerals Management Service, Anchorage, AK. NTIS PB86-174174.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Report 5586. Report from Bolt Beranek & Newman, Inc., Cambridge, MA, for Minerals Management Service, Anchorage, AK. NTIS PB86-218377.

Mann, J. 2000. Unraveling the dynamics of social life: long-term studies and observational methods. Pages 45-64 *in* J. Mann, R.C. Connor, P.L. Tyack, and H. Whitehead, eds. Cetacean Societies: Field Studies of Dolphins and Whales. University of Chicago Press, Chicago, IL.

Maybaum, H.L. 1990. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae* in Hawaiian waters. Eos 71(2):92.

Maybaum, H.L. 1993. Responses of humpback whales to sonar sounds. Journal of the Acoustical Society of America 94(3, Pt.2):1848-1849.

McSweeney, D., R. W. Baird, and S. D. Mahaffy. 2007. Site fidelity, associations, and movements of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales off the island of Hawai'i. Marine Mammal Science 23:666-687.

Mobley, J.R., Jr. 2004. Results of 2004 aerial surveys north of Kauai. Report to the North Pacific Acoustic Laboratory Program. 25 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/2004NPAL.pdf

Mobley, J.R., Jr. 2007. Lunar influences as possible cause for simultaneous aggregations of melon-headed whales in Hanalei Bay, Kauai and Sasanhaya Bay, Rota. Abstracts, 17th Biennial Conference on the Biology of Marine Mammals. 29 November – 3 December 2007. Cape Town, South Africa.

Mobley, J.R., Jr. 2008a. Final report: Aerial surveys of marine mammals performed in support of USWEX MTEs Nov. 11-17, 2007. Prepared by Marine Mammal Research Consultants , Honolu, HI for Environmental Division, Commander, U.S. Pacific Fleet, Honolulu, HI. Submitted by.

Available as downloadable pdf file at: http://www.nmfs.noaa.gov/pr/pdfs/permits/uswex_report_nov2007.pdf.

Mobley, J.R., Jr. 2008b. Aerial surveys of marine mammals and sea turtles in conjunction with RIMPAC 2008 MTEs near Kauai and Niihau, Hawaii. Field Summary Report for Contract #N62742-08-P-1934. Prepared for NAVFAC Pacific, Pearl Harbor, HI . Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/08RIMPACaerial.pdf

Mobley, J.R., Jr., L.M. Herman, and A.S. Frankel. 1988. Responses of wintering humpback whales (*Megaptera novaeangliae*) to playback of recordings of winter and summer vocalizations and of synthetic sound. Behavioral Ecology and Sociobiology 23:211-223. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/playback.pdf.

Mobley, J.R., Jr., S.S. Spitz, K.A. Forney, R. Grotefendt, and P.H. Forestell. 2000. Distribution and abundance of odontocete species in Hawaiian waters: Preliminary results of 1993-98 aerial surveys. NOAA/NMFS/Southwest Fisheries Science Center Administrative Report LJ-00-14C. 26 pp. Available as downloadable pdf file at: http://socrates.uhwo.hawaii.edu/SocialSci/jmobley/SWFSC.pdf.

NMFS. 2009. Taking and Importing Marine Mammals; U.S. Navy Training in the Southern California Range Complex; Final Rule. January 21, 2009. 74FR3882.

Norris, T.F., M.A. Smultea, S. Rankin, C. Loftus, C. Oedekoven, E. Silva, and A.M. Zoidis. 2005. A preliminary acoustic-visual survey in deep waters around Ni;ihau, Kaua;i, and portions of O;ahu, Hawai;i, February 2005. Contract No. 2057SA-05F. Prepared by Cetos Research Organization, Bar Harbor, ME for Geo-Marine, Inc., Plano, TX and NAVFAC Pacific, Honolulu, HI.

Patenaude, N.J., W.J. Richardson, M.A. Smultea, W.R. Koski, G.W. Miller, B. Wursig, and C.R. Greene, Jr. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18:309-335.

Richardson, W.J., M.A. Fraker, B. Würsig, and R.S. Wells. 1985a. Behavior of bowhead whales *Balaena mysticetus* summering in the Beaufort Sea: reactions to industrial activities. Biological Conservation 32(3):195-230.

Richardson, W.J., C.R. Greene, and B. Würsig. 1985b. Behavior, disturbance responses and distribution of bowhead whales (*Balaena mysticetus*) in the eastern Beaufort Sea, 1980-84: A summary. OCS Study MMS 85-0034.

Richardson, W.J., B. Würsig, and C.R. Greene, Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. Journal of the Acoustical Society of America 79(4):1117-1128.

Richardson, W.J., B. Würsig, and C.R. Greene, Jr. Reactions of bowhead whales, *Balaena mysticetus*, to drilling and dredging noise in the Canadian Beaufort Sea. Marine Environmental Research 29(2):135-160.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, 576 pp.

Shane, S.H. 1990. Behavior and ecology of the bottlenose dolphin at Sannibel Island, Florida. Pages 245-266 in S. Leatherwood and R.R. Reeves, eds. The bottlenose dolphin. Academic Press, New York, NY, USA.

Simmonds, M. P., and L. F. Lopez-Jurado. 1991. Whales and the military. Nature 351:448.

Smultea, M.A. 1994. Segregation by humpback whale (*Megaptera novaeangliae*) cows with a calf in coastal habitat near the Island of Hawai'i. Canadian Journal of Zoology 72:805-811.

Smultea, M.A. 2008. *Visual survey for marine mammals and sea turtles in conjunction with RIMPAC navy exercises off Kauai and Niihau, 12-17 July 2008, Final Field Summary Report.* Prepared by Marine Mammal Research Consultants, Honolulu, HI, and Smultea Environmental Sciences, LLC., Issaquah, WA, under Contract No. N62742-08-P-1934 for Naval Facilities Engineering Command Pacific, EV2 Environmental Planning, Pearl Harbor, HI.

Smultea, M.A., T.R. Kieckhefer, and A.E. Bowles. 1995. Response of humpback whales to an observation aircraft as observed from shore near Kauai, Hawaii, for the 1994 Marine Mammal Research Program of the Acoustic Thermometry of Ocean Climate (ATOC) Study. Prepared by the Bioacoustics Research Program of the Cornell Laboratory of Ornithology, Cornell University, Ithaca, NY, USA. 46 pp.

Smultea, M.A., and B. Würsig. 1991. Behavioral reactions of bottlenose dolphins to the *Mega Borg II* oil spill, Gulf of Mexico 1990. Aquatic Mammals 21.3:171-181.

Smultea, M.A., J.L. Hayes, and A.M. Zoidis. 2007. Final Field Summary Report. Marine mammal visual survey in and near the Alenuihaha Channel and the Island of Hawai'i: Monitoring in support of Navy training exercises in the Hawai'i Range Complex, January 27 – February 2, 2007. Prepared by: Cetos Research Organization, Oakland, CA, under Contract No. N62742s-07-P-1895, Naval Facilities Engineering Command Pacific, EV3 Environmental Planning, Pearl Harbor, HI, USA. Authors: Smultea, M.A., J.L. Hopkins, and A.M. Zoidis. March 5, 2007.

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

Southall, B.L., A.E. Bowles, W.R. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33(4):411-522.

Tyack, P. L., M. Johnson, N. Aguilar Soto, A. Sturlese, and P. T. Madsen. 2006. Extreme diving of beaked whales. J. Exp. Biol. 209:4238-4253.

Urick, R.J. 1972. Noise signature of an aircraft in level flight over a hydrophone in the sea. Journal of the Acoustical Society of America 52(3, Pt. 2):993-999.

Würsig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne, and W.J. Richardson. 1985. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: A description. Fishery Bulletin 83:357-377.

Würsig, B., E.M. Dorsey, W.J. Richardson, and R.S. Wells. 1989. Feeding, aerial and play behavior of the bowhead whale, *Balaena mysticetus*, summering in the Beaufort Sea. Aquatic Mammals 15:27-37

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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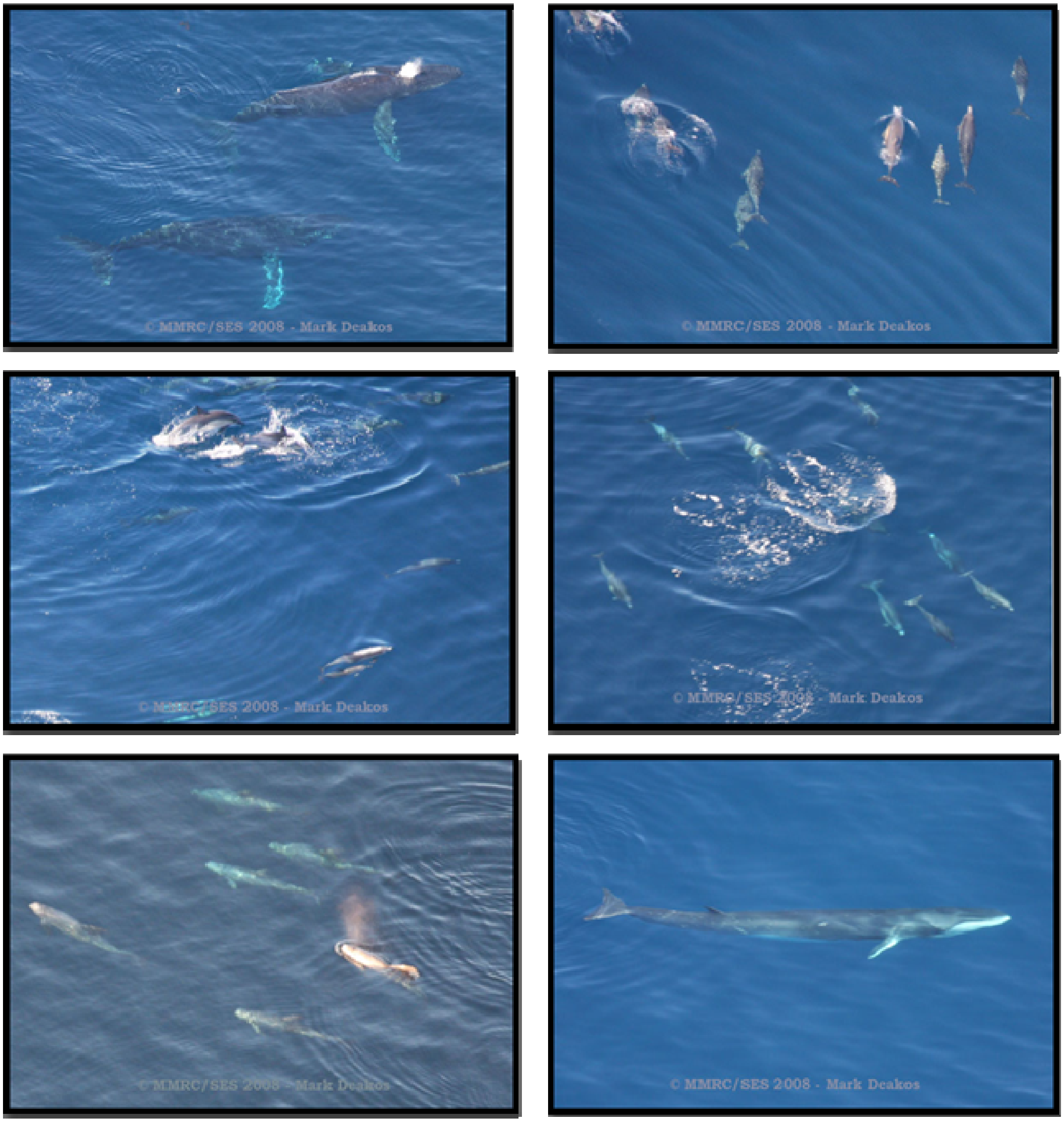
14-Nov	Fin whale	2	11:10	11:23	13	2	0	TR	Yes	No	2 fin whales traveling W, observed logging below the surface, traveling at slow pace, no obvious reaction to aircraft.
14-Nov	Unid. dolphin	2	11:34	11:44	9	18	unknown	SAC TR	No	No	Unidentified dolphin, traveling W, porpoising, possible common dolphin, dark 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.