AERIAL SURVEYS CONDUCTED IN THE SOCAL OPAREA FROM 01 AUGUST 2011 TO 31 JULY 2012

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Cover Photo: Gray whales (*Eschrichtius robustus*), photographed with a telephoto lens from the Partenavia fixed-wing aircraft during a winter 2012 SOCAL aerial monitoring survey. Photo by B. Würsig under NMFS permit 14451.

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Acronyms and Abbreviations

AC	alternating current
A/D	analog-to-digital
Ah	ampere-hours
CO	calibrated omni-directional
CSV	comma separated value
DC	direct-current
DoN	Department of the Navy
DF	direction-finding
DIFAR	directional frequency analysis and ranging
ft	foot/feet
FY	fiscal year
GPS	global positioning system
GUI	graphical user interface
hr	hour(s)
Hz	Hertz
ICMP	integrated comprehensive monitoring program
IDIQ	indefinite delivery/indefinite quantity
kHz	kilohertz
km	kilometer(s)
kt	knot(s)
LTSA	long term spectral average
m	meter(s)
MFAS	mid-frequency active sonar
mp	megapixel
MTE	major training exercise
NAOPA	Northern Air Operating Area
NMFS	National Marine Fisheries Service
NAVFAC	Naval Facilities Engineering Command
nm	nautical mile(s)
NOAA	National Oceanic and Atmospheric Administration
NTR	Navy technical representative
PAM	passive acoustic monitoring
RHIB	rigid-hull inflatable boat
RPM	rotations per minute
SAG	Scientific Advisory Group
SCB	Santa Catalina Basin
SD	secure digital
SES	Smultea Environmental Sciences
SIO	Scripps Institution of Oceanography
SNB	San Nicolas Basin
SOAR	Southern California Anti-Submarine Warfare Range
SOCAL	Southern California Range Complex
SMSMP	SOCAL Marine Species Monitoring Plan
VHF	very high frequency

Introduction

This report summarizes three aerial surveys conducted between 31 August 2011 and 31 July 2012 on the Navy's Southern California Range Complex (SOCAL), and includes results from the first year of deploying sonobuoys from the aircraft to simultaneously monitor both acoustic and visually-observed behaviors. This was the fourth fiscal year (FY) that aerial surveys have been conducted to obtain baseline data on the occurrence and behavior of marine mammals in SOCAL. The 2012 monitoring program addressed directives identified in the Navy's SOCAL Marine Species Monitoring Plan (SMSMP) (DoN 2011), Integrated Comprehensive Monitoring Program (ICMP) (DoN 2010) and the Scientific Advisory Group's (SAG) recommendations. Such baseline data are needed to assess future potential changes in these parameters (or lack thereof) relative to various received sound levels from mid-frequency active sonar (MFAS) and underwater detonations, and other major training exercise (MTE) activities.

Unlike in past years, surveys in FY 2012 did not overlap with any MTEs and occurred only in the Northern Air Operating Area (NAOPA [Santa Catalina Basin]) and the Southern California Anti-Submarine Warfare Range (SOAR [San Nicolas Basin]). The primary goals for the FY 2012 aerial surveys were:

1. Conduct approximately 100 hours of aerial visual survey effort using line-transect methodology to obtain data suitable for estimating the abundance and density of marine mammals for the second year during the cold-water season (November – May) defined in Carretta et al. (2000).
2. Conduct approximately 20 hours of aerial surveys to deploy passive acoustic monitoring (PAM) sonobuoys to match and further describe cetacean vocalization characteristics with confirmed species identification and group/behavior characteristics.
3. Conduct opportunistic focal behavior follows as time and effort allow.

The line-transect visual survey (30 Jan–5 Feb, 13–15 Mar, and 28 Mar–1 Apr) and acoustic-visual behavior study (7–10 Feb, 16 Mar, and 2–3 April) and methods are discussed in separate subsections below. Opportunistic focal-follow behavior data are mentioned briefly in the visual survey subsection but are presented in detail in the Navy's 2008-2012 Comprehensive Monitoring Report. Detailed summaries for each survey are presented in tables and figures (maps) in separate appendices as follows: Photos (**Appendix A**), Visual Survey Figures (**Appendix B**) and Tables (**Appendix C**), and Acoustic-Visual Behavior Survey Figures and Tables (**Appendix D**).

Visual Survey

Methods

Visual survey methods consisted of protocols implemented during aerial-survey monitoring efforts conducted in SOCAL during 12 previous aerial surveys (e.g., Smultea and Lomac-MacNair 2010, Smultea et al. 2011a,b,c,d) except that effort focused on line-transect surveys only, rather than on line-transect surveys and focal-behavioral follows (Smultea and Bacon 2012, Smultea et al. 2012 a,b). In accordance with past SOCAL aerial surveys (e.g., Smultea and Lomac-MacNair 2010), the first-observed behavior state, heading (degrees magnetic), and minimum and maximum dispersal distance (in estimated body lengths) between nearest neighbors within animal subgroups was recorded for each sighting as possible. Effort was divided into "on-effort" (at least one observer searching for animals) and "off-effort" (no observers searching; e.g., while flying over land, or while clouds obscured viewing). The "on-effort" category was further divided into percentage of time conducting line-transect surveys, connectors (i.e., short lines connecting systematic transect lines), transit, random, and circling modes (during "focal follow" and "identify" modes) (for detailed definitions see Smultea et al. 2009a,b and Smultea and Lomac-MacNair 2010).

All surveys were flown from a fixed-wing, twin-engine Partenavia P68-C equipped with center-seat bubble windows and one porthole opening in the left window at the rear bench seat (tail identification number N300LF, www.aspenhelicopters.com). This same aircraft model has been used in many past SOCAL aerial surveys/monitoring (e.g., Smultea et al. 2010), and during two of four 2011 SOCAL aerial surveys (Smultea et al. 2011a,b). Photographs were taken through the opening window by the data recorder in the rear seat to confirm species as needed by breaking from line-transect effort for several minutes then returning to the transect line. Photographs were prioritized for sightings made during line-transect effort given flight range/time restrictions and 2012 survey goals. High-resolution (18 megapixel [mp]) photographs often allowed subsequent identification of short- vs. long-beaked common dolphins, and other whale and dolphin species unidentified in the field. Photographs were later examined in detail by a species expert (T. Jefferson) who confirmed species as possible. Photographs were not typically taken for species easily confirmed visually in the field (e.g., fin whales and Risso's dolphins, respectively identified in the field by the right white jaw and conspicuous white coloration).

The primary exceptions to past survey protocols were:

1. The 2012 surveys were conducted on behalf of the Navy by Smultea Environmental Sciences (SES) under contract to HDR, Inc.
2. The Silver Strand area (located south of Point Loma) was not flown in 2012 (but was flown in winter 2011).
3. During the April survey period, a Sony HXR-NX5U NXCAM high-definition 16-mp professional video camera with a 20x zoom lens and internal image stabilization was rented to video the behavior of focal-follow groups. This video camera was rented to assess the higher frames per second (as it was twice as fast as the Sony video camera normally used) but the size of the camera was problematic to position in the small space of the plane and the small opening window. (As in past surveys, a Sony HD HDR-XR550 12-mp video camera was used during the January and March aerial surveys and an 18-mp Canon EOS 7D digital still camera was used for photographs [Smultea et al. 2011a,b]).
4. Throughout the 2012 survey period, Mysticetus Observation Platform software, (Entiat River Technologies, www.mysticetus.com), was used in place of a custom-designed Excel spreadsheet that had been used in most of the past surveys. This program improved efficiency of data collection by providing real-time distance and bearing to a sighting by synthesizing real-time Global Positioning System (GPS) data with declination angles (converted to distance) and sighting times. This feature was critical in helping the pilots relocate sightings quickly, even in higher Beaufort conditions when sightings are typically difficult to re-find. Relative location of the sighting to the aircraft was continuously

displayed on the laptop screen and adapted to changing distances and headings of the aircraft. The recorder communicated to the pilots how to adjust the flight pattern to relocate the sighting.

5. Ocean sunfish (*Mola mola*) sightings were recorded during the March 2011 survey (and continued through the 2012 survey period). This protocol was adopted in response to communications with Navy personnel indicating that there was a desire to collect information on other large marine species observable from the aircraft. Collection of shark and fish school counts and declination angles began during the 2011 survey (and continued throughout the 2012 survey period).

6. During aerial surveys in March and April 2012, data were collected to assess the accuracy of observer distance estimates made with the clinometer. This was accomplished by recording declination angle readings of a known location at the end of the Scripps' pier in San Diego while flying past the pier en route to and from the study area, and by obtaining a land-based GPS position for the end of the pier.

Results

The following subsections briefly summarize results with respect to marine mammal sightings for the three visual aerial surveys conducted in January–February, March, and March–April 2012. Similar to all past monitoring surveys in 2008-2011, no sea turtles were seen and they are thus not further addressed. Ocean sunfish sightings are summarized in **Appendix C, Table 1**. These sightings are excluded from the overall sighting counts for marine mammals. During the three 2012 surveys, 216 ocean sunfish were observed (**Appendix C, Table 1, Figure 6**). The highest number of individuals occurred in January (n=91), then March (n=65) and April (n=60). Relative effort during these periods is summarized in **Appendix C**. Other non-marine mammal animals seen during the line-transect surveys included: a red crab aggregation (extending 1 kilometer [km] long and about 200 meters [m] across), three groups of sharks (n=6), and one group (n=30) of yellow fin tuna near a kelp flotsam. Minimal information was recorded for such sightings to avoid compromising effort focused on searching for marine mammals and sea turtles.

a. Effort and Sightings

30 January to 5 February

The 30 January–5 February aerial survey was originally scheduled for 30 January–8 February; however, due to unusual, exceptionally calm waters associated with Santa Ana winds, this survey finished on 5 February when the allocated survey hours had been used. Two flights were conducted on 5 of the 7 survey days. A total of 34.5 hours (hr) or 5,973 km (3,225 nautical miles [nm]) of flight time from "wheels up" to "wheels down" was flown over 5 days in NAOPA (the Santa Catalina Basin [SCB]) and 2 days in SOAR (the San Nicolas Basin [SNB]) (an additional approximate 3 hr was used to ferry the aircraft back and forth from Oxnard to San Diego, California, plus approximately 2 hr of engines-on time on the runway (i.e., waiting in line to take off from the Montgomery Airport) (**Appendix C**). Observers were on watch for 96 percent of the 34.5 hr of in-airtime during systematic line-transect, transit, random, connector, and circling effort (the remaining 4 percent of time was over land between the airport and the water's edge) (**Appendix C**) (see Smultea and Lomac-MacNair 2010 for detailed protocol and definitions). The total hours and flight descriptions for each day by date are listed in **Appendix C**.

The January–February 2012 survey was the fifth SOCAL aerial monitoring effort conducted during the "cold-water" winter period (four occurred in 2011). A total of 227 sightings of an estimated 25,520 individual marine mammals representing at least 10 species were recorded over the 7 survey days (**Appendix C**). The most frequently sighted species in terms of both sightings (41, or 18 percent of 227) and individuals (76 percent of an estimated 25,520) were common dolphins. California sea lions were the second-most frequently recorded species in terms of number of sightings (40, or 18 percent of 227 sightings). Dall's porpoise was seen three times; this species was seen previously only during our cold-water surveys (one sighting in February 2011 and one in April 2011). Including 2011, we have seen gray whales only during the cold-water season (32 sightings in this 2012 late January/early February survey, and in 2011 there were 5 sightings in February, 5 in March, and 4 in April). Two species not seen during the February 2011 survey were observed: the northern right whale dolphin (four sightings) and humpback whale (one sighting). Unidentified whale and dolphin sightings occurred primarily during transits to and from the survey area when we did not have enough time to circle to identify species. **Appendix C** provides a list of all visual survey sightings and their GPS locations. A dead California sea lion was seen on 2 February 2012 (**Appendix C**). The dead California sea lion sighting was reported by the lead field biologist (Mari Smultea) to the Navy, who forwarded the information on to the National Marine Fisheries Service Southwest Regional Office.

13 to 15 March

During the second survey period two flights were conducted on each of the 3 survey days during 13–15 March, for a total of six flights (**Appendix C**). A total of 19.1 hours or 3,233 km (1,746 nm) of flight time from "wheels up" to "wheels down" was flown during this period over the SCB between the San Diego coastline and San Clemente Island (An additional approximately 3 hr was used to ferry the aircraft back and forth between Oxnard and San Diego, California, plus 54 minutes of engines-on time on the runway [**Appendix C**].). Stormy weather over 17–18 March precluded pre-planned surveys west of San Clemente Island in the SNB. Observers were on watch for 95 percent of flight time during systematic line-transect, connector, transit, and circling effort (the remaining 5 percent of time was over land between the airport and the water's edge) (**Appendix C**). Total hours and flight descriptions for each day by date are listed in **Appendix C**.

A total of 156 sightings of an estimated 11,084 individual marine mammals representing at least 10 species were recorded over the 3 survey days (**Appendix C**). Nineteen percent of the total 155 sightings were Risso's dolphins (n=30) followed by fin whales (15 percent or 23 sightings) and common dolphins (14 percent or 22 sightings). The common dolphin was the most frequently seen species in terms of number of individuals (approximate 9,732 or 88 percent of the total 11,084 individuals seen), followed by the Risso's dolphin (*n*=363) and bottlenose dolphin (*n*=255). **Appendix C** provides a list of all sightings and their GPS locations.

When results of the March 2012 (3,233 km [1,746 nm]of flight effort) and March 2011 (1,865 km [1,007 nm] of flight effort) aerial surveys were compared, some differences were notable (however, flight effort in 2012 was nearly double that in 2011). For example, the northern right whale dolphin was not seen during March 2012 but was seen four times in March 2011. Twenty sightings of 45 individual gray whales were made during March 2012 vs. five sightings of 14 individuals during March 2011. In addition, 23 fin whale sightings of 40 individuals were made in March 2012 while no fin whales were seen in March 2011.

28 March to 1 April

Surveys were dedicated to line-transect effort 28 March–1 April. Two flights occurred on each of these four dates for a total of eight flights (**Appendix C**). All survey effort occurred in the SCB because low marine clouds precluded observations west of San Clemente Island in the SNB on the days we had scheduled to fly there (**Appendix C**). A total of 26.9 hr or 4,528 km (2,445 nm) of flight time from "wheels up" to "wheels down" was flown over 5 days in the SCB. (An additional approximate 3 hr was used to ferry the aircraft back and forth between Oxnard and San Diego, California, plus 1.2 hr of engines-on time on the runway [**Appendix C**]**.**). Observers were on watch for 96 percent of this time during systematic line-transect, random, connector, transit, and circling effort (the remaining 4 percent of time was over land between the airport and the water's edge) (**Appendix C**). Total hours and flight descriptions for each day by date are listed in **Appendix C**.

This survey was the seventh SOCAL aerial monitoring effort conducted during the "cold-water" winter period (four occurred in 2011 and two earlier in 2012). A total of 125 sightings of an estimated 5,725 individual marine mammals representing at least 10 species were recorded over the 5 survey days (**Appendix C**). The most frequently sighted species were common dolphins (17, or 14 percent of 125) and Risso's dolphins (also 17, or 14 percent of 125 sightings). In terms of number of individuals, common dolphins were the most frequently seen species (1,776, or 31 percent of the estimated total of 5,720 individuals of all species) (**Appendix C**). Including 2011, we have seen gray whales only during the cold-water season (12 sightings in this 2012 late March/April survey and in 2011, 5 sightings in February, 5 in March, and 4 in April). Four species seen during the April 2011 survey were not observed in April 2012: the blue whale (three sightings in 2011), the northern right whale dolphin (two 2012 sightings), the minke whale (two 2012 sightings), and the Dall's porpoise (one 2012 sighting). **Appendix C** provides a list of all sightings and their GPS locations.

b. Photography/Videography

Over 3,821 digital photos were taken during 101 (20 percent) of the total 508 sightings made during the three visual survey periods in 2012 (**Appendix C**). As indicated previously, photographs were taken primarily of unusual/rare sightings and unidentified species to confirm or verify species as possible, focusing on periods of line-transect effort rather than transit periods (see Methods above). Species photographed during the first 2012 survey in January were the fin whale, gray whale, Risso's dolphin, common dolphin sp., short-beaked common dolphin, long-beaked common dolphin, Dall's porpoise, northern right whale dolphin, bottlenose dolphin, and California sea lion (including one dead California sea lion) (**Appendix C**). Of the total 3,815 photos, over 1,026 digital photos were taken during the February survey, approximately 1,868 during the March survey, and 921 during the April survey.

During the three 2012 aerial surveys, a total of 193 minutes of video was taken during focal follows, which is preliminarily considered useable for behavioral analyses based on initial video review (**Appendix C**). Video included footage of systematic observations of the behavior of fin whales, bottlenose dolphins, Risso's dolphins, northern right whale dolphins, long-beaked common dolphins, and common dolphin sp. using focal behavioral protocol. About 54 minutes of video was taken during the February survey, about 82 min during the March survey, and about 57 minutes during the April survey.

c. Summary of Behavioral Analyses

Behavior data were to be summarized similarly to previous SOCAL aerial survey reports from 2008-2011 (e.g., Smultea et al. 2009a,b, Smultea and Lomac-MacNair 2010, Smultea et al. 2010). Thus, behavioral analyses focused on first-observed behaviors from all sightings, as available. Summary statistics for behavioral data collected during the 2012 aerial surveys are presented in the SOCAL section of the Navy's 2008-2012 Comprehensive Monitoring Report (DoN 2012 in prep.). Statistical analyses were conducted by and in consultation with professional biostatisticians from West Inc. Analyses focused on those parameters identified as potential quantitative indicators of stress based on previous studies of different or similar species (e.g., summarized in Richardson et al. 1985a,b, 1995; Smultea and Würsig 1995; also see Würsig et al. 1985, 1986, 1989; Vaughn et al. 2010). These included the following dependent variables: (1) dispersal distance between nearest individuals within a subgroup, (2) behavior state, (3) heading/reorientation rates, and (4) group size.

In 2012, preliminary analyses showed that 29 focal follows were conducted on six different species totaling 193 minutes of video (see **Appendix C**). Analyses of these behavioral data were limited to focal follows of Risso's dolphins as presented in the Comprehensive Monitoring Report for the 2008-2012 data. The Risso's dolphin was selected for focal-group behavioral analyses because: (1) sample size was the largest of any species (around 50 focal groups during 2008-2012), and (2) it is identified as a priority species in the Navy' SOCAL Monitoring Plan as well as the ongoing SOCAL Behavioral Response Study (www.sea-inc.net/socal-brs/). Funding was not available in FY 2012 to conduct analyses of extended focal follows of other species, including potential respiration and dive parameters and behavioral event frequencies of fin and blue whales.

Summaries of behavioral data included herein are: (1) a tabular list of focal groups and associated descriptors; and (2) an inventory list of video names, times, durations, subjects, and brief content summaries (**Appendix C**). Associated video data summary formats and protocols followed those developed and provided to the Navy by SES in spring 2011 (Smultea and Bacon 2011, SES, unpublished data).

Acoustic-Visual Behavior Study

The acoustic-visual behavior study was a pilot study designed to simultaneously collect both visual and acoustic data from focal groups of whales and dolphins being monitored from an aircraft circling overhead. Project goals included: (1) integration of hardware and software to allow simultaneous acoustic and visual data-collection and processing, and (2) real-time mapping of acoustic and visual data for marine mammals. Our ultimate goal was to attempt to provide information about behaviors of whales that can be detected acoustically, and to attempt to correlate these with surface and sub-surface behaviors (as monitored from the airplane in real-time and recorded on video and/or audio). Sonobuoy deployments were also intended to provide important information on the general acoustic environment in the near vicinity of focal groups (e.g., anthropogenic noise, other marine mammal sounds, and natural noise).

Achieving these goals presented many challenges, including real-time acquisition, processing display, and integration of visual and acoustic data. Space and weight limitations on the small Partenavia aircraft were considerable, and required personnel and equipment to be kept to a bare minimum. Finally, the complexity of simultaneously monitoring recordings and processing acoustic and visual data in real-time was significant. However, the success of previous visual-behavioral monitoring surveys in this program provided a great opportunity for us to further the use and integration of these remote passive technologies for monitoring marine mammals and the effects of anthropogenic activities on these animals.

Sonobuoys are expendable devices that were originally designed for the U.S. Navy to be dropped from aircraft to remotely monitor underwater sounds from ships and submarines (Richardson et al. 1995). There are various models available, and the DIFAR (directional frequency analysis and ranging) DF (direction-finding)-capable model has been shown to be a particularly useful tool in marine mammal bioacoustic research (McDonald 2004). In general, sonobuoys are most commonly deployed from research ships to remotely collect acoustic data on marine mammals (Norris et al. 1999, Swartz et al. 2003, Rankin et al. 2006, Stafford et al. 2008). However, they have been deployed from aircraft to study bowhead whales (Ljungblad et al. 1982; Würsig et al. 1985), gray whales and, killer whales (Ljungblad and Moore 1983), right whales (Laurinolli et al. 2003), and humpback whales (Levenson and Leapley 1978). Most of these studies did not attempt to localize animals in real-time. A very recent study by the National Marine Mammal Laboratory on right whales in the Bering sea deployed DIFAR sonobuoys to detect and locate North Pacific endangered right whales in real-time as part of a larger study (Rone et al. in press).

Methods

The methods used in this component of the study involved integrating established visually based behavioral monitoring protocols (e.g., see Smultea and Lomac-MacNair 2010) with PAM methods using sonobuoys. The integration was mostly implemented by modifying existing software programs that were already in use for aerial surveys (e.g., Mysticetus) or were developed for passive acoustic data acquisition and processing.

Equipment and Personnel Configuration in the Aircraft

The same aircraft was used as in the visual line-transect surveys (a twin-engine Partenavia P68-C) but was modified with a sonobuoy deployment chute. The chute was installed in the existing belly window port (located between the rear bench and center right seats; **Appendix D, Photo 1**). In addition, very high frequency (VHF) antennas were mounted to the undersides of each wing to receive the sonobuoy signals. Various seat configurations were tested to allow personnel, equipment and sonobuoys to be accommodated. As described below, for the first three flight days (8 and 9 February, and 16 March), the two single middle-window seats were removed so that sonobuoys could be loaded in their place; for the remaining flight days, all seats remained intact (**Appendix D, Photo 2**).

Acoustic hardware was mounted in a small acoustic equipment case and strapped to the rear bench-seat between two field personnel sitting on either side of it next to the windows. In this configuration, the primary observer/videographer/photographer was located on the left side of the rear bench seat so that he/she could videotape/photograph through the one opening porthole in the rear window. The bioacoustician was located in the right side of rear bench seat. This configuration allowed ample room for equipment and sonobuoy storage, but restricted the movement of the videographer/photographer. Photographs were taken through a small opening in the window by the left observer when necessary to confirm species or document other aspects of the focal group. The bioacoustician operated the acoustic monitoring and recording equipment. In this configuration, the bioacoustician also plotted sonobuoy drop locations and resights on a laptop.

For the last 3 flight days we used a different seating configuration in which the middle right seat was turned backwards and the acoustic equipment rack was mounted onto it. The bioacoustician sat in the left middle seat to monitor the acoustic software and hardware. A computer operator/observer sat in the right side of the rear bench seat to operate the aerial-datalogging program Mysticetus, deploy sonobuoys, and secondarily to observe/videotape behavioral data when possible. This configuration provided slightly less space, but allowed more mobility for the observer/videographer. Three scientific personnel participated in the afternoon flights on the last 2 survey days: one bioacoustician in the middle left seat, one observer/videographer/ photographer in the left side of the rearbench seat, and a computer operator to run Mysticetus and deploy sonobuoys as needed.

With four personnel onboard (two pilots, bioacoustician, and observer/videographer/computer operator) and 4-6 sonobuoys, flight duration was limited to about 3.5-5 hr. With five personnel (two pilots, bioacoustician, computer operator, and observer/videographer/photographer), flight duration was limited to only 1.5-2 hr, depending on weight of personnel and the total number of sonobuoys loaded for the flight. Also, when multiple sonobuoys were deployed early in the flight, flight durations were somewhat increased.

Equipment

Prior to each flight, model AN/SSQ-53F sonobuoys were prepared for deployment by manually selecting the settings via an electronic controller. One of the following two operating modes was selected: (1) DF or (2) Calibrated Omni-directional (CO). DF mode was used to collect data on low-frequency sounds (5-2,400 hertz [Hz]) and bearings to sounds of interest. CO mode was used to collect higher frequency sounds (5–20,000 Hz); however, in CO mode, individual sonobuoys were not capable of obtaining data on directions to a sound source. Other sonobuoy settings that were manually pre-selected included: hydrophone depth (usually 90 feet [ft]), operating duration (usually either 4 or 8 hr), and automatic gain control (always off). Typically, 3-6 sonobuoys were loaded into the plane for each flight, with the exact number dependent upon weight limitations of the flight relative to the total weight of personnel and fuel onboard.

Field Methods

Focal groups of cetaceans were located by conducting directed (i.e., non-random) searches of areas where sightings were made during previous line-transect surveys, or in areas where high densities of animals were expected to occur based on pilot and observer experience. All species identifications were confirmed (from photographs and/or based on the judgment of an experienced observer[s]). Animals were circled at an altitude of about 1,000–1,500 ft and a radial distance of around 0.5–1 km to avoid potential disturbance of the focal animals. After approximate group size and general heading or orientation of the focal group was determined, one or more sonobuoys were deployed at a location such that the focal group was oriented (or moving) towards the sonobuoy. Sonobuoys were dropped at least 250 m from animals to minimize any potential responses to the splash caused by the sonobuoy impact on the ocean surface. This distance was based on expert advice from experienced observers who have dropped sonobuoys on whales and other species (Richardson et al. 1985b). Priority species for baleen whales included (in general order of priority): fin, humpback, and gray whales. Priority species for toothed whales and dolphins (in general order of priority) included Risso's dolphins and offshore bottlenose dolphins.

Sonobuoys were deployed manually by dropping them through the sonobuoy chute. In most deployments, one or two non-toxic (fluorescein) dye-markers (**Appendix D, Photo 2**) were dropped immediately after each sonobuoy to provide a visible cue on the water surface to assist the pilots and observers in re-locating the sonobuoys for position updates (Würsig et al. 1985; Forney and Barlow 1993). The deployment time of the sonobuoy was noted verbally on the audio recorder and entered into the computer to be matched with a GPS position. Sonobuoy re-sight locations were made by either flying directly over the sonobuoy and marking the position or by using a clinometer to take declination readings to the sonobuoy when it was approximately perpendicular to the airplane.

After sonobuoy deployment, the aircraft continued circling while attempting to maintain a constant altitude (1000–1,500 ft) and horizontal distance (0.5–1 km) to the focal group. Behavioral observations (via voice narration), photographs, and video were taken as possible during sonobuoy monitoring. Voice narration was made during most observations and was recorded using a dedicated handheld, digital audio recorder. During later flights, voice recordings were made on the fourth channel of the sonobuoy signal receiver using a miniature microphone taped inside a spare set of aviation headphones.

Sonobuoy-Acoustic System

The sonobuoy-acoustic recording system consisted of two sonobuoy-radio receivers, a digital recorder, an external analog-to-digital (A/D) sound card, a time-code generator (for the last three surveys), and 7.2 or 12 ampere-hr (Ah) sealed lead-acid batteries to power the laptop computer and digital recorder (**Appendix D, Figure 1**). A Tascam DR-680 portable digital recorder was the main audio recorder. This secure digital (SD) card recorder could record 2, 4 or 6 channels of audio data at 48 or 96 kilohertz (kHz) sample rates. Initially, only sonobuoy data were recorded on two channels (at 48 kHz). However, after the first survey series (8–10 February), audio-narration was recorded on a third channel to facilitate synchronization of sonobuoy recordings to video and behavioral audio-narration data. On one survey (16 March), a portable time-code generator was recorded on the fourth audio channel to allow precise time records to be included on the same audio recordings. All of these latter recordings consisted of four channels recorded at 48 kHz sample rates.

Two Winradio (model WR-G39WSBe) sonobuoy receivers were used to receive and monitor sonobuoy radio and audio signals. These receivers were controlled via software running on a Dell ATG laptop computer or an IBM T60. The audio channel from each of the two sonobuoy receivers was fed into the Tascam recorder. Analog outputs from the Tascam recorder were fed into a Soundblaster Audigy NX external sound card capable of digitizing two channels of audio data. The external sound card was connected to a laptop computer running Ishmael real-time sound acquisition and processing software. Both the recorder and the external sound card sampled the audio data at 48 kHz, allowing for an effective audio frequency range of 24 kHz.

Audio data from the external sound card were displayed as real-time spectrograms using Ishmael acoustic analysis software (Mellinger 2001). Pre-saved Ishmael settings (i.e., *.ipf files) were loaded as needed to allow quick viewing of calls from different species or audio channels in real-time display. Recordings were made as possible in Ishmael when DF processing was not occurring (recording in Ishmael had to be stopped to process DF data) so not all data were recorded. Ishmael was only used as a backup recording system to the Tascam recorder. When underway, Ishmael was used to acquire acoustic data from the Winradio receivers (passed through the Tascam recorder) and pass them on to the DF processing program 'DIFAR'. When sounds of interest were detected by the acoustic operator, the spectrogram was stopped, the signal was selected by 'windowing' it, and it was passed on to the MATLAB algorithm 'DIFAR' for further processing (**Appendix D, Figure 2**).

DIFAR Processing

DIFAR signal processing was accomplished using 'DIFAR' software custom written in MATLAB. This program was originally written by M. McDonald (WhaleAcoustics) and modified by C. Berschok (National Oceanic and Atmospheric Administration [NOAA]/National Marine Mammal Laboratory, Seattle). Bio-Waves Inc. further modified DIFAR to allow improved viewing and bearing picking of short sound files that were sent to MATLAB from the Ishmael program. Modifications mostly involved the graphical user interface (GUI) via the addition of multi-channel spectrograms to correlate and compare to the DIFAR-grams so data could be more easily interpreted in real time (**Appendix D, Figure 2**).

Because the directional information from the sonobuoys is multiplexed in the upper frequencies of the audio signal (**Appendix D, Figure 3**), a de-multiplexing algorithm (purchased from Greeneridge Sciences, Inc.) was needed to decode the bearing information coded in the upper frequencies of the audio signal (McDonald 2004).

For the first 3 survey days (8–10 February) we plotted the airplane track, sonobuoy locations (i.e., the position of the sonobuoy drop), and sonobuoy bearings to signals using a single laptop computer running the programs Ishmael and DIFAR. However, it soon became apparent that this approach was inefficient. Processing the audio signals in Ishmael and plotting sonobuoy positions, bearings, and plane locations using DIFAR created problems with reliable data-collection of the aircraft positions due to occasional software crashes. Furthermore, because the program DIFAR is intended primarily as a sonobuoy-analysis program, it was not capable of plotting animal positions from clinometer readings on the map. Finally, because the DIFAR program is compiled in MATLAB, it runs relatively slowly, uses a large proportion of computer memory, and has more limited real-time data display and mapping capabilities than dedicated software.

Because of these issues, we decided to use the program Mysticetus (Entiat River Technologies) as the primary non-acoustic datalogging and geo-spatial software for the remaining surveys (16 March and 2–3 April). This program was developed specifically for geo-spatial plotting of the aircraft, animal positions, and behaviors (for details of protocols see Smultea and Bacon 2011; Smultea et al. 2012b). Modifications to the software allowed sonobuoy positions and bearings to animal calls to be plotted on a map in real time. In this configuration, two computers/operators were used. One computer (an IBM T60 running Windows 7) ran the acoustic programs Ishmael and DIFAR, and the second computer (an Acer Aspire running 64-bit Windows 7) ran the aerial survey and behavioral monitoring program Mysticetus. A wired Ethernet connection (cat6 via small passive hub) was used to share information between the two computers. Data were transferred between computer programs using simple comma-separated value (CSV) files that included the basic information needed to identify sonobuoys and plot bearings to sound sources (**Appendix E**).

Post-Processing

Due to limited time and multi-tasking requirements for the bioacoustician and computer operator during a flight, it was necessary to post-process data. Acoustic data recorded from both the Tascam digital recorder and the Ishmael computers (when available) were used. All acoustic data were first reviewed in Triton from long-term spectral averages (LTSA's) and spectrograms, so that acoustic events could be quickly identified and summarized. All species-call events were logged in Triton using 2 minutes as the largest time period separating new events. Anthropogenic-noise events such as boat and ship noise, sonar events, and (our) airplane noise during direct over-flights of the sonobuoy were logged in the same manner. These data were compiled into spreadsheets from which call and noise events were summarized.

Protocols for DF data analyses were similar to real-time processing except that notes and comments could be made on the DF bearings in the resulting CSV files that were generated from the DIFAR program. Individual (one-line) CSV files were compiled into a single spreadsheet that could be imported into the program Mysticetus for plotting on a map. Detailed protocols for post-processing are provided in **Appendix E.**

Post-processing of acoustic data provided more detailed information about animal positions, but in many cases the large numbers of bearings we obtained were difficult to interpret (**Appendix D, Figure 4**). Because some of the bearing data were of poor quality, and others had different signal strengths (i.e., originating from animals from different distances and, thus, locations) we decided to include this information in the data. The quality of bearings was already saved with the bearing data when processing it with DIFAR (**Appendix D, Figure 5**). We visually assessed relative signal strength of all calls and appended this information with the bearing analysis results. When post-processing, this information could then include relative signal intensity as a proxy for the relative distance of the calling animal. Bearing quality and signal strength "filters" were developed in Mysticetus specifically for these data. This allowed the user to remove poor quality data or low-level calls from the data and provided a simple way to quickly filter and display data on a map (**Appendix D, Figure 6**). This greatly facilitated the display and interpretation of bearing data and allowed potential calls from animals in the focal group to be better assessed (**Appendix D, Figure 6).**

Integration of Acoustic and Visual Data and Post-Processing

Integration of acoustic and visual data during post-processing involved several steps. Selected videos recordings of focal follows with concurrent good-quality acoustic recordings (see above) were transcribed onto customized Excel datasheets formatted to integrate the visual-acoustic behavior data. Video data were supplemented by listening to voice recordings for periods when video recordings were not available. Following previous focal-follow protocols (e.g., Smultea and Lomac-MacNair 2010; Smultea et al. 2011a,b,c,d), transcribed times of whale behavioral events, behavioral states, whale headings, and minimum and maximum dispersal distances between nearest neighbors within a group were noted, as were unusual behaviors (e.g., whales touching). Sonobuoy deployment times, whale sightings, and vessels in the immediate area were also noted when information was provided. Sonobuoy data included call type and relative signal intensity, and bearing of the call (when available). These data were then merged using times for both datasets. Finally, this database was compared with maps and plots of sightings, bearings to calls from sonobuoys, aircraft tracklines, and sonobuoy locations.

Mysticetus Updates

The Mysticetus Observation Platform used for the sonobuoy flights was modified in a number of significant ways, both for use in the airplane in real-time as well as during the later post-processing phase:

1. Mysticetus was modified to monitor a special location in the file system for the creation of CSV files. This is the location where the DIFAR program wrote its information across via an Ethernet network to a shared folder. Mysticetus then processed the CSV file to extract the information necessary to (a) associate acoustic bearings with a buoy and (b) plot those bearings on the map window already present in Mysticetus.
2. Mysticetus was further augmented to allow the saving and loading of these data for future analysis. Other changes, including the ability to save to various other applications (e.g., Microsoft Excel or Google Earth) were implemented.
3. For post-processing, the ability to read bulk acoustic bearings was added to Mysticetus. As post-flight analysis of the acoustic data generated more—and more refined—acoustic bearings, Mysticetus could read these new data en masse, without the need for hand entry. All other functions (map plotting, export, etc.) were then available.
4. While performing the actual post-processing, it was determined it would be more efficient for Mysticetus to provide a chronological filter on its display. Thus, Mysticetus was augmented with a time-scale filter mechanism that allowed the post-process operator to specify the exact timeframe to examine. Mysticetus only displayed airplane tracks, buoy drop points and acoustic bearing lines that were recorded within the specified time constraint, as needed.
5. Similarly, “quality” filters were added to Mysticetus so we could limit the display of acoustic bearing lines to those signals that were deemed to be nearby.

Results

Seven partial or whole flight days with sonobuoy effort occurred, for a total of 23.7 hr of flight effort (**Appendix D, Table 1**). A total of 23 sonobuoys were deployed: 21 in the DF mode and 2 in the CO mode (**Appendix D, Tables 2 and 3**). The total 23 sonobuoys were deployed as follows: 1 during initial testing in the Santa Barbara Channel, 12 on fin whale focal groups (1 of which failed), 6 on gray whales (1 of which failed), 2 on a solitary humpback whale (but only fin whale sounds were detected), and 2 (both CO mode) on Risso's dolphins. One of the sonobuoy failures occurred because its flotation bag did not deploy (a common source of failure). Overall, the sonobuoy failure rate was approximately 9 percent (2 of 23 sonobuoys).

Real-Time Acoustic Bearings and Localizations

Real-time acoustic bearing and localization processing was attempted during the flights with mixed results. For the first few days of survey effort (in which sonobuoys were deployed sparsely) we were able to obtain bearings for most deployments in real-time. However, due to the constant circling, it was rarely absolutely certain if the focal animals that were being visually observed were the same individuals acoustically monitored. Due mostly to initial software issues, we were unable to obtain reliable cross-fix localizations in real-time for focal follows (see previous discussion related to computer issues).

Post-Processing Results

We focused detailed post-processing on data that we considered to provide the best available combination of geo-spatial acoustic and visual behavior data (i.e., airplane and sonobuoy locations). Although sounds from several species were recorded, we chose to focus most of our post-processing effort on fin whale encounters. This is because fin whales produced extended call bouts with very high signal-to-noise calls that were easy to detect and process. We did very limited analyses of gray whale sounds, only to compare and contrast the differences between these two species.

Sounds were detected from three of four target/focal species on which sonobuoys were deployed. Although possible humpback calls were detected during a sonobuoy deployment on gray whales, they were not detected during a deployment on a solitary humpback whale (**Appendix D, Table 2**). Calling events were greatest for fin whales, with 88 percent of calling event durations attributed to this species (**Appendix D, Figure 7**). When anthropogenic sounds are included in the totals of event durations, fin whale calling events represented just less than 70 percent of the total, with approximately 21 percent of the sounds recorded due to anthropogenic sources, and the remaining 9 percent of the total attributed to fish and other species of marine mammals (**Appendix D, Figure 8**).

Baleen Whale Sounds Detected

Recordings were made on focal groups containing three species of baleen whales (fin, humpback, and gray whales [**Appendix D, Figure 9 and Table 3**]). Sounds were detected for all three species, but call rates for the gray whales (4 percent) and humpback whales (1 percent) were extremely low (**Appendix D, Table 4**). With the exception of this humpback whale, all sonobuoy deployments occurred on focal groups containing at least two animals. The humpback whale was sighted while trying, unsuccessfully, to relocate a group of fin whales. The humpback whale was confirmed by an experienced observer and by inspection of photographs.

Fin whale calls consisted of intense, low-frequency calls of two types of signals: 80-20-Hz downsweeps and 20-Hz pulses (**Appendix D, Figure 10**). Fin whale calling rates were the highest of all species recorded, with calling events ranging as high as 83 percent of total time recorded for each focal group (**Appendix D, Table 4**). As an example, over 250 fin whale calls were detected during just 1 hour of a recording of a focal group of 3-5 animals on 9 February. The data collected from this focal group were analyzed in greater detail as one of the case studies below.

Sonobuoys were deployed on focal groups of gray whales on two separate occasions. In general, gray whales did not produce loud or frequent calls. In some cases, suspected gray whale calls were of too low intensity to be classified. We were able to identify only one call type that was similar to the "S3" call type described by Dahlheim (1987; **Appendix D, Figure 11**). Bearings to calls could not be determined for these low signal-to-noise gray whale sounds; therefore, we did not conduct bearing analysis of these data.

Dolphin Sounds Detected

We detected dolphin sounds during two focal recordings. In one case, we recorded whistles presumed to be produced by a group of bottlenose dolphins (not a focal group) that was seen relatively close to our sonobuoys. These sonobuoys had been deployed on a focal group of gray whales. In the second case, two CO sonobuoys were deployed near a small group of Risso's dolphins. Vocalization rates for the Risso's dolphins (as a function of group, not individuals) were extremely low. Of the 22 minutes of recordings that were saved from this encounter, only 17 seconds contained whistles.

Non-Focal Species

Calls from non-focal species that were detected in recordings included dolphin whistles (probably bottlenose dolphins—see above), sea-lion barks, and a variety of fish sounds (**Appendix D, Figure 12**).

Anthropogenic Noise

We detected a variety of anthropogenic sounds including small boats, medium-sized vessels (e.g., whale-watching boats), bulk-carriers, and container ships (**Appendix D, Figure 13**). Sonar was also detected but was not detected with enough samples for a detailed analysis (**Appendix D, Figure 14**). Finally, we occasionally detected brief periods (less than 5-12 seconds) of propeller/engine sounds from our aircraft during overflights of the sonobuoys (**Appendix D, Figure 15**).

Sonar was detected on several occasions during the 2012 sonobuoy monitoring. Two types of sonar were most common: 1.4-kHz pings (**Appendix D, Figure 14**) and 12-kHz pings. The 12-kHz sonar was detected from the CO sonobuoys deployed near Risso's dolphins. Interestingly, even though only a few whistles were identified during this brief recording, for several of the whistles we detected possible mimicry by the Risso's dolphins of the sonar signal (**Appendix D, Figure 16**).

Further inspection of the spectrogram of noise from our aircraft indicated that it was broadband in nature, with multiple harmonics and dominant frequencies mostly below approximately 600 Hz. For aircraft noise, the fundamental frequencies and harmonic intervals are usually indicative of the rotations per minute (RPM) and number of propeller blades. The duration of the recorded sound was usually brief (less than approximately 12 seconds) as it passed above the sonobuoy. This is consistent with the principles of Snell's law, whereby sound transmission from the air to water is greatest within a 26-degree sound cone under the aircraft (Urick 1972; reviewed in Richardson et al. 1995).

Case Studies—Selected Focal Groups

9 February Fin Whales

On 9 February at approximately 12:20 a group of five fin whales was sighted traveling north (magnetic) at medium speed about 15 km west of Carlsbad (**Appendix D, Photo 3**). Fin whales were circled in this general location by the aircraft for a total of 2.2 hr until 14:31. A map of this encounter displaying plane tracks, sonobuoy and whale locations, and bearings to recorded calls is provided in **Appendix D, Figure 17**. During this time period three sonobuoys were deployed and video was recorded. Although five individual fin whales were initially seen together for the first minute of the focal session, later re-sightings of what was believed to be part of this same group consisted of only 1-3 whales at the surface at any one time. Our overall impression based on visual and acoustic data (including evidence of counter calling) was that there were numerous fin whales in the general area (approximate 5–10+ km radius), and that the initial group of five fin whales split into smaller groups about 1 minute after they were first seen. A chronological summary of events by time is provided in **Appendix D, Table 5**.

The first of the three DF sonobuoys was deployed at approximately 12:30, the second at approximately 12:53, and the third near the end of the focal follow at 14:04 (**Appendix D, Figure 18 and Table 5**). All three sonobuoys were successfully recorded and resighted. Fin whale calls were detected immediately after dropping all three sonobuoys, with fewer calls detected immediately after dropping the second sonobuoy than the first (**Appendix D, Table 5 and Figures 19-20**).

We conducted a detailed analysis of these data using recordings from all three sonobuoys, visual observation data and video recordings. Approximately 2 hr of audio recordings from sonobuoys were made, with over 350 calls from fin whales detected. Visual inspection of an LTSA and spectrogram sequence of fin whale calls indicated that counter-calling was possibly occurring (**Appendix D, Figure 19**). A detailed analysis of one of these call bouts from 13:14 to 13:29 indicates calls and counter-calls were originating from different bearings and had received different signal strengths (**Appendix D, Figure 20 and Table 5**). Due to the differences in relative intensity and bearings of these calls, we believe that these calls came from at least two different animals (or groups of animals) that may have been in acoustic communication with each other. Plots of the bearings showed that some bearings passed through the region where animals were expected to occur (based on the circling path of the aircraft during the same time period and/or declination angles of animal positions taken from the aircraft) (**Appendix D, Figure 20**). However, given the limited number of sonobuoys and their configuration, we were not able to localize calls to individual animals, so we could not confirm the distances over which animals were communicating.

Fin whales were within view of the aircraft observers intermittently, usually for periods of several minutes separated by periods of about 5-15 minutes when they were out of view below the surface on a dive (**Appendix D, Table 5**). After the initial sighting of five fin whales, only one to three individuals were observed at any one time. Throughout the focal session, fin whales (while in view) traveled at medium speed (wake but no white water, approximately 4–6 knots [kt]) (Smultea et al. 2009a), spaced a maximum of about 2–6 body lengths apart. They were initially headed north at 12:34 then primarily west with a short bout of travel to the southwest (**Appendix**

D, Table 5 and Figure 17). Based on video and audio descriptions no other surface behaviors were observed besides traveling and blowing.

Fin whales were calling nearly continuously in bouts while sonobuoys were deployed, at various signal strengths; (**Appendix D, Figures 19 and 20 and Table 5**). From one to three fin whales were within view of aircraft observers during some of these call periods (**Appendix D, Table 5 and Figure 20**). Although bearings were obtained for approximately 50 percent of the calls during this focal period, it is not possible with the available data to determine if individual whales seen at or below the water surface were calling (i.e., it cannot be determined if a fin whale(s) below the surface and out of view was calling or whether it was an individual within view at or just below the surface). There was a distinct period from around 13:05 to 13:15 when two fin whales were observed twice at or near the surface but no calls were recorded (**Appendix D, Figure 20**). Video was taken, as possible, during the periods when whales were at the surface; however, because the videographer was also responsible for launching the sonobuoy, video footage was intermittent and discontinuous. Thus, video data were supplemented with voice recordings (see Methods).

10 February Gray Whales

On 10 February, aircraft-based sonobuoy/behavior monitoring efforts were opportunistically coordinated with a small vessel (i.e., a rigid-hull inflatable boat [RHIB] operated by G. Campbell of Scripps' Institution of Oceanography [SIO]). Before the aircraft left the airport that day, the RHIB crew relayed the position of a group of two gray whales to the aircraft science team via cell phone. At approximately 10:15, a group of two gray whales (**Appendix D, Photo 5**) was spotted by the aircraft just west/northwest of Oceanside Harbor. The location was relayed to the RHIB, which quickly repositioned to the area. A sonobuoy was dropped around 10:25. This sonobuoy failed to operate (the floatation bag never inflated). A second sonobuoy was dropped at 10:29 and soon thereafter recordings were started. A third sonobuoy was dropped at approximately 10:45. At about 11:00, we realized that the second sonobuoy's hydrophone was most likely touching the ocean bottom. This determination was based on sounds being monitored from the sonobuoy which sounded like intermittent knocks. Also, it was determined by the RHIB that water depth was less than 90 ft in the deployment location.

Fortunately, the RHIB crew was contacted and was able to pick up the sonobuoy, shorten the hydrophone cable, and reposition it closer to the traveling whales, thereby extending the duration of the sonobuoy recording (see **Appendix D, Figure 21**). During a brief surface series for the two gray whales, an SIO biologist in the RHIB was able to quickly collect photo-identification data and a biopsy sample from the gray whales without disrupting observation efforts from the plane (see **Appendix D**, **Table 3, Photo 6, and Figure 22**). The crew of the RHIB was also able to retrieve a spent sonobuoy for disposal on shore.

The acoustic data from these data were reviewed using Triton software. However, very few calls were detected from the gray whales (**Appendix D, Table 4**). Detected calls were low-intensity and relatively broadband (**Appendix D, Figure 16**). Possible reasons for low call rates and call intensity for this encounter are discussed below.

Throughout this focal follow the gray whales traveled, for the most part, at medium speed separated by 0.25–1 body length. A few short bouts of socializing (whales touching and orienting towards one another) and milling also occurred and were recorded on video. For example, at approximately 11:04, one of the gray whales turned on its right side and swam under the other gray whale (notably, no vocalizations were recorded at this time). On several occasions, the whales appeared to swap positions, criss-crossing one another's paths. All blows that were seen were recorded; however, video was not continuous and some respirations may have been missed due to the limited space and maneuverability inside the aircraft. Video was also taken of the SIO RHIB near the gray whales as the RHIB personnel took photo-identification photographs and a biopsy from one of the grays, and moved and retrieved sonobuoys for the aircraft personnel.

2 April Risso's Dolphins

On 2 April, two CO sonobuoys were deployed on a small group (possibly eight animals) of Risso's dolphins that were observed for 1 hr (no video was obtained). Low-level whistles were detected, but were not frequent enough to analyze in detail. Interestingly, during this encounter, a 12-kHz depth sounder was detected and whistles of similar duration and frequency were detected within a few seconds of the echosounder signals (**Appendix D, Figure 16**). This possible case of mimicry of the echosounder by the Risso's dolphin is of particular interest and is discussed further below.

Discussion

The acoustic-visual behavioral component of this study was a first attempt at simultaneously collecting both acoustic and visual behavioral data on focal groups from an aerial platform using sonobuoys, videography, and real-time acoustic-visual observations. As such, the methods and protocols were refined and modified continuously throughout the effort. Because the existing software was not designed specifically to be used in this way, we had to modify it significantly for the project's requirements. The limited space and cargo capacity of our Partenavia observation aircraft made this effort even more challenging. For example, acoustic hardware had to be reduced into a much smaller package than typically used on ships. Also, the additional weight of the sonobuoys and acoustic processing hardware limited both the number of observers that could be carried and flight duration. Finally, the space constraints made videography (particularly in the first 3 days of effort) very difficult. Considerable effort was required to set up, integrate, and test hardware and software as well as establish and refine new protocols. In spite of these challenges, we were able to collect both acoustic and visual data that provided a unique insight into the behaviors of marine mammals that could not be obtained using other methods. In addition, we demonstrated that sonobuoys could be deployed from small boats, repositioned as needed and retrieved to eliminate any marine debris resulting from this effort. The data collected from this effort are directly relevant to goals of the Navy's SOCAL Marine Species Monitoring Plan (DoN 2011).

Visual-Acoustic Behavior

The highlight of the visual-acoustic effort is the integrated focal behavioral results for fin whales, the most vocally active species encountered during this effort. In particular, the focal behavior session on 9 February was interesting and unprecedented compared to the 12 other aerial surveys conducted in the SOCAL from 2008 to 2011, due to the high concentration and apparent socializing of fin whales in 2012. During the 30 January–5 February 2012 visual survey, fin whales had been sighted more frequently and with larger mean group sizes than previous spring–fall 2008–2011 surveys. In winter 2012, fin whale group size ranged from 1 to 7 individuals (mean

2.4 whales for 9 groups). In contrast, mean group size of fin whales was 1.9 individuals during 12 spring–fall 2008–2011 surveys (Smultea et al. 2011f). Furthermore, during the fin whale focal session on 9 February 2012, very high (greater than 80 percent) calling rates were observed, and calling and counter-calling behavior was recorded. This indicates that fin whales were interacting acoustically. Simultaneous visual behavioral observations indicated that focal fin whales were frequently joining and splitting groups. In addition, fin whale sightings were scattered throughout the general area within view of the aircraft observers. This suggests that fin whales were concentrated in unusually high numbers and may have been in acoustic contact while migrating through the area.

In general, our results suggest that calling occurred primarily while whales were below the water surface (i.e., out of sight) on protracted dives. In particular, there was a conspicuous 9-minute period of silence on 9 February when two fin whales were seen twice at the surface traveling, suggesting they were not calling while at/near the surface. However, there were some occasions when a fin whale was seen at the surface when calls were being heard/recorded from that same location (i.e., within about 0.5–1 km), some of which were very closely matched both temporally and spatially. Because the number of matched visual-call locations is very small, based on this preliminary analysis, it is not currently possible to match visually observed individual whales with call localizations. However, we collected strong evidence that at least some of the whales we were following were vocalizing based on generally converging bearing lines for some calls, simultaneous sighting data, and aircraft tracklines (**Appendix D, Figure 6**). Our results also indicate that the traveling fin whales we followed on 9 February were engaged in calling and counter-calling as they moved in a westerly, then northwesterly direction over a period of approximately 2 hours.

Overall, results suggest that fin whales were socially and acoustically active during our visual-acoustic focal efforts. Individuals were within visual contact (i.e., focal group sizes of 2–5 animals) interacting socially over small spatial scales. Animals were also acoustically interacting with each other over much larger scales, as indicated by counter-calling behaviors. Notably, however, animals within close range can also detect counter-calls. Several authors have suggested that traveling fin whales maintain acoustic contact over large areas (tens to hundreds of km) (McDonald et al. 1995; Wilcock et al. 2009). Results from Sirovic et al. (2007), using bottom recorders deployed in western Antarctica, indicate that fin whales could be detected over 50 km away. Behavioral studies of fins whales have mostly focused on either visual monitoring or acoustic monitoring (e.g., Castellote et al. 2012; Gedamke 2009) but a few have attempted both (Croll et al. 2002; Watkins 1981; Watkins et al. 1987). Our study is one of the first attempts to integrate both visual and acoustic data over small and large scales.

Behavioral data from 2008-2011 (Smultea et al. 2011f), and our results in this 2012 study suggest that fin whales are socially active during late winter and spring in the Southern California Bight area. This may be occurring with migrating and/or resident individuals. On multiple occasions, we have recorded video of usually three fin whales socializing via touching, rolling over one another, etc., including apparent displacement of individuals on some occasions. This could suggest that mating/courting is occurring during migration and/or among resident SOCAL fin whales. Loud calls (i.e., acoustic displays or songs) from fin whales are believed to be produced predominantly by males (Croll et al. 2002). Such information has implications for management of this endangered species and as such, is relevant to the goals of the Navy's SOCAL Marine Species Monitoring Plan (DoN 2011) and ICMP (DoN 2010). In summary, we implemented and began development of an integrated approach to acoustic-visual monitoring of cetaceans and nearby anthropogenic activities from an aircraft platform. Highlights of these results are listed below:

1. Fin whales were vocally and socially (from a visual perspective) active, suggesting they are engaged in important (possibly courtship and breeding) behaviors in SOCAL.
2. Although we could not localize calling individuals, we were able to demonstrate counter-calling from animals nearby (using sonobuoys deployed in the general vicinity of the focal group), as well as calls coming from areas (animals) farther away.
3. Based on 2012 sighting and visual/acoustic data, it appears that multiple groups or aggregations of fin whales were traveling/migrating through the area while maintaining acoustic contact.
4. We were able to record sounds from all species on which we dropped sonobuoys and conducted focal observations.
5. We were able to collect data on anthropogenic activities (e.g., boat, shipping, and sonar noise) concurrent with marine mammal vocalizations (and in some cases behaviors).

These types of data are new and important relative to the goals of the Navy's SOCAL Marine Species Monitoring Plan (DoN 2011) and ICMP (DoN 2010). They provide insight into the biological importance of this region for the endangered fin whale and other species. They also provide a promising method to integrate visual and PAM data across a continuum of marine mammal behavior and habitat use above and below the water's surface. Such information contributes to baseline information and provides additional tools and techniques for assessing potential effects of Navy activities on marine mammals. Finally, this effort presents novel techniques that may be further developed and applied to address the Navy's management goals.

Hardware and Software Integration

We were able to successfully integrate the acoustic hardware system into a compact package that could fit in the small space available in the Partenavia aircraft. In addition, we were able to power the system entirely on direct-current (DC) battery power to minimize electrical noise which is common in alternating current (AC) systems.

There were difficulties in recording continuous behavioral observations and videotaping focal groups. This was because of the limited, cramped space in the plane and because the primary focal observer/videographer also had to deploy sonobuoys and/or record sightings of animal and sonobuoy positions into a laptop running Mysticetus. Therefore, the focal observer could not maintain a continuous watch for animals, not all behaviors were recorded, and the data that were recorded were limited.

Software integration was initially problematic, but nearly successful by the end of the project. Real-time sonobuoy bearing processing was successful. We were able to process bearings from single sonobuoys and display them in real-time for most sonobuoy deployments. In some cases, we were able to get individual bearings that crossed through regions of focal groups (based on the circular track of the aircraft). However, cross-fixing of bearings from multiple sonobuoys was not achieved in real-time. This was entirely due to a bug in the DIFAR software, which prevented bearings from multiple sonobuoys to display at the same time. This bug has been identified and corrected.

The additions and modifications to the program Mysticetus to log and map aircraft, whale, and sonobuoy positions and bearings was largely successful. Integration of Ishmael/DIFAR (for processing of sonobuoy data) and Mysticetus was also successful when the program DIFAR was able to send data files via the ethernet connection.

Only a few hardware improvements are recommended. A time-code generator or recorder capable of time-stamping (with local or GMT time) would facilitate integration of visual and acoustic data. A four-channel (or greater) sonobuoy receiver would allow more sonobuoys to be deployed and potentially larger (or both small- and fine-scale) spatial scales to be monitored. It would also allow CO buoys to be used to obtain localizations to groups of whistling delphinids or other mid-frequency calls. Finally, GPS-integrated sonobuoys would greatly improve sonobuoy position estimates. This would eliminate one potentially significant source of error in localizations and significantly increase their precision and accuracy.

Localization Results

Post-processing of sonobuoy data produced some interesting results but did not result in as many localizations from multiple sonobuoys as we had originally expected. In the first few surveys (through 10 February), this probably was due to sparse deployment of sonobuoys. As a result, cross-fixing on individuals within a focal group was difficult due to the wide configuration of the sonobuoy array. In other cases, the bearings pointed in a direction away from the focal group, possibly indicating that other animals (i.e., not the focal group) were vocalizing (**Appendix D, Figure 6**). Finally, there is the possibility of errors in the bearings obtained from post-processing the DF sonobuoy signals. McDonald (2004) stated a maximum bearing error of 10 degrees (for an older model of DIFAR sonobuoy) and empirically estimated a standard deviation of only 2.1 degrees for blue whales that they followed using an RHIB. If a maximum bearing error of 10 degrees occurs in the sonobuoy model 53F used in this project, this could account for some of the difficulty in obtaining cross-fixes to animal calls. Alternatively, there could be other sources of error, such as clipping of the DF signal when sonobuoys were in close proximity to fin whales (McDonald, pers. comm.). We did not attempt to empirically assess the bearing error of the sonobuoy system used in this study because that was beyond the scope of this effort. Finally, for many of the deployments on fin whales, there were multiple animals calling and bearings obtained were relatively accurate, but cross-fixes were difficult due to the problem of associating bearings to one of many calling animals.

Fin Whale Counter-Calling

There is some support for the last possibility from preliminary analysis conducted on fin whale call bouts. A detailed analysis of a fin whale call bout indicated that at least two groups of animals were calling from different locations in what appeared to be counter-calling (**Appendix D, Figure 19**). It is likely that there were additional animals calling from different locations (i.e., those with signal strengths too weak to get bearings to). Counter-calling of fin whales has been proposed (but not yet statistically documented) in several studies (McDonald et al. 1995; Wilcock et al. 2009).Based on sightings from line-transect surveys and encounter rates of fin whales during the time period of this study, we believe there were likely numerous groups of fin whales in the study area in addition to the focal groups. Given the high calling rate of fin whales that we documented, and the loud, low-frequency nature of their calls, it is likely that these animals were maintaining acoustic contact over large ranges. This may have resulted in some of the confusion if determining precise localizations for a given call.

Overall, the results of the post-processing indicate that fin whales were a good choice for acoustic detection, monitoring and localization behavior studies using sonobuoys deployed from aircraft. Fin whales called frequently at high levels and low frequencies that make them ideal for monitoring with sonobuoys. Further refinement of software, methods and protocols will likely allow better results to be obtained with respect to identifying individual animals and spatio-temporally correlating sounds with visually observed behaviors for this species.

Gray Whales

As expected, gray whales were much less vocal than fin whales. Previous research on migrating gray whales indicates that although they do call when migrating, they typically produce sounds that are broadband and low level, and when in deep water, they call much less frequently (Crane 1992; Crane and Lashkari 1996). Our data confirmed these findings. Gray whales we recorded produced calls only infrequently. When they did call, the low signal-to-noise ratios of the calls made them difficult to detect, thus making it nearly impossible to obtain bearings from DIFAR sonobuoys. In spite of these difficulties, we were able to monitor and record several low signal-to-noise calls from gray whales. With the help of the RHIB and crew from SIO, we were also able to successfully coordinate obtaining biopsies, photo-identifications and behavioral data. We recommend further acoustic-visual effort on this acoustically stealthy but common winter/spring migratory species in the Southern California Bight. It is important to point out that even limited or negative acoustic data coupled with sighting and behavioral information is important for interpreting the low detections from passive acoustic monitoring systems like bottom recorders and hydrophones.

There will always be a trade-off between small- and large-scale spatial resolution in PAM monitoring using sonobuoys, the balance of which is not always easy to determine. For animals that produce higher frequencies, or low-level calls, placement of sonobuoys closer to the animals is necessary to obtain good recordings. Dolphin groups might require multiple (3-4) sonobuoys spaced relatively close together to obtain the same signals from individuals. If locations of sonobuoys are precisely known, localization using hyperbolic methods in Ishmael should be possible. These methods could also be used with widely separated sonobuoys receiving the same fin whale calls. This would theoretically allow three bearing lines to be obtained from two DIFAR sonobuoys. These methods will require additional analysis and in some cases additional data.

Despite these formidable challenges, we were able to collect very detailed information on the vocal behaviors of focal animals. In future efforts, we expect that we will be able to better monitor animals both visually and acoustically based on the lessons learned in this study. Our data indicate that low-frequency calls (e.g., fin) are the best focal species for DIFAR buoy monitoring. Additional effort should be expended deploying multiple (three or more) omni-directional buoys to monitor high-frequency species such as Risso’s dolphins and bottlenose dolphins.

Overall, we obtained considerable acoustic data, and the combined visual-acoustic behavioral monitoring approach is promising. Space and weight/time limitation of our Partenavia aircraft presented some challenges that curtailed our ability to obtain continuous uninterrupted behavioral monitoring/videography. A larger plane and at least one more scientist to allow a dedicated focal behavioral observer would facilitate collection of detailed behavioral data. Despite these limitations, we succeeded in simultaneously collecting acoustic and visual behavioral data on species for which there is limited information. We were also able to provide detailed information about the acoustic behaviors and general locations of calling animals. Results included some interesting observations and recordings, including apparent counter-calling by fin whales and possible mimicry of sonar sounds by Risso's dolphins. Finally, we were able to develop, test, and apply a novel, integrated visual-acoustic monitoring and recording methods to provide new data on several species of protected marine mammals.

Pre-Flight and In-Flight Communications

Conducting the aerial surveys involved considerable planning, communications and clearances given the logistical complexity and high degree of safety planning associated with operating in and near the busy airspace near the Southern California coastline and on the SOCAL. These have been described in detail in Smultea et al. (2011e) and thus are not repeated herein.

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APPENDIX A: PHOTOGRAPHS

Photo 1. Two northern right whale dolphin mother/calf pairs photographed 3 February 2012 by J. Black under NMFS permit 14451. Note the stark difference in body coloration of the gray calves next to the darker adults.

Photo 2. Bottlenose dolphin mother and calf (bottom) and additional adult (top) photographed 30 January 2012 by M. Smultea under NMFS permit 14451.

Photo 3. Two gray whales photographed 2 February 2012 by B. Würsig under NMFS permit 14451.

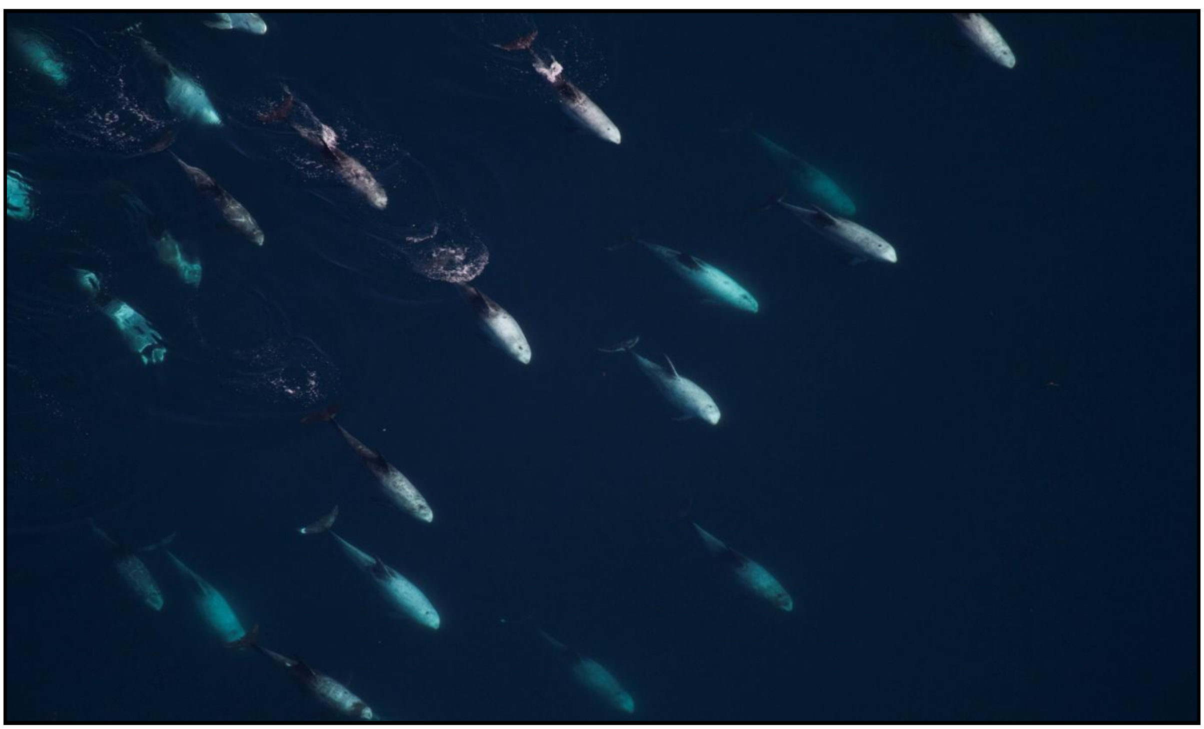

Photo 4. Risso's dolphins photographed 2 February 2012 by B. Würsig under NMFS permit 14451.

Photo 5. Two Dall's porpoises photographed 2 February 2012 by J. Black under NMFS permit 14451.

Photo 6. Two gray whales photographed 14 March 2012 by D. Steckler under NMFS permit 14451.

Photo 7. Risso's dolphins mixed with two bottlenose dolphins (lower center, dorsal fin visible at surface) photographed 13 March 2012 by D. Steckler under NMFS permit 14451.

Photo 8. Long-beaked common dolphin mother/calf pair photographed 13 March 2012 by D. Steckler under NMFS permit 14451. The thick white line color behind the mother's rostrum is an underwater exhalation.

Photo 9. Fin whale photographed 28 March 2012 by D. Steckler under National Marine Fisheries Service (NMFS) permit 14451. Note white right jaw indicative of this species.

Photo 10. Risso's dolphins photographed 31 March 2012 by M. Smultea under NMFS permit 14451.

Photo 11. Long-beaked common dolphins photographed 31 March 2012 by M. Smultea under NMFS permit 14451. Photos of a dolphin's head fully exposed above the water surface like this are usually required to confirm species among the short- and long-beaked common dolphins.

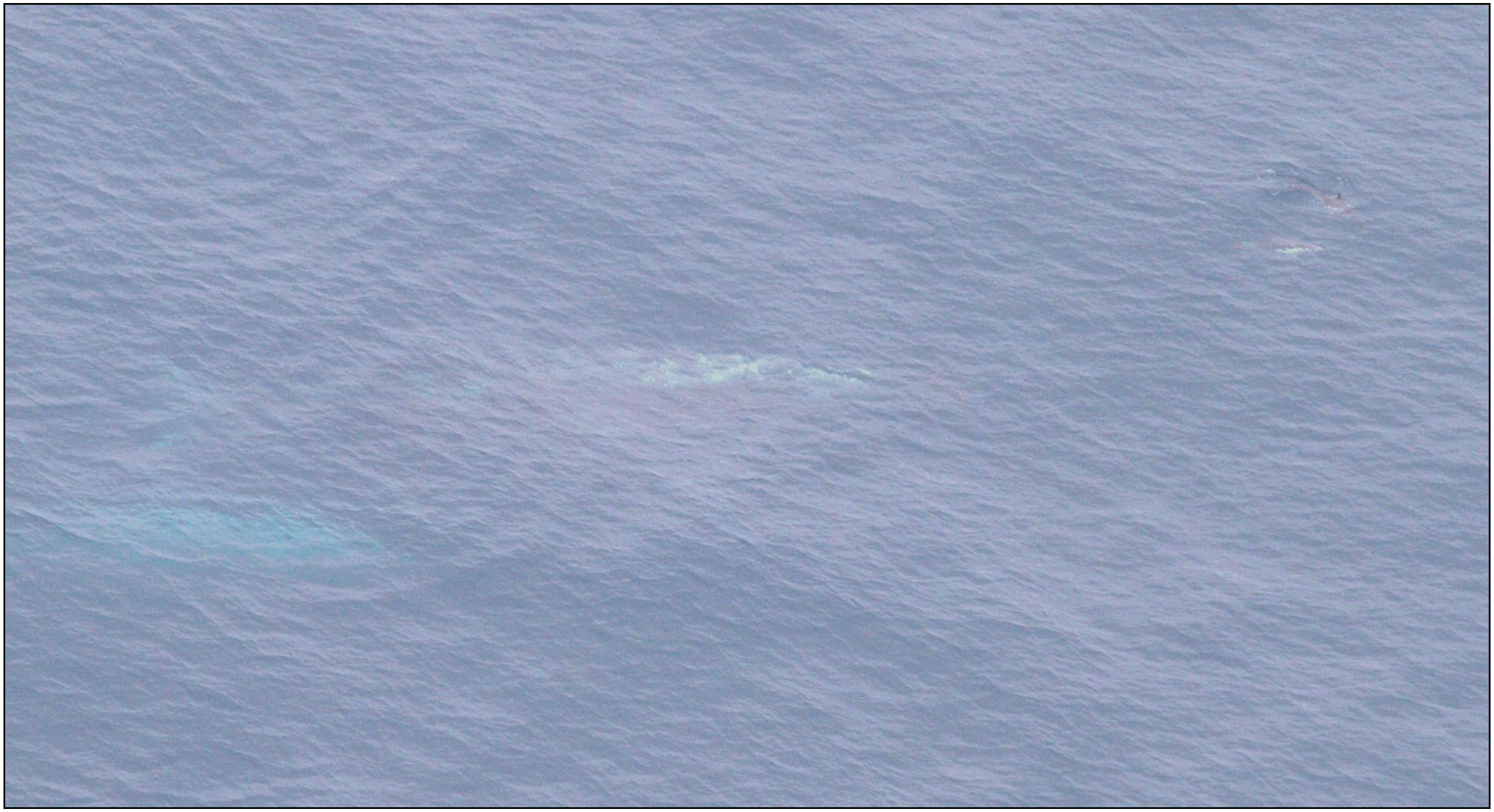

Photo 12. A pair of gray whales subsurface swimming with long-beaked common dolphins (upper right hand corner) photographed 30 March 2012 by M. Smultea under NMFS permit 14451.

Photo 13. A group of short-beaked common dolphin surface-active traveling photographed 31 March 2012 by M. Smultea under NMFS permit 14451.

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APPENDIX B: FIGURES

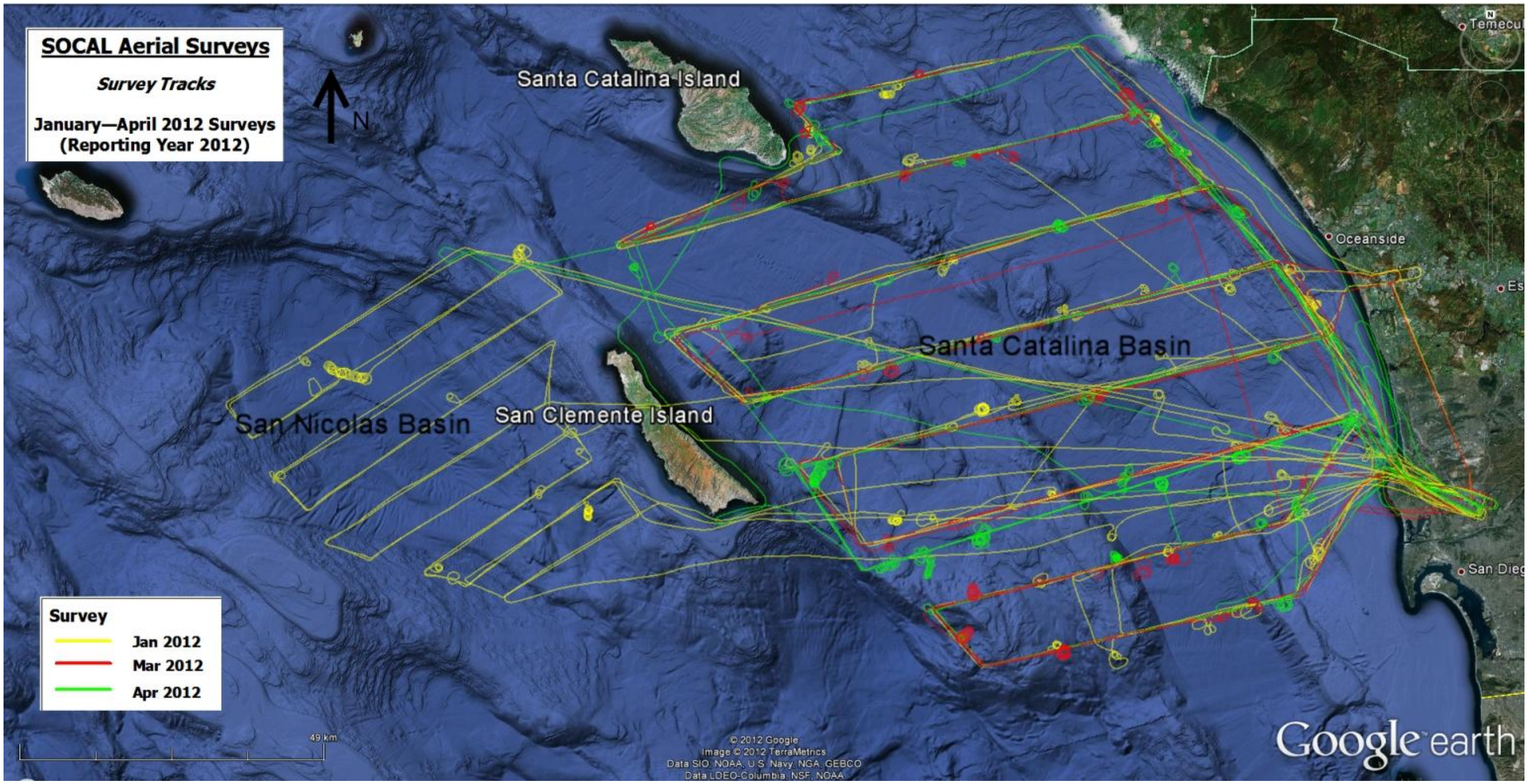


Figure 1. All tracklines made during January-April 2012 aerial monitoring surveys in SOCAL, color-coded by survey month.

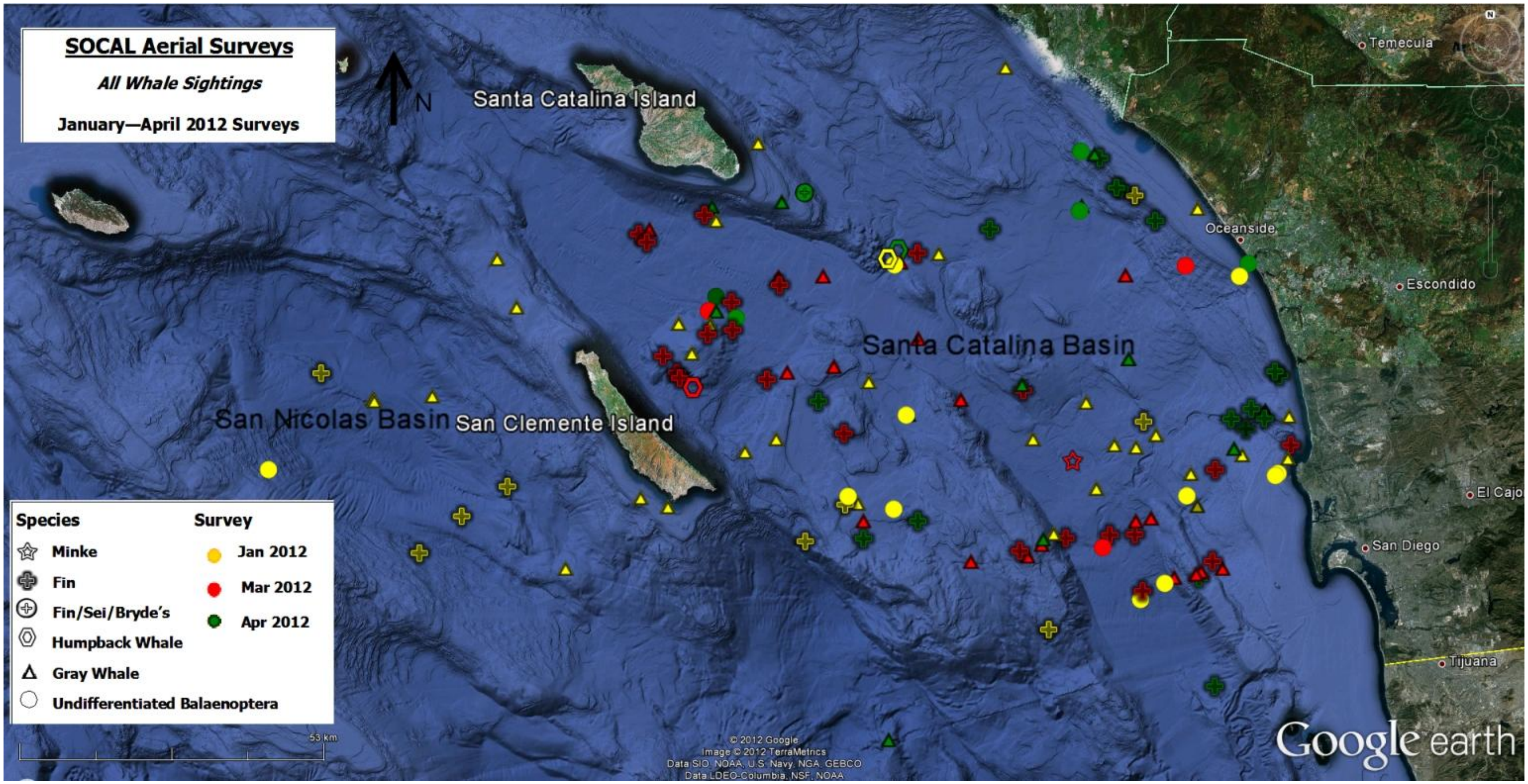


Figure 2. All whale sightings by species color-coded by month during aerial surveys in SOCAL January-April 2012.

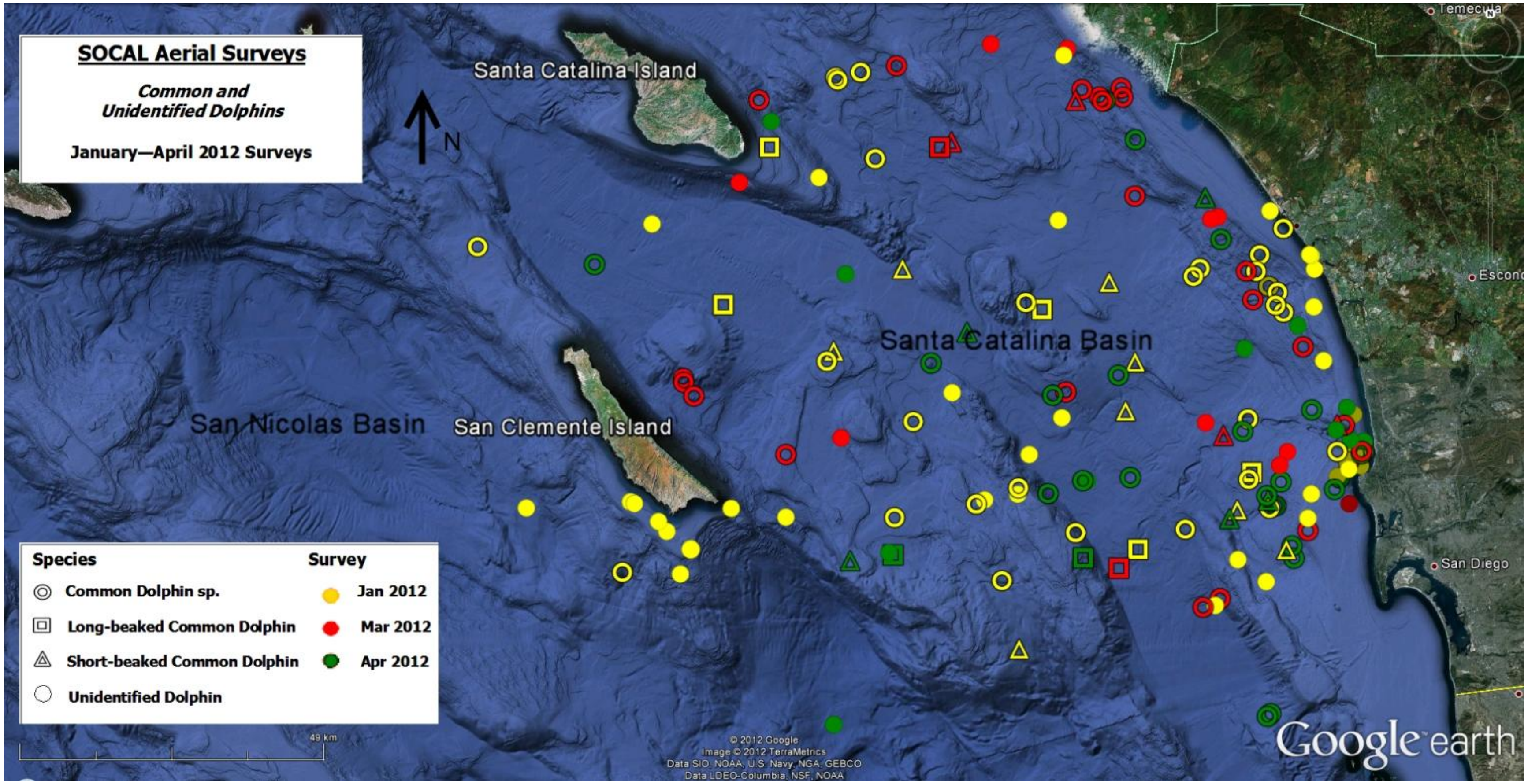


Figure 3. Common dolphin and unidentified dolphin sightings by species color-coded by month during aerial surveys in SOCAL January-April 2012.

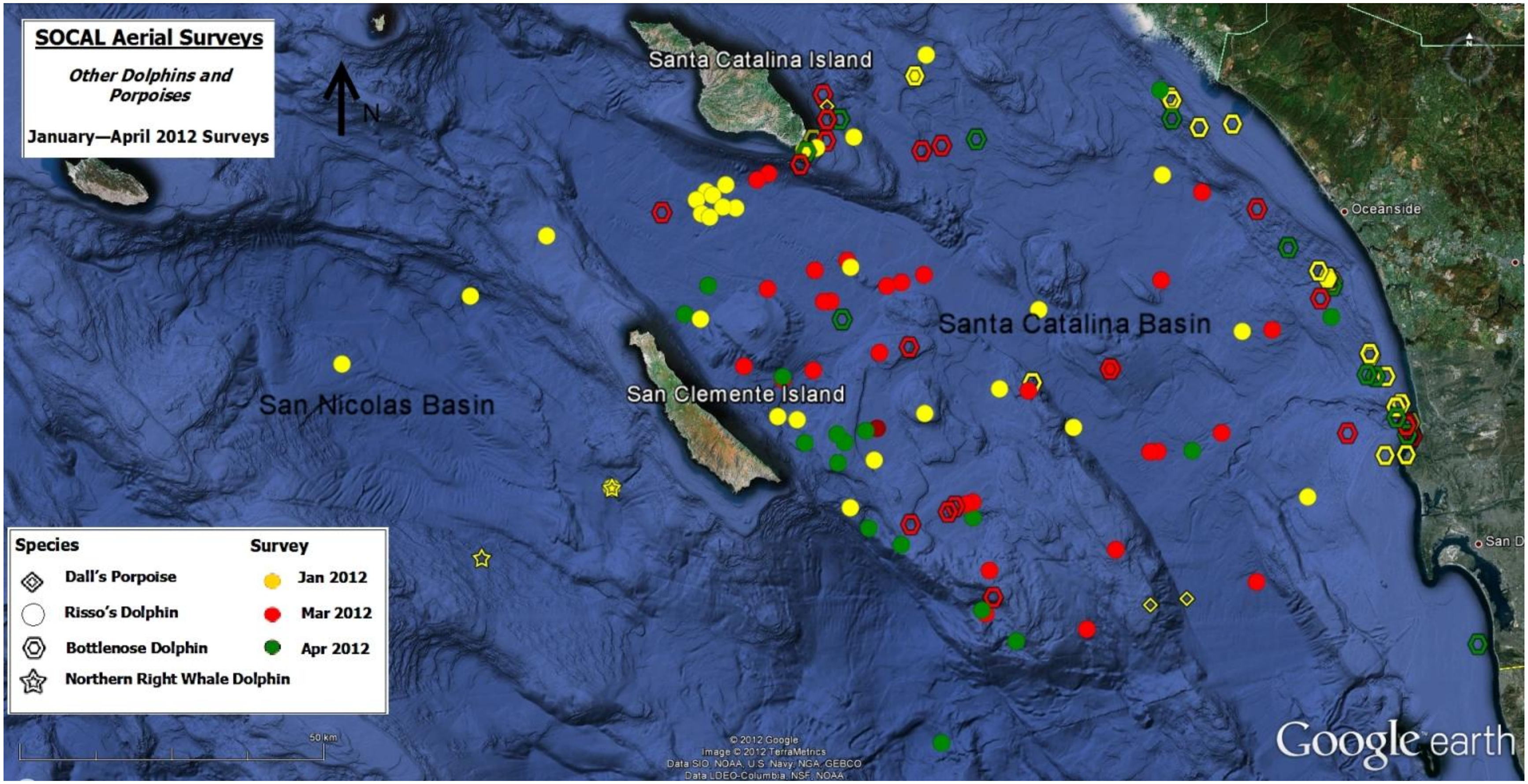


Figure 4. Risso's dolphin, bottlenose dolphin, northern right whale dolphin, and Dalls' porpoise sightings by species color-coded by month during aerial surveys in SOCAL January-April 2012.

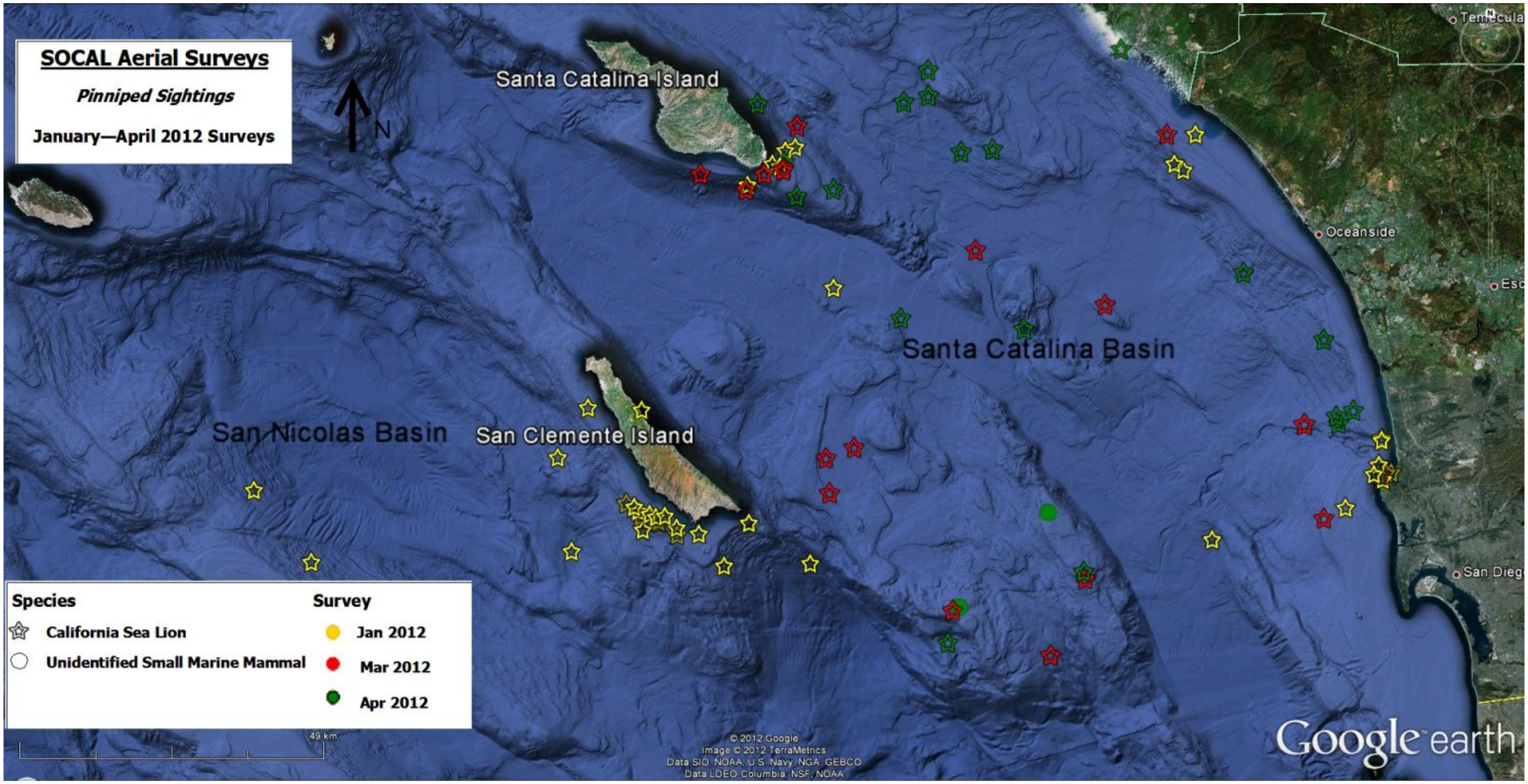


Figure 5. Pinniped and unidentified small marine mammal sightings by species color-coded by month during aerial surveys in SOCAL January-April 2012.

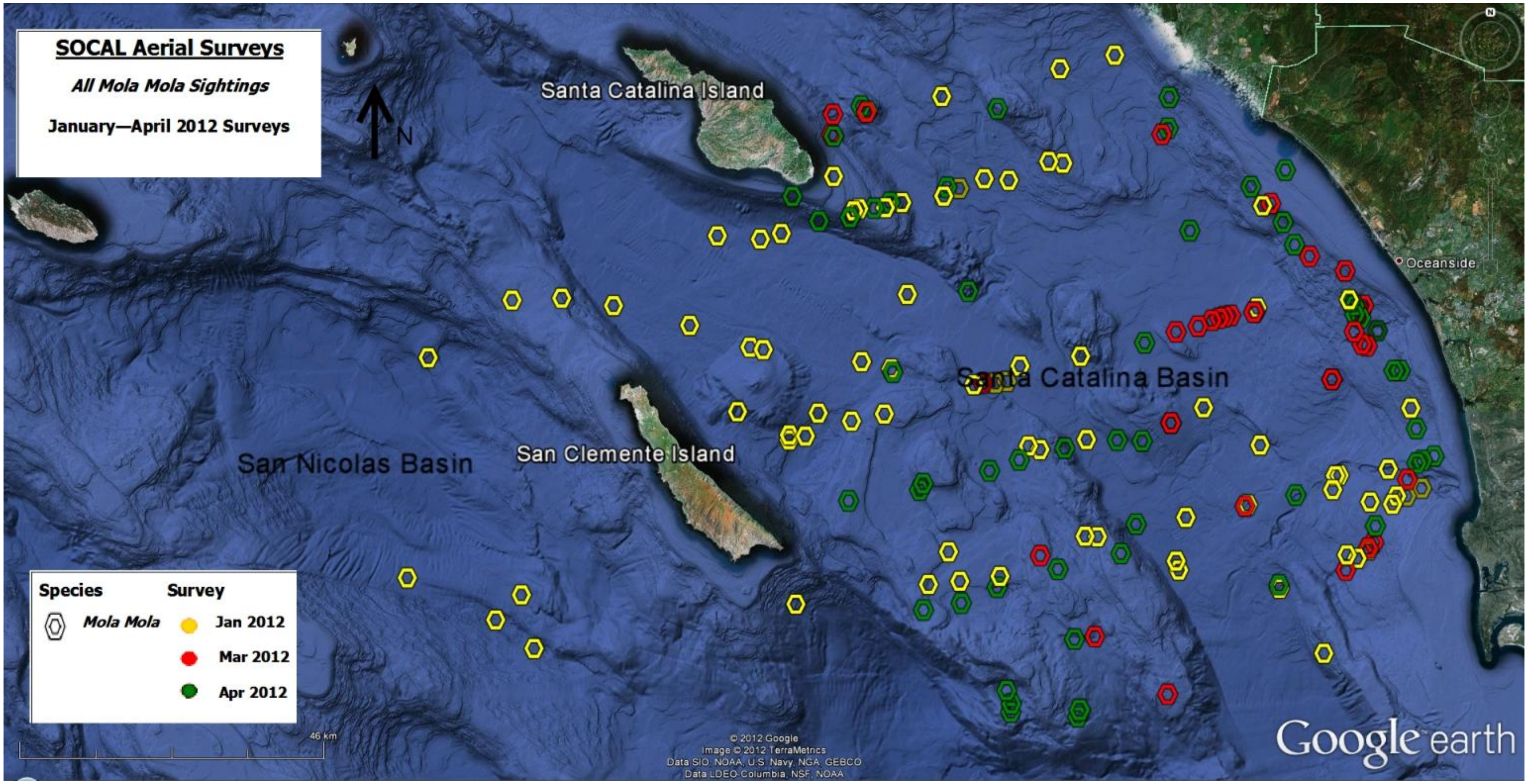


Figure 6. Ocean sunfish (Mola mola) sightings color-coded by month during aerial surveys in SOCAL January-April 2012.

APPENDIX C: TABLES

Table 1. Summary of Aerial Surveys January – April 2012.

Parameter	January - February	Mid-March	March - April	Total
Survey Dates	30 January - 5 February 2012	13-15 March 2012	28 March - 1 April 2012	**3 surveys: "February", "mid-March", and "April"**
No. Days Flown	7	3	5	**15**
Platform Used	Partenavia P68-C with bubble windows	Partenavia P68-C with bubble windows	Partenavia P68-C with bubble windows	**Partenavia P68-C with bubble windows**
Major Training Exercise (MTE) Before, During or After Survey?	None	None	None	**None**
Total Flight Hr (Wheels up/down)	34.5	19.1	26.9	**80.5**
Total Observation Effort (km) *(excl. poor weather, over land)*	5,973 km	3,233 km	4,528 km	**13,734 km**
	3,225 nm	1,746 nm	2,445 nm	**7,416 nm**
No. Groups Seen	227	156	123	**504**
Estimated No. Individuals	25,520	11,081	5,720	**42,321**
Ocean sunfish sightings (*Mola mola*)	91	65	60	**216**
No. Dead Sightings	1 (CA sea lion)	0	0	**1 (CA sea lion)**
No. Species	11	10	10	**11 total species**
No. Focal Groups Circled 5-9 min	12	0	2	**14**
No. Extended Focal Groups Circled >10 min	4	6	5	**15**
Longest Focal Follow Duration	31 min (Fin whale)	15 min (Fin whale)	23 min (Fin whale)	**31 min (Fin whale)**
No. Photos Taken	1,868	1,026	921	**3,815**
Estimated Useable Video (min)	82	54	57	**193 min**

Table 2. Unusual or noteworthy observations of marine mammals in SOCAL aerial survey area during January - April 2012.

Date	Time	Species	Group Size	Data Format Available for Review	Comments	Why Considered Unusual
1/30/2012	15:56:13	Gray whale, *Eschrichtius robustus with* bottlenose dolphin*, Tursiops truncatus*	4 gray whales, 2 bottlenose dolphins	field data sheet: observation record	2 bottlenose dolphins swimming with group of gray whales	Inter-species Association
1/31/2012	12:06:08	Dall's porpoise, *Phocoenoides dalli*	1	field data sheet: observation record	Small distinct black and white body coloration, small dolphin size of common but more robust and fatter.	Rarely Seen Species
1/31/2012	12:08:08	Dall's porpoise	2	field data sheet: observation record	Small distinct black and white body coloration, small dolphin size of common but more robust and fatter.	Rarely Seen Species
2/2/2012	11:44:46	Dead California sea lion, *Zalophus californianus*	1	field data sheet: observation record; photos	7 nm offshore of Camp Pendleton Marine Base and 5.4 nm south of San Clemente	Dead Animal
2/2/2012	12:43:55	Dall's porpoise	4	field data sheet: observation record	Small distinct black and white body coloration, small dolphin size of common but more robust and fatter.	Rarely Seen Species
2/2/2012	12:59:42	Risso's dolphin, *Grampus griseus* with bottlenose dolphin	75 Risso's dolphins, 4 bottlenose dolphins	field data sheet: observation record; photos	4 different subgroups of Risso's dolphins; 4 bottlenose dolphins traveling with Risso's 18 body lengths away	Inter-species Association
2/3/2012	14:44:05	Fin whale, *Balaenoptera physalus*	7	field data sheet: observation record; video	6 adults and 1 possible calf. Animal in the lead of group. Rolling/socializing behavior seen.	Socializing/touching
2/4/2012	14:27:51	Risso's dolphin with northern right whale dolphin, *Lissodelphis borealis*	48 Risso's dolphin, 1 northern right whale dolphin	field data sheet: observation record; video, photos	Risso's dolphins and northern right whale dolphin appeared to forage and intersperse in same area. Northern right whale dolphin seen swimming with lead Risso's and in front of Risso's group.	Inter-species Association

Date	Time	Species	Group Size	Data Format Available for Review	Comments	Why Considered Unusual
3/13/2012	11:39:17	Risso's dolphin with bottlenose dolphin	7 Risso's dolphins, 5 bottlenose dolphins	field data sheet: observation record; video, photos	Bottlenose group mainly to the right of Risso's, but sometimes 1 or 2 individuals in between. Risso's changed directions (possibly caused by a *bottlenose*). Risso's very largely dispersed following behavior change. Formed back into slight C-shape formation with bottlenose *on* right side and a couple in middle of Risso's group. Bottlenose group lagged behind Risso's a bit, Risso's slightly tighter group formation.	Inter-species Association
3/13/2012	12:39:54	Fin whale	3	field data sheet: observation record; video	3 fin whales exhibiting social activity. Individuals rolling over numerous times. Rolling over and staying belly up for long periods of time. Slow milling. Fins hung vertically in water (head up near surface)	Socializing/touching
3/30/2012	11:16:47	California sea lion with Risso's dolphins	1 California sea lion, 15 Risso's dolphins	field data sheet: observation record	Risso's below surface right underneath about 30 birds on water surface with a California sea lion	Inter-species Association
3/30/2012	11:38:40	Gray whale with common dolphin sp., *Delphinus* sp.	2 gray whales, 50 common dolphin sp.	field data sheet: observation record; video, photos	Gray whales surfaced in the middle of a subgroup of common dolphins. Dolphins were bow riding with the gray whales.	Inter-species Association

Table 3. Numbers of individuals and groups by species seen during SOCAL visual marine species monitoring surveys, January - April 2012.

Common Name	Scientific Name	February		Mid-March		April		Total	
		# Grps	# Indiv	# Grps	# Indiv	# Grps	# Indiv	# Grps	# Indiv
Common Dolphin sp.	*Delphinus* sp.	28	10,800	22	4,432	17	1,763	**67**	**16,995**
California Sea Lion	*Zalophus californianus*	40	145	18	22	16	28	**74**	**195**
Unidentified Dolphin	Delphinidae sp.	38	4,689	10	621	9	1,188	**57**	**6,498**
Risso's Dolphin	*Grampus griseus*	31	443	30	363	17	256	**78**	**1,062**
Bottlenose Dolphin	*Tursiops truncatus*	18	459	21	255	12	287	**51**	**1,001**
Fin Whale	*Balaenoptera physalus*	9	22	23	40	16	25	**48**	**87**
Gray Whale	*Eschrichtius robustus*	32	75	20	45	12	24	**64**	**144**
Unidentified Baleen Whale	*Balaenoptera* sp.	4	4	1	1	4	4	**9**	**9**
Northern Right Whale Dolphin	*Lissodelphis borealis*	2	151	0	0	0	0	**2**	**151**
Minke Whale	*Balaenoptera acutorostrata*	0	0	1	1	0	0	**1**	**1**
Humpback Whale	*Megaptera novaeangliae*	1	1	1	1	1	2	**3**	**4**
Unidentified Whale	Cetacea	8	9	2	3	1	1	**11**	**13**
Short-beaked Common Dolphin	*Delphinus delphis*	8	6,410	4	2,575	6	884	**18**	**9,869**
Long-beaked Common Dolphin	*Delphinus capensis*	5	2,305	3	2,725	7	1,115	**15**	**6,145**
Unidentified Small Marine Mammal	Cetacea or Pinnipedia	0	0	0	0	2	2	**2**	**2**
Fin/Bryde's/Sei Whale	*Balaenoptera physalus/brydei/borealis*	0	0	0	0	1	2	**1**	**2**
Dall's Porpoise	*Phocoenoides dalli*	3	7	0	0	0	0	**3**	**7**
Unidentified Small Dolphin	Delphinidae sp.	0	0	0	0	4	144	**4**	**144**
Total		**227**	**25,520**	**156**	**11,084**	**125**	**5,725**	**508**	**42,329**

Table 4. Locations, species descriptions and group sizes for all marine mammal sightings January - April 2012 SOCAL visual aerial surveys.

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
01/30/2012 11:52:22	Bottlenose Dolphin	*Tursiops truncatus*	30	32.8456	-117.3151
01/30/2012 11:52:36	Unidentified Whale	Unidentified Whale	1	32.8362	-117.3144
01/30/2012 12:06:08	Dall's Porpoise	*Phocoenoides dalli*	1	32.6452	-117.6597
01/30/2012 12:08:08	Dall's Porpoise	*Phocoenoides dalli*	2	32.6362	-117.7220
01/30/2012 12:12:19	Short-beaked Common Dolphin	*Delphinus delphis*	60	32.6101	-117.8528
01/30/2012 12:30:42	Common Dolphin sp.	Undifferentiated *Delphinus*	40	32.7060	-117.8806
01/30/2012 12:49:29	Risso's Dolphin	*Grampus griseus*	55	32.7881	-117.4477
01/30/2012 13:02:46	Gray Whale	*Eschrichtius robustus*	6	32.8995	-117.5395
01/30/2012 13:05:22	Gray Whale	*Eschrichtius robustus*	2	32.8835	-117.6159
01/30/2012 13:08:10	Gray Whale	*Eschrichtius robustus*	3	32.8793	-117.5763
01/30/2012 13:30:05	Risso's Dolphin	*Grampus griseus*	12	32.8474	-118.1912
01/30/2012 13:58:36	Common Dolphin sp.	Undifferentiated *Delphinus*	50	33.1033	-117.4133
01/30/2012 13:59:00	Bottlenose Dolphin	*Tursiops truncatus*	45	33.1009	-117.4103
01/30/2012 14:01:42	Risso's Dolphin	*Grampus griseus*	4	33.1009	-117.4103
01/30/2012 14:13:09	Bottlenose Dolphin	*Tursiops truncatus*	15	33.1013	-117.4090
01/30/2012 14:15:09	Bottlenose Dolphin	*Tursiops truncatus*	12	33.0955	-117.4012
01/30/2012 15:01:43	Gray Whale	*Eschrichtius robustus*	1	33.0786	-118.4158
01/30/2012 15:07:18	Risso's Dolphin	*Grampus griseus*	12	33.1242	-118.2285
01/30/2012 15:12:56	Short-beaked Common Dolphin	*Delphinus delphis*	300	33.1426	-118.0397
01/30/2012 15:18:17	Unidentified Whale	Unidentified Whale	1	33.1636	-118.0187
01/30/2012 15:31:33	Risso's Dolphin	*Grampus griseus*	21	33.2524	-117.6920
01/30/2012 15:35:01	Fin Whale	*Balaenoptera physalus*	1	33.2658	-117.5729
01/30/2012 15:43:07	Common Dolphin sp.	Undifferentiated *Delphinus*	250	33.1527	-117.4497
01/30/2012 15:48:10	Bottlenose Dolphin	*Tursiops truncatus*	70	33.1097	-117.4278
01/30/2012 15:53:13	Bottlenose Dolphin	*Tursiops truncatus*	16	32.9903	-117.3357
01/30/2012 15:56:00	Gray Whale	*Eschrichtius robustus*	4	32.9214	-117.2906
01/30/2012 15:56:13	Bottlenose Dolphin	*Tursiops truncatus*	2	32.9135	-117.2979
01/30/2012 15:58:20	California Sea Lion	*Zalophus californianus*	3	32.8597	-117.2653

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
01/31/2012 09:00:25	California Sea Lion	*Zalophus californianus*	2	32.9071	-117.2777
01/31/2012 09:00:30	California Sea Lion	*Zalophus californianus*	5	32.9094	-117.2782
01/31/2012 09:00:52	Bottlenose Dolphin	*Tursiops truncatus*	1	32.9195	-117.2856
01/31/2012 09:01:15	Unidentified Dolphin	Unidentified Dolphin	40	32.9313	-117.2882
01/31/2012 09:02:23	Bottlenose Dolphin	*Tursiops truncatus*	5	32.9576	-117.3133
01/31/2012 09:03:53	Bottlenose Dolphin	*Tursiops truncatus*	5	32.9913	-117.3396
01/31/2012 09:04:19	Unidentified Dolphin	Unidentified Dolphin	10	33.0073	-117.3371
01/31/2012 09:07:27	Common Dolphin sp.	Undifferentiated *Delphinus*	125	33.0753	-117.4031
01/31/2012 09:07:58	Common Dolphin sp.	Undifferentiated *Delphinus*	18	33.0840	-117.4185
01/31/2012 09:08:58	Common Dolphin sp.	Undifferentiated *Delphinus*	20	33.1121	-117.4266
01/31/2012 09:09:55	Common Dolphin sp.	Undifferentiated *Delphinus*	75	33.1316	-117.4500
01/31/2012 09:24:14	Unidentified Dolphin	Unidentified Dolphin	400	33.4394	-117.7675
01/31/2012 09:34:46	Common Dolphin sp.	Undifferentiated *Delphinus*	150	33.4187	-118.1083
01/31/2012 09:40:53	Common Dolphin sp.	Undifferentiated *Delphinus*	125	33.4050	-118.1461
01/31/2012 09:40:57	Common Dolphin sp.	Undifferentiated *Delphinus*	62	33.4109	-118.1497
01/31/2012 09:50:04	Long-beaked Common Dolphin	*Delphinus capensis*	350	33.3128	-118.2618
01/31/2012 09:53:48	California Sea Lion	*Zalophus californianus*	10	33.3261	-118.2553
01/31/2012 09:54:23	California Sea Lion	*Zalophus californianus*	1	33.3214	-118.2719
01/31/2012 09:57:26	California Sea Lion	*Zalophus californianus*	2	33.2978	-118.2802
01/31/2012 09:57:35	Bottlenose Dolphin	*Tursiops truncatus*	100	33.3070	-118.2916
01/31/2012 10:05:45	California Sea Lion	*Zalophus californianus*	1	33.3027	-118.2938
01/31/2012 10:08:33	California Sea Lion	*Zalophus californianus*	1	33.2715	-118.3348
01/31/2012 10:24:52	Gray Whale	*Eschrichtius robustus*	2	33.2365	-118.3459
01/31/2012 10:33:06	Common Dolphin sp.	Undifferentiated *Delphinus*	400	33.2968	-118.0850
01/31/2012 11:11:30	Humpback Whale	*Megaptera novaeangliae*	1	33.1713	-118.0304
01/31/2012 11:20:51	Long-beaked Common Dolphin	*Delphinus capensis*	125	33.0932	-118.3399
01/31/2012 11:29:56	Risso's Dolphin	*Grampus griseus*	8	33.0512	-118.4843
01/31/2012 11:40:48	Common Dolphin sp.	Undifferentiated *Delphinus*	20	33.0132	-118.1686
01/31/2012 11:46:32	Short-beaked Common Dolphin	*Delphinus delphis*	500	33.0274	-118.1567
01/31/2012 12:09:00	Common Dolphin sp.	Undifferentiated *Delphinus*	150	33.1383	-117.5438

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
01/31/2012 12:16:56	Unidentified Whale	Unidentified Whale	1	33.1390	-117.3814
01/31/2012 12:17:37	Unidentified Dolphin	Unidentified Dolphin	7	33.1547	-117.3559
01/31/2012 12:17:52	Unidentified Dolphin	Unidentified Dolphin	250	33.1348	-117.3499
01/31/2012 13:48:39	Unidentified Dolphin	Unidentified Dolphin	100	33.0819	-117.3531
01/31/2012 14:06:08	Bottlenose Dolphin	*Tursiops truncatus*	40	32.9563	-117.9197
01/31/2012 14:14:14	Risso's Dolphin	*Grampus griseus*	13	32.9452	-117.9722
01/31/2012 14:38:00	Common Dolphin sp.	Undifferentiated *Delphinus*	50	32.9268	-118.0257
01/31/2012 14:47:45	Gray Whale	*Eschrichtius robustus*	2	32.8971	-118.2377
01/31/2012 14:52:08	Gray Whale	*Eschrichtius robustus*	5	32.8716	-118.2958
01/31/2012 15:20:13	Common Dolphin sp.	Undifferentiated *Delphinus*	2500	32.9252	-117.4669
01/31/2012 15:55:07	Gray Whale	*Eschrichtius robustus*	2	32.7476	-117.7301
02/01/2012 10:12:33	Unidentified Dolphin	Unidentified Dolphin	300	32.6984	-117.4393
02/01/2012 10:15:46	Unidentified Dolphin	Unidentified Dolphin	100	32.6652	-117.5237
02/01/2012 10:18:51	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	32.6669	-117.5276
02/01/2012 11:02:07	Gray Whale	*Eschrichtius robustus*	1	32.7863	-117.4640
02/01/2012 11:08:04	Gray Whale	*Eschrichtius robustus*	1	32.8590	-117.2969
02/01/2012 12:19:34	Bottlenose Dolphin	*Tursiops truncatus*	15	32.8930	-117.2693
02/01/2012 12:40:19	Common Dolphin sp.	Undifferentiated *Delphinus*	80	32.8133	-117.9193
02/01/2012 12:43:02	Unidentified Dolphin	Unidentified Dolphin	1	32.8182	-117.9072
02/01/2012 12:54:24	Risso's Dolphin	*Grampus griseus*	6	32.7905	-118.2143
02/01/2012 13:01:24	Risso's Dolphin	*Grampus griseus*	15	32.9062	-118.1010
02/01/2012 13:07:55	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	32.9328	-117.9998
02/01/2012 13:20:48	Short-beaked Common Dolphin	*Delphinus delphis*	2000	33.0085	-117.6531
02/01/2012 13:27:35	Risso's Dolphin	*Grampus griseus*	22	33.0275	-117.5588
02/01/2012 13:44:47	Short-beaked Common Dolphin	*Delphinus delphis*	500	33.1200	-117.6956
02/01/2012 13:52:10	Common Dolphin sp.	Undifferentiated *Delphinus*	50	33.0933	-117.8355
02/01/2012 14:23:28	Gray Whale	*Eschrichtius robustus*	2	33.0315	-118.3904
02/01/2012 14:39:02	Gray Whale	*Eschrichtius robustus*	2	33.1810	-117.9351
02/01/2012 14:55:03	Bottlenose Dolphin	*Tursiops truncatus*	60	33.3640	-117.6775
02/01/2012 15:16:41	Unidentified Dolphin	Unidentified Dolphin	1000	33.2190	-117.7681

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
02/02/2012 10:13:22	Unidentified Dolphin	Unidentified Dolphin	2	32.8767	-117.2715
02/02/2012 10:13:47	Unidentified Dolphin	Unidentified Dolphin	400	32.8885	-117.2800
02/02/2012 10:13:50	Unidentified Dolphin	Unidentified Dolphin	2	32.8888	-117.2728
02/02/2012 10:28:15	Common Dolphin sp.	Undifferentiated *Delphinus*	400	33.1274	-117.5527
02/02/2012 10:42:42	Long-beaked Common Dolphin	*Delphinus capensis*	100	33.0891	-117.8100
02/02/2012 10:52:48	Risso's Dolphin	*Grampus griseus*	6	33.0604	-117.9068
02/02/2012 11:23:28	California Sea Lion	*Zalophus californianus*	1	33.1296	-118.1935
02/02/2012 11:44:16	California Sea Lion	*Zalophus californianus*	1	33.2986	-117.6222
02/02/2012 11:44:52	California Sea Lion	*Zalophus californianus*	1	33.2890	-117.6054
02/02/2012 11:49:07	Bottlenose Dolphin	*Tursiops truncatus*	12	33.3124	-117.6412
02/02/2012 11:56:42	Bottlenose Dolphin	*Tursiops truncatus*	50	33.3589	-117.6730
02/02/2012 12:16:06	Unidentified Dolphin	Unidentified Dolphin	3	33.2702	-118.1786
02/02/2012 12:23:58	Risso's Dolphin	*Grampus griseus*	3	33.2089	-118.4236
02/02/2012 12:24:36	Risso's Dolphin	*Grampus griseus*	20	33.2118	-118.4466
02/02/2012 12:24:59	Unidentified Dolphin	Unidentified Dolphin	8	33.2080	-118.4587
02/02/2012 12:25:24	Risso's Dolphin	*Grampus griseus*	3	33.1962	-118.4689
02/02/2012 12:25:46	Risso's Dolphin	*Grampus griseus*	3	33.2024	-118.4832
02/02/2012 12:32:20	Risso's Dolphin	*Grampus griseus*	20	33.2223	-118.4924
02/02/2012 12:33:00	Risso's Dolphin	*Grampus griseus*	1	33.2339	-118.4753
02/02/2012 12:33:12	Risso's Dolphin	*Grampus griseus*	1	33.2274	-118.4638
02/02/2012 12:34:03	Risso's Dolphin	*Grampus griseus*	12	33.2437	-118.4417
02/02/2012 12:38:28	Risso's Dolphin	*Grampus griseus*	10	33.2930	-118.3071
02/02/2012 12:39:04	Risso's Dolphin	*Grampus griseus*	3	33.2941	-118.2848
02/02/2012 12:41:06	Risso's Dolphin	*Grampus griseus*	5	33.3095	-118.2212
02/02/2012 12:43:45	Gray Whale	*Eschrichtius robustus*	3	33.3543	-118.2671
02/02/2012 12:43:55	Dall's Porpoise	*Phocoenoides dalli*	4	33.3598	-118.2638
02/02/2012 12:59:42	Risso's Dolphin	*Grampus griseus*	75	33.3981	-118.1150
02/02/2012 12:59:52	Bottlenose Dolphin	*Tursiops truncatus*	3	33.3981	-118.1150
02/02/2012 13:20:36	Risso's Dolphin	*Grampus griseus*	1	33.4281	-118.0959
02/02/2012 13:29:30	Gray Whale	*Eschrichtius robustus*	3	33.4701	-117.8082

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
02/02/2012 13:37:37	California Sea Lion	*Zalophus californianus*	1	33.3400	-117.5838
02/02/2012 13:38:15	Bottlenose Dolphin	*Tursiops truncatus*	2	33.3226	-117.5706
02/02/2012 13:42:21	Gray Whale	*Eschrichtius robustus*	1	33.2482	-117.4550
02/02/2012 13:43:46	Unidentified Dolphin	Unidentified Dolphin	8	33.2188	-117.4231
02/02/2012 13:44:53	Common Dolphin sp.	Undifferentiated *Delphinus*	65	33.1933	-117.4013
02/02/2012 13:46:46	Unidentified Dolphin	Unidentified Dolphin	7	33.1544	-117.3584
02/02/2012 15:22:58	Common Dolphin sp.	Undifferentiated *Delphinus*	70	32.7931	-118.0583
02/02/2012 15:25:55	Unidentified Whale	Unidentified Whale	2	32.7866	-118.0242
02/02/2012 15:36:12	Common Dolphin sp.	Undifferentiated *Delphinus*	90	32.8351	-117.8567
02/02/2012 16:03:55	Common Dolphin sp.	Undifferentiated *Delphinus*	80	32.8015	-117.4313
02/02/2012 16:12:41	California Sea Lion	*Zalophus californianus*	1	32.7724	-117.5659
02/02/2012 16:12:56	Common Dolphin sp.	Undifferentiated *Delphinus*	130	32.7731	-117.5737
02/03/2012 09:12:43	California Sea Lion	*Zalophus californianus*	2	32.8707	-117.2850
02/03/2012 09:12:50	Unidentified Dolphin	Unidentified Dolphin	40	32.8741	-117.2887
02/03/2012 10:11:55	Risso's Dolphin	*Grampus griseus*	4	32.9867	-119.0996
02/03/2012 10:19:58	Risso's Dolphin	*Grampus griseus*	10	33.0839	-118.8783
02/03/2012 10:25:06	Common Dolphin sp.	Undifferentiated *Delphinus*	100	33.1757	-118.7481
02/03/2012 10:37:22	Gray Whale	*Eschrichtius robustus*	1	33.1039	-118.7141
02/03/2012 10:46:50	Gray Whale	*Eschrichtius robustus*	2	32.9578	-118.9755
02/03/2012 11:05:29	Gray Whale	*Eschrichtius robustus*	3	32.9658	-118.8692
02/03/2012 11:32:16	California Sea Lion	*Zalophus californianus*	2	32.7466	-119.0662
02/03/2012 11:51:28	California Sea Lion	*Zalophus californianus*	1	32.8929	-118.6539
02/03/2012 11:57:55	Fin Whale	*Balaenoptera physalus*	3	32.7761	-118.8097
02/03/2012 12:10:25	Northern Right Whale Dolphin	*Lissodelphis borealis*	150	32.7109	-118.8607
02/03/2012 12:26:12	California Sea Lion	*Zalophus californianus*	1	32.7927	-118.5129
02/03/2012 12:27:53	California Sea Lion	*Zalophus californianus*	1	32.7857	-118.4559
02/03/2012 12:28:24	Gray Whale	*Eschrichtius robustus*	1	32.7942	-118.4400
02/03/2012 12:28:29	Unidentified Dolphin	Unidentified Dolphin	40	32.7760	-118.4357
02/03/2012 12:28:58	California Sea Lion	*Zalophus californianus*	6	32.7870	-118.4207
02/03/2012 12:31:30	Unidentified Dolphin	Unidentified Dolphin	300	32.8089	-118.3283

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
02/03/2012 12:34:04	Unidentified Dolphin	Unidentified Dolphin	4	32.7988	-118.2382
02/03/2012 12:38:04	Gray Whale	*Eschrichtius robustus*	3	32.7961	-118.0873
02/03/2012 12:44:26	Unidentified Dolphin	Unidentified Dolphin	60	32.8267	-117.8523
02/03/2012 12:56:51	Gray Whale	*Eschrichtius robustus*	2	32.8659	-117.3804
02/03/2012 12:58:29	Unidentified Dolphin	Unidentified Dolphin	100	32.8444	-117.3150
02/03/2012 13:40:09	Unidentified Dolphin	Unidentified Dolphin	250	32.8596	-117.2891
02/03/2012 13:52:49	Unidentified Dolphin	Unidentified Dolphin	125	32.8810	-117.8324
02/03/2012 13:59:05	Unidentified Whale	Unidentified Whale	1	32.8106	-118.1043
02/03/2012 14:07:25	California Sea Lion	*Zalophus californianus*	60	32.8139	-118.4753
02/03/2012 14:07:37	Gray Whale	*Eschrichtius robustus*	1	32.8075	-118.4863
02/03/2012 14:07:45	Unidentified Dolphin	Unidentified Dolphin	35	32.8178	-118.4895
02/03/2012 14:07:55	Unidentified Dolphin	Unidentified Dolphin	10	32.8199	-118.4961
02/03/2012 14:26:21	Unidentified Dolphin	Unidentified Dolphin	4	32.8116	-118.6702
02/03/2012 14:30:35	California Sea Lion	*Zalophus californianus*	1	32.8303	-118.5397
02/03/2012 14:31:01	California Sea Lion	*Zalophus californianus*	1	32.8250	-118.5267
02/03/2012 14:31:18	California Sea Lion	*Zalophus californianus*	1	32.8164	-118.5213
02/03/2012 14:31:33	California Sea Lion	*Zalophus californianus*	1	32.8097	-118.5164
02/03/2012 14:31:55	California Sea Lion	*Zalophus californianus*	1	32.8149	-118.5008
02/03/2012 14:32:17	California Sea Lion	*Zalophus californianus*	1	32.8106	-118.4908
02/03/2012 14:32:30	California Sea Lion	*Zalophus californianus*	3	32.8029	-118.4880
02/03/2012 14:32:35	California Sea Lion	*Zalophus californianus*	1	32.8014	-118.4861
02/03/2012 14:33:33	California Sea Lion	*Zalophus californianus*	1	32.7926	-118.4574
02/03/2012 14:33:49	Unidentified Dolphin	Unidentified Dolphin	10	32.7901	-118.4499
02/03/2012 14:37:17	California Sea Lion	*Zalophus californianus*	1	32.7994	-118.3364
02/03/2012 14:44:05	Fin Whale	*Balaenoptera physalus*	7	32.7934	-118.1123
02/03/2012 15:26:50	Long-beaked Common Dolphin	*Delphinus capensis*	1750	32.8509	-117.4604
02/03/2012 15:36:56	Common Dolphin sp.	Undifferentiated *Delphinus*	2600	32.8770	-117.3219
02/04/2012 08:46:19	Unidentified Dolphin	Unidentified Dolphin	8	32.8613	-117.2777
02/04/2012 08:46:42	Unidentified Dolphin	Unidentified Dolphin	15	32.8530	-117.2977
02/04/2012 08:46:50	Unidentified Dolphin	Unidentified Dolphin	12	32.8677	-117.3003

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
02/04/2012 08:52:49	Fin Whale	*Balaenoptera physalus*	2	32.9178	-117.5617
02/04/2012 09:03:34	Unidentified Dolphin	Unidentified Dolphin	150	32.9705	-117.9576
02/04/2012 09:12:36	Gray Whale	*Eschrichtius robustus*	2	33.0735	-118.3578
02/04/2012 09:49:24	Fin Whale	*Balaenoptera physalus*	4	32.9982	-119.0759
02/04/2012 10:31:29	Gray Whale	*Eschrichtius robustus*	9	33.1783	-118.7486
02/04/2012 10:35:54	Risso's Dolphin	*Grampus griseus*	1	33.1708	-118.7483
02/04/2012 10:49:51	Gray Whale	*Eschrichtius robustus*	3	32.9620	-118.9790
02/04/2012 10:56:38	Unidentified Whale	Unidentified Whale	1	32.8510	-119.1738
02/04/2012 11:00:32	California Sea Lion	*Zalophus californianus*	2	32.8490	-119.1604
02/04/2012 11:32:23	Risso's Dolphin	*Grampus griseus*	13	32.9121	-118.3545
02/04/2012 11:33:17	Risso's Dolphin	*Grampus griseus*	27	32.9087	-118.3214
02/04/2012 11:45:46	Risso's Dolphin	*Grampus griseus*	5	32.8905	-117.8492
02/04/2012 11:47:35	Unidentified Dolphin	Unidentified Dolphin	600	32.9288	-117.7793
02/04/2012 11:47:58	Gray Whale	*Eschrichtius robustus*	1	32.8908	-117.7655
02/04/2012 13:04:23	Short-beaked Common Dolphin	*Delphinus delphis*	700	32.9714	-117.6706
02/04/2012 13:05:31	Gray Whale	*Eschrichtius robustus*	1	32.9495	-117.6658
02/04/2012 13:18:42	Gray Whale	*Eschrichtius robustus*	1	32.9844	-118.0649
02/04/2012 13:28:56	California Sea Lion	*Zalophus californianus*	12	32.9610	-118.5137
02/04/2012 13:30:58	California Sea Lion	*Zalophus californianus*	10	32.9636	-118.6036
02/04/2012 14:07:16	Fin Whale	*Balaenoptera physalus*	1	32.8233	-118.7308
02/04/2012 14:13:27	Fin Whale	*Balaenoptera physalus*	2	32.7219	-118.8930
02/04/2012 14:27:51	Risso's Dolphin	*Grampus griseus*	48	32.8099	-118.6381
02/04/2012 14:28:54	Northern Right Whale Dolphin	*Lissodelphis borealis*	1	32.8099	-118.6381
02/04/2012 15:01:37	California Sea Lion	*Zalophus californianus*	1	32.7630	-118.6322
02/04/2012 15:11:46	Gray Whale	*Eschrichtius robustus*	2	32.6991	-118.6245
02/04/2012 15:15:11	Common Dolphin sp.	Undifferentiated *Delphinus*	350	32.7206	-118.5112
02/04/2012 15:17:57	Unidentified Dolphin	Unidentified Dolphin	60	32.7186	-118.4136
02/04/2012 15:18:37	Unidentified Dolphin	Unidentified Dolphin	150	32.7519	-118.3973
02/04/2012 15:19:07	California Sea Lion	*Zalophus californianus*	1	32.7427	-118.3784
02/04/2012 15:23:17	California Sea Lion	*Zalophus californianus*	1	32.7446	-118.2351

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
02/04/2012 15:24:44	Fin Whale	*Balaenoptera physalus*	1	32.7362	-118.1858
02/04/2012 15:36:58	Common Dolphin sp.	Undifferentiated *Delphinus*	1250	32.7708	-117.7560
02/04/2012 15:43:11	Gray Whale	*Eschrichtius robustus*	1	32.8178	-117.6504
02/04/2012 15:47:41	Short-beaked Common Dolphin	*Delphinus delphis*	2000	32.8017	-117.4850
02/04/2012 15:47:44	Unidentified Whale	Unidentified Whale	1	32.8017	-117.4850
02/04/2012 15:47:58	Gray Whale	*Eschrichtius robustus*	2	32.8378	-117.4758
02/04/2012 15:48:13	Common Dolphin sp.	Undifferentiated *Delphinus*	1500	32.8412	-117.4675
02/05/2012 09:46:39	California Sea Lion	*Zalophus californianus*	2	32.8588	-117.2728
02/05/2012 09:47:09	California Sea Lion	*Zalophus californianus*	1	32.8586	-117.2876
02/05/2012 09:48:40	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	32.8313	-117.3202
02/05/2012 09:49:48	Unidentified Dolphin	Unidentified Dolphin	125	32.8198	-117.3620
02/05/2012 09:50:51	Unidentified Dolphin	Unidentified Dolphin	120	32.7858	-117.3664
02/05/2012 09:52:43	Short-beaked Common Dolphin	*Delphinus delphis*	350	32.7413	-117.4027
02/05/2012 10:04:25	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	32.6750	-117.5833
02/05/2012 10:15:12	Fin Whale	*Balaenoptera physalus*	1	32.6025	-117.7325
02/05/2012 10:31:40	Long-beaked Common Dolphin	*Delphinus capensis*	70	32.7471	-117.6488
02/05/2012 10:40:57	Common Dolphin sp.	Undifferentiated *Delphinus*	2400	32.7378	-117.4849
02/05/2012 10:55:54	California Sea Lion	*Zalophus californianus*	1	32.8114	-117.3407
02/05/2012 10:57:45	Bottlenose Dolphin	*Tursiops truncatus*	6	32.8434	-117.2785
02/05/2012 10:58:05	California Sea Lion	*Zalophus californianus*	1	32.8535	-117.2779
03/13/2012 10:42:48	Unidentified Dolphin	Unidentified Dolphin	12	32.8799	-117.4001
03/13/2012 10:45:19	California Sea Lion	*Zalophus californianus*	1	32.7981	-117.3781
03/13/2012 10:49:07	Fin Whale	*Balaenoptera physalus*	3	32.6993	-117.4383
03/13/2012 10:51:41	Gray Whale	*Eschrichtius robustus*	2	32.6772	-117.5086
03/13/2012 10:51:58	Common Dolphin sp.	Undifferentiated *Delphinus*	20	32.6749	-117.5164
03/13/2012 11:01:08	Fin Whale	*Balaenoptera physalus*	1	32.6553	-117.5678
03/13/2012 11:14:35	Risso's Dolphin	*Grampus griseus*	15	32.6023	-117.8300
03/13/2012 11:39:17	Risso's Dolphin	*Grampus griseus*	7	32.6263	-118.0023
03/13/2012 11:57:10	Bottlenose Dolphin	*Tursiops truncatus*	5	32.6489	-117.9894
03/13/2012 12:03:04	California Sea Lion	*Zalophus californianus*	1	32.6762	-117.9991

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/13/2012 12:03:31	Risso's Dolphin	*Grampus griseus*	23	32.6880	-117.9952
03/13/2012 12:03:31	Bottlenose Dolphin	*Tursiops truncatus*	6	32.8176	-117.1409
03/13/2012 12:23:33	Gray Whale	*Eschrichtius robustus*	1	32.7059	-117.8819
03/13/2012 12:27:46	California Sea Lion	*Zalophus californianus*	1	32.7183	-117.7779
03/13/2012 12:28:32	Risso's Dolphin	*Grampus griseus*	24	32.7160	-117.7793
03/13/2012 12:28:46	Gray Whale	*Eschrichtius robustus*	9	32.7131	-117.7775
03/13/2012 12:31:29	Long-beaked Common Dolphin	*Delphinus capensis*	2500	32.7197	-117.6853
03/13/2012 12:33:33	Gray Whale	*Eschrichtius robustus*	1	32.4255	-117.4266
03/13/2012 12:39:54	Fin Whale	*Balaenoptera physalus*	3	32.7425	-117.6266
03/13/2012 12:41:42	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	32.7237	-117.6411
03/13/2012 13:01:41	Fin Whale	*Balaenoptera physalus*	2	32.7429	-117.5808
03/13/2012 13:08:58	Fin Whale	*Balaenoptera physalus*	3	32.8410	-117.4309
03/13/2012 13:19:13	Unidentified Dolphin	Unidentified Dolphin	12	32.8612	-117.4133
03/13/2012 14:47:16	Bottlenose Dolphin	*Tursiops truncatus*	4	32.8873	-117.2780
03/13/2012 14:52:06	California Sea Lion	*Zalophus californianus*	1	32.9304	-117.4084
03/13/2012 15:14:53	Risso's Dolphin	*Grampus griseus*	6	32.7863	-118.0230
03/13/2012 15:43:17	Common Dolphin sp.	Undifferentiated *Delphinus*	5	32.9668	-117.7701
03/13/2012 15:46:33	Fin Whale	*Balaenoptera physalus*	2	32.9672	-117.7831
03/13/2012 16:10:44	Gray Whale	*Eschrichtius robustus*	1	33.1454	-117.5912
03/13/2012 16:27:59	Gray Whale	*Eschrichtius robustus*	2	33.0090	-118.1305
03/13/2012 16:33:54	Bottlenose Dolphin	*Tursiops truncatus*	9	33.0084	-118.1291
03/13/2012 16:38:33	Risso's Dolphin	*Grampus griseus*	13	33.0014	-118.1798
03/13/2012 16:39:34	Gray Whale	*Eschrichtius robustus*	1	33.0004	-118.2163
03/13/2012 16:42:12	Risso's Dolphin	*Grampus griseus*	40	32.9767	-118.2933
03/13/2012 16:43:48	Risso's Dolphin	*Grampus griseus*	2	32.9637	-118.3455
03/13/2012 16:45:22	Humpback Whale	*Megaptera novaeangliae*	1	32.9761	-118.3913
03/13/2012 16:46:04	Risso's Dolphin	*Grampus griseus*	7	32.9830	-118.4118
03/13/2012 16:55:02	Fin Whale	*Balaenoptera physalus*	1	33.1075	-118.3180
03/13/2012 17:04:23	Gray Whale	*Eschrichtius robustus*	5	33.1689	-118.0063
03/13/2012 17:15:01	Common Dolphin sp.	Undifferentiated *Delphinus*	400	33.2399	-117.6505

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/13/2012 17:35:15	Short-beaked Common Dolphin	*Delphinus delphis*	200	32.9161	-117.3166
03/13/2012 17:35:28	Common Dolphin sp.	Undifferentiated *Delphinus*	200	32.9150	-117.3044
03/13/2012 17:36:39	Fin Whale	*Balaenoptera physalus*	1	32.8774	-117.2905
03/13/2012 17:36:53	Common Dolphin sp.	Undifferentiated *Delphinus*	50	32.8780	-117.2760
03/14/2012 08:26:31	Common Dolphin sp.	Undifferentiated *Delphinus*	2	33.0258	-117.3719
03/14/2012 08:30:00	Common Dolphin sp.	Undifferentiated *Delphinus*	400	33.0928	-117.4550
03/14/2012 08:31:12	Common Dolphin sp.	Undifferentiated *Delphinus*	30	33.1329	-117.4652
03/14/2012 08:34:13	Unidentified Dolphin	Unidentified Dolphin	400	33.2073	-117.5229
03/14/2012 08:42:40	Common Dolphin sp.	Undifferentiated *Delphinus*	425	33.3900	-117.7369
03/14/2012 08:52:29	Common Dolphin sp.	Undifferentiated *Delphinus*	350	33.3794	-117.7078
03/14/2012 09:05:55	Bottlenose Dolphin	*Tursiops truncatus*	12	33.2892	-118.1046
03/14/2012 09:18:35	Unidentified Dolphin	Unidentified Dolphin	NA	33.2647	-118.3117
03/14/2012 09:20:24	Bottlenose Dolphin	*Tursiops truncatus*	6	33.2709	-118.3136
03/14/2012 09:31:17	Bottlenose Dolphin	*Tursiops truncatus*	17	33.2030	-118.5508
03/14/2012 09:41:55	Gray Whale	*Eschrichtius robustus*	1	33.2223	-118.4684
03/14/2012 09:44:43	Fin Whale	*Balaenoptera physalus*	3	33.2425	-118.3672
03/14/2012 09:48:22	California Sea Lion	*Zalophus californianus*	1	33.2669	-118.3382
03/14/2012 09:49:48	California Sea Lion	*Zalophus californianus*	1	33.2889	-118.3077
03/14/2012 09:50:25	California Sea Lion	*Zalophus californianus*	1	33.2938	-118.2761
03/14/2012 09:51:03	Bottlenose Dolphin	*Tursiops truncatus*	1	33.3047	-118.2687
03/14/2012 09:53:57	Bottlenose Dolphin	*Tursiops truncatus*	20	33.3351	-118.2671
03/14/2012 09:54:05	California Sea Lion	*Zalophus californianus*	1	33.3558	-118.2522
03/14/2012 10:02:14	Common Dolphin sp.	Undifferentiated *Delphinus*	11	33.3791	-118.2786
03/14/2012 10:02:50	California Sea Lion	*Zalophus californianus*	1	33.2891	-118.4140
03/14/2012 10:03:24	Bottlenose Dolphin	*Tursiops truncatus*	18	33.3709	-118.2736
03/14/2012 10:17:24	Common Dolphin sp.	Undifferentiated *Delphinus*	18	33.4274	-118.0837
03/14/2012 10:21:59	Common Dolphin sp.	Undifferentiated *Delphinus*	60	33.4256	-118.0476
03/14/2012 10:30:36	Unidentified Dolphin	Unidentified Dolphin	25	33.4484	-117.7604
03/14/2012 10:33:45	Common Dolphin sp.	Undifferentiated *Delphinus*	700	33.3735	-117.7028
03/14/2012 10:50:30	California Sea Lion	*Zalophus californianus*	1	33.1800	-117.9552

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/14/2012 10:51:02	Fin Whale	*Balaenoptera physalus*	1	33.1811	-117.9756
03/14/2012 10:56:21	Gray Whale	*Eschrichtius robustus*	1	33.1485	-118.1488
03/14/2012 10:58:50	Fin Whale	*Balaenoptera physalus*	4	33.1334	-118.2296
03/14/2012 10:59:01	Risso's Dolphin	*Grampus griseus*	8	33.1334	-118.2341
03/14/2012 11:01:09	Gray Whale	*Eschrichtius robustus*	1	33.1476	-118.2311
03/14/2012 11:03:46	Risso's Dolphin	*Grampus griseus*	19	33.1198	-118.2893
03/14/2012 11:06:01	Unidentified Whale	Unidentified Whale	1	33.0944	-118.3613
03/14/2012 11:06:20	Risso's Dolphin	*Grampus griseus*	4	33.0935	-118.3704
03/14/2012 11:10:23	Fin Whale	*Balaenoptera physalus*	2	32.9992	-118.4195
03/14/2012 11:10:40	Fin Whale	*Balaenoptera physalus*	1	32.9909	-118.4147
03/14/2012 11:10:51	Common Dolphin sp.	Undifferentiated *Delphinus*	30	32.9903	-118.4077
03/14/2012 11:10:58	Common Dolphin sp.	Undifferentiated *Delphinus*	150	32.9848	-118.4069
03/14/2012 11:11:44	Long-beaked Common Dolphin	*Delphinus capensis*	200	32.9656	-118.3901
03/14/2012 11:26:54	Gray Whale	*Eschrichtius robustus*	3	33.0508	-117.9747
03/14/2012 11:37:55	Risso's Dolphin	*Grampus griseus*	4	33.1014	-117.6963
03/14/2012 13:30:36	Risso's Dolphin	*Grampus griseus*	15	32.9753	-117.7810
03/14/2012 13:30:46	Bottlenose Dolphin	*Tursiops truncatus*	25	32.9744	-117.7858
03/14/2012 13:43:44	Gray Whale	*Eschrichtius robustus*	3	32.9561	-117.8975
03/14/2012 13:51:19	Unidentified Dolphin	Unidentified Dolphin	2	32.9066	-118.1450
03/14/2012 13:51:44	California Sea Lion	*Zalophus californianus*	1	32.9051	-118.1608
03/14/2012 13:53:17	California Sea Lion	*Zalophus californianus*	3	32.8904	-118.2078
03/14/2012 13:53:54	Common Dolphin sp.	Undifferentiated *Delphinus*	300	32.8830	-118.2375
03/14/2012 13:55:09	California Sea Lion	*Zalophus californianus*	3	32.8418	-118.2021
03/14/2012 13:59:40	Bottlenose Dolphin	*Tursiops truncatus*	4	32.7544	-118.1290
03/14/2012 14:04:07	Gray Whale	*Eschrichtius robustus*	2	32.7702	-118.0785
03/14/2012 14:04:33	Bottlenose Dolphin	*Tursiops truncatus*	9	32.7721	-118.0648
03/14/2012 14:05:05	Bottlenose Dolphin	*Tursiops truncatus*	1	32.7797	-118.0534
03/14/2012 14:05:40	Risso's Dolphin	*Grampus griseus*	7	32.7834	-118.0342
03/14/2012 15:02:06	California Sea Lion	*Zalophus californianus*	1	32.6116	-117.8368
03/14/2012 15:22:35	California Sea Lion	*Zalophus californianus*	2	32.8576	-117.2817

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/15/2012 09:21:22	Gray Whale	*Eschrichtius robustus*	3	32.6817	-117.4682
03/15/2012 09:23:34	Risso's Dolphin	*Grampus griseus*	8	32.6669	-117.5390
03/15/2012 09:50:49	Fin Whale	*Balaenoptera physalus*	1	32.7195	-117.7925
03/15/2012 09:52:33	Gray Whale	*Eschrichtius robustus*	2	32.7309	-117.7516
03/15/2012 09:52:45	Fin Whale	*Balaenoptera physalus*	2	32.7322	-117.7339
03/15/2012 09:57:57	Gray Whale	*Eschrichtius robustus*	2	32.7653	-117.5780
03/15/2012 09:58:37	Gray Whale	*Eschrichtius robustus*	1	32.7693	-117.5500
03/15/2012 10:05:56	Bottlenose Dolphin	*Tursiops truncatus*	55	32.8778	-117.3795
03/15/2012 10:20:00	Short-beaked Common Dolphin	*Delphinus delphis*	700	32.9035	-117.5073
03/15/2012 10:28:19	Risso's Dolphin	*Grampus griseus*	5	32.8813	-117.5958
03/15/2012 10:35:00	Minke Whale	*Balaenoptera acutorostrata*	1	32.8584	-117.6948
03/15/2012 10:35:27	Risso's Dolphin	*Grampus griseus*	50	32.8557	-117.7058
03/15/2012 10:35:30	Risso's Dolphin	*Grampus griseus*	1	32.8554	-117.7190
03/15/2012 10:58:48	Risso's Dolphin	*Grampus griseus*	3	32.8928	-118.1847
03/15/2012 11:00:38	Fin Whale	*Balaenoptera physalus*	1	32.9038	-118.1134
03/15/2012 11:08:33	Risso's Dolphin	*Grampus griseus*	16	32.9448	-117.9259
03/15/2012 11:21:48	Risso's Dolphin	*Grampus griseus*	1	33.0282	-117.5067
03/15/2012 11:30:38	Unidentified Whale	Unidentified Whale	2	33.1573	-117.4814
03/15/2012 11:39:03	California Sea Lion	*Zalophus californianus*	1	33.1017	-117.7397
03/15/2012 11:55:13	Fin Whale	*Balaenoptera physalus*	3	32.9879	-118.2543
03/15/2012 12:02:45	Fin Whale	*Balaenoptera physalus*	1	33.0245	-118.4450
03/15/2012 12:07:13	Fin Whale	*Balaenoptera physalus*	1	33.0580	-118.3627
03/15/2012 12:08:00	Bottlenose Dolphin	*Tursiops truncatus*	32	33.0341	-118.2261
03/15/2012 12:10:39	Fin Whale	*Balaenoptera physalus*	1	33.0647	-118.3167
03/15/2012 12:12:10	Risso's Dolphin	*Grampus griseus*	11	33.0748	-118.2745
03/15/2012 12:12:14	Risso's Dolphin	*Grampus griseus*	1	33.0752	-118.2626
03/15/2012 12:15:07	Risso's Dolphin	*Grampus griseus*	4	33.0966	-118.1664
03/15/2012 12:15:52	Risso's Dolphin	*Grampus griseus*	6	33.1016	-118.1412
03/15/2012 12:17:29	Risso's Dolphin	*Grampus griseus*	8	33.1123	-118.1029
03/15/2012 12:32:12	Risso's Dolphin	*Grampus griseus*	8	33.2269	-117.6242

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/15/2012 12:35:21	Bottlenose Dolphin	*Tursiops truncatus*	1	33.2014	-117.5297
03/15/2012 12:39:54	Bottlenose Dolphin	*Tursiops truncatus*	2	33.0717	-117.4229
03/15/2012 12:46:58	Common Dolphin sp.	Undifferentiated *Delphinus*	125	32.8633	-117.2979
03/15/2012 14:20:22	Bottlenose Dolphin	*Tursiops truncatus*	10	32.8716	-117.2676
03/15/2012 14:20:56	Bottlenose Dolphin	*Tursiops truncatus*	15	32.8910	-117.2765
03/15/2012 14:32:10	Unidentified Dolphin	Unidentified Dolphin	75	33.2104	-117.5110
03/15/2012 14:36:56	California Sea Lion	*Zalophus californianus*	1	33.3392	-117.6324
03/15/2012 14:38:11	Common Dolphin sp.	Undifferentiated *Delphinus*	25	33.3788	-117.6685
03/15/2012 14:40:03	Short-beaked Common Dolphin	*Delphinus delphis*	1500	33.3755	-117.7475
03/15/2012 14:52:05	Short-beaked Common Dolphin	*Delphinus delphis*	375	33.3187	-117.9566
03/15/2012 14:58:39	Long-beaked Common Dolphin	*Delphinus capensis*	25	33.3112	-117.9769
03/15/2012 15:06:56	Bottlenose Dolphin	*Tursiops truncatus*	90	33.2966	-118.0706
03/15/2012 15:20:11	Fin Whale	*Balaenoptera physalus*	3	33.2008	-118.4736
03/15/2012 15:25:49	Fin Whale	*Balaenoptera physalus*	1	33.2133	-118.4886
03/15/2012 15:29:08	Risso's Dolphin	*Grampus griseus*	1	33.2498	-118.3875
03/15/2012 15:29:51	Risso's Dolphin	*Grampus griseus*	28	33.2586	-118.3678
03/15/2012 15:32:58	California Sea Lion	*Zalophus californianus*	19	33.2972	-118.2749
03/15/2012 15:50:21	Unidentified dolphin	Unidentified Dolphin	1	33.4559	-117.8885
03/15/2012 15:56:37	Common Dolphin sp.	Undifferentiated *Delphinus*	2	33.3915	-117.6710
03/15/2012 15:03:28	Unidentified Dolphin	Unidentified Dolphin	575	32.9222	-117.5366
03/15/2012 16:22:21	Fin Whale	*Balaenoptera physalus*	1	32.7385	-117.7078
03/15/2012 16:48:57	Common Dolphin sp.	Undifferentiated *Delphinus*	350	32.6629	-117.5451
03/15/2012 16:55:16	Gray Whale	*Eschrichtius robustus*	3	32.6859	-117.4587
03/15/2012 16:55:51	Gray Whale	*Eschrichtius robustus*	1	32.6900	-117.4193
03/15/2012 16:58:52	Common Dolphin sp.	Undifferentiated *Delphinus*	3	32.7681	-117.3682
03/15/2012 17:01:00	Unidentified Dolphin	Unidentified Dolphin	3	32.8057	-117.2979
03/28/2012 09:44:07	Common Dolphin sp.	Undifferentiated *Delphinus*	250	32.8412	-117.3137
03/28/2012 09:44:35	Common Dolphin sp.	Undifferentiated *Delphinus*	250	32.8253	-117.3226
03/28/2012 09:47:18	Common Dolphin sp.	Undifferentiated *Delphinus*	40	32.7469	-117.3954
03/28/2012 09:47:41	Common Dolphin sp.	Undifferentiated *Delphinus*	200	32.7298	-117.3922

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/28/2012 09:49:58	Fin Whale	*Balaenoptera physalus*	1	32.6737	-117.4636
03/28/2012 09:53:13	Unidentified Dolphin	Unidentified Dolphin	40	32.4061	-117.2814
03/28/2012 10:39:06	Short-beaked Common Dolphin	*Delphinus delphis*	150	32.8035	-117.4210
03/28/2012 10:39:26	Common Dolphin sp.	Undifferentiated *Delphinus*	NA	32.8180	-117.4362
03/28/2012 10:49:17	Common Dolphin sp.	Undifferentiated *Delphinus*	350	32.8370	-117.4123
03/28/2012 10:58:13	Fin Whale	*Balaenoptera physalus*	1	32.9036	-117.3733
03/28/2012 11:03:19	California Sea Lion	*Zalophus californianus*	1	32.9410	-117.3547
03/28/2012 11:03:30	Common Dolphin sp.	Undifferentiated *Delphinus*	15	32.9372	-117.3587
03/28/2012 11:09:24	California Sea Lion	*Zalophus californianus*	1	32.9310	-117.3513
03/28/2012 11:11:03	Fin Whale	*Balaenoptera physalus*	1	32.9191	-117.4002
03/28/2012 11:13:08	Short-beaked Common Dolphin	*Delphinus delphis*	225	32.9088	-117.4750
03/28/2012 11:25:28	Common Dolphin sp.	Undifferentiated *Delphinus*	50	32.8460	-117.6641
03/28/2012 11:39:29	Long-beaked Common Dolphin	*Delphinus capensis*	40	32.8426	-117.7435
03/28/2012 11:41:17	Common Dolphin sp.	Undifferentiated *Delphinus*	50	32.5084	-117.4399
03/28/2012 11:48:05	Common Dolphin sp.	Undifferentiated *Delphinus*	8	32.5122	-117.4343
03/28/2012 11:53:17	Unidentified Dolphin	Unidentified Dolphin	9	32.8431	-117.7355
03/28/2012 11:55:56	Common Dolphin sp.	Undifferentiated *Delphinus*	35	32.8251	-117.8016
03/28/2012 12:06:38	Fin Whale	*Balaenoptera physalus*	2	32.7675	-117.9790
03/28/2012 12:45:32	Risso's Dolphin	*Grampus griseus*	40	32.8729	-118.3085
03/28/2012 12:48:36	Risso's Dolphin	*Grampus griseus*	20	32.8851	-118.2530
03/28/2012 12:50:05	Risso's Dolphin	*Grampus griseus*	1	32.8895	-118.2042
03/28/2012 12:56:29	Gray Whale	*Eschrichtius robustus*	1	32.9339	-117.9943
03/28/2012 13:08:59	Gray Whale	*Eschrichtius robustus*	1	33.0160	-117.5875
03/28/2012 13:12:27	Unidentified Dolphin	Unidentified Dolphin	300	33.0254	-117.4698
03/28/2012 13:23:30	California Sea Lion	*Zalophus californianus*	1	33.0488	-117.3741
03/28/2012 13:25:41	Fin Whale	*Balaenoptera physalus*	1	32.9916	-117.3179
03/28/2012 15:36:46	California Sea Lion	*Zalophus californianus*	1	33.0688	-117.8757
03/28/2012 16:04:16	Gray Whale	*Eschrichtius robustus*	1	33.0956	-118.3459
03/28/2012 16:20:08	Fin Whale	*Balaenoptera physalus*	1	33.2170	-117.8409
03/28/2012 16:44:14	Common Dolphin sp.	Undifferentiated *Delphinus*	125	33.3190	-117.6483

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/28/2012 16:53:21	Fin Whale	*Balaenoptera physalus*	2	32.5058	-117.4371
03/28/2012 17:01:50	Long-beaked Common Dolphin	*Delphinus capensis*	50	33.3741	-117.6985
03/28/2012 17:07:07	Fin Whale	*Balaenoptera physalus*	2	33.3249	-117.6363
03/29/2012 12:41:38	Unidentified Dolphin	Unidentified Dolphin	400	32.8929	-117.2725
03/29/2012 12:42:59	Unidentified Dolphin	Unidentified Dolphin	140	32.9406	-117.2993
03/29/2012 12:47:52	Bottlenose Dolphin	*Tursiops truncatus*	24	33.0898	-117.4016
03/29/2012 12:59:19	Risso's Dolphin	*Grampus griseus*	3	33.3743	-117.6939
03/29/2012 13:09:12	Bottlenose Dolphin	*Tursiops truncatus*	10	33.3055	-118.0110
03/29/2012 13:17:26	Humpback Whale	*Megaptera novaeangliae*	2	33.1856	-118.0119
03/29/2012 13:23:45	California Sea Lion	*Zalophus californianus*	1	33.2667	-118.1922
03/29/2012 13:24:38	Gray Whale	*Eschrichtius robustus*	2	33.2636	-118.2240
03/29/2012 13:25:31	California Sea Lion	*Zalophus californianus*	1	33.2570	-118.2538
03/29/2012 13:45:04	Bottlenose Dolphin	*Tursiops truncatus*	2	33.2891	-118.3026
03/29/2012 13:50:20	Unidentified Dolphin	Unidentified Dolphin	1	33.3499	-118.2580
03/29/2012 14:04:14	California Sea Lion	*Zalophus californianus*	1	33.4326	-118.0318
03/29/2012 14:17:07	Bottlenose Dolphin	*Tursiops truncatus*	150	33.3322	-117.6743
03/29/2012 14:17:38	Gray Whale	*Eschrichtius robustus*	2	33.3332	-117.6454
03/29/2012 14:28:12	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	33.3364	-117.6720
03/29/2012 14:31:13	Fin Whale	*Balaenoptera physalus*	2	33.2775	-117.5993
03/29/2012 15:09:48	Risso's Dolphin	*Grampus griseus*	6	32.8734	-118.2404
03/29/2012 15:57:23	Gray Whale	*Eschrichtius robustus*	5	33.2532	-117.6705
03/29/2012 16:03:28	Long-beaked Common Dolphin	*Delphinus capensis*	200	33.2371	-117.5324
03/29/2012 16:08:06	Fin Whale	*Balaenoptera physalus*	1	33.2272	-117.5354
03/29/2012 16:29:38	Bottlenose Dolphin	*Tursiops truncatus*	9	32.9616	-117.3444
03/29/2012 16:45:44	Unidentified Dolphin	Unidentified Dolphin	8	32.8741	-117.2842
03/29/2012 16:58:28	Bottlenose Dolphin	*Tursiops truncatus*	3	32.5711	-117.1597
03/29/2012 16:53:23	Fin Whale	*Balaenoptera physalus*	2	32.9852	-117.3093
03/30/2012 11:14:14	Risso's Dolphin	*Grampus griseus*	7	32.5864	-117.9509
03/30/2012 11:16:47	Risso's Dolphin	*Grampus griseus*	15	32.6312	-118.0085
03/30/2012 11:16:47	California Sea Lion	*Zalophus californianus*	1	32.6308	-118.0074

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/30/2012 11:31:20	Unidentified Small Marine Mammal	Unidentified Small Cetacean	1	32.6802	-117.9875
03/30/2012 11:37:37	California Sea Lion	*Zalophus californianus*	1	32.7281	-117.7805
03/30/2012 11:38:40	Long-beaked Common Dolphin	*Delphinus capensis*	50	32.7349	-117.7448
03/30/2012 11:44:33	Gray Whale	*Eschrichtius robustus*	2	32.7392	-117.7486
03/30/2012 12:05:00	Short-beaked Common Dolphin	*Delphinus delphis*	200	32.8115	-117.4344
03/30/2012 12:11:08	Gray Whale	*Eschrichtius robustus*	2	32.8752	-117.3951
03/30/2012 12:13:39	Gray Whale	*Eschrichtius robustus*	1	32.9331	-117.3364
03/30/2012 12:33:50	Unidentified Small Marine Mammal	Unidentified Small Cetacean	1	32.8118	-117.8381
03/30/2012 12:41:08	Long-beaked Common Dolphin	*Delphinus capensis*	325	32.7418	-118.0607
03/30/2012 12:57:24	Gray Whale	*Eschrichtius robustus*	3	32.4315	-118.0354
03/30/2012 13:31:24	Gray Whale	*Eschrichtius robustus*	2	32.9783	-117.7847
03/30/2012 13:34:17	Common Dolphin sp.	Undifferentiated *Delphinus*	150	32.9894	-117.6821
03/30/2012 14:16:05	Risso's Dolphin	*Grampus griseus*	55	32.9677	-118.3457
03/30/2012 14:30:30	Fin Whale	*Balaenoptera physalus*	1	32.9537	-118.1598
03/30/2012 16:20:21	Risso's Dolphin	*Grampus griseus*	8	33.0455	-117.4041
03/30/2012 16:23:41	Bottlenose Dolphin	*Tursiops truncatus*	15	33.1453	-117.4771
03/30/2012 16:28:39	Unidentified Whale	Unidentified Whale	1	33.1594	-117.3648
03/30/2012 16:30:38	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	33.2442	-117.6759
03/30/2012 16:45:43	Unidentified Dolphin	Unidentified Dolphin	40	33.1356	-118.1352
03/30/2012 16:49:46	California Sea Lion	*Zalophus californianus*	1	33.0854	-118.0812
03/30/2012 17:01:31	Risso's Dolphin	*Grampus griseus*	15	33.0579	-118.5121
03/30/2012 17:05:12	Common Dolphin sp.	undifferentiated *Delphinus*	30	33.1502	-118.5549
03/30/2012 17:25:19	Fin/Bryde's/Sei Whale	*Balaenoptera physalus/brydei/borealis*	2	33.2756	-118.1842
03/30/2012 17:31:37	California Sea Lion	*Zalophus californianus*	7	33.3175	-117.9779
03/30/2012 17:43:54	Fin Whale	*Balaenoptera physalus*	1	33.2791	-117.6062
03/30/2012 17:48:29	Common Dolphin sp.	Undifferentiated *Delphinus*	20	33.1778	-117.5071
03/30/2012 17:54:05	Unidentified Small Dolphin	Unidentified Small Dolphin	10	33.0565	-117.3798
03/30/2012 18:00:06	Bottlenose Dolphin	*Tursiops truncatus*	10	32.8992	-117.2947
03/31/2012 10:28:19	Common Dolphin sp.	undifferentiated *Delphinus*	150	33.0092	-117.9945
03/31/2012 10:34:45	Bottlenose Dolphin	*Tursiops truncatus*	10	33.0486	-118.2433

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
03/31/2012 10:36:47	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	33.0833	-118.3106
03/31/2012 10:37:59	Unidentified Baleen Whale	Undifferentiated *Balaenoptera*	1	33.1167	-118.3475
03/31/2012 10:40:55	Risso's Dolphin	*Grampus griseus*	9	33.0988	-118.4720
03/31/2012 11:07:00	Gray Whale	*Eschrichtius robustus*	2	33.2570	-118.3528
03/31/2012 11:13:21	California Sea Lion	*Zalophus californianus*	1	33.3051	-118.2744
03/31/2012 11:15:55	Bottlenose Dolphin	*Tursiops truncatus*	30	33.3353	-118.2453
03/31/2012 11:25:57	California Sea Lion	*Zalophus californianus*	3	33.3869	-118.3181
03/31/2012 11:54:38	California Sea Lion	*Zalophus californianus*	1	33.3208	-117.9251
03/31/2012 12:35:41	Short-beaked Common Dolphin	*Delphinus delphis*	200	33.0524	-117.9340
03/31/2012 12:50:10	Long-beaked Common Dolphin	*Delphinus capensis*	200	33.1603	-117.5609
03/31/2012 13:01:10	California Sea Lion	*Zalophus californianus*	1	33.1442	-117.5071
03/31/2012 15:00:37	California Sea Lion	*Zalophus californianus*	5	32.9488	-117.3259
03/31/2012 15:00:58	Bottlenose Dolphin	*Tursiops truncatus*	15	32.9585	-117.3299
03/31/2012 15:17:32	Long-beaked Common Dolphin	*Delphinus capensis*	250	32.9625	-117.7921
03/31/2012 15:42:26	Unidentified Dolphin	Unidentified Dolphin	250	32.5056	-118.1608
03/31/2012 15:42:56	Risso's Dolphin	*Grampus griseus*	36	32.8440	-118.2523
03/31/2012 16:30:57	Risso's Dolphin	*Grampus griseus*	15	32.7502	-118.2004
03/31/2012 16:32:57	Risso's Dolphin	*Grampus griseus*	6	32.7262	-118.1452
03/31/2012 16:33:35	Short-beaked Common Dolphin	*Delphinus delphis*	9	32.7343	-118.1318
03/31/2012 16:34:57	Risso's Dolphin	*Grampus griseus*	9	32.4415	-118.0792
03/31/2012 16:48:43	Unidentified Small Dolphin	Unidentified Small Dolphin	4	32.7457	-118.0670
03/31/2012 16:49:59	Fin Whale	*Balaenoptera physalus*	2	32.7409	-118.0791
03/31/2012 16:55:45	Risso's Dolphin	*Grampus griseus*	3	32.7639	-118.0226
03/31/2012 17:07:24	Risso's Dolphin	*Grampus griseus*	8	32.8561	-117.6464
03/31/2012 17:18:25	Unidentified Small Dolphin	Unidentified Small Dolphin	110	32.9097	-117.3180
03/31/2012 17:19:04	Unidentified Small Dolphin	Unidentified Small Dolphin	20	32.8954	-117.2942
03/31/2012 17:28:40	Common Dolphin sp.	Undifferentiated *Delphinus*	40	32.8111	-117.1403
03/31/2012 17:30:50	Bottlenose Dolphin	*Tursiops truncatus*	9	32.8109	-117.1406
04/01/2012 10:19:00	California Sea Lion	*Zalophus californianus*	3	32.8586	-117.2858
04/01/2012 11:22:58	California Sea Lion	*Zalophus californianus*	4	33.3883	-118.0730

Date and Time	Species Common Name	Species Scientific Name	Group Size	Latitude (N)	Longitude (W)
04/01/2012 11:23:00	California Sea Lion	*Zalophus californianus*	13	33.3968	-118.0315
04/01/2012 11:24:22	California Sea Lion	*Zalophus californianus*	4	33.4596	-117.7076
04/01/2012 12:09:08	Fin Whale	*Balaenoptera physalus*	3	32.9191	-117.3386
04/01/2012 12:10:14	Fin Whale	*Balaenoptera physalus*	2	32.9344	-117.3627
04/01/2012 12:40:39	Short-beaked Common Dolphin	*Delphinus delphis*	100	32.7870	-117.4989

Table 5. Summary of Flight Effort during SOCAL Marine Mammal Aerial Survey Monitoring 30 January–5 February 2012.

Date	Flight of Day	Time Engines On	Time Engines Off	Total Engine Time (hh:mm)	Time Wheels Up	Time Wheels Down	Total Flight Time (hh:mm	Total Flight Dist (km)	Total Flight Dist (nm)	Start Obs.	End Obs.	Total Obs. Time (hh:mm	Flight Area	General Weather	Comments
30 Jan	1	11:39	16:08	4:29	11:46	16:03	4:17	792.5	427.9	11:51	15:58	4:07	Santa Catalina Basin	Clear Skies Bf 1-4	Late start due to plane arriving in San Diego
31 Jan	1	8:45	12:24	3:39	8:55	12:21	3:26	629.6	340.0	8:59	12:18	3:19	Santa Catalina Basin	Clear Skies Bf 1-3	
31 Jan	2	13:42	16:17	2:35	13:45	16:13	2:28	447.5	241.6	13:47	16:07	2:20	Santa Catalina Basin	Clear Skies Bf 1-3	
01 Feb	1	9:54	11:20	1:26	10:00	11:15	1:15	229.3	123.8	10:04	11:09	1:05	Santa Catalina Basin	Clear Skies Bf 2-3	
01 Feb	2	12:08	15:45	3:37	12:15	15:40	3:25	552.5	298.3	12:18	15:34	3:16	Santa Catalina Basin	Clear Skies Bf 1-4	
02 Feb	1	10:02	13:55	3:53	10:09	13:53	3:44	660.7	356.8	10:12	13:46	3:34	Santa Catalina Basin	Clear Skies Bf 1-3	
02 Feb	2	14:32	16:36	2:04	14:41	16:31	1:50	327.4	176.8	14:43	16:26	1:43	Santa Catalina Basin	Clear Skies Bf 1-3	
03 Feb	1	8:59	13:09	4:10	9:08	13:05	3:57	779.8	421.1	9:11	13:00	3:49	San Nicolas Basin	Clear Skies Bf 1-4	
03 Feb	2	13:33	15:52	2:19	13:35	15:49	2:14	425.3	229.6	13:39	15:47	2:08	San Nicolas Basin	Clear Skies Bf 1-4	
04 Feb	1	8:36	12:12	3:36	8:42	12:06	3:24	684.8	369.8	8:45	12:01	3:16	San Nicolas Basin	Clear Skies Bf 1-4	
04 Feb	2	12:44	16:10	3:26	12:51	16:04	3:13	630.6	340.5	12:54	16:00	3:06	San Nicolas Basin	Clear Skies Bf 1-4	
05 Feb	1	9:37	11:06	1:29	9:42	11:03	1:21	248.1	134.0	9:46	10:59	1:13	Santa Catalina Basin	Clear Skies Bf 1-3	
		Total Engine Time:		**36:43**	**Total Flown:**		**34:34**	**6408**	**3460**	**Total Obs Time:**		**32:56**			**Add 3 hours (RT) for ferry time to and from Oxnard for aircraft**

Table 6. Summary of Flight Effort during SOCAL Marine Mammal Aerial Survey Monitoring 13–15 March 2012.

Date	Flight of Day	Time Engines On	Time Engines Off	Total Engine Time (hh:mm)	Time Wheels Up	Time Wheels Down	Total Flight Time (hh:mm)	Total Flight Distance (km)	Total Flight Distance (NM)	Start Obs. Time	End Obs. Time	Total Obs. Time (hh:mm)	Flight Area	General Weather	Comments
13 Mar	1	10:30	13:33	3:03	10:37	13:29	2:52	501.7	270.9	10:45	13:23	2:38	Santa Catalina Basin	Clear Skies Bf 1-3	Started at Line 1
13 Mar	2	14:37	17:46	3:09	14:42	17:42	3:00	571.3	308.5	14:45	17:37	2:52	Santa Catalina Basin	Clear Skies Bf 2-4	Started at line 3
14 Mar	1	8:09	11:54	3:45	8:16	11:51	3:35	661.0	357.0	8:19	11:48	3:29	Santa Catalina Basin	Clear Skies Bf 1-3	Started at line 7
14 Mar	2	13:08	15:32	2:24	13:13	15:28	2:15	417.0	225.2	13:15	15:24	2:09	Santa Catalina Basin	Clear Skies Bf 2-4	
15 Mar	1	9:03	12:57	3:54	9:08	12:54	3:46	564.7	305.0	9:11	12:48	3:37	Santa Catalina Basin	Overcast Bf 1-4	Flight delayed by low clouds
15 Mar	2	14:13	17:10	2:57	14:16	17:06	2:50	694.1	374.8	14:20	17:02	2:42	Santa Catalina Basin	Overcast Bf 1-4	
		Total Engine Time (hh:mm):		**19:12**	**Total Hrs Flown (hh:mm):**		**18:18**	**3410**	**1841**	**Total Obs Time (hh:mm):**		**17:27**			**Add 3 hours (RT) for ferry time to and from Oxnard for aircraft**

Table 7. Summary of Flight Effort during SOCAL Marine Mammal Aerial Survey Monitoring 28 March-1 April, 2012.

Date	Flight of Day	Time Engines On	Time Engines Off	Total Engine Time	Time Wheels Up	Time Wheels Down	Total Flight Time	Total Flight Dist (km)	Total Flight Dist (nm)	Start Obs.	End Obs.	Total Obs. Time	Flight Area	General Weather	Comments
28 Mar	1	9:25	13:38	4:13	9:38	13:34	3:56	734.6	396.7	9:49	13:29	3:40	Santa Catalina Basin	Clear Skies Bf 1-4	Finished Santa Catalina Basin (SCB) lines 1-4
28 Mar	2	15:04	17:30	2:26	15:08	17:25	2:17	372.8	201.3	15:12	17:21	2:09	Santa Catalina Basin	Clear Skies Bf 2-4	Started on SCB line 5
29 Mar	1	12:25	17:09	4:44	12:37	17:05	4:28	871.7	470.7	12:41	16:56	4:15	Santa Catalina Basin	Partly Cloudy Bf 1-4	Flight delayed by fog. Started on SCB south Line 1
30 Mar	1	10:42	15:00	4:18	10:48	14:56	4:08	791.4	427.3	10:51	14:52	4:01	Santa Catalina Basin	Partly Cloudy Bf 1-3	Flight delayed by fog. Started on SCB Line 6
30 Mar	2	16:05	18:09	2:04	16:10	18:06	1:56	383.0	206.8	16:12	18:01	1:49	Santa Catalina Basin	Clear Skies Bf 1-2	
31 Mar	1	9:59	13:22	3:23	10:06	13:18	3:12	625.8	337.9	10:10	13:14	3:04	Santa Catalina Basin	Partly Cloudy Bf 1-4	Flight delayed by morning overcast layer; scheduled to fly W of San Clemente Island but could not due to low marine cloud layer.
31 Mar	2	14:50	17:34	2:44	14:53	17:24	2:31	464.6	250.9	14:58	17:17	2:19	Santa Catalina Basin	Partly Cloudy Bf 1-4	

Date	Flight of Day	Time Engines On	Time Engines Off	Total Engine Time	Time Wheels Up	Time Wheels Down	Total Flight Time	Total Flight Dist (km)	Total Flight Dist (nm)	Start Obs.	End Obs.	Total Obs. Time	Flight Area	General Weather	Comments
01 Apr	1	10:10	13:14	3:04	10:14	13:17	3:03	583.4	315.0	10:18	13:10	2:52	Santa Catalina Basin	Windy, high scattered clouds Bf 3-6	High winds throughout SCB, so flew along E side of San Clemente Island and coast to try and find lee, but Beaufort was too high to conduct useful surveys.
		Total Engine Time:		**26:56**	**Total Flown:**		**25:30**	**4827**	**2607**	**Total Obs Time:**		**24:09**			**Add 3 hours (RT) for ferry time to and from Oxnard for aircraft**

Table 8. Summary of Photo and Video Effort during SOCAL Marine Mammal Aerial Survey Monitoring 28 March-1 April, 2012.

Survey Date	Total Video Clips	Total Useable Video (Animals In View)	Total Video (hh:mm:ss)	Total Useable Video (hh:mm:ss)	Total Photos
Jan- Feb 12	18	14	1:22:19	1:22:16	1868
Mar-12	7	4	0:54:30	0:54:06	1026
Mar-Apr 12	21	18	0:57:33	0:57:10	921
Total	**46**	**36**	**3:14:22**	**3:13:32**	**3815**

Table 9. Video recorded during 31 January-5 February SOCAL 2012 aerial monitoring surveys off San Diego, California.

Navy Range	Video Name	Date (day mo yr)	Start Time (hr:min:sec)	End Time (hr:min:sec)	Total Video (hr:min:sec)	Daily Sighting ID#	Species	Group Size (best estim.)	Beaufort sea state	Taken by	Video Utility/ Quality[a]	General Description of Video Content
SOCAL	SOCAL_2012Jan_31_SES_Video_141704-143332_ID36_Risso	1/31/2012	14:17:04	14:33:32	0:16:28	36	Risso's Dolphin	13	2	David Steckler	Good	Two groups separated by 10 body lengths (BL) traveling line abreast, second group 3 animals, then split into 3 subgroups, with 2 groups 3 animals each, then all form one group, then back to 3 subgroups
SOCAL	SOCAL_2012Jan_31_SES_Video_143334-143536_ID36_Risso	1/31/2012	14:33:34	14:35:56	0:02:22	36	Risso's Dolphin	13	2	David Steckler	Fair	All traveling in one group subsurface, then split into 2 groups, second group 5 animals, then split into 3 groups
SOCAL	SOCAL_2012Feb_2_SES_Video_130516-130532_ID27_Risso	2/2/2012	13:05:16	13:05:32	0:00:16	27	Risso's Dolphin	75	1	Bernd Würsig	Fair	One large group with 2 subgroups, one subgroup with 9 animals and the other with 2 animals, all traveling
SOCAL	SOCAL_2012Feb_2_SES_Video_130552-131136_ID27_Risso	2/2/2012	13:05:52	13:11:36	0:05:44	27	Risso's Dolphin	75	1	Bernd Würsig	Fair	One large group with dispersal 1-20BL, medium travel to the 270, whale seen diving out ahead of group, no calves seen, 1 subgroup seen 7 animals line abreast
SOCAL	SOCAL_2012Feb_3_SES_Video_144732-144906_ID43_Fin	2/3/2012	14:47:32	14:49:06	0:01:34	43	Fin Whale	7	2	Bernd Würsig	Excellent	5 fin whales seen at the surface, dispersal 0.5- 2, BL, multiple blows seen, 6 adults and 1 calf, one lead animal, changed direction to 240 degrees
SOCAL	SOCAL_2012Feb_3_SES_Video_145422-150253_ID43_Fin	2/3/2012	14:54:22	15:02:53	0:08:31	43	Fin Whale	7	2	Bernd Würsig	Excellent	Whales seen surfacing, blowing, all oriented in different directions, one split off 6 BL away, overall dispersal 1-6, whale seen rolling, oriented to 270 degrees, dispersal is 2-8 BL
SOCAL	SOCAL_2012Feb_4_SES_Video_95212-95311_ID8_Fin	2/4/2012	9:52:12	9:53:11	0:00:59	8	Fin Whale	4	3	Bernd Würsig	Fair	Whales subsurface, rear whale seen rapid dive with chin slap and spun under water slightly inverted
SOCAL	SOCAL_2012Feb_4_SES_Video_95455-100224_ID8_Fin	2/4/2012	9:54:55	10:02:24	0:07:29	8	Fin Whale	4	3	Bernd Würsig	Good	Video not really on animals at beginning, observer calls first and second blows, lead animal dive, heading towards 12 o'clock, fast travel, both subsurface now, trailing animal up and blow, 2 whales separated by 2 BL, trailing animal dove, lead blow, lead dove
SOCAL	SOCAL_2012Feb_4_SES_Video_100313-100412_ID8_Fin	2/4/2012	10:03:13	10:04:12	0:00:59	8	Fin Whale	4	3	Bernd Würsig	Fair	Puka seen, lead animal blew in glare, 2 groups separated by 4 BL, lead animal blew

Navy Range	Video Name	Date (day mo yr)	Start Time (hr:min:sec)	End Time (hr:min:sec)	Total Video (hr:min:sec)	Daily Sighting ID#	Species	Group Size (best estim.)	Beaufort sea state	Taken by	Video Utility/ Quality[a]	General Description of Video Content
SOCAL	SOCAL_2012Feb_4_SES_Video_130634-132030_ID24_Fin	2/4/2012	13:06:34	13:20:30	0:13:56	24	Fin Whale	1	1	Bernd Würsig	Fair	2 groups of 2 whales, whales traveling all in a line same direction, groups separated by 20 BL, video of the front group, lead animal blew, traveling towards 090 degrees, lead blew, traveling subsurface, only one animal visible, trailing pair 30-40 BL away
SOCAL	SOCAL_2012Feb_4_SES_Video_143014-145118_ID26_27_Risso's_NRWD	2/4/2012	14:30:14	14:51:18	0:21:04	26, 27	Risso's Dolphin/N. right whale dolphin (NRWD)	48	1	Bernd Würsig	Good	Slow travel/rest, one group in V shape, three calves seen, tight group traveling 120 degrees, 1- 1.5 BL dispersal, one lead animal, ball formation now, NRWD seen swimming with lead Risso's, some are paired off, NRWD animal seen again at front of Risso's.
SOCAL	SOCAL_2012Feb_5_SES_Video_104831-105022_ID9_LBCD	2/5/2012	10:48:31	10:50:22	0:01:51	9	Long-beaked Common Dolphin	2400	1	Mari Smultea	Good	Large group, surface-active behavior, splashing, traveling, sprinting
SOCAL	SOCAL_2012Feb_5_SES_Video_105033-105138_ID9_LBCD	2/5/2012	10:50:33	10:51:38	0:01:05	9	Long-beaked Common Dolphin	2400	1	Mari Smultea	Good	Same group as above, surface-active behavior, splashing, sprinting
SOCAL	SOCAL_2012Feb_5_SES_Video_105205-105308_ID9_LBCD	2/5/2012	10:52:05	10:53:08	0:01:03	9	Long-beaked Common Dolphin	2400	1	Mari Smultea	Good	Same group as above, surface-active behavior, splashing, sprinting, very spread out, bird association
				Total Hours =	1:22:16							

Table 10. Video recorded during 13-15 March SOCAL 2012 aerial monitoring surveys off San Diego, California.

Navy Range	Video Name	Date (day mo yr)	Start Time (hr:min:sec)	End Time (hr:min:sec)	Total Video (hr:min:sec)	Daily Sighting ID#	Species	Group Size (best estim.)	Beaufort sea state	Taken by	Video Utility/ Quality	General Description of Video Content
SOCAL	SOCAL_2012March_13_SES_Video_111841-113319_ID7_Risso's	13-Mar-2012	11:18:41	11:33:19	0:14:38	7	Risso's Dolphin	15	2	Dave Steckler	Good	Medium size group. Slow travel. Possibly at least one calf. Mostly tight group (especially when underwater) a bit loose when up at surface. Closer to end more spread out; separated in smaller sub-groups.
SOCAL	SOCAL_2012March_13_SES_Video_114218-115609_ID8&9_Risso_Bottlenose	13-Mar-2012	11:42:18	11:56:09	0:13:51	9 & 10	Bottlenose Dolphin/ Risso's Dolphin	Risso's=7 Bottlenose=5	3	Dave Steckler	Good	Two small groups. Slow travel. Loose dispersal. Oval shape. Bottlenose and Risso's group merge together. Middle of video Risso's group in C shape. Bottlenose group mainly to the right of Risso's, but sometimes 1 or 2 individuals in between. About 9 minutes in video major behavior change, one indiv. Risso's changes directions (possibly caused by a bottlenose). Risso's very largely dispersed following behavior change. Form back into slight C formation with bottlenose on right side and a couple in middle of Risso's group. Near end bottlenose group falls behind Risso's a bit, Risso's slightly tighter group formation.
SOCAL	SOCAL_2012March_13_SES_Video_120538-121626_ID11_Risso&tursiops	13-Mar-2012	12:05:38	12:16:26	0:10:48	12 & 13	Bottlenose Dolphin/ Risso's Dolphin	Risso's=23 Bottlenose=6	2	Dave Steckler	Good	2 subgroups. One medium size, one small size. Medium travel. Bottlenose within Risso's groups. Line formation. Stay mostly tight within groups. Smaller group stays to right of larger group. Bottlenose possible stay in between Risso's groups. Within smaller group, Risso's paired off. Near end smaller Risso's group moved closer to larger group.
SOCAL	SOCAL_2012March_13_SES_Video_124458-125947_ID18_Fin	13-Mar-2012	12:44:58	12:59:47	0:14:49	20	Fin Whale	3	2	Dave Steckler	Good	Lots of social activity. Individuals rolling over numerous times. Rolling over and staying belly up for long periods of time. Slow milling. Social behavior. About 10 minutes in video fins are hanging vertically in water (head up near surface)
				Total Hours =	0:54:06							

Table 11. Video recorded during 28 March-1 April SOCAL 2012 aerial monitoring surveys off San Diego, California.

Navy Range	Date	Start Time (hr:min:sec)	End Time (hr:min:sec)	Total Video (hr:min:sec)	Daily Sighting ID#	Species	Group Size (best estim.)	Beaufort sea state	Taken by	Video Utility/ Quality[a]	General Description of Video Content
SOCAL	3/28/2012	11:32:26	11:36:42	0:04:16	16	Common Dolphin sp.	50	2	Dave Steckler	Fair	Video on one animal of the group, surface-active behavior seen, splashing, with birds, inverted swimming, chasing, very fast travel, seems to be feeding
SOCAL	3/30/2012	11:40:40	11:41:15	0:00:35	6	Long-beaked Common Dolphin	50	2	Mari Smultea	Good	Group of surface-active fast travel common dolphins, heading 210 degrees, tightly dispersed 1-4 BL with birds
SOCAL	3/30/2012	11:44:35	11:47:03	0:02:28	6	Long-beaked Common Dolphin	50	2	Mari Smultea	Good	Same group as above, surface-active fast travel, oval shaped group, with birds, front of group dispersing a little, dispersal 1-3 BL, heading 210 degrees
SOCAL	3/30/2012	11:49:07	11:49:46	0:00:39	6, 7	Long-beaked Common Dolphin/Gray Whale	Long-beaked Common Dolphin 50, Gray Whale 2	2	Mari Smultea	Fair	Whale seen traveling subsurface with a group of common dolphins surface-active travel just in front of whale, short video clip with little behavior
SOCAL	3/30/2012	11:50:13	11:52:16	0:02:03	6,7	Long-beaked Common Dolphin/Gray Whale	Long-beaked Common Dolphin 50, Gray Whale 2	2	Mari Smultea	Fair	Whale seen surfacing, blow, with dolphins just in front, whale and dolphins apart by .5 BL, traveling medium speed, 2nd whale subsurface but visible, 12 dolphins seen bowriding the left whale, whales 1.5 BL apart from each other
SOCAL	3/30/2012	11:52:13	11:52:25	0:00:12	6,7	Long-beaked Common Dolphin/Gray Whale	Long-beaked Common Dolphin 50, Gray Whale 2	2	Mari Smultea	Poor	Graywhale seen at surface, left barely visible, dolphins just out in front, very short video clip
SOCAL	3/30/2012	11:52:58	11:54:31	0:01:33	6,7	Long-beaked Common Dolphin/Gray Whale	Long-beaked Common Dolphin 50, Gray Whale 2	2	Mari Smultea	Fair	Dolphins bowriding left gray whale, whale blew and went subsurface, main group of dolphins out ahead of whales, clumped surface-active travel
SOCAL	3/30/2012	12:50:49	13:03:33	0:12:44	12	Long-beaked Common Dolphin	325	3	Mari Smultea	Fair	Very large group seen surface-active fast travel with birds, very tightly dispersed, heading to 220 degrees, dispersal 1-2 BL, seen leaping out of the water, inverted swimming, possible feeding seen

Navy Range	Date	Start Time (hr:min:sec)	End Time (hr:min:sec)	Total Video (hr:min:sec)	Daily Sighting ID#	Species	Group Size (best estim.)	Beaufort sea state	Taken by	Video Utility/ Quality[a]	General Description of Video Content
SOCAL	3/30/2012	14:22:05	14:22:19	0:00:14	16	Risso's Dolphin	55	3	Mari Smultea	Poor	Large group of Risso's dolphin spread out, video too far from animals and too short to discern any behaviors
SOCAL	3/30/2012	14:22:36	14:25:54	0:03:18	16	Risso's Dolphin	55	3	Mari Smultea	Fair	Oriented at 060 degrees, 11 animals seen in front group and separated by 1-7 BL, 2nd subgroup with 6-7 animals and dispersed by 1-7 BL, 3rd subgroup behind by 15 BL with 15 individuals, 4th subgroup 40 BL behind with 4 animals, all seen traveling subsurface, reorientation seen in front group socializing, now heading north (360 degrees)
SOCAL	3/30/2012	14:25:59	14:26:18	0:00:19	16	Risso's Dolphin	55	3	Mari Smultea	Poor	Risso's seen really spread in subgroups, very short clip
SOCAL	3/31/2012	16:01:25	16:04:36	0:03:11	18	Risso's Dolphin	36	2	Bernd Würsig	Fair	Staggered line abreast, some pairing, very slow travel
SOCAL	3/31/2012	16:05:45	16:18:22	0:12:37	18	Risso's Dolphin	36	2	Bernd Würsig	Good	Staggered line abreast formation, very slow travel/resting, 2 subgroups, 14-18 animals visible, some breaking the surface, some animals crossing over, one animal visible rest took a deep dive, breaking the surface synchronized, 2nd group social with a dispersal of .5-5 BL and synchronized with large group, both groups heading the same direction, 2nd group separated by 100 BL from large group
SOCAL	3/31/2012	16:12:31	16:23:15	0:10:44	18	Risso's Dolphin	36	2	Bernd Würsig	Good	Large group of Risso's seen, slow travel in subgroups, spread by 15 BL, clumped and some paired, one lead animal in front, dispersal 1-8 BL, coordinated movements with all groups, now all one group, flank formation
SOCAL	3/31/2012	16:23:28	16:26:04	0:02:36	18	Risso's Dolphin	36	2	Bernd Würsig	Fair	Boat seen passing by 1 mile away from Risso's, staggered line abreast, one large group, slow travel, clumped and paired, dispersal 1-2
			Total Hours =	0:57:29							

Table 12. List of Photographs Taken during January – April 2012 Navy SOCAL Aerial Surveys off San Diego, California

Date	Daily Sighting ID No.	Species Common Name	Best Group Size Estim.	Start Frame #	End Frame #	Total Photos	First Frame Time	Last Frame Time
30 January - 5 February Photos								
30-Jan	5	Short-beaked Common Dolphin	60	2447	2486	40	12:14:22	12:15:40
30-Jan	6	Common Dolphin sp.	40	2489	2501	13	12:33:28	12:34:10
30-Jan	9	Gray Whale	3	2506	2533	28	13:05:00	13:06:36
30-Jan	13	Bottlenose Dolphin	45	2534	2600	66	14:00:52	14:07:26
30-Jan	16	Bottlenose Dolphin	15	2601	2631	31	14:13:00	14:18:02
30-Jan	19	Short-beaked Common Dolphin	300	2634	2698	68	15:14:32	15:16:40
30-Jan	23	Common Dolphin sp.	250	2701	2774	74	15:44:32	15:46:34
31-Jan	13	Common Dolphin sp.	150	2778	2809	32	9:35:54	9:38:06
31-Jan	16	Long-beaked Common Dolphin	350	2811	2851	41	9:51:02	9:53:14
31-Jan	20	Bottlenose Dolphin	100	2853	2875	23	9:58:44	10:01:20
31-Jan	24	Common Dolphin sp.	400	2878	2933	56	10:35:54	10:39:54
31-Jan	26	Long-beaked Common Dolphin	125	2936	3006	71	11:21:32	11:22:58
31-Jan	28	Common Dolphin sp.	20	3009	3079	71	11:43:38	11:45:12
31-Jan	29	Short-beaked Common Dolphin	500	3080	3210	131	11:47:54	11:50:18
31-Jan	30	Common Dolphin sp.	150	3212	3267	56	12:10:08	12:11:48
31-Jan	35	Bottlenose Dolphin	40	3270	3316	47	14:08:54	14:11:16
31-Jan	37	Common Dolphin sp.	50	3317	3383	67	14:39:00	14:41:10
31-Jan	40	Common Dolphin sp.	2500	3389	3465	77	15:22:16	15:25:34
1-Feb	8	Common Dolphin sp.	80	3483	3519	37	12:42:32	12:43:48
1-Feb	11	Risso's Dolphin	15	3521	3531	11	13:04:04	13:04:12
1-Feb	13	Short-beaked Common Dolphin	2000	3533	3563	31	13:22:08	13:23:00
1-Feb	15	Short-beaked Common Dolphin	500	3566	3597	32	13:45:36	13:47:34
1-Feb	16	Common Dolphin sp.	50	3600	3639	40	13:55:34	13:56:24
1-Feb	19	Bottlenose Dolphin	60	3642	3714	73	14:56:32	15:00:32
2-Feb	N/A	Ocean Sunfish	1	3719	3722	4	10:24:12	10:24:34

Date	Daily Sighting ID No.	Species Common Name	Best Group Size Estim.	Start Frame #	End Frame #	Total Photos	First Frame Time	Last Frame Time
30 January - 5 February Photos (continued)								
2-Feb	4	Common Dolphin sp.	400	3723	3738	16	10:29:40	10:31:48
2-Feb	5	Long-beaked Common Dolphin	100	3740	3746	7	10:43:52	10:46:42
2-Feb	8	Dead California Sea Lion	1	3748	3755	8	11:46:20	11:47:02
2-Feb	10	Bottlenose Dolphin	12	3756	3767	12	11:51:06	11:53:48
2-Feb	11	Common Dolphin sp.	50	3769	3780	12	11:57:42	11:58:44
2-Feb	25	Gray Whale	3	3785	3794	10	12:45:26	12:45:46
2-Feb	26	Dall's Porpoise	4	3801	3802	2	12:49:02	12:49:10
2-Feb	27	Risso's Dolphin	75	3807	3862	56	13:12:18	13:18:32
2-Feb	36	Common Dolphin sp.	70	3864	3879	16	15:24:50	15:27:16
2-Feb	38	Common Dolphin sp.	90	3884	3897	14	15:37:36	15:39:24
2-Feb	39	Common Dolphin sp.	80	3899	3911	13	16:05:34	16:06:58
2-Feb	41	Common Dolphin sp.	130	3914	3919	6	16:14:34	16:14:48
3-Feb	5	Common Dolphin sp.	100	3921	3945	24	10:27:36	10:32:00
3-Feb	10	California Sea Lion	1	3946	3955	10	11:52:46	11:53:22
3-Feb	11	Fin Whale	3	3957	3960	4	12:00:30	12:00:50
3-Feb	12	Northern Right Whale Dolphin	11	3963	3974	150	12:11:40	12:12:08
3-Feb	43	Fin Whale	7	3976	3987	12	15:03:40	15:04:32
3-Feb	44	Long-beaked Common Dolphin	1750	3989	4024	35	15:28:08	15:41:08
4-Feb	9	Gray Whale	9	4026	4041	17	10:33:26	10:34:28
4-Feb	19	Short-beaked Common Dolphin	700	4044	4053	10	13:07:04	13:08:46
4-Feb	26	Risso's Dolphin	48	4055	4095	41	14:52:00	14:53:52
4-Feb	36	Common Dolphin sp.	1250	4097	4102	6	15:38:08	15:38:04
4-Feb	38	Short-beaked Common Dolphin	2000	4104	4112	9	15:52:04	15:52:56
5-Feb	6	Common Dolphin sp.	350	4114	4136	23	9:55:06	9:56:04
5-Feb	8	Fin Whale	1	4138	4158	21	10:20:38	10:20:56
5-Feb	9	Long-beaked Common Dolphin	70	4160	4216	57	10:33:00	10:35:30
5-Feb	10	Common Dolphin sp.	2400	4218	4274	57	10:44:52	10:46:14

Date	Daily Sighting ID No.	Species Common Name	Best Group Size Estim.	Start Frame #	End Frame #	Total Photos	First Frame Time	Last Frame Time
13 - 15 March Photos								
13-Mar	5	Common Dolphin sp.	20	4707	4737	31	10:56:45	10:57:47
13-Mar	8	Risso's Dolphin	7	4740	4799	60	11:37:39	12:19:10
13-Mar	9	Bottlenose Dolphin	5	4740	4799	60	11:37:39	12:19:10
13-Mar	16	Long-beaked Common Dolphin	2500	4800	4952	153	12:32:29	12:36:16
13-Mar	21	Fin Whale	3	4956	4985	30	13:12:37	13:16:33
13-Mar	40	Short-beaked Common Dolphin	400	4986	5096	111	17:15:48	17:18:43
14-Mar	5	Common Dolphin sp.	425	5099	5188	90	8:44:39	8:50:07
14-Mar	9	Bottlenose Dolphin	6	5190	5194	5	9:23:03	9:23:04
14-Mar	10	Bottlenose Dolphin	17	5197	5208	12	9:33:09	9:33:50
14-Mar	17	Bottlenose Dolphin	20	5211	5224	14	9:55:24	9:56:56
14-Mar	19	Common Dolphin sp.	11	5226	5265	40	10:05:13	10:10:01
14-Mar	21	Common Dolphin sp.	18	5269	5279	11	10:18:38	10:19:05
14-Mar	39	Short-beaked Common Dolphin	200	5282	5341	60	11:12:55	11:14:18
14-Mar	40	Gray Whale	3	5344	5357	14	11:28:07	11:28:24
14-Mar	42	Risso's Dolphin	15	5359	5371	13	13:36:35	13:37:58
14-Mar	43	Bottlenose Dolphin	25	5359	5371	13	13:36:35	13:37:58
15-Mar	8	Bottlenose Dolphin	55	5373	5405	33	10:08:06	10:09:42
15-Mar	9	Short-beaked Common Dolphin	700	5407	5467	61	10:20:58	10:24:04
15-Mar	39	Short-beaked Common Dolphin	1500	5469	5545	77	14:40:44	14:44:20
15-Mar	40	Short-beaked Common Dolphin	375	5547	5624	78	14:53:24	14:56:22
15-Mar	41	Long-beaked Common Dolphin	25	5626	5639	14	15:00:22	15:02:28
15-Mar	52	Common Dolphin sp.	350	5641	5686	46	16:50:18	16:51:36
28 March - 1 April Photos								
28-Mar	7	Short-beaked Common Dolphin	150	5733	5775	42	10:42:41	10:46:06
28-Mar	9	Common Dolphin sp.	350	5778	5807	30	10:51:18	10:54:44
28-Mar	12	Common Dolphin sp.	15	5809	5841	33	11:05:16	11:07:08
28-Mar	15	Short-beaked Common Dolphin	225	5844	5881	38	11:14:24	11:17:06

Date	Daily Sighting ID No.	Species Common Name	Best Group Size Estim.	Start Frame #	End Frame #	Total Photos	First Frame Time	Last Frame Time
28 March - 1 April Photos (continued)								
28-Mar	16	Common Dolphin sp.	50	5883	5926	44	11:28:01	11:28:38
28-Mar	17	Long-beaked Common Dolphin	40	5928	6044	116	11:42:02	11:49:43
28-Mar	21	Common Dolphin sp.	35	6046	6072	27	11:57:19	11:58:51
28-Mar	22	Fin Whale	2	6074	6080	7	12:08:34	12:08:37
28-Mar	28	Unidentified Dolphin	300	6082	6121	40	13:14:00	13:18:15
28-Mar	33	Fin Whale	1	6124	6166	43	16:28:58	16:31:50
28-Mar	35	Fin Whale	2	6168	6218	28	16:47:13	16:52:27
28-Mar	34	Common Dolphin sp.	125	6219	6237	19	16:52:36	16:52:47
28-Mar	36	Long-beaked Common Dolphin	50	6240	6272	33	17:00:24	17:03:50
29-Mar	5	Bottlenose Dolphin	10	6277	6283	7	13:11:24	13:13:01
29-Mar	19	Short-beaked Common Dolphin	200	6285	6322	37	14:18:56	16:18:48
30-Mar	6	Long-beaked Common Dolphin	50	6324	6368	44	11:42:14	11:46:40
30-Mar	7	Gray Whale	2	6369	6380	12	11:46:40	11:47:08
30-Mar	8	Short-beaked Common Dolphin	200	6382	6402	21	12:05:58	12:06:34
30-Mar	12	Long-beaked Common Dolphin	325	6404	6439	35	12:42:00	12:43:52
30-Mar	25	Common Dolphin sp.	30	6482	6502	21	17:09:16	17:09:16
31-Mar	8	Bottlenose Dolphin	30	6504	6514	10	11:18:38	11:22:44
31-Mar	11	Short-beaked Common Dolphin	200	6516	6533	18	12:37:26	12:39:00
31-Mar	12	Long-beaked Common Dolphin	200	6535	6582	47	12:51:38	12:55:18
31-Mar	16	Long-beaked Common Dolphin	250	6584	6638	54	15:18:38	15:22:02
31-Mar	18	Risso's Dolphin	36	6641	6667	26	15:48:06	16:21:48
31-Mar	21	Short-beaked Common Dolphin	9	6669	6690	21	16:40:20	16:45:46
1-Apr	6	Fin Whale	2	6691	6700	10	12:28:14	12:29:14
1-Apr	7	Short-beaked Common Dolphin	100	6701	6760	58	12:42:03	12:48:14

APPENDIX D: ACOUSTIC-VISUAL BEHAVIOR STUDY DATA

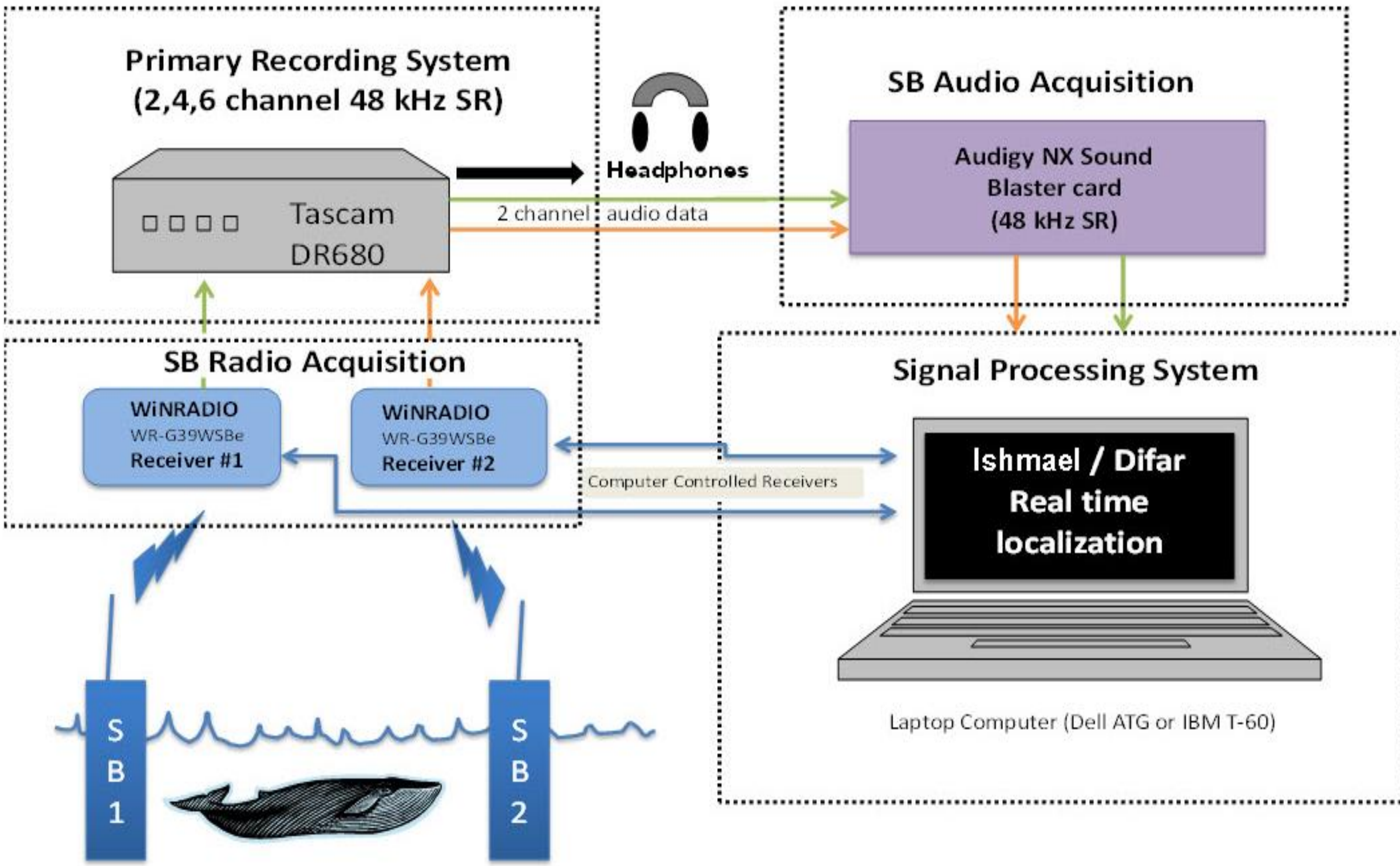


Figure 1. Block diagram of sonobuoy signal acquisition, recording, and processing system.

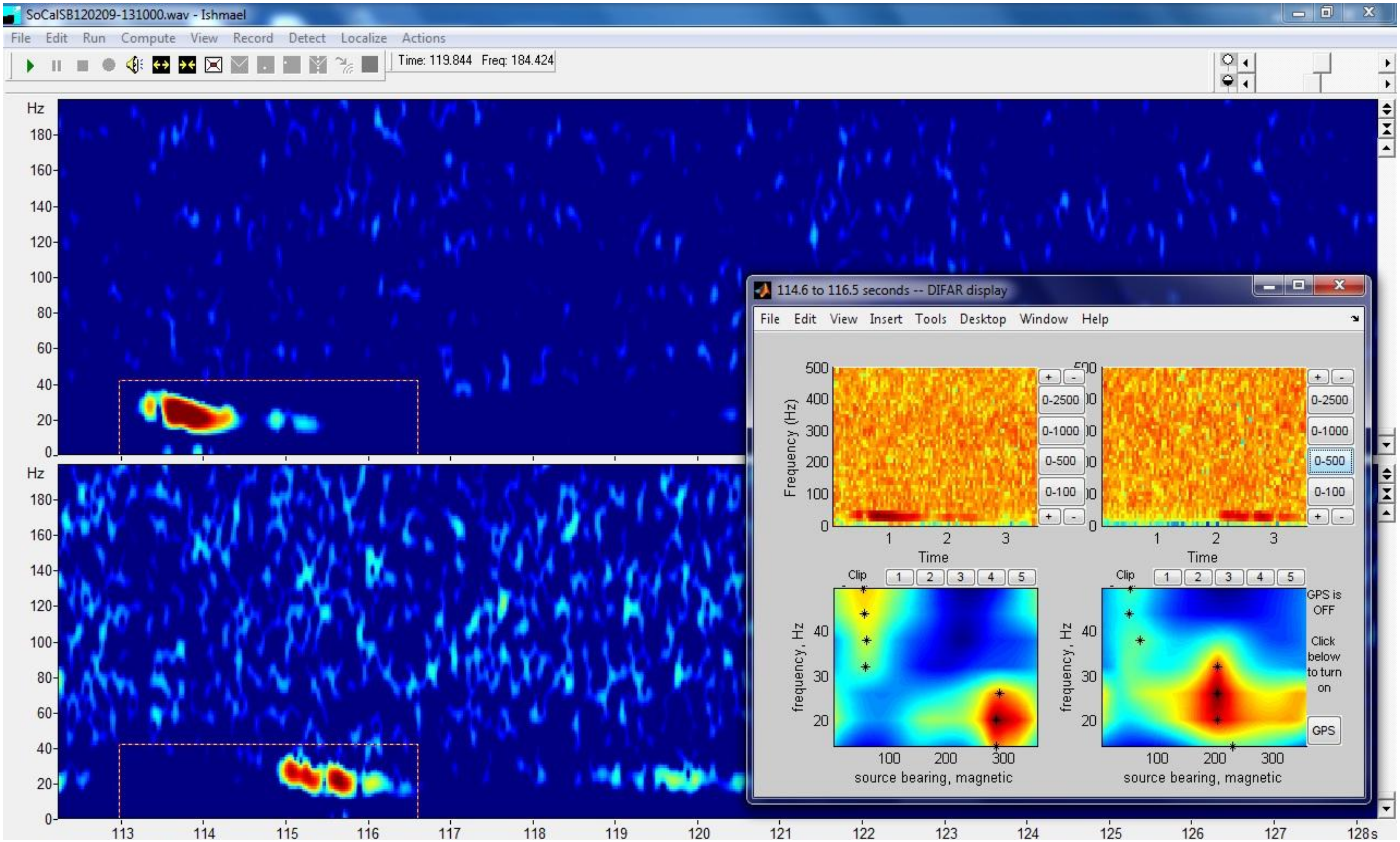


Figure 2. Ishmael and DIFAR graphical user interface (GUI). Ishmael window includes 2 channels from two different sonobuoys for the same fin whales calls. DIFAR GUI window width of a fin whale call is located at the lower right. See Appendix E for more details.

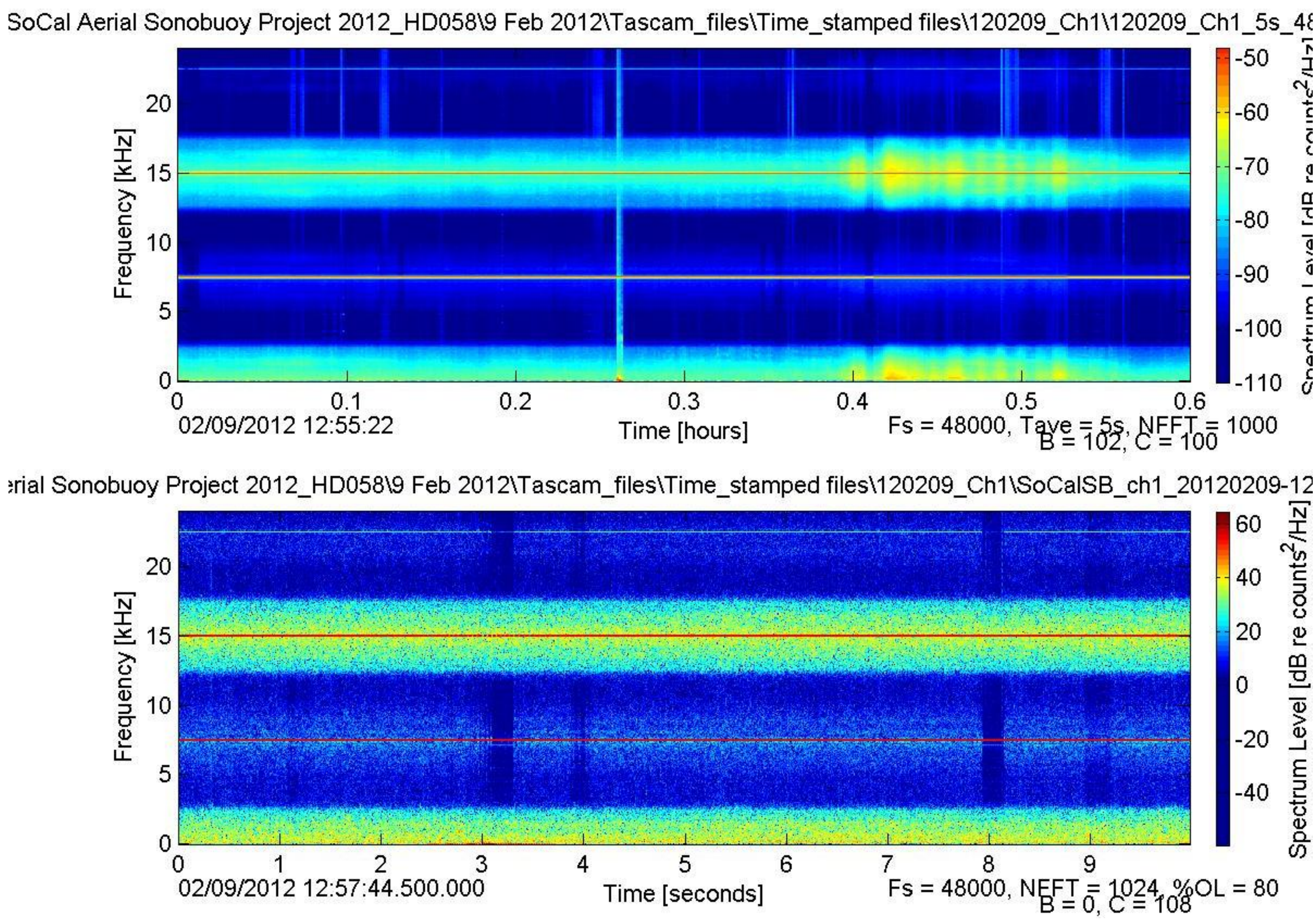


Figure 3. Long term spectral average (top panel) and spectrogram of DF sonobuoy signal. Note the DIFAR signal is apparent as a line with energy extending above and below ~7.5 kHz. The audio signal is apparent below 2.5 kHz.

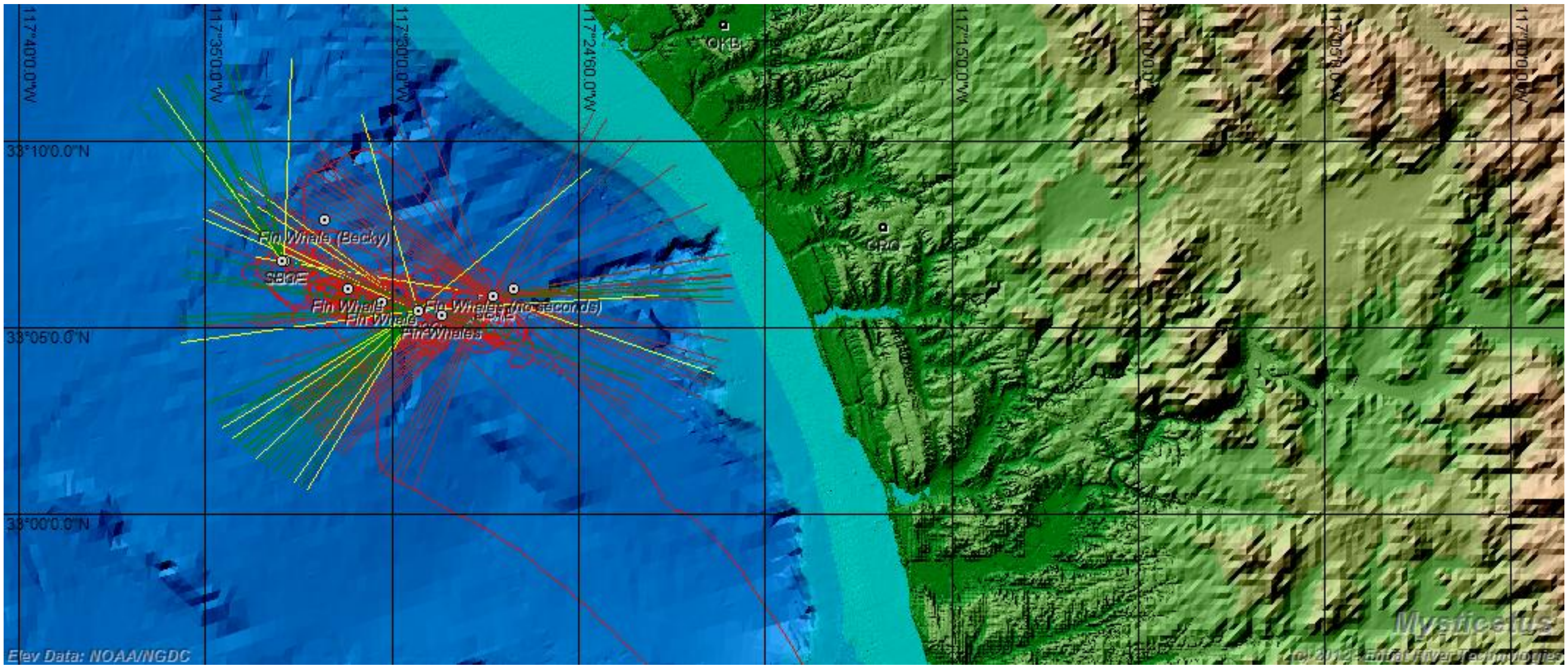


Figure 4. Sonobuoy bearing data plotted without time-window filter applied. The 1-hour period includes all bearings with relative signal strengths of 1 (low), 4 (medium-hi), and 5(hi), depicted as dark-red, green, and yellow lines, respectively. Survey aircraft track is depicted as the red, irregular track visible behind the bearings and extending to the southeast. The difficulty interpreting data is readily apparent by the confusing mix of bearing lines (from multiple sonobuoys) and airplane tracks.

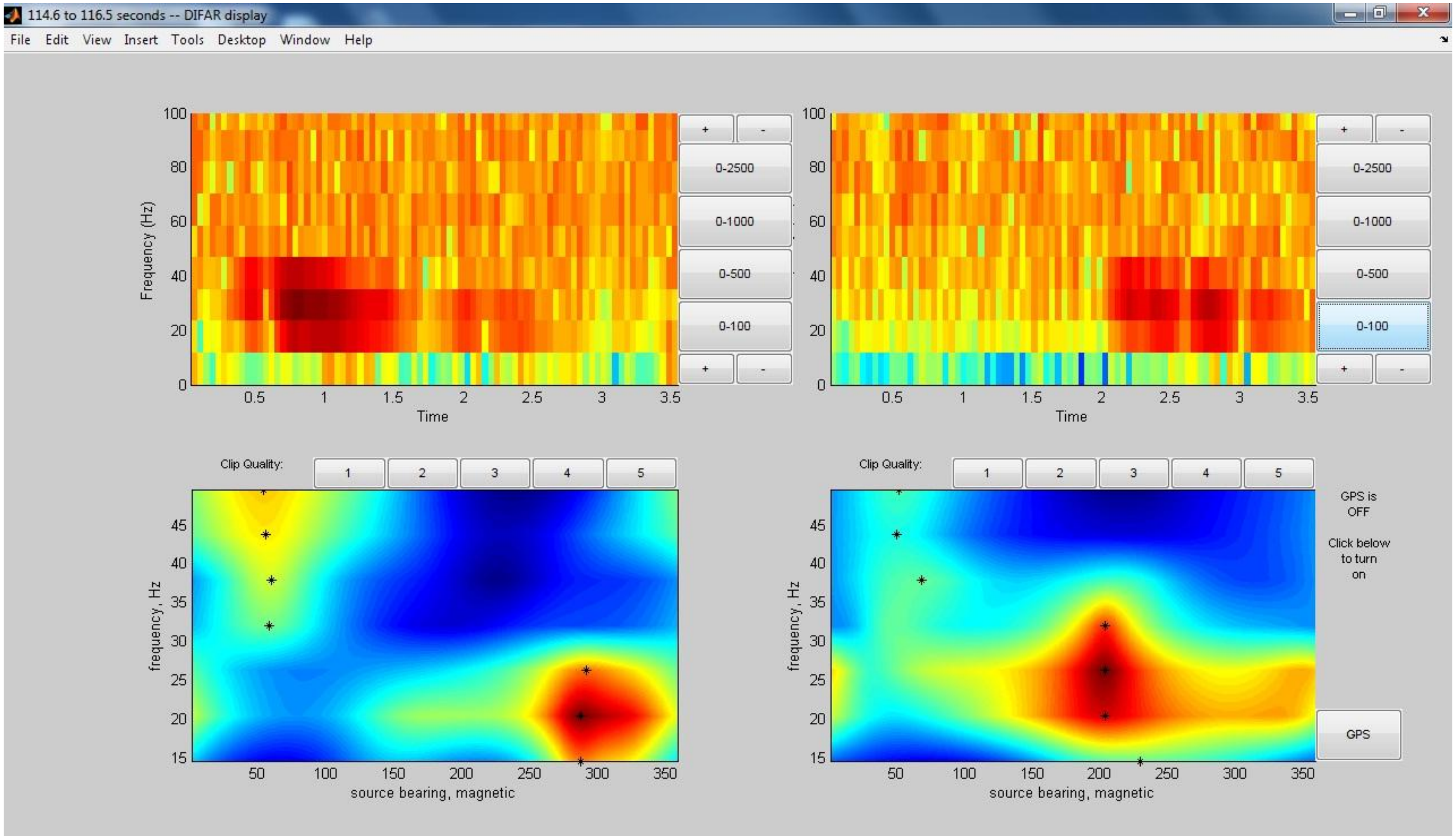


Figure 5. GUI window of DIFAR program. Signal displayed is a fin whale call. Top panels represent spectrogram of signals selected for processing. Bottom panel represents DIFAR-gram of frequency versus bearing. Crosses in the bottom panel are bearing for peak frequency in each bin. Because there is no time display on the bottom panel, both windows must be viewed to pick the correct bearing of the call.

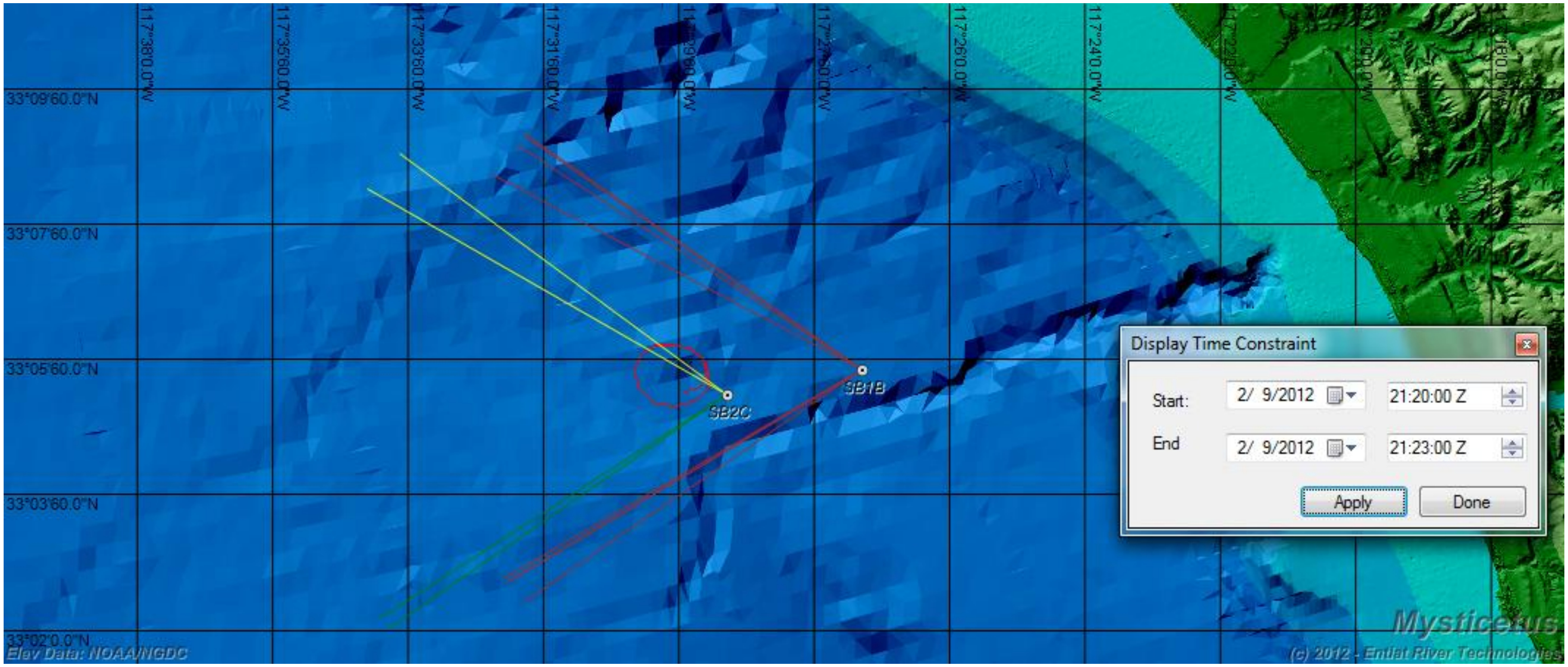


Figure 6. Plot of bearings with time-window and quality filters applied indicating bearings from the closer sonobuoy that are crossing through the region of where focal animals were located as indicated by circle pattern of the observation aircraft track. Yellow and green lines are high-signal strength; red lines are low signal strength.

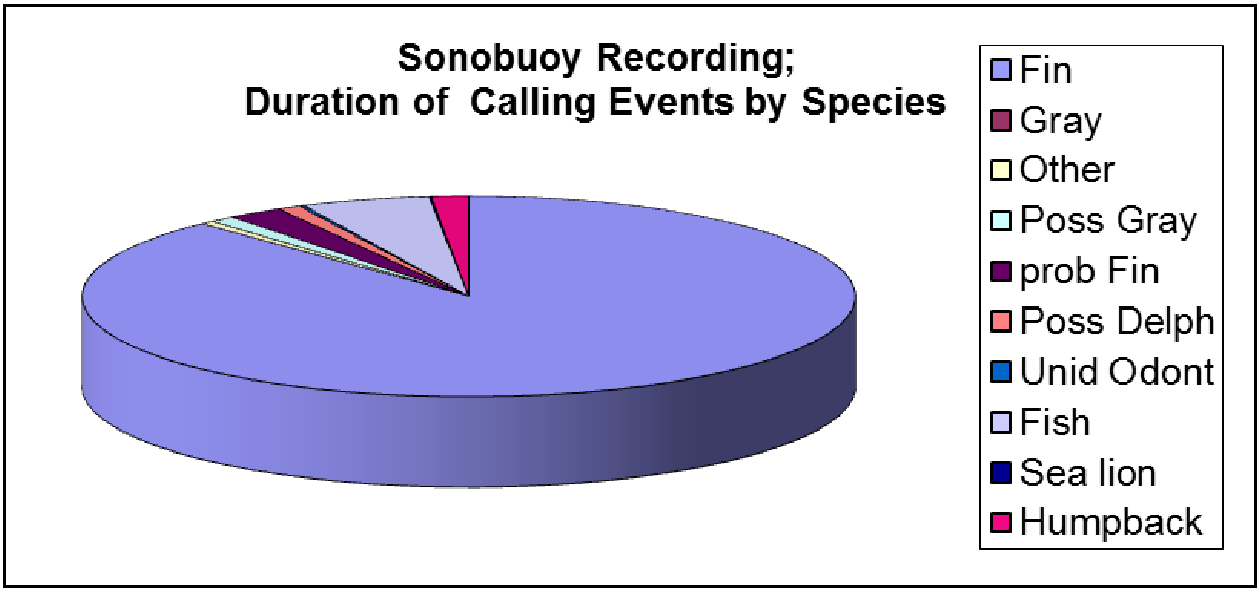


Figure 7. Pie graph of duration of calling events by species excluding anthropogenic noise events. Fin whales represented 88% of total calling event durations. Fish represented 5%, and the remaining species were all 2% or less of the total.

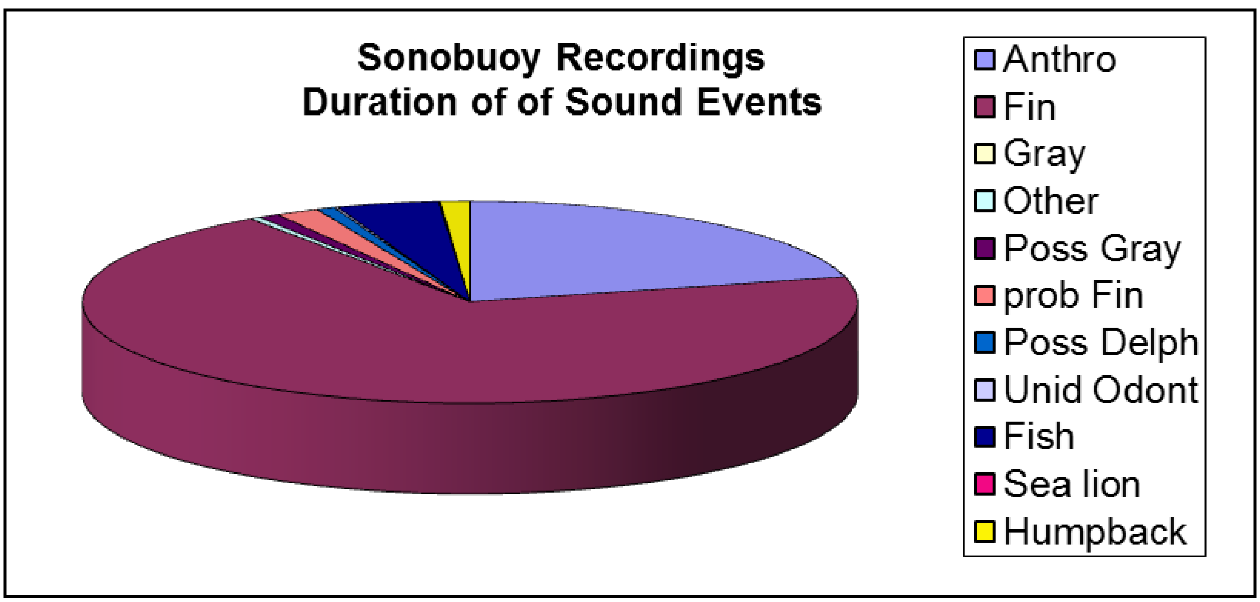


Figure 8. Pie graph of duration of sound events including anthropogenic noise events. Anthropogenic noise represented 21% of the total duration of events in all recordings. Fin whales represented 69% of total calling event durations. Fish represented 4%, and the remaining marine mammal species were all 2% or less of the total.

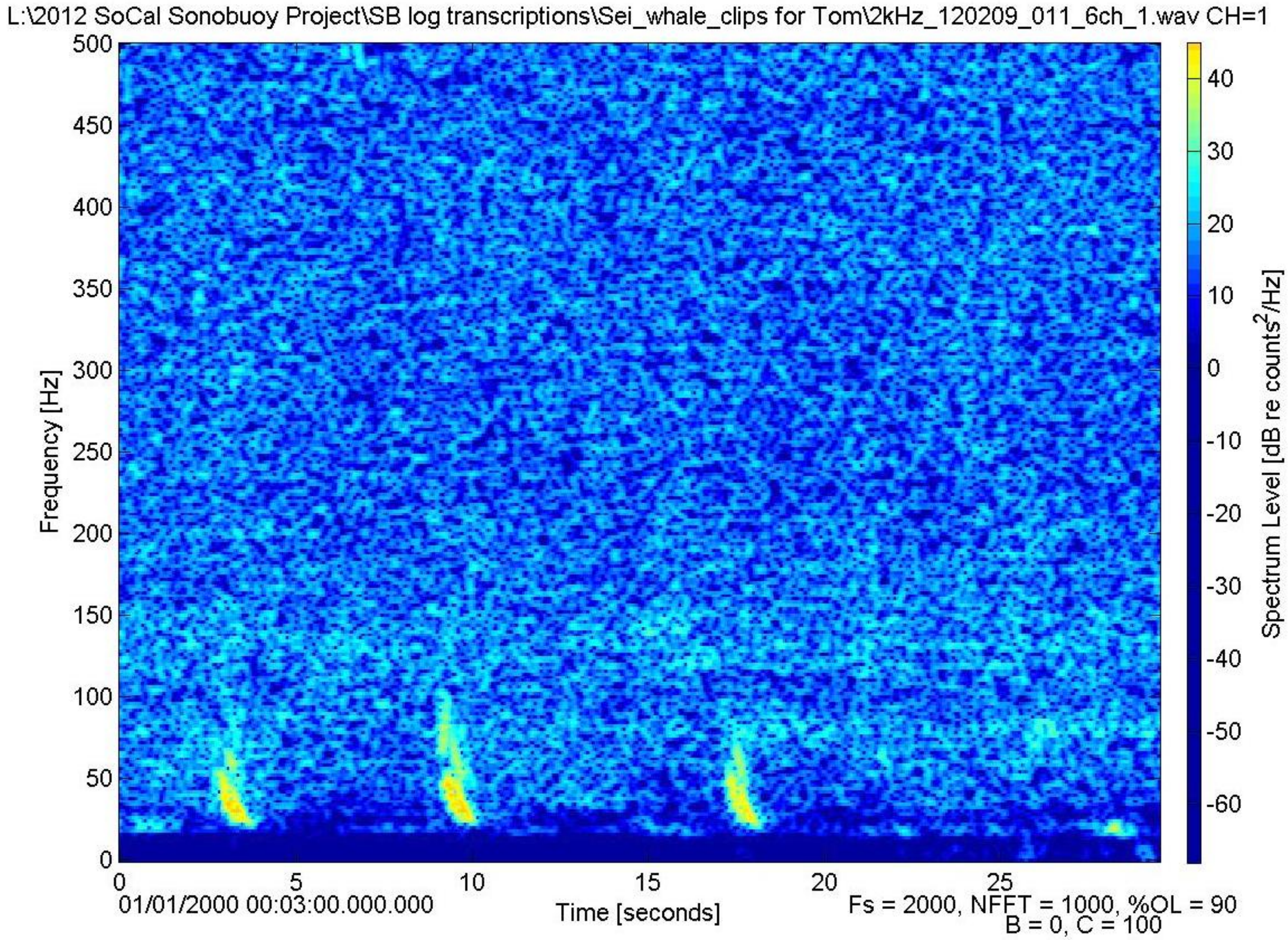


Figure 9. Three loud calls (80 – 20 Hz downsweeps) with a weak 20 Hz pulse (at far right) recorded in the presence of a focal group of fin whales on February 9, 2012.

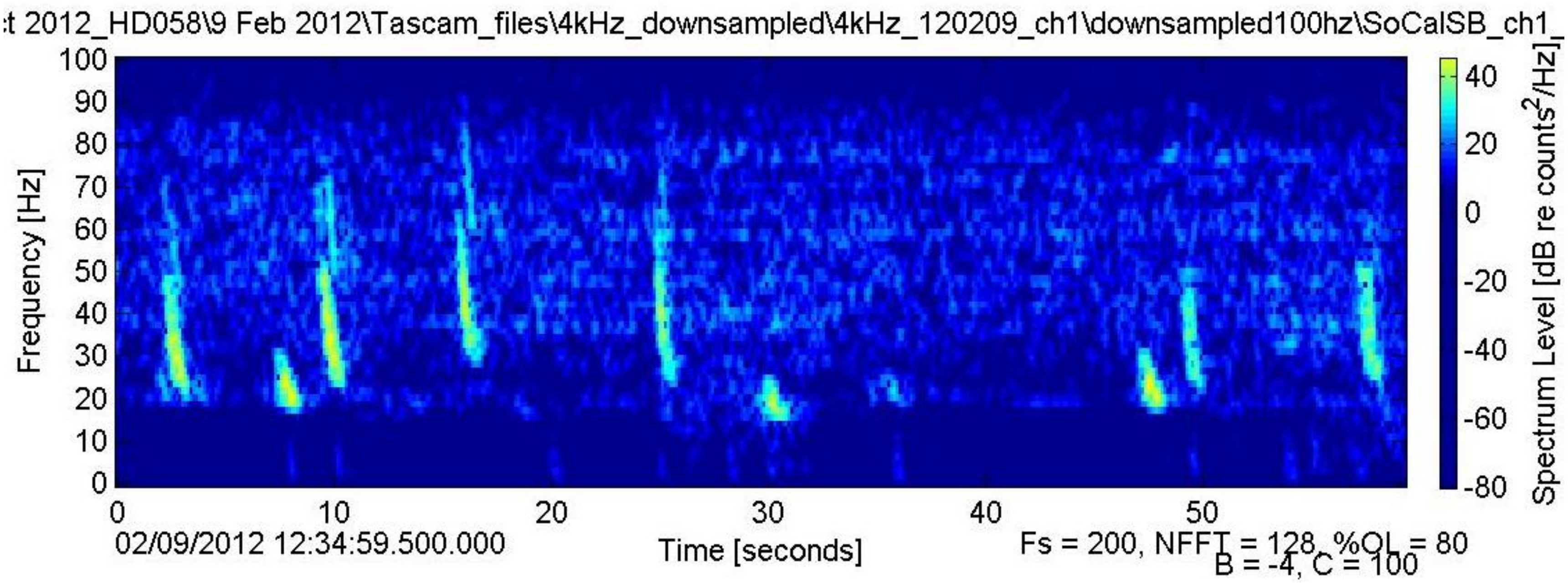


Figure 10. Example of two types of fin whale calls in a calling bout recorded during the acoustic-visual behavior survey on 9 February 2012. The first call in the series is an 80-20Hz downsweep and the second call is a 20-Hz pulse.

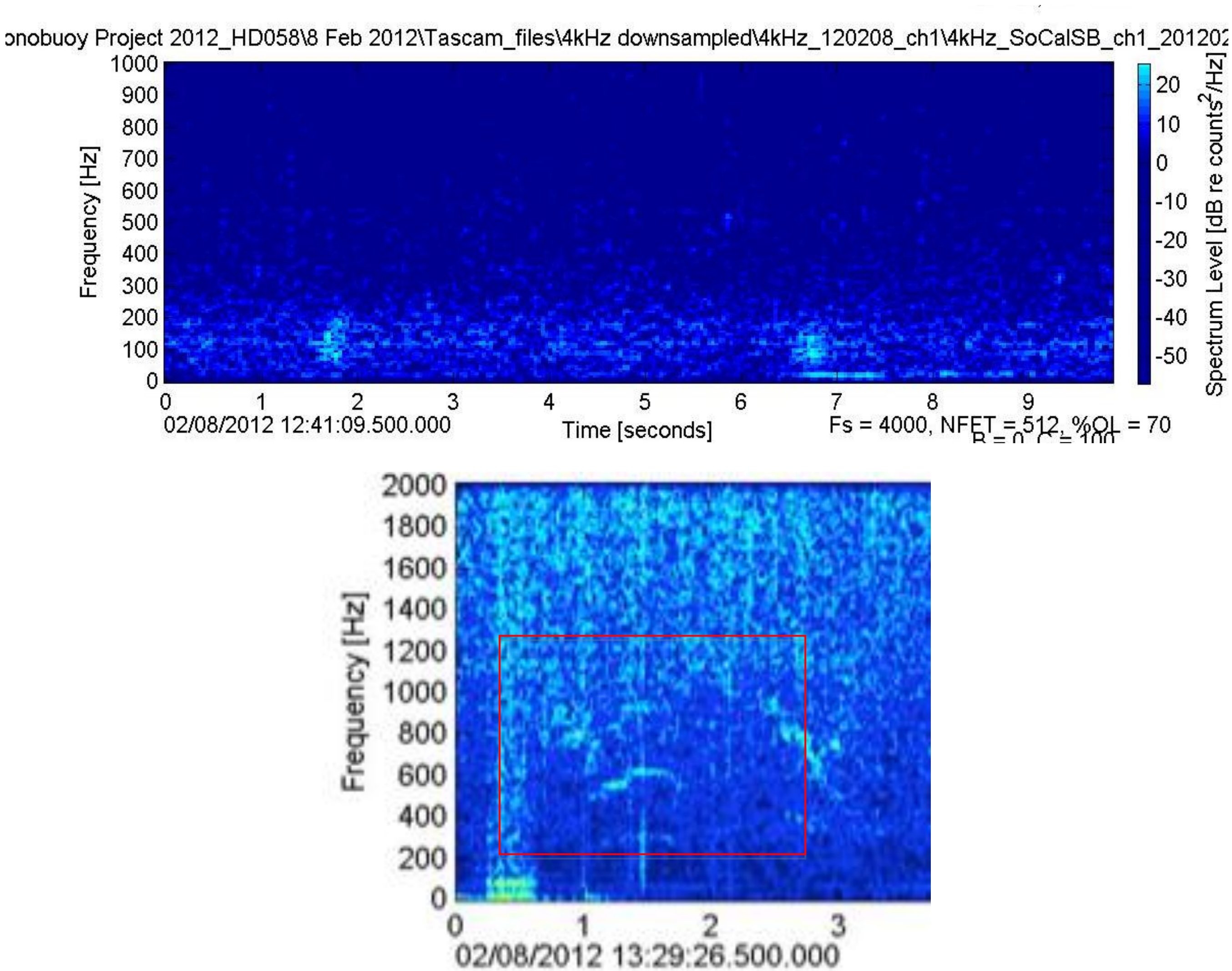


Figure 11. Spectrogram of gray whale calls. Two faint calls visible at approximately 100-200 Hz in the top panel (0-1 kHz band), and single calls in bottom panels (0-2 kHz band). Note the low signal-to-noise (S/N) level and broadband 'noisy' quality to their structure.

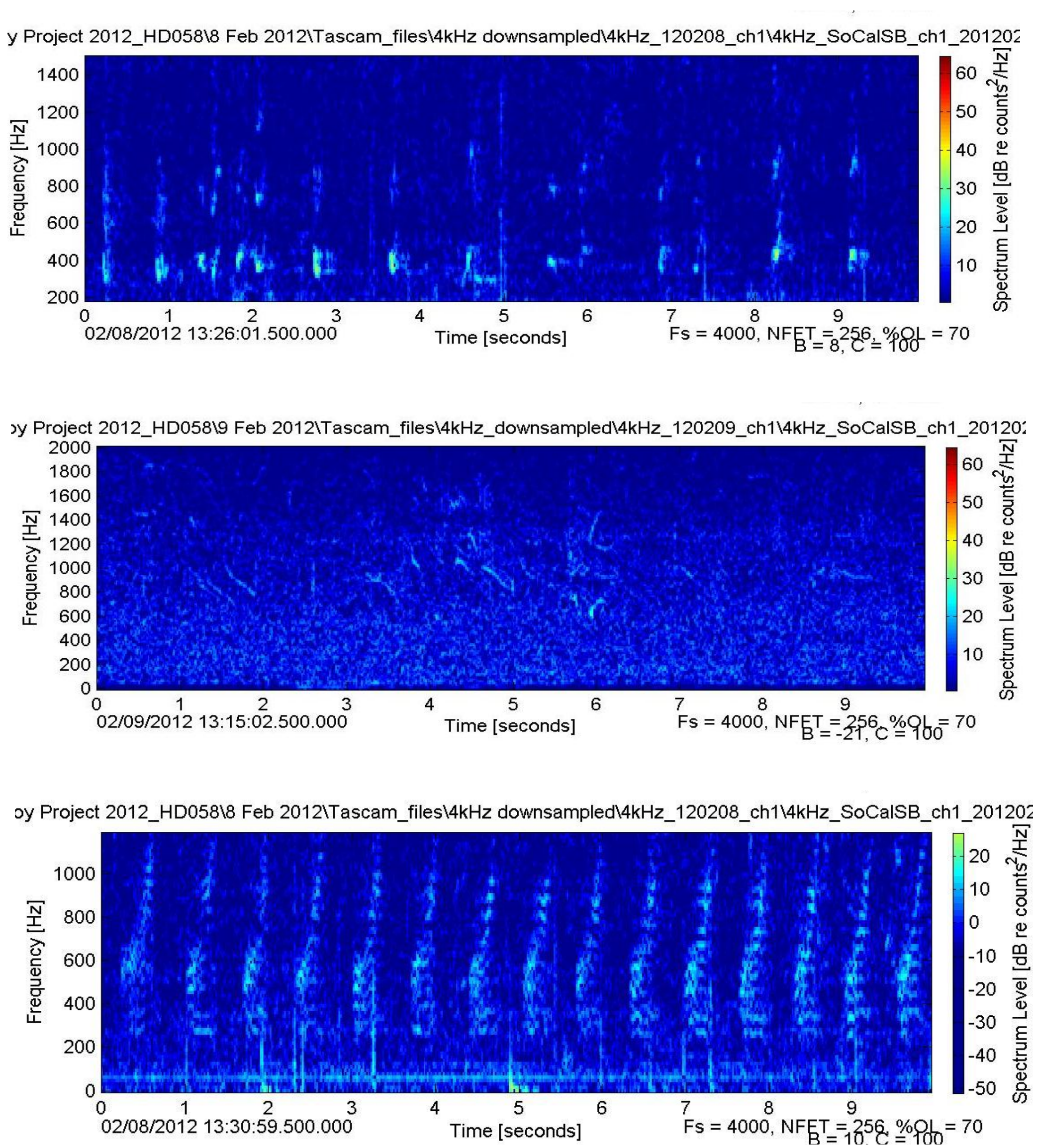


Figure 12. Sounds from non-focal species detected on February 8 and 9, 2012. From top to bottom panels (1) sea-lion barks (February 8); (2) unidentified dolphins (February 9); and (3) unidentified marine mammal or fish sounds (February 8).

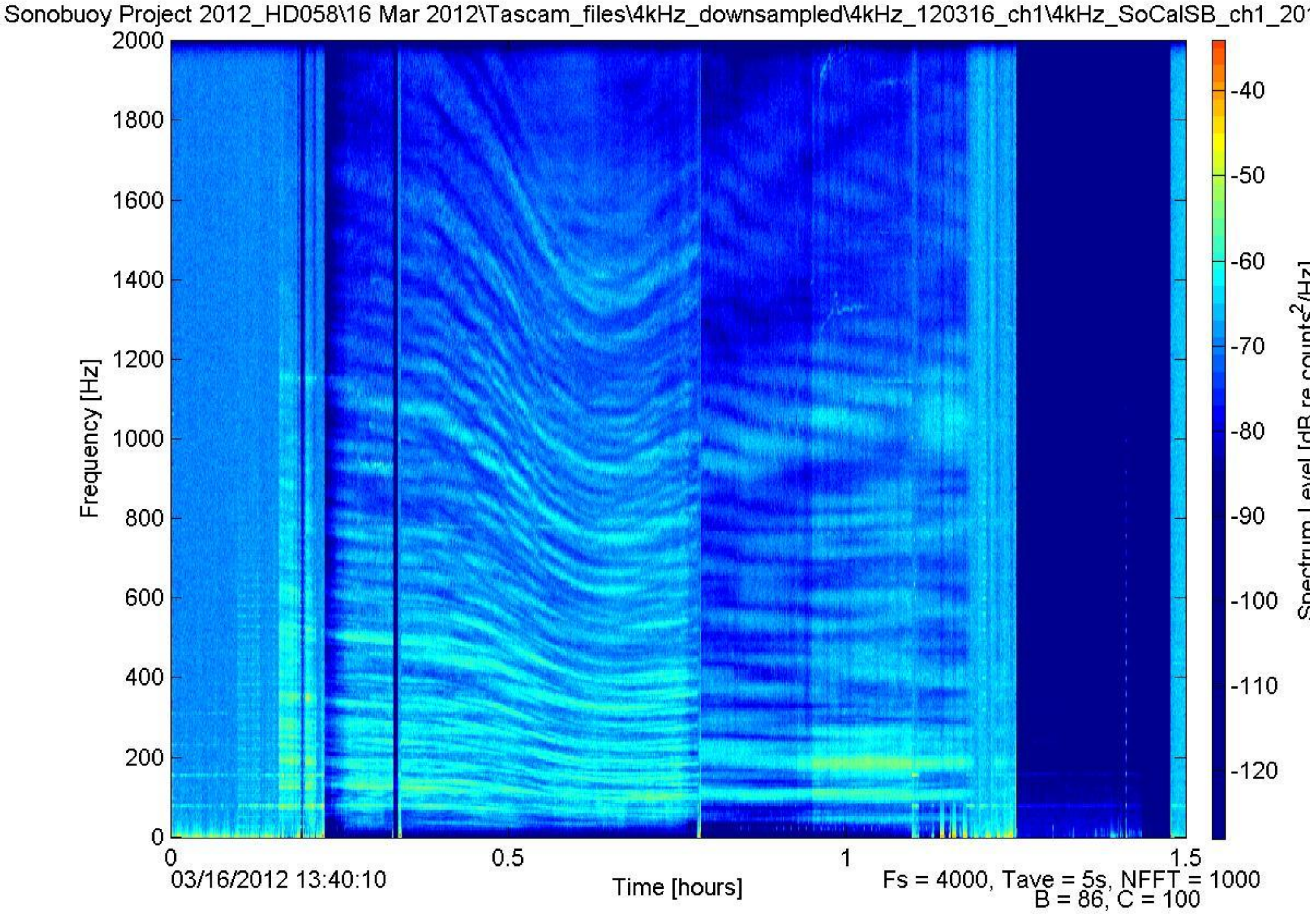


Figure 13. Long term spectral average (LTSA) of large ship noise recorded from a sonobuoy from March 16th 13:54:12-14:27:01, with duration of 0:32:49 minutes.

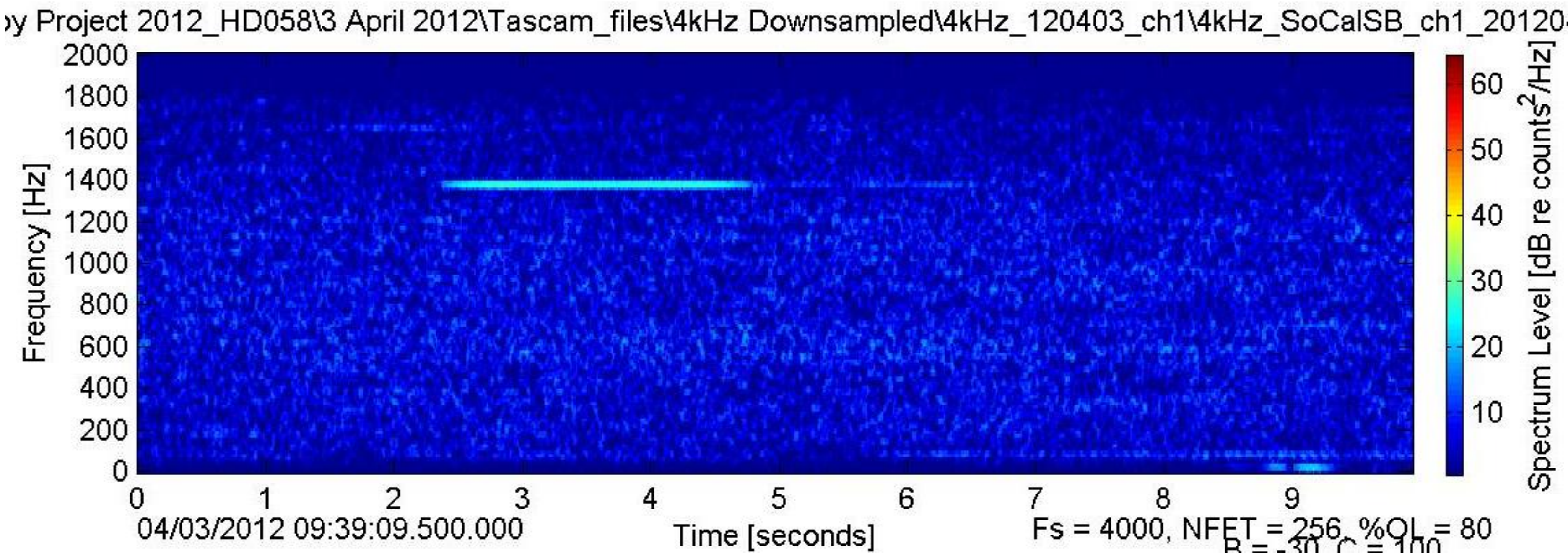


Figure 14. Spectrogram of a mid-frequency sonar signal centered at 1.375 kHz recorded from a sonobuoy on 3 April.

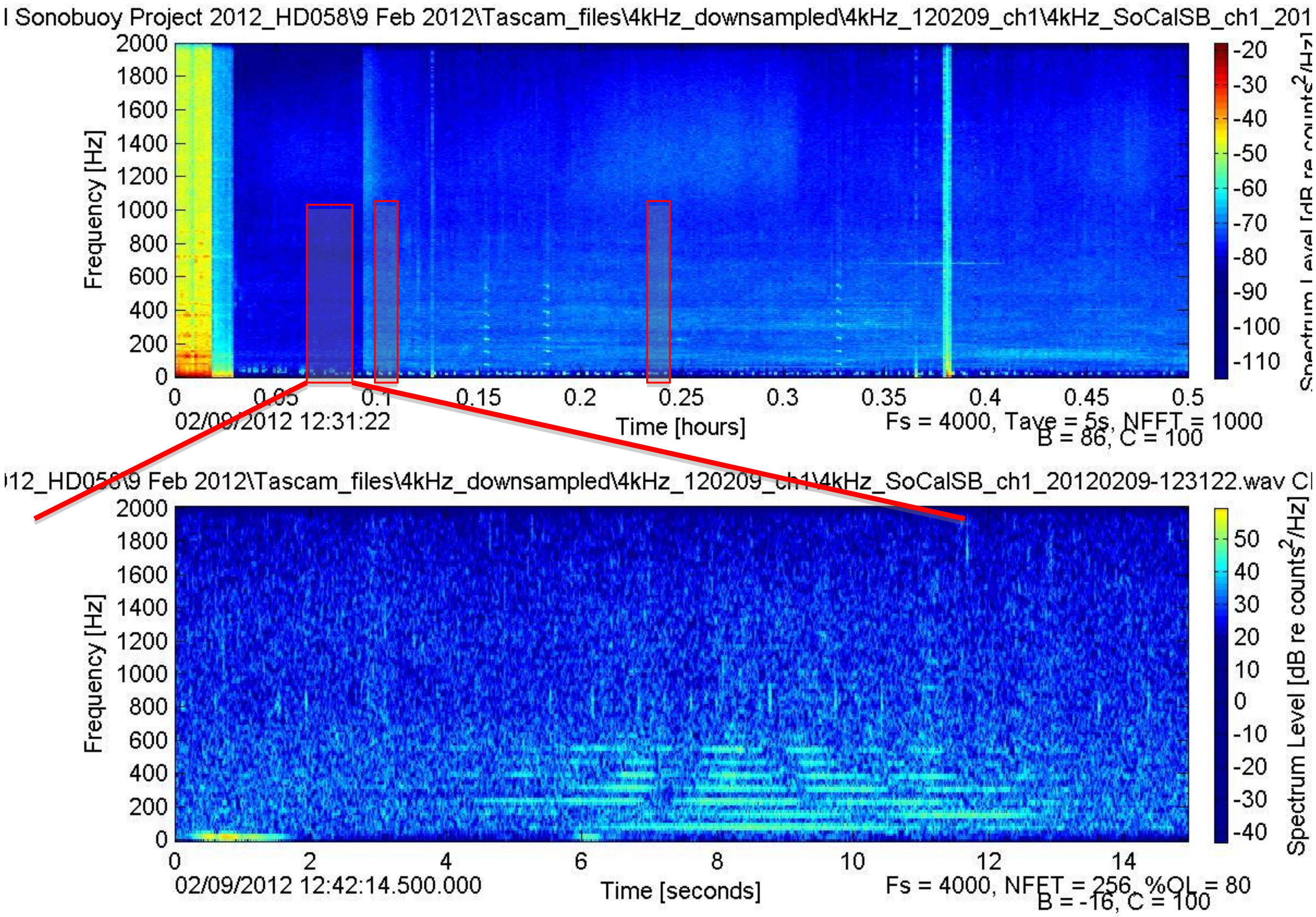


Figure 15. Long-term spectral average (top panel) and spectrogram (bottom panel) of airplane noise from the Partenavia P68-C observation aircraft used in the study as it circled above the sonobuoy. Red boxes in top figure are from brief periods of noise from airplane over-flights of sonobuoys. In spectrogram in the bottom panel, notice the banding pattern (from ~60 to 600 Hz). Harmonics and dominant frequencies are indicative of the rotations per minute (RPM) and number of propeller blades. Noise from overflights typically lasted 8-10 seconds; depending on how close to the sonobuoy the airplane passed (i.e. if the overpass was directly over the sonobuoy or not).

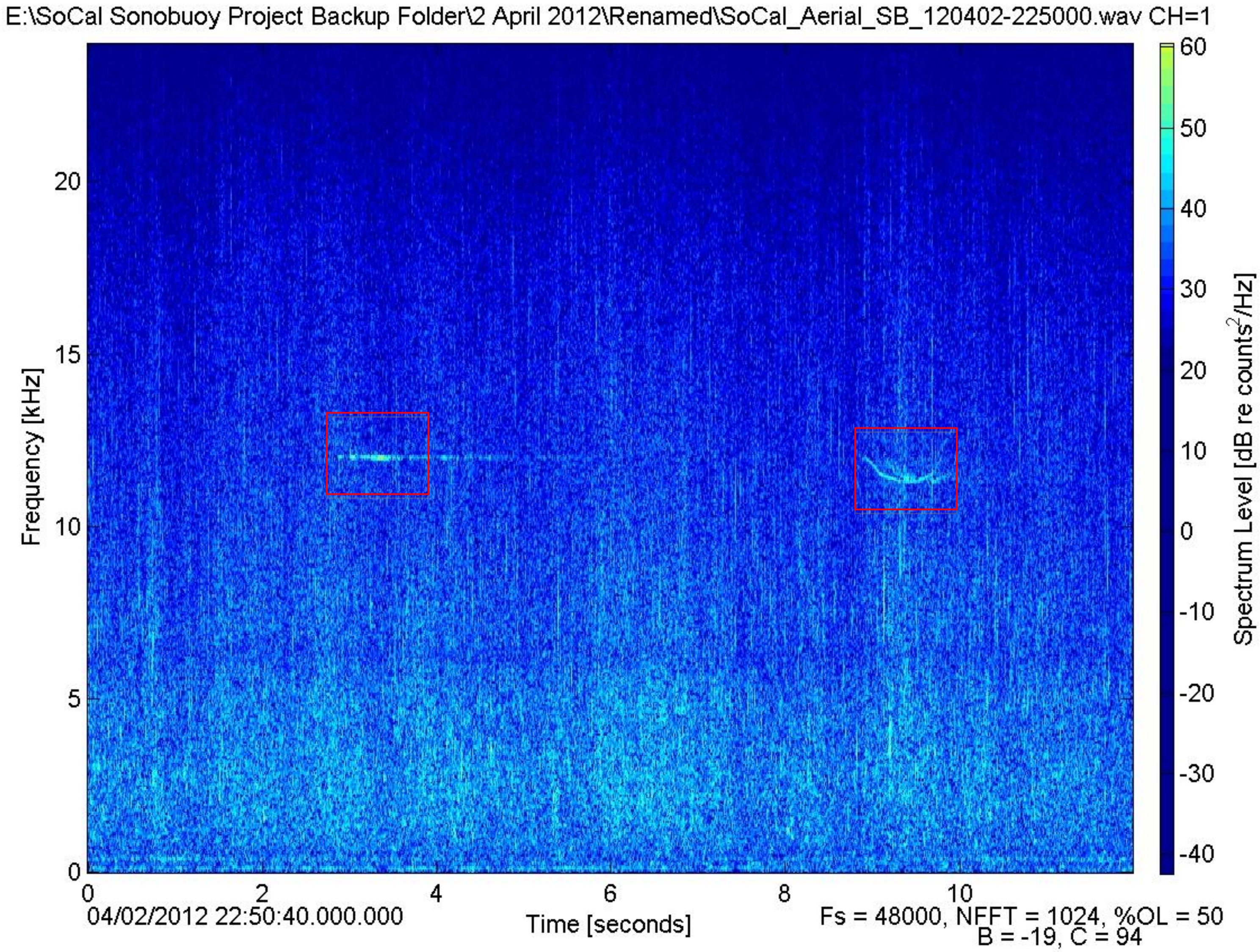


Figure 16. Spectrogram (frequency along y-axis and time along x-axis) showing 12 kHz echosounder ping followed by a possible Risso's dolphin whistle mimic of the echosounder event based on the similar frequency and signal duration

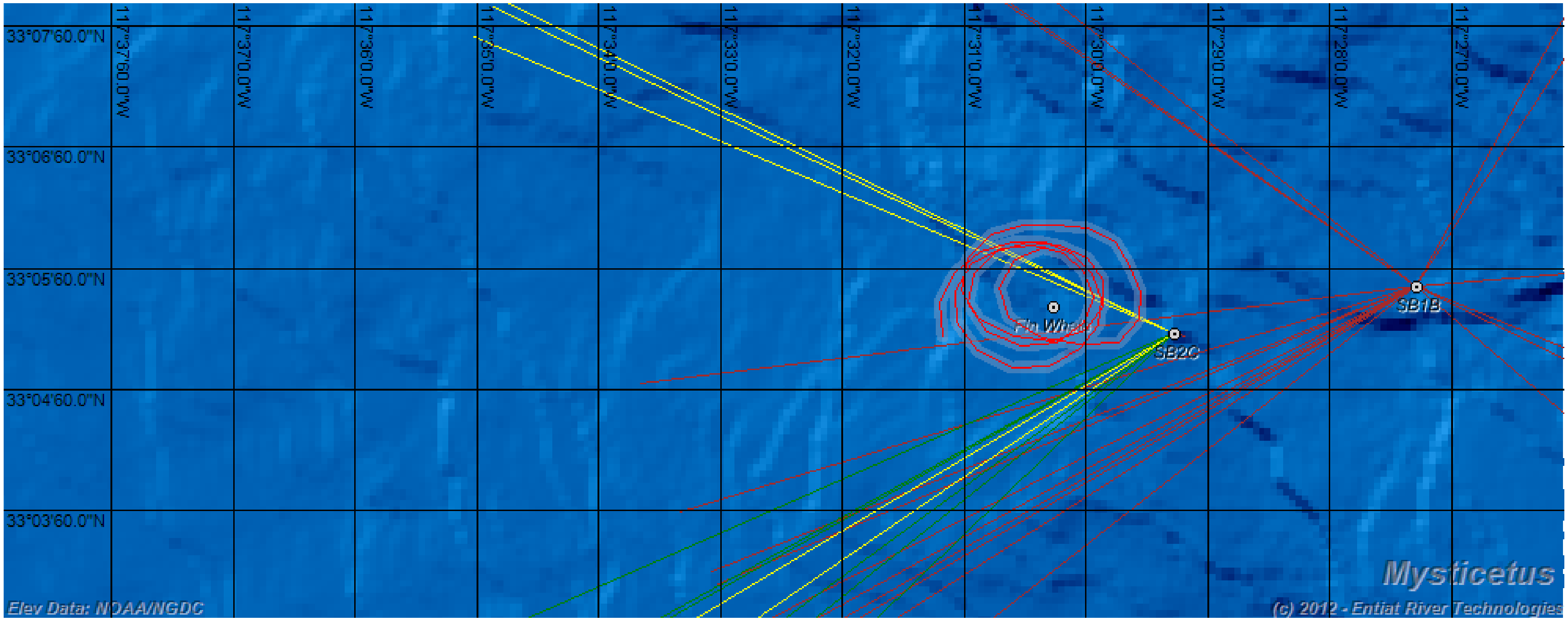


Figure 17. Plot of airplane track (red) and bearings from first and second sonobuoys deployed near focal group of 2-5 fin whales that were moving in a westerly direction. The first sonobuoy position (SB1B located on the right of the plot) was deployed near the initial location of the focal animals. The white bull's eye symbol located inside the center of plane tracks is a sighting of the focal group which occurred at approximately the same time (within 10 minutes) as the bearings displayed here. Yellow and green colored bearings are high quality/confidence (as determined by a data-analyst when processing DF data) and red bearings are low quality/confidence. Note that although bearings do not cross, they do pass through the circle and near the location of animals. The time filter was set to approximately 10 minutes (i.e., the time window over which data were included/excluded).This could result in some of the discrepancy of whale locations and bearings. In general, baleen whales do not call frequently when at the surface.

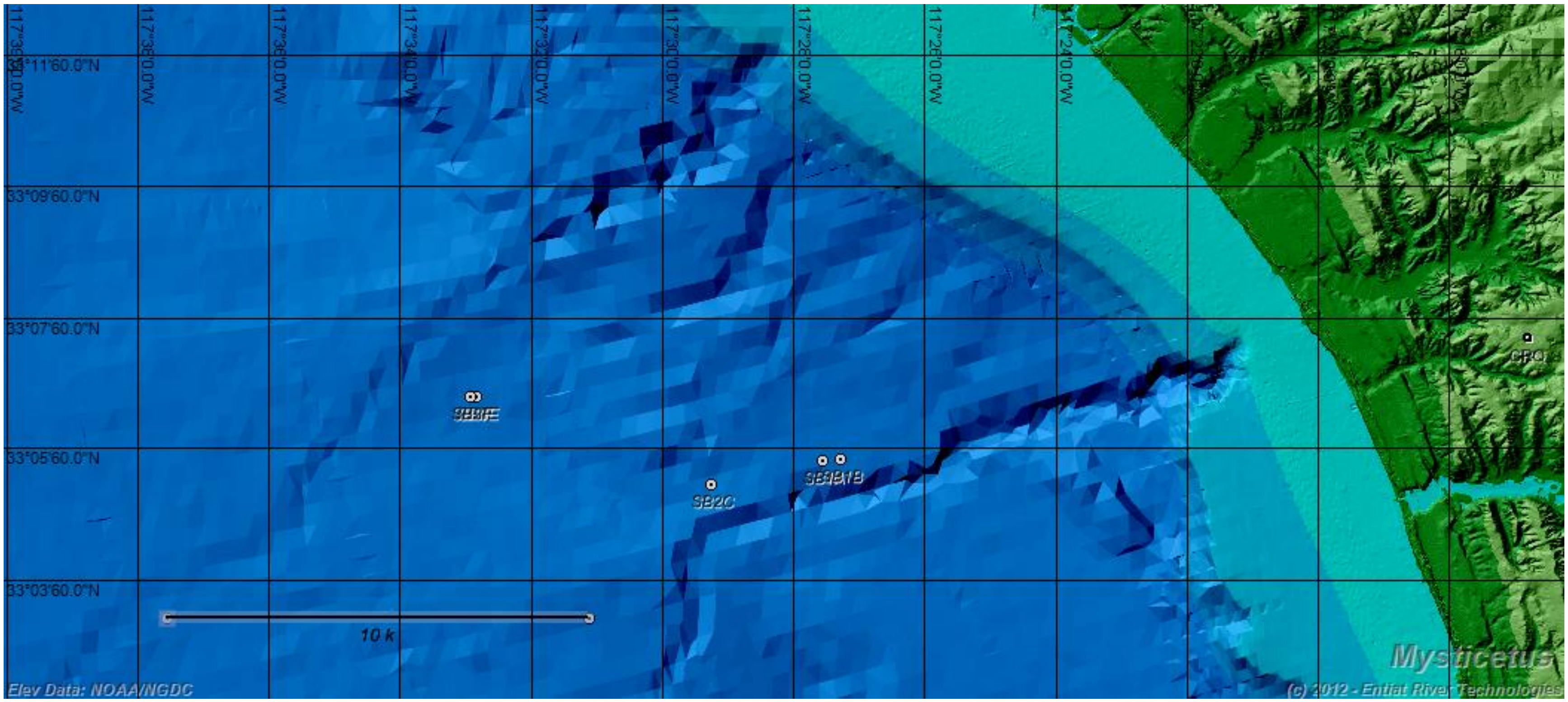


Figure 18. Sonobuoy locations (including resightings) for deployments of fin whale on February 9, 2012. Note that sonobuoys were drifting to the west, which could explain some of the errors in the localizations. Improved sonobuoy locations (e.g., using GPS-integrated sonobuoys) will improve localization results.

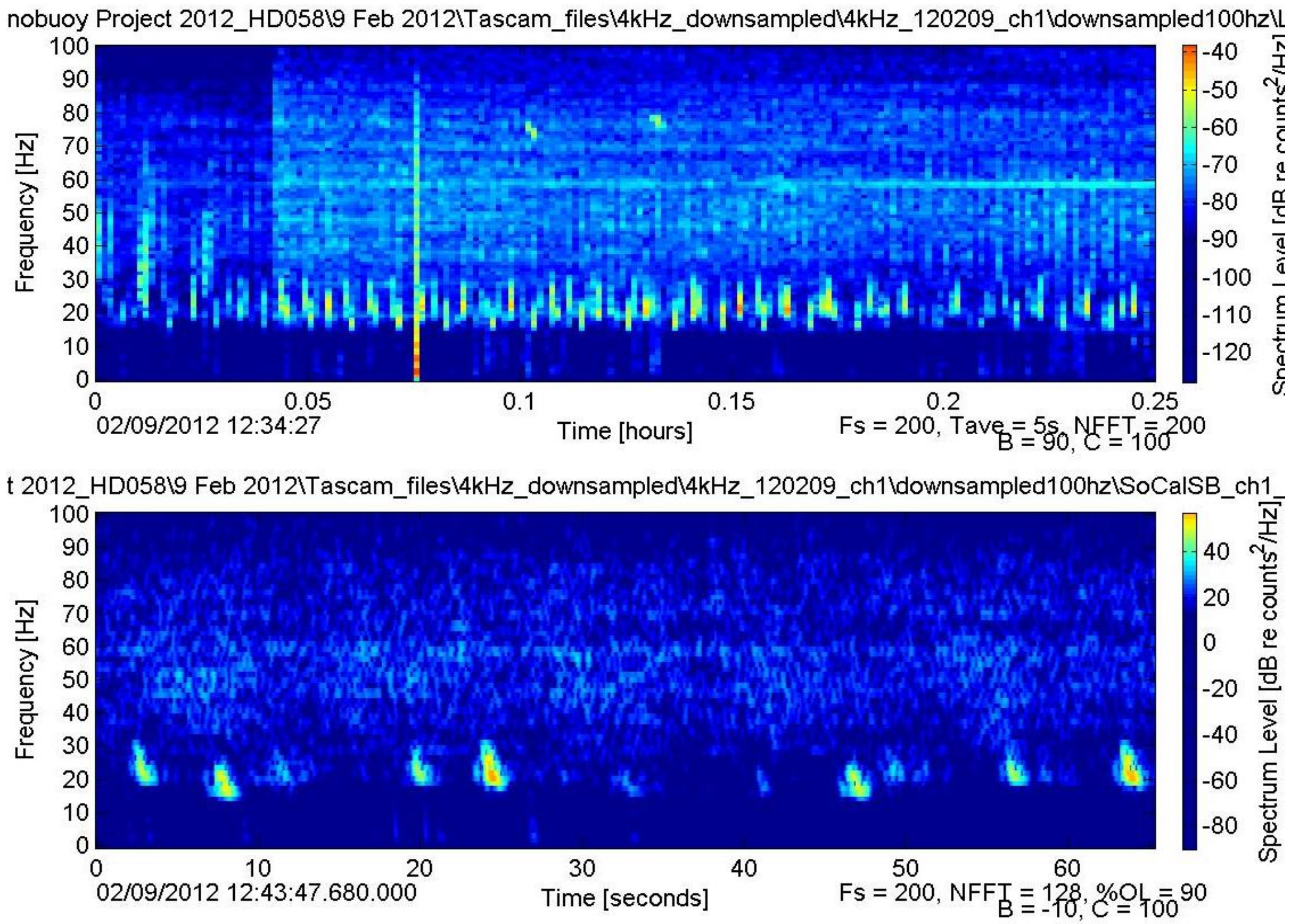


Figure 19. Example of fin whale call/counter-call vocal event. Top panel is Long-Term Spectral Average (LTSA), bottom panel is spectrogram. Brief signals at ~80 Hz, 0.1 hr in LTSA are aircraft noise. Differences in relative call intensity and bearings to calls (not presented here) indicated that calls were coming from different animals.

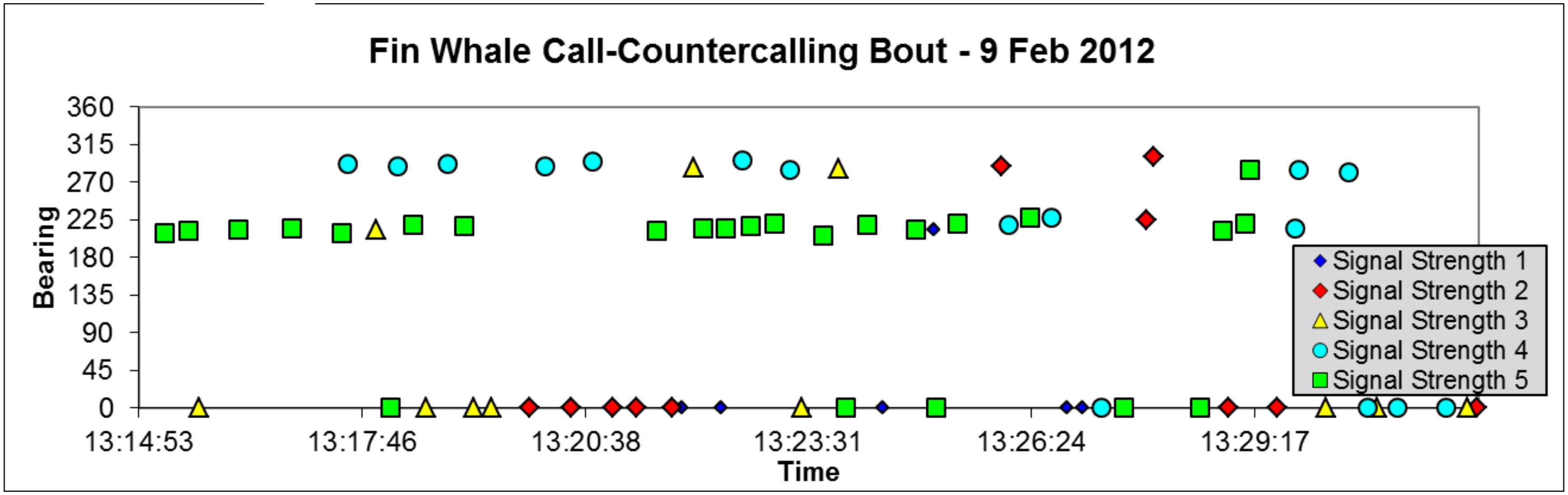


Figure 20. Fin whale calls plotted as a function of sonobuoy bearing (Y axis) and relative call intensity (from weakest [signal strength 1] to strongest [signal strength 5]). Call/counter-calling behavior is evident by differences in bearing and intensity. Calls plotted at zero are calls for which bearings could not be obtained. Bearings obtained from two different sonobuoy locations during this period indicated that fin whales were calling from at least two different locations. Call/counter-calling behavior is evident by differences in bearing and intensity.

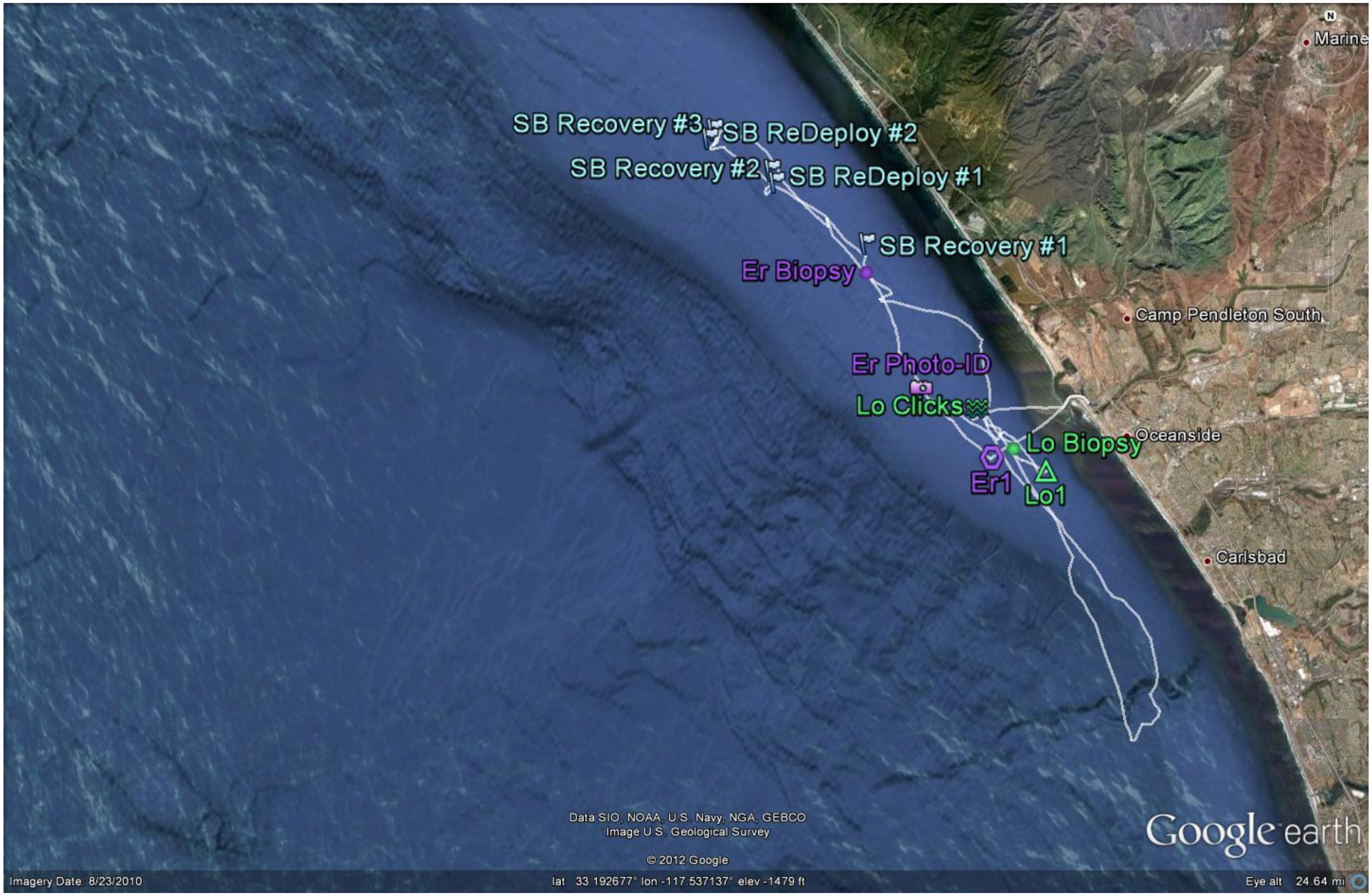


Figure 21. Vessel tracks of the Scripps' Institution of Oceanography rigid-hull inflatable boat (RHIB) on February 10, 2012. Research efforts were coordinated between the RHIB and the aircraft sonobuoy-behavior monitoring efforts (see Table 3 and Photo 5). The RHIB assisted in recovery and repositioning of sonobuoys deployed initially. This allowed sonobuoys to be relocated closer to two gray whales being monitored by the aircraft. The RHIB biologist (G. Campbell-SIO) also obtained photo-identification and biopsy data from the focal gray whales. Er = Eschrichtius robustus (gray whale).

Table 1. Summary of flight effort during SOCAL acoustic-visual behavior study of cetaceans February-April 2012.

Date	Flight of Day	Time Engines On	Time Engines Off	Total Engine Time (hh:mm)	Time Wheels Up	Time Wheels Down	Total Flight Time (hh:mm)	Flight Area within /near Santa Catalina Basin
2/7	1	15:29	16:13	0:44	15:37	16:11	0:34	Oil platform off Oxnard, Santa Barbara Channel
2/8	1	7:45	9:05	1:20	7:55	9:00	1:05	~16 km W of Laguna Canyon
2/8	2	11:34	13:57	2:23	11:39	13:55	2:16	~ 7 km W of La Jolla
2/9	1	11:50	14:46	2:56	11:59	14:43	2:44	~15 km W of Carlsbad
2/10	1	9:46	12:52	3:06	9:55	12:49	2:54	~5 km W of Oceanside
2/10	2	14:23	17:11	2:48	14:28	17:06	2:38	~5 km NW of Oceanside
3/16	1	12:00	15:02	3:02	12:08	14:57	2:49	~43 km W of Encinitas
3/16	2	15:57	17:24	1:27	16:02	17:19	1:17	~42 km W of Carlsbad
4/2	1	11:30	16:22	4:52	11:46	16:19	4:33	~18 km W of La Jolla Canyon
4/2	2	17:32	19:18	1:46	17:42	19:13	1:31	~ 38 km W of La Jolla Canyon
4/3	1	8:42	10:13	1:31	8:49	10:10	1:21	~16 km SW of La Jolla Canyon
			Total Engine Time (hh:mm)	**25:55**		**Total Time Flown: (hh:mm)**	**23:42**	

Table 2. Sonobuoy success/fail log for February 7-10, March 16, and April 2-3, 2012. Recording times were estimated based on field notes Secondary (non-focal) species encountered on some sonobuoy deployments are excluded from this focal-species list. DF =Direction-finding, CO = Calibrated omni-directional.

Date	Buoy Number	Success/Fail	Sonobuoy Mode	RF Channel	Focal Species	Estimated Recording Time (hh:mm)
2/7	1	Success	DF	53	Test (Oil Platform)	NA
2/8	2	Success	DF	50	Gray Whale	0:41
2/8	3	Success	DF	56	Gray Whale	0:24
2/8	4	Success	DF	55	Gray Whale	0:25
2/9	5	Success	DF	90	Fin Whale	1:32
2/9	6	Success	DF	52	Fin Whale	1:09
2/9	7	Success	DF	59	Fin Whale	0:41
2/10	8	Fail	DF	54	Gray Whale	NA
2/10	9	Success	DF	60	Gray Whale	1:25
2/10	10	Success	DF	68	Gray Whale	1:10
2/10	11	Success	DF	43	Fin Whale	0:37
2/10	12	Fail	DF	47	Fin Whale	NA
3/16	13	Success	DF	65	Fin Whale	1:45
3/16	14	Success	DF	68	Fin Whale	1:04
3/16	15	Success	DF	62	Fin Whale	0:18
4/2	16	Success	DF	51	Fin Whale	0:54
4/2	17	Success	DF	53	Fin Whale	0:49
4/2	18	Success	CO	61	Risso's Dolphin	0:21
4/2	19	Success	CO	63	Risso's Dolphin	0:22
4/2	20	Success	DF	55	Fin Whale	0:15
4/2	21	Success	DF	59	Fin Whale	0:06
4/3	22	Success	DF	51	Humpback Whale/Fin Whale	1:28
4/3	23	Success	DF	54	Humpback Whale/Fin Whale	1:01
	TOTAL 23	**91%**				**16:27**

Table 3. Summary of focal cetacean groups followed by the circling aircraft indicating when sonobuoys were deployed, video was taken, and when efforts were coordinated with a small rigid-hull inflatable boat (RHIB) vessel (operated by G. Campbell of Scripps Institution of Oceanography) during February-April 2012 in the SOCAL study area.

Date	# SB Deployed (# failed)	SB Type	Species Seen	Video	Vocalizations Detected	Vessel Photo-ID and Biopsy	Comments
2/8	2	DF	Gray Whale	X	X		Detected possible S3 type gray whale calls; also detected sea lions and whale watch vessel noise;
2/9	3	DF	Fin Whale	X	X		Numerous 20 Hz pulses and 50 Hz calls
2/10	2 (1)	DF	Gray Whale	X	X	X	Weak 200-100 Hz calls, 1 biopsy and photo-ID by SIO RHIB which repositioned and retrieved 1 SB
	1 (1)	DF	Fin Whale	X	X		20 Hz pulses
3/16	1	DF	Fin Whale		X		20 Hz pulses and noise from tanker vessels near focal group
	1	DF	Fin Whale		X		20 Hz pulses
4/2	4	DF	Fin Whale	X	X		20 Hz pulses
	2	CO	Risso's Dolphin	X	X		12 kHz echosounder and possible Risso's dolphin mimicry whistles
	2	DF	Fin Whale	X	X		20 Hz pulses
4/3	2	DF	Humpback Whale		X		Initial sighting was a fin whale; Possible weak humpback calls detected
		DF	Fin Whale	X	X		20 Hz pulses and 50 Hz calls detected
Total	**20 (2)**						

Table 4. Percent of time vocalization events recorded for fin and gray whales by flight date in the SOCAL range complex. Vocal events were defined as a continuous time period in which at least one call from the focal species was detected in a two-minute period. Channels represent different sonobuoys recorded some of which may have contained an overlapping time-period (i.e., both sonobuoys were not always recorded for the same time periods.

Date	Species	Channel 1		Channel 2	
		% of total	Total Duration	% of total	Total Duration
2/8/12	Gray Whale	0%	1:29:47	0%	1:27:12
2/9/12	Fin Whale	83%	2:00:41	75%	1:59:45
2/10/12	Gray Whale	3%	2:29:31	0%	1:02:00
2/10/12	Fin Whale	17%	2:29:31	0%	1:02:00
3/16/12	Fin Whale	16%	3:53:30	16%	3:56:50
4/2/12	Fin Whale	7%*	1:29:37	15%	1:22:18
4/3/12	Fin Whale	69%	1:27:46	41%	1:22:30

* This recording was only partially recovered from backup data and thus not representative of call rates for fin whales in general.

Table 5. Summary of visual sightings, surface behaviors, call times and call bearings of a fin whale focal group on 9 February 2012 in the SOCAL range complex.

Time	Event	Comment	Call Type	Signal Strength	Bearing
12:21:00	visual	5 fin whales seen			
12:31:00	SB deployed	deploy sonobuoy #1			
12:34:58	calls				
12:35:19-21	visual				
12:40:27	visual				
12:40:53-41:05	calls	altitude 1500'			
12:41:31-42:43	visual	traveling medium speed			
12:42:13	calls	lots of calling			
12:44:22-43	visual	1 fin visible			
12:45:39	visual	1 fin visible, SB ~1 km away			
12:46:02-19	visual	1 fin visible traveling medium speed subsurface to west			
12:46:45	calls	some calls			
12:48:15-49	visual	2 fins travel subsurface			
12:40:03		end video			
12:53:00	SB deployed	deploy sonobuoy #2			
12:57:44		start video (no whales seen at surface)			
12:59:24	calls	different fin whales heard (from different location)			
13:00:33	calls		20hz	4	192.3777
13:00:49	calls		20hz	4	192.3777
13:01:24	calls	counter calling fin whales			
13:01:25	calls		20hz		
13:01:39	calls		20hz		
13:01:44	calls		20hz	4	198.0904
13:02:01	calls		20hz	5	205.7074
13:02:18	calls		20hz	4	295.2074
13:02:40	calls		20hz	4	203.8032
13:02:56	calls		20hz	4	207.6117
13:03:15	calls		20hz	5	199.9947

Time	Event	Comment	Call Type	Signal Strength	Bearing
13:03:22	visual				
13:03:35	calls		20hz		
13:03:54	calls		20hz	5	198.0904
13:04:13	calls		20hz	4	289.4947
13:04:35	calls		20hz		
13:04:54	calls		20hz	4	295.2074
13:05:16	calls		20hz	5	205.7074
13:05:32	calls		20hz	4	289.4947
13:05:54	calls		20hz	5	198.0904
13:09:29-33	visual	2 fins traveling (no calls heard ~13:05-13:15)			
13:15:11-12	visual	2 fin whales traveling			
13:15:13	visual and calls		20hz	5	209.8333
13:15:31	visual and calls		20hz	5	211.7581
13:15:40	visual and calls		20hz		
13:16:10	visual and calls	2 fin whales traveling subsurface	20hz	5	213.6828
13:16:51	calls		20hz	5	215.6075
13:17:30	calls		20hz	5	209.8333
13:17:33	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:17:35	calls		20hz	5	292.5968
13:17:57	calls		20hz		
13:18:08	visual and calls	now 3 fin whales traveling subsurface	20hz	5	213.6828
13:18:13	visual and calls, localized calls		20hz	4	289.4947
13:18:25	visual and calls		20hz	5	219.457
13:18:35	visual and calls		20hz		
13:18:52	visual and calls		20hz	4	292.5968
13:19:05	visual and calls		20hz	5	217.5323
13:19:12	visual and calls		20hz		
13:19:26	visual and calls		20hz		
13:19:55	visual and calls		20hz		

Time	Event	Comment	Call Type	Signal Strength	Bearing
13:20:07	visual and calls		20hz	4	289.4947
13:20:28	visual and calls		20hz	2	211.7581
13:20:44	visual and calls	2 fin whales travel mediums speed, dispersal 4 body lengths	20hz		
13:21:00	visual and calls		20hz		
13:21:18	visual and calls		20hz		
13:21:34	visual and calls		20hz		
13:21:46	visual and calls		20hz		
13:21:53	visual and calls		20hz		
13:22:02	visual and calls		20hz		
13:22:10	visual and calls		20hz	5	215.6075
13:22:24	visual and calls		20hz		
13:22:27	visual and calls		20hz		
13:22:38	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:22:40	visual and calls		20hz	4	296.4462
13:22:47	visual and calls		20hz	5	217.5323
13:23:05	visual and calls		20hz	5	220.9415
13:23:15	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:23:17	visual and calls		20hz	4	285.6862
13:23:26	visual and calls		20hz		
13:23:43	visual and calls	3 fin whales traveling medium speed to west	20hz	5	205.9839
13:23:55	calls		20hz	3	286.8226
13:24:00	calls		20hz	5	221.3817
13:24:17	calls		20hz	5	219.457
13:24:29	visual and calls	3 fin whales traveling medium speed to west	20hz		
13:24:54	calls		20hz	5	213.6828
13:24:55	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:25:08	calls		20hz	1	213.6828
13:25:10	calls		20hz		

Time	Event	Comment	Call Type	Signal Strength	Bearing
13:25:27	calls		20hz	5	221.3817
13:26:01	calls		20hz	2	288.7473
13:26:06	calls		20hz	4	219.457
13:26:23	calls		20hz	5	227.1559
13:26:39	visual and calls	fin whales resurface traveling medium speed to west	20hz		
13:26:51	visual and calls		20hz		
13:27:03	visual and calls		20hz		
13:27:18	visual and calls		20hz	4	278.0691
13:27:35	visual and calls		20hz		
13:27:53	visual and calls		20hz	2	225.2312
13:27:58	visual and calls		20hz	2	300.2957
13:28:34	visual and calls and localized calls	fin whales travel heading now 230 degrees	20hz	5	243.7926
13:28:52	visual and calls and localized calls		20hz	5	211.4202
13:28:56	visual and calls and localized calls		20hz		
13:29:09	visual and calls and localized calls	2 fin whales visible travel medium speed subsurface -6 body lengths apart	20hz	5	221.3817
13:29:11	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:29:13	visual and calls and localized calls		20hz	5	284.8978
13:29:34	visual and calls and localized calls	2 fin whales at surface travel medium 2.5 body lengths apart	20hz		
13:29:48	visual and calls and localized calls		20hz	4	215.6075
13:29:51	visual and calls and localized calls		20hz	4	284.8978
13:30:12	visual and calls and localized calls		20hz	3	281.8777

Time	Event	Comment	Call Type	Signal Strength	Bearing
13:30:28	localized calls	intersect of bearings from two sonobuoys in or near the aircraft's location while circling within ~1 km from a focal group			intersection
13:30:29	visual and calls		20hz	4	281.8777
13:30:44	visual and calls		20hz		
13:30:51	visual and calls		20hz		
13:31:07	visual and calls		20hz		
13:31:45	visual and calls		20hz		
13:32:01	visual and calls		20hz		
13:32:09	visual and calls		20hz		
13:32:26	visual and calls		20hz	4	30.516
13:33:03	calls	whales out of view below surface; did not resight through when plane left area at 14:31 but calls still heard	20hz	4	331.3883
13:33:17	calls		20hz		
13:33:25	calls		20hz		
13:33:41	calls		20hz	4	281.8777
13:34:03	calls		20hz		
13:34:12	calls		20hz		
13:35:07	calls		20hz		
13:35:39	calls		20hz		
13:36:45	calls		20hz	4	70.5053
13:37:06	calls		20hz		
13:37:22	calls		20hz		
13:37:44	calls		20hz		
13:38:00	calls		20hz		
13:38:22	calls		20hz		
13:38:37	calls		20hz	3	91.4521
13:38:49	calls		20hz		
13:39:11	calls		20hz		
13:39:21	calls		20hz		
13:39:27	calls		20hz		
13:39:38	calls		20hz		

Time	Event	Comment	Call Type	Signal Strength	Bearing
13:39:45	calls		20hz		
13:39:59	calls		20hz		
13:40:16	calls		20hz	3	95.2606
13:40:54	calls		20hz		
13:41:32	calls		20hz		
13:41:42	calls		20hz	2	230.4628
13:41:57	calls		20hz	2	222.8457
13:42:09	calls		20hz	3	287.5904
13:42:12	calls		20hz	2	211.4202
13:42:47	calls		20hz	3	283.7819
13:44:06	calls		20hz	2	287.5904
13:44:08	calls		20hz	2	93.3564
13:44:26	calls		20hz		
13:44:42	calls		20hz	2	232.367
13:44:48	calls		20hz		277.6364
13:44:58	calls		20hz		225.9465
13:45:15	calls		20hz	2	224.75
13:45:31	calls		20hz	2	222.8457
13:45:49	calls		20hz		
13:46:28	calls		20hz	2	228.5585
13:47:05	calls		20hz		
13:47:45	calls		20hz	2	120.016
13:48:08	calls		20hz		
13:48:25	calls		20hz		
13:48:42	calls		20hz	3	228.5585
13:48:59	calls		20hz	3	230.4628
13:49:37	calls		20hz		
13:50:52	calls		20hz		
14:04:00	SB deployed	deploy sonobuoy #3			
14:31:00		departed area			

Photo 1. View of sonobuoy chute from inside the Partenavia aircraft. The white disk is a cover that keeps the wind from blowing inside the aircraft, and is removed immediately prior to sonobuoy launch.

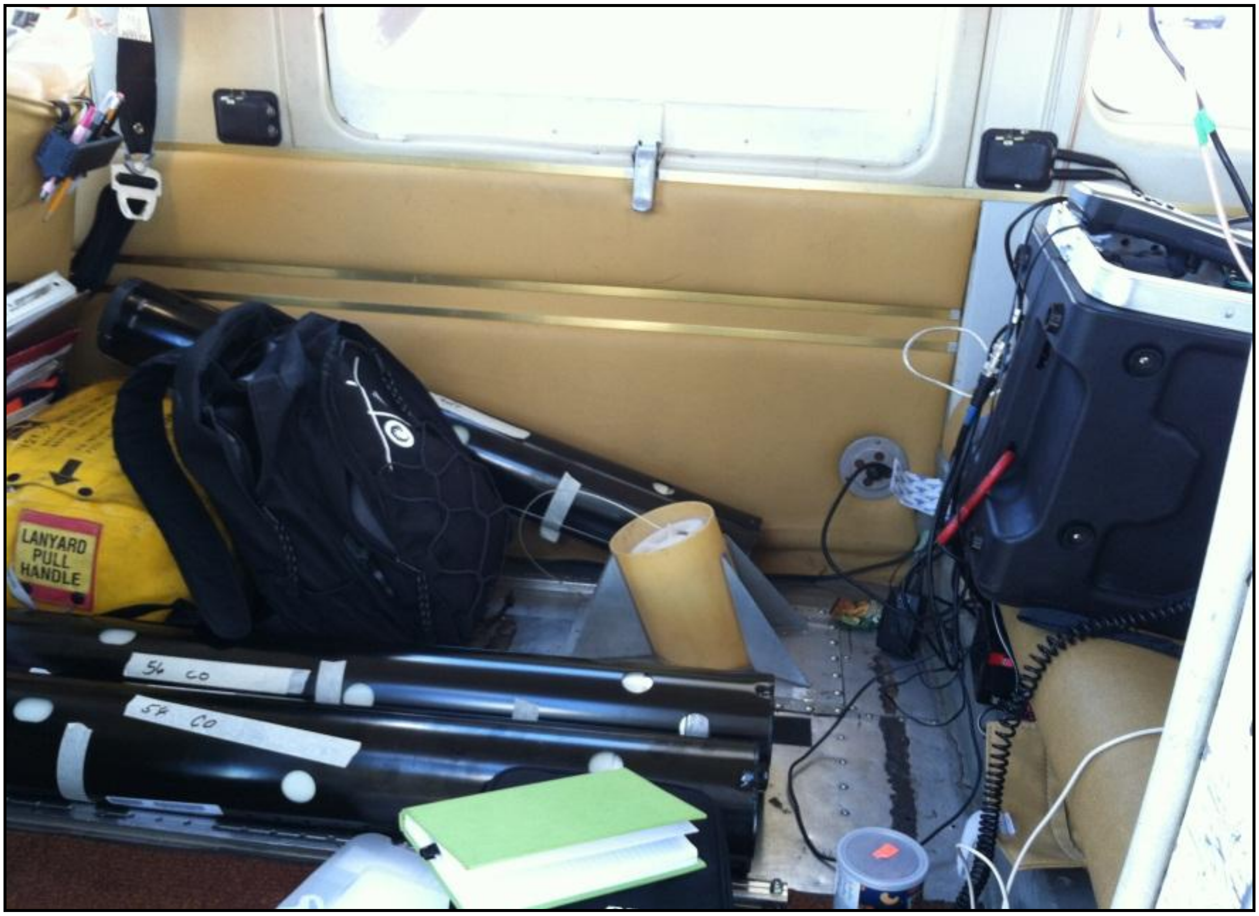


Photo 2. Acoustic hardware mounted in a small acoustic equipment case and strapped to the rear bench-seat. This initial configuration was abandoned for a configuration in which the equipment case was strapped to a rear-facing seat behind the co-pilot, allowing more space for the observer and recorder in the back seat. Three sonobuoys (labeled with their frequencies and mode settings on white tape) are ready for deployment. In this configuration, the life raft is secured behind the co-pilot's seat.

Photo 3. Two fluorescein dye markers and a sonobuoy (small red dot on lower left side of photo). Photo taken 10 February 2012 by B. Würsig.

Photo 4. Fin whales photographed 9 February 2012 during a visual-acoustic behavior flight by B. Würsig under National Marine Fisheries Service (NMFS) permit 14451. Sonobuoys were deployed near this group and calls were recorded.

Photo 5. Gray whales photographed 10 February 2012 during an acoustic-behavior focal follow by B. Würsig under National Marine Fisheries Service (NMFS) permit 14451.

Photo 6. A RHIB (operated by Scripps' Institution of Oceanography) and a gray whale tracked from both the aircraft and RHIB. Sonobuoys were deployed from the aircraft near this sighting and behavior and sighting data were obtained from the aircraft. Biologists in the RHIB were able to obtain photo-identification and biopsy data from this sighting. Photographed by B. Würsig 10 February 2012.

APPENDIX E: DIFAR AND ISHMAEL POST-PROCESSING PROTOCOL

Wav file Recordings of DIFAR mode sonobuoys were post-processed using Ishmael and DIFAR (a custom Matlab script used to obtain bearings from Direction-finding [DF] sonobuoys) to obtain bearings-to-sound-sources, bearing quality, and relative signal strength information. These data were saved in an excel spreadsheet for importing into the program Mysticetus (download available from www.mysticetus.com). Mysticetus was then used to plot bearings and cross-fixes from sonobuoys. For more information about DF sonobuoys and processing:

McDonald, M.A., DIFAR hydrophones applied to whale research, *Canadian Acoustics*, 32:155-160, 2004. Available from: http://www.whaleacoustics.com/publications.html

WAV file requirements

- WAV files need to be 16 bit
- Single or channel WAV files may be used, but single channel files should be save as a stereo file (same file on both channels)
- Must have a DIFAR signal usually present at 15 kHz (see **Figure 1** at bottom of file for an example of a DF spectrogram).
- Do not down-sample WAV files as this will potentially remove the DF signal.
- WAV file name should be in the format xxxxYYMMDD-hhmmss.wav, where
  - xxxxx is a project descriptor of arbitrary length (not used)
  - YY is the year (2 digits)
  - MM is the month (2 digits)
  - DD is the day (2 digits)
  - hh is the hour (2 digits)
  - mm is the minutes (2 digits)
  - ss is the seconds (2 digits).

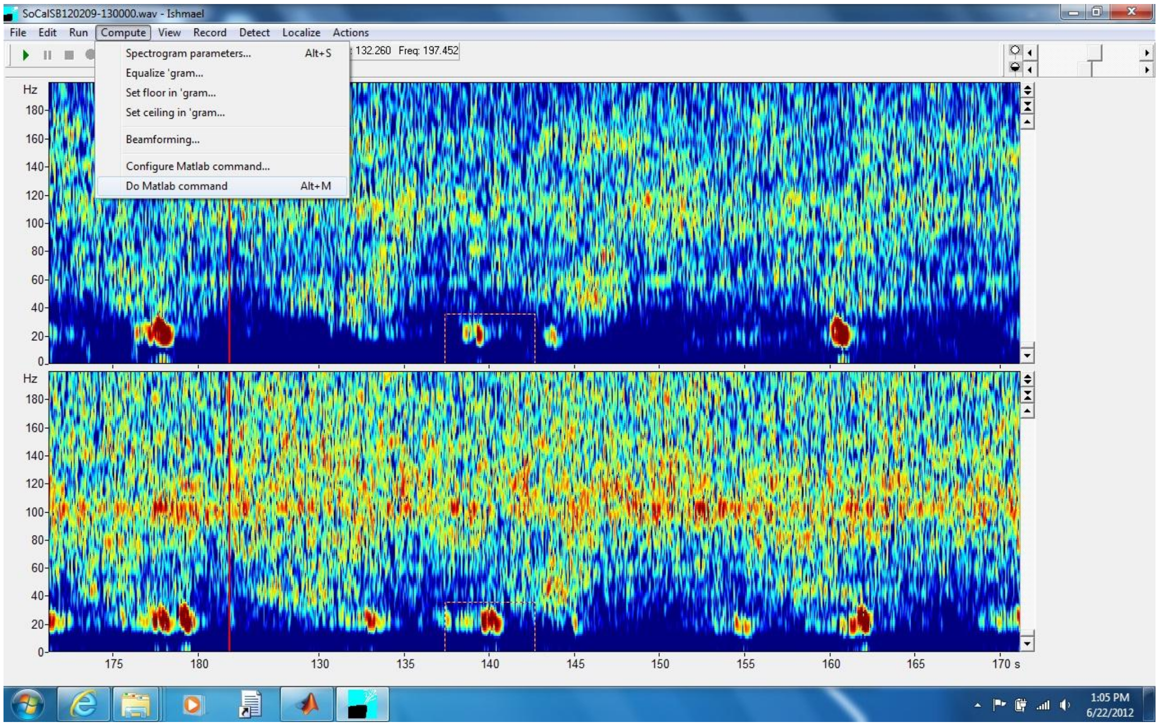
DIFAR

- To get the latest version of DIFAR , send an e-mail to info@bio-waves.com
- Requires Matlab version 2007, Win XP or Win7 32-bit version.
- To start DIFAR, type 'DIFAR' in Matlab command prompt window.
- Run RWDifartest.wav as a test file to see if the program is working

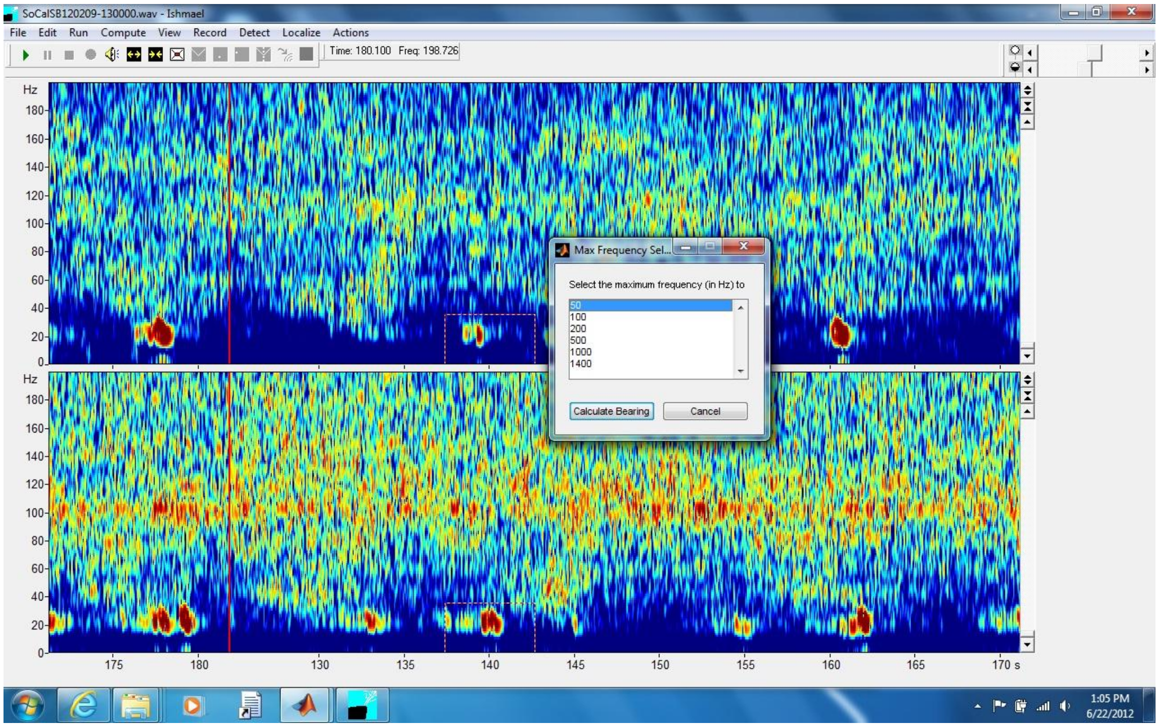
Steps:

1. Open Ishmael and load settings 'Difar postprocessing.ipf'.
2. Settings
3. Open desired WAV file to process.

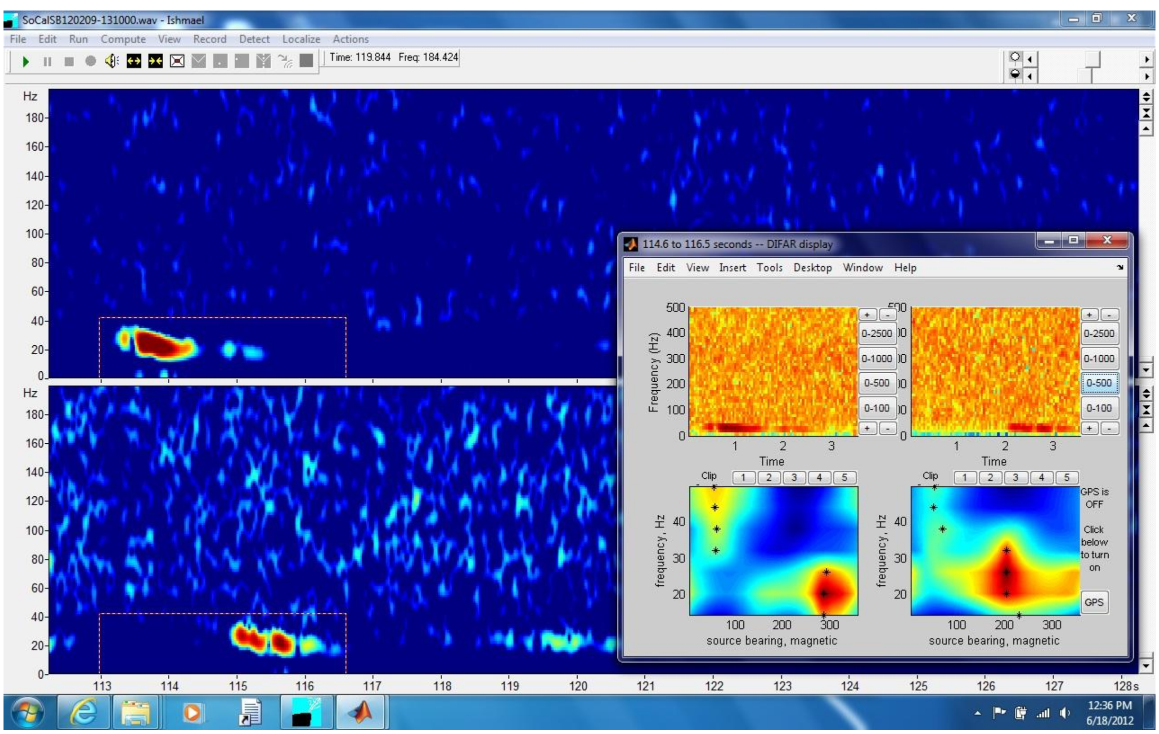
4. Uncheck both boxes for **Fit this file to window** then click OK.
5. Click the **play** button. Can adjust settings here and save it to be loaded later if needed.
6. Click the **stop** button when you come across a call.
7. Use the cursor to drag a box around the call (Note: this might require up to a 4-second box).
8. From the File menu select **Compute**→Do Matlab command (or type 'Alt-M' from keyboard).



9. In a few seconds, after Matlab loads, two Matlab windows will appear (you might need to click on Matlab button on the bottom toolbar to get them to appear), a Matlab command window and a Max frequency window.
    a. If the 'Max frequency' window does not appear, then type 'ishDifarAllChannels' in the Matlab command window (Also check that the DIFAR folder is in the Matlab path - if not, you will get an error because Matlab wouldn't be able to find the file.
    b. Note: when you run Matlab via Ishmael, errors don't appear in the Matlab command window.
10. Pick a max frequency (for the signal of interest) and click '**Calc Bearing**'. (e.g., for a 60 Hz calls pick 100 Hz. A 200 Hz or 500 Hz would allow for too much noise/interference). Click 'Calculate Bearing'.

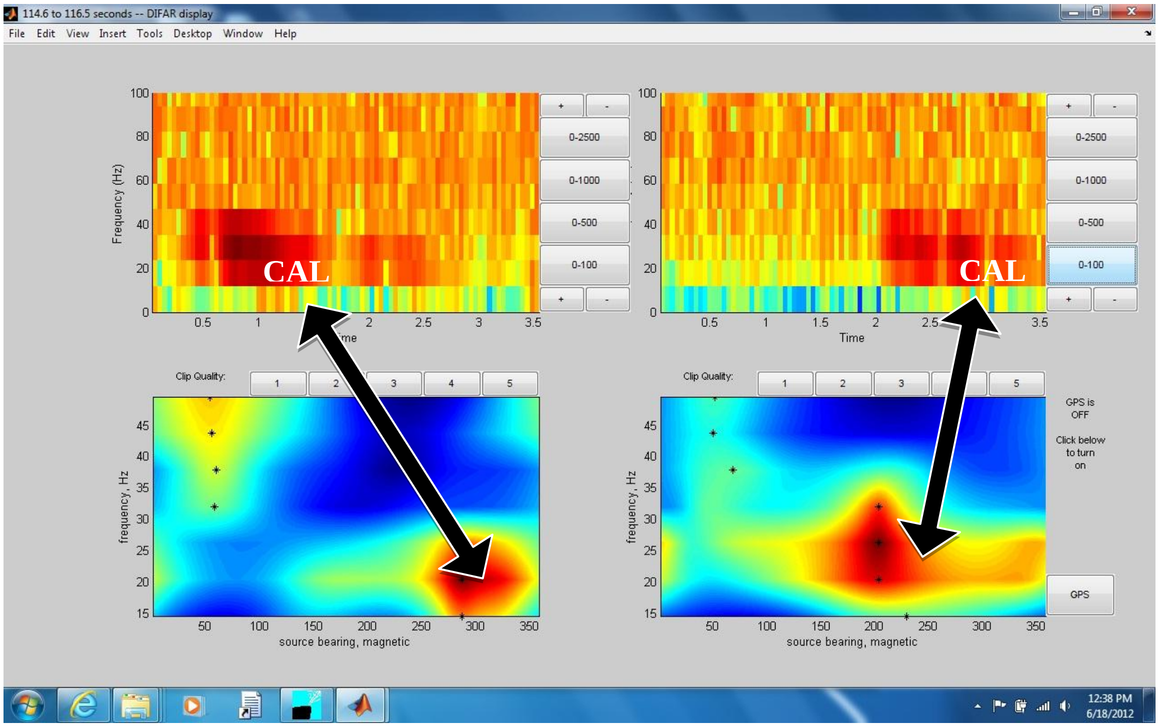


11. If the operation is successful, a Matlab window will pop up that includes a spectrogram of the boxed call (Top panel below) and a 'Difargram' (bottom panel below) of the bearings for each frequency bin (denoted by a cross) for each channel (channel 1 = left panel, channel 2 = right panel).

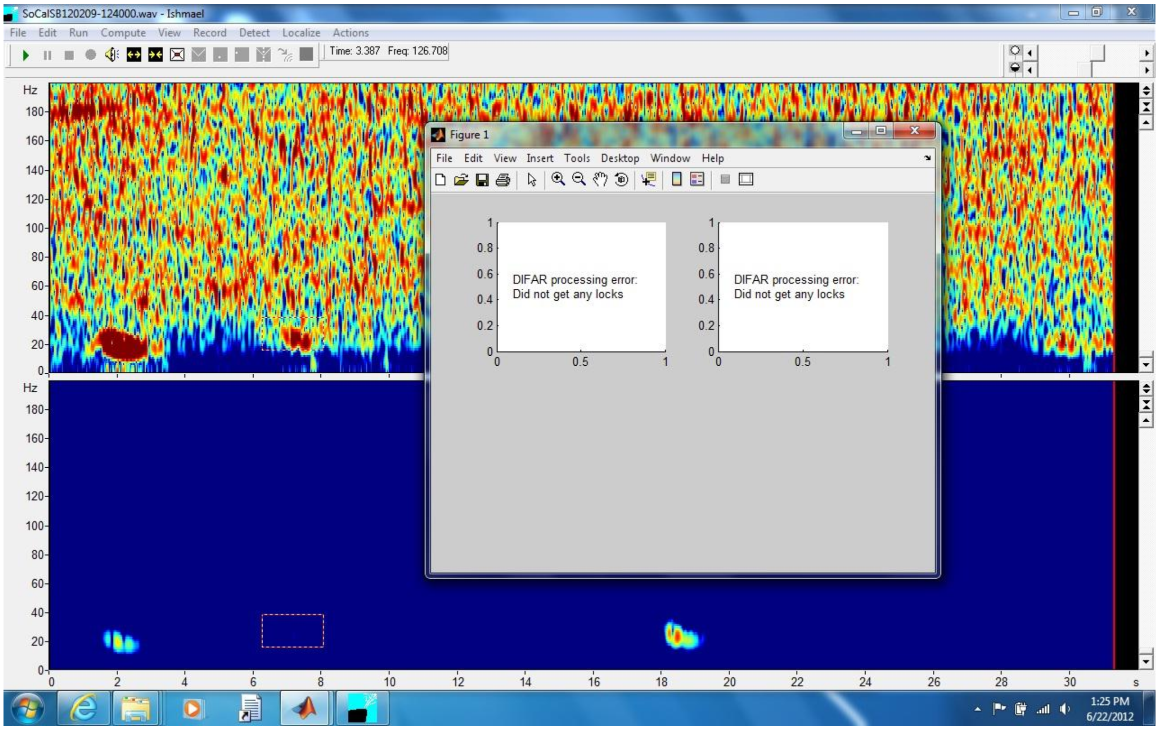


12. You can zoom in or out of the spectrogram (top panel, by selection the appropriate buttons to the right of the spectrogram window for each channel). The signal in the

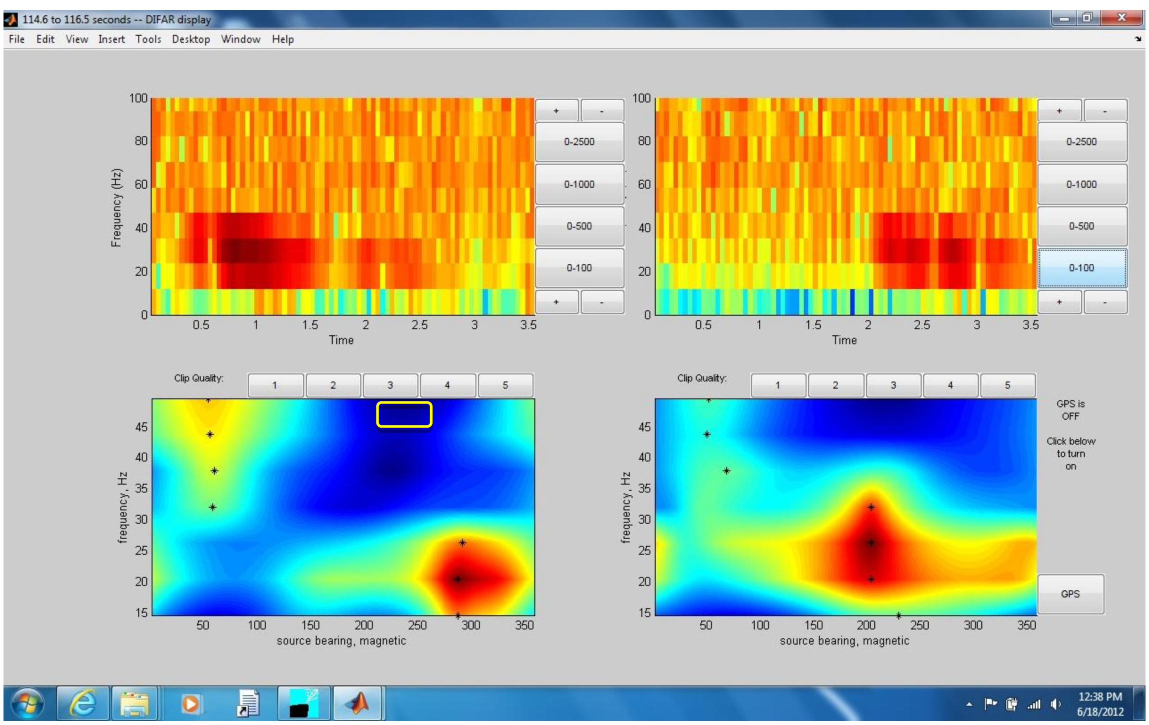
spectrogram should correlate with the difargram. Note: there is no time-axis in the DIFAR-gram display (i.e., x-axis is the bearing, not time).



13. If an error message "DIFAR processing error: did not get any locks" appears, the box around the signal in Ishmael may need to be redrawn using a longer time-duration, or a more intense call might need to be selected. If none of the signals selected are getting bearings, check to see that the there is a DIFAR signal present in the WAV file (at 15 kHz – see Fig. 1 below). Also check to see that the WAV file format is 16 bit.
If the error continues to appear and all the above conditions are verified, send an e-mail to mike.oswald@bio-waves.net with a detailed explanation and a copy of the WAV file used.

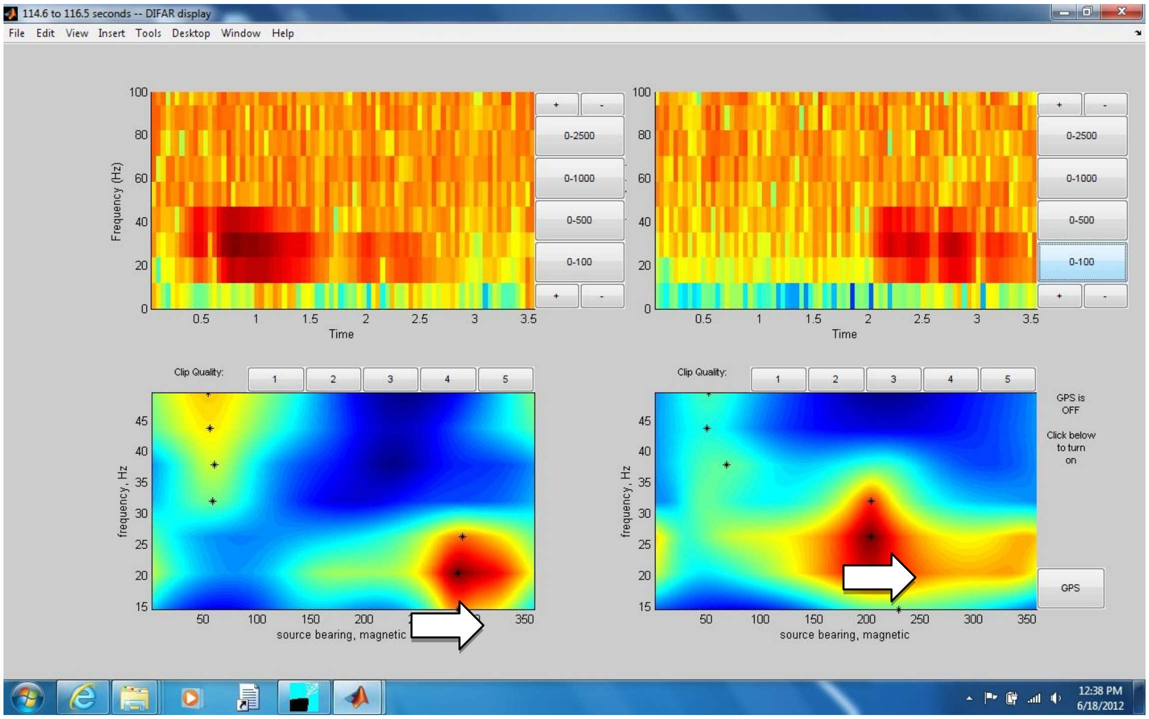


14. If a DIFAR-gram appears, click on the appropriate bearing quality button (see buttons 1-5 above the DIFAR-gram). The scale is qualitative with 1 = poor quality and 5 = excellent. The relative number of crosses in your signal with similar values should be used to indicate quality).



15. Next, mouse over the DIFAR-gram and a cross-bar should appear. Move the cross-bar to the appropriate position on the X-axis to pick the best bearing of the call. Do this for both

channels. This will save the data as two CSV files in the folder C:Difar/DifarOutput with one line of data for each channel.



16. Continue to process signals of interest (e.g., calls) for each call until the calling event has ended.

17. Import your saved CSVs to an excel spreadsheet and format as needed for importing into Mysticetus (see Mysticetus DIFAR display protocols for more details on formatting requirements).

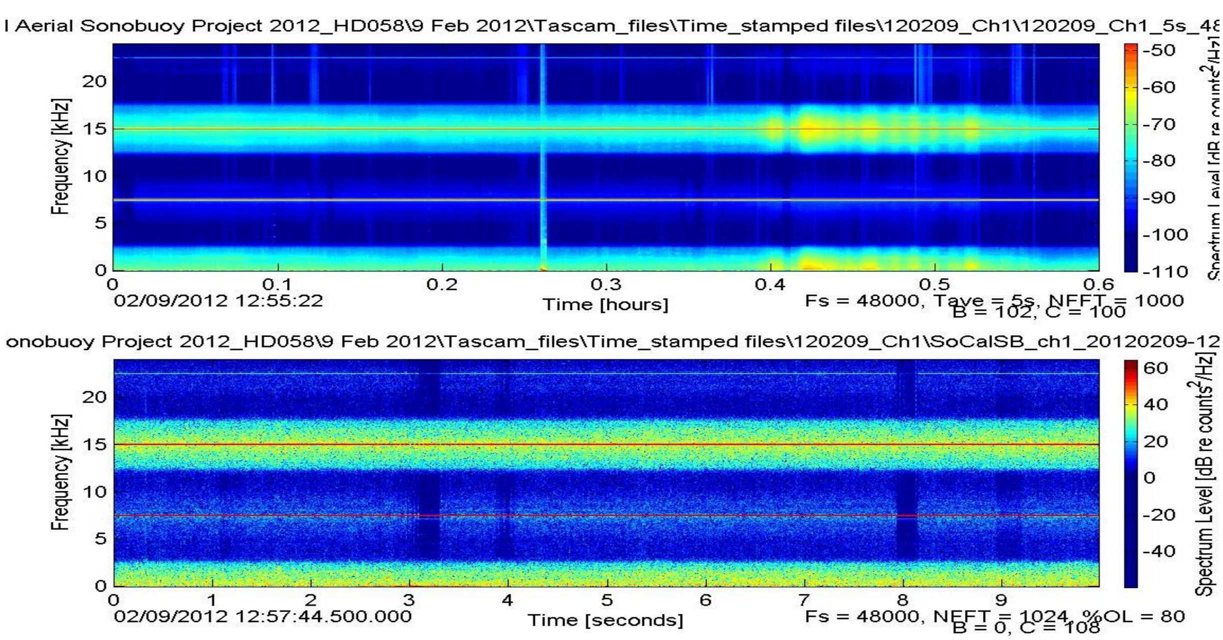
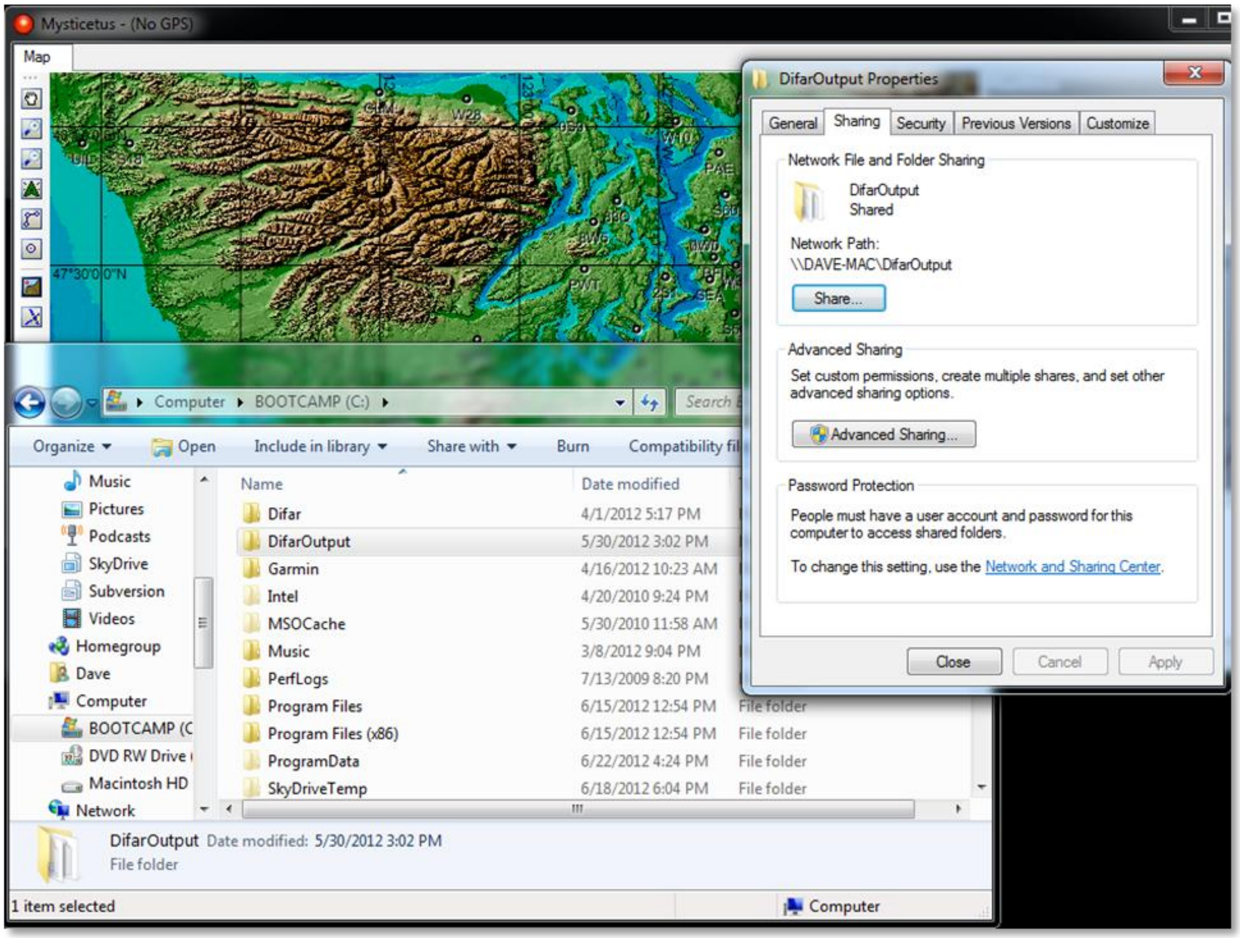


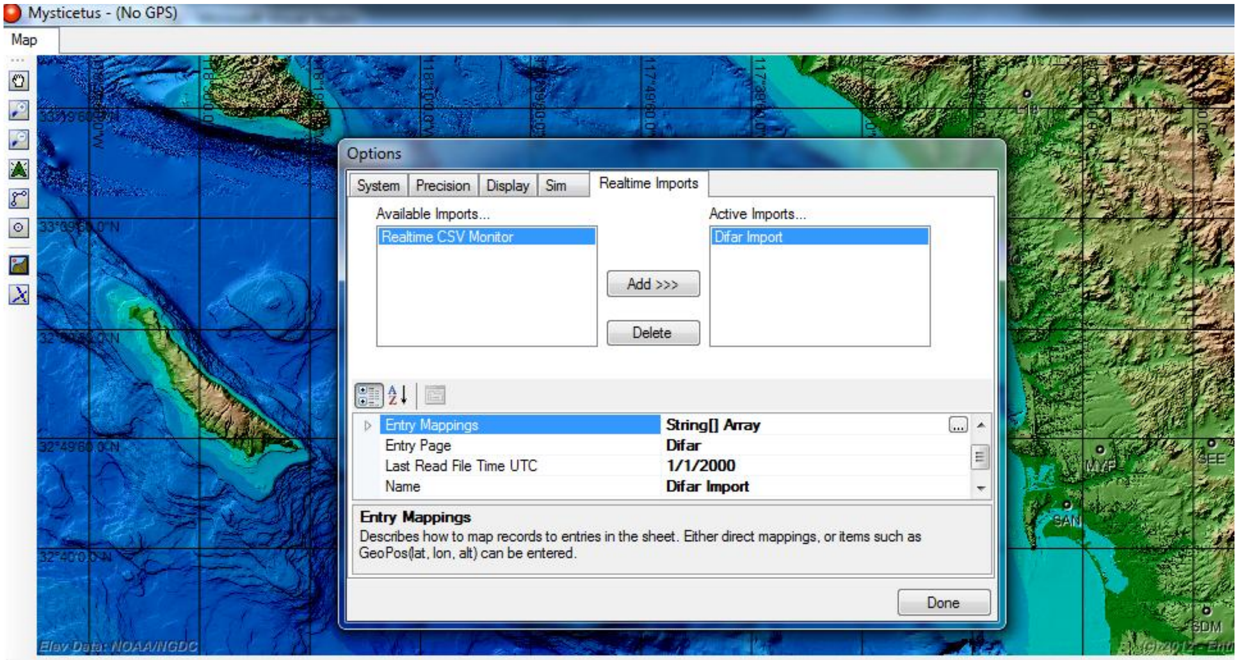
Figure 1. Example of an LTSA (top panel) and spectrogram (bottom panel) with a good DF signal.

MYSTICETUS REAL-TIME PROTOCOL

The first step in configuring Mysticetus is to share a folder on the PC running Mysticetus. This allows the DIFAR program to write CSV files to this folder across the in-plane network.

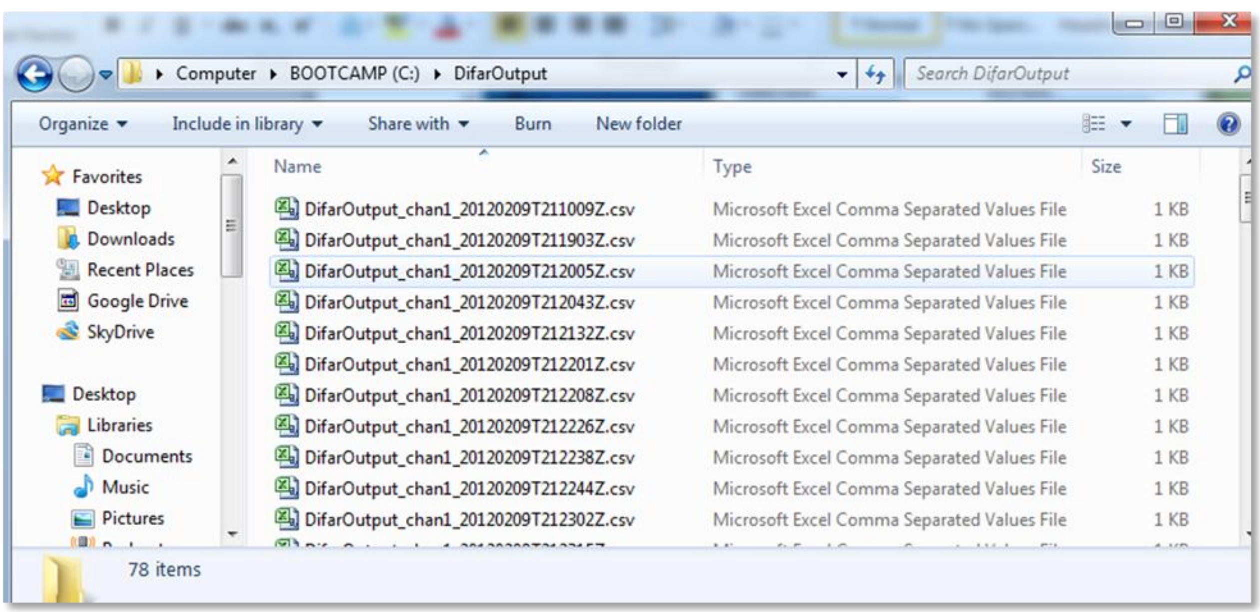


Mysticetus itself is then configured to receive CSV files from the DIFAR program by adding a “CSV Import” in the Mysticetus System Options.

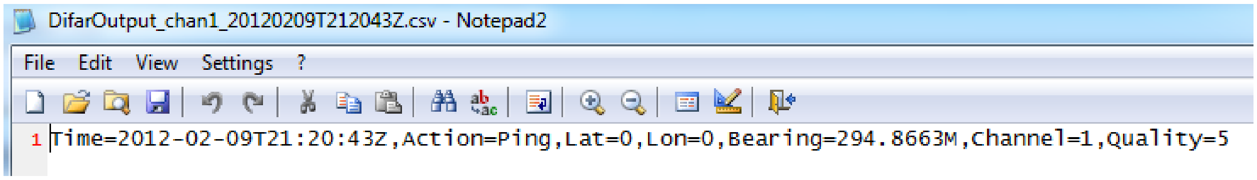


This causes Mysticetus to look for any CSV file in the specified directory. When a new CSV file is discovered (after being placed there by DIFAR) – the file is parsed into its constituent pieces and automatically entered into a Mysticetus data sheet and real-time map display.

The following screenshot shows a collection of CSV files that have been placed (via the network connection in the airplane) in a shared folder. Note the file name includes the date, time and channel related to the acoustic bearing.

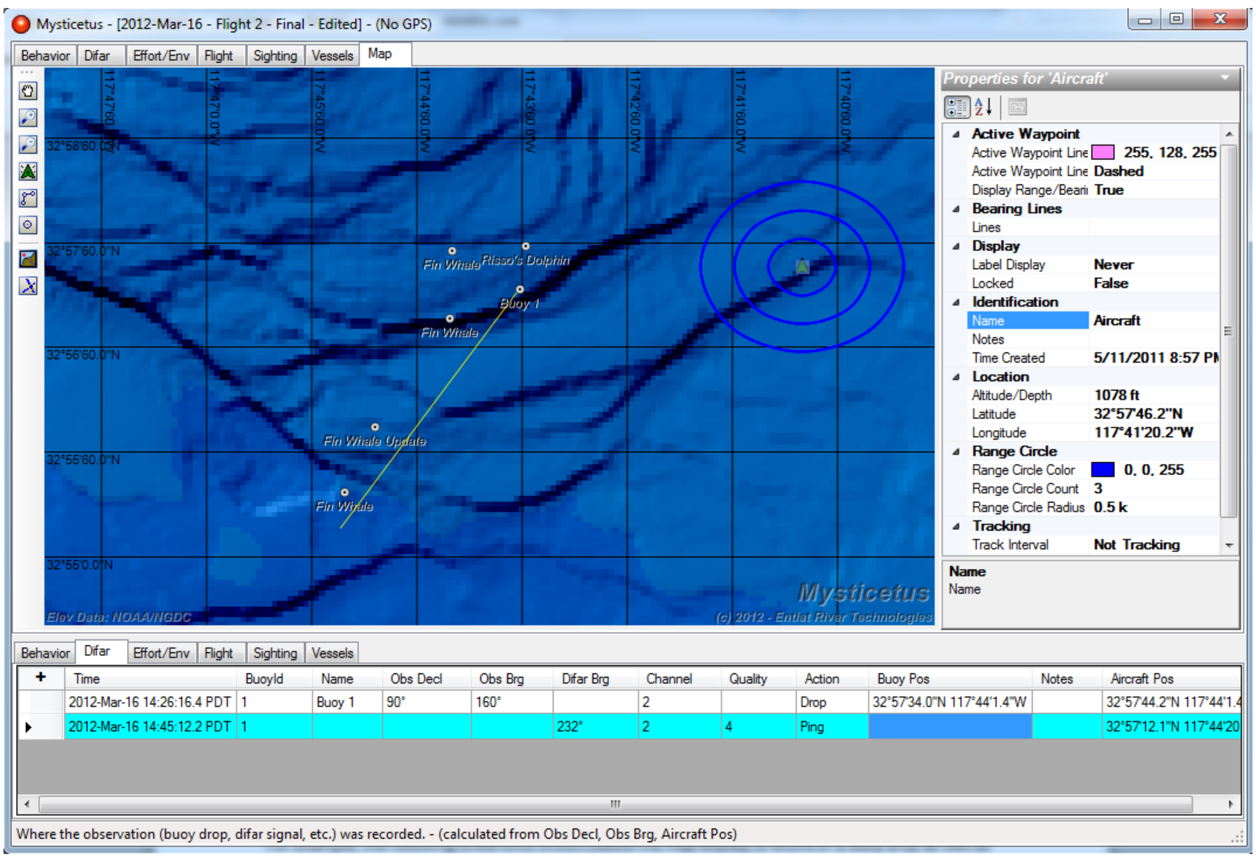


An example of the contents of one of these CSV files:



Note that for subsequent post-processing purposes, we included the latitude and longitude values in these fields so they could be easily correlated with the appropriate sonobuoy.

The following screenshot shows a record of a buoy drop as well as a Ping record (yellow) - a bearing received from the buoy, processed in DIFAR and transmitted to Mysticetus. The map display shows the directional bearing as received at the buoy. The airplane's track line was removed from this map display for clarity of this document.



All this information – about the DF bearings, sightings, GPS trackline, etc. are stored in a *.Mysticetus file. Typically this file is named (by the operator) by incorporating the date, e.g., "2012-Feb-09.Mysticetus". This allows all data to be re-loaded and re-examined in Mysticetus at a later date.

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APPENDIX F: ABSTRACTS SUBMITTED TO THE 2012 SOUTHERN CALIFORNIA MARINE MAMMAL WORKSHOP

Bryde's Whale (*Balaenoptera brydei/edeni*) in the Southern California Bight

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Bryde's whales (*Balaenoptera brydei/edeni*) have been considered an anomalous occurrence in the Southern California Bight (SCB). Thus, they typically have been excluded from species lists associated with SCB management documents. In the last 40 years only two visual sightings of Bryde's whales were documented in California waters, the last one in 1991 (Carretta et al. 2007). This is despite extensive systematic vessel and aerial surveys and presumed recent recordings of Bryde's whale vocalizations in the SCB. Bryde's whales are notoriously difficult to differentiate in the field and from fin (*B. physalus*) and sei whales (*B. borealis*), given the subtle differences in physical characteristics. Between August 2006 and September 2010, we photo-documented five sightings of five single Bryde's whales in the SCB. Two of the five sightings occurred in October 2008 and September 2010 during 33,880 km of aerial surveys. The remaining three sightings occurred during small-vessel surveys that included offshore waters: two in June 2006 and one in September 2010. These sightings combined with other reports of presumed vocalizations suggest that Bryde's whale numbers may be increasing in the SCB. This may be related to global warming, large-scale oceanographic events (e.g., El Niño and La Niña) and resulting changes in prey availability. However, no clear association pattern was evident between ENSO events and our sightings. The recent sightings reported herein indicate that the Bryde's whale should be considered as a species present in the SCB and photo-documentation is critical to ascertain species.

Comparison of Blue and Fin Whale Behavior, Headings and Group Characteristics in the Southern California Bight during Summer and Fall 2008-2010

Cathy Bacon [1], Mari A. Smultea [1], Bernd Würsig [2], and Kate Lomac-MacNair [1]

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Baseline undisturbed behavior and social patterns of blue (*Balaenoptera musculus)* and fin whales (*B. physalus*) are not well described and are needed to identify and understand potential effects of anthropogenic activities. Behavioral data for blue and fin whales were collected during line-transect and focal-follow effort. Initially observed behavior state, heading, and minimum and maximum inter-individual dispersal distance were recorded during line-transect sampling. Focal groups were circled for 10-60+ minutes and videotaped from outside Snell's sound cone to avoid disturbance. During 24,736 km of survey effort, 51 fin whale sightings (85 individuals) and 49 blue

whale sightings (81 individuals) were seen. Over 7 hours of video was collected for 16 blue and 15 fin focal follows. During the summer seasons, blues (n=48) were seen more commonly than fins (n=35); in fall, fins (n=16) were seen significantly more frequently than blues (n=1). Mean group size was 1.7 whales for both species. Initially observed blue behavior was usually travel (85%) or mill (11%). Observed fin whale behavior was also mostly travel (90%), mill (4%), or surface-active travel (4%). Both species were seen socializing in fall but not summer; foraging was observed in summer through fall. Mean initial dispersal for blues and fins was 9.1 and 14.2 body lengths, respectively. In summer, blues were most frequently (26%) seen headed S; in fall (n=2), they were headed only inshore (E). In summer, fin whales were most commonly headed SSW (26%) or WNW (26%); in fall, they were headed mostly NE (38%) or WSW (38%). Dive/respiration/behavioral event rates were also collected. Both species may directly compete for food based on observations of inter-specific maneuvering for a bait ball. Data represent the most extensive record of systematic undisturbed behavior on these species in SOCAL and include social interactions not previously documented in this region.

Interactions between Sperm Whales and Risso's and Northern Right Whale Dolphins off San Diego

Jessica Bredvik[1], Mari Smultea[2], Kate Lomac-MacNair[2], David Steckler[2], and Chip Johnson[1]

[1]Unites States Navy, U.S. Pacific Fleet, Environmental, Naval Base Coronado, PO Box 357033, San Diego, CA 92135-7033; [2]HDR|EOC, Inc., 9449 Balboa Avenue, Suite 210, San Diego, 92123

Aerial surveys provide a valuable platform to record and document behavior of marine mammals above and below the sea surface. This approach is advantageous in avoiding disturbance from the observational platform while circling outside the sound cone of the plane. Since 2008, the U.S. Navy has instituted a marine mammal monitoring program in southern California from several platforms, including aerial surveys, and previously undocumented behaviors and species interactions have been recorded during the aerial effort. This included focal behavioral interactions between sperm whales, northern right whale dolphins, and Risso's dolphins on 14 May 2011, 24 nm west of San Diego, CA. This ~1.5 hr encounter was documented in detail with high-definition digital photographs and video as the group traveled NE along the edge of a steep underwater drop-off. Risso's dolphins initiated charges towards the heads of the sperm whales on multiple occasions, followed by fast retreats. Sperm whale adults responded by displaying an open lower jaw. Risso's dolphins appeared to direct this behavior only toward adult sperm whales that had recently surfaced from long (> 20 min) dives; it was not directed toward the four calves in the group. Northern right whale dolphins intermingled with the Risso's dolphins and sperm whales, although they did not approach sperm whales as closely or abruptly as the Risso's dolphins. While similar apparently aggressive Risso's dolphin behavior has been documented toward other cetacean species, this is the first known occurrence of head-on charging by Risso's dolphins, accompanied by the elicited jaw display response from sperm whales. The interaction may be similar to pilot whales being aggressive towards sperm whales, and may function in acquiring regurgitated sperm whale food, or other needs by the Risso's dolphins.

Changes in Abundance, Density and Diversity of Marine Mammals in the Southern California Bight 1998-1999 vs. 2008-2011

Mari A. Smultea[1], Thomas A. Jefferson[2], Jenelle Black[3], and Kate Lomac-MacNair[1], Cathy Bacon[1]

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Twelve line-transect aerial surveys occurred during fall/summer 2008-2011 to monitor the occurrence, abundance and behavior of marine mammals in the Southern California Bight. The study area overlapped where Carretta et al. (2000) flew surveys in 1998-1999, coinciding with their "warm-water period". Density and abundance were estimated using standard line transect methods and DISTANCE software. Analyses were limited to 12,206 km flown in Beaufort 0-4 conditions and 495 marine mammal sightings of the seven most commonly observed species. Blue whale densities were all well below historical estimates. Fin whales continue to be the most commonly abundant large whale. Risso's dolphins have apparently dramatically increased in numbers and/or distribution over the last several decades: calculated density east of San Clemente Island (SCI) was 19.99 animals/100 km^2. This is much higher than those for Carretta et al.'s warm season, but similar to those they estimated for the cold season. Our densities of common dolphins were lower than Carretta et al.'s warm-water season (318.99 animals/100 km^2 east of and 58.43 animals/100 km^2 west of SCI). However, short-beaked common dolphins were still by far the most abundant species (~29,044 individuals). Historically, Pacific white-sided dolphins were seen only in the cold-water season, but we had 26 sightings (density 19.7 individuals/100 km2) in the warm-water period. Pilot whales, though historically common, were never seen. Results indicate that recent patterns of cetacean relative abundance and presence are, in many cases, very different from historical records. This is likely related to previous exploitation and depletion of these species and long-term changes in oceanographic conditions, concomitant changes in prey distribution and densities, and anomalous El Niño and La Niña events. This study provides the only available recent estimates of abundance for marine mammal species east and west of San Clemente Island where the U.S. Navy conducts major training exercises.

Got Milk? Aircraft Observations Provide Rare Glimpses into Whale Calf Nursing and Back Riding

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Nursing behavior by large cetaceans in situ is not well described. During ~30,000 km of aerial surveys off Southern California to monitor marine mammals relative to U.S. Navy military training activities (2008-2011), nursing behaviors were documented for three species: Eastern Pacific gray whale (*Eschrichtius robustus*), fin whale (*Baleanoptera physalus*) and killer whale (*Orcinus orca*). Photographs, video, notes and audio recordings were used to analyze mother-calf interactions. Back riding occurred in gray and fin whales, as described for bowhead whale (*Balaena mysticetus*) mother-calf pairs by Würsig et al. (1999). During slow sub-surface travel, a fin whale calf swam alongside mother's peduncle area, touching her head-first for short (<1 min) bouts at a 45° angle. During the sighting (~50 min) the calf switched from one side of the mother's peduncle to the other 12 times, usually by "riding" (n=8) the mother's back or swimming underneath her (n=4). Nursing was assumed based on the persistent (~1 min) position of the calf's head relative to mother's peduncle/teat area. Observations of the gray whale pair showed

similar behavior (~19 min) with calf riding mothers back 3 times, except mother was resting not traveling. During nursing, the calf faced mother at a 45° angle while mother held up her flukes. Two apparent nursing positions of a traveling killer whale mother-calf pair were also photo-documented (~40 min). One position showed both whales lying parallel, facing one another, in the same orientation. The second position showed the same mother lying on her back, with calf nursing on top of mother, ventral side to ventral side. These positions were similar to those described among captive killer whales. Observations indicate nursing occurs during travel and calves of other whale species back ride. Data contribute to rare documentations of whales nursing in the wild, furthering the understanding of cetacean mother-calf interactions.

Diurnal Behavior and Group Size Patterns of Common Dolphins (Delphinus spp.) during 2008-2010 Aerial Surveys off San Diego, California

Kate Lomac-MacNair, Mari A. Smultea, Cathy Bacon, and Megan Blees

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Aerial surveys offer an ideal observation platform to document the behavior and group size of dolphin species over a wide range in offshore waters in a short period. Eight aerial surveys were conducted near San Clemente Island off southern California, Oct/Nov 2008, Jun/Jul/Nov 2009 and May/Jul/Sep 2010 to monitor behavior of marine mammal species using line-transect and focal-behavioral circling methods. An estimated 94,867 short-beaked (*Delphinus delphis*) and long-beaked (*Delphinus capensis*) common dolphins were observed during 346 separate events. Number of sightings, mean group size and initial group behavior state were recorded and compared by diurnal periods. Daytime observation hours were divided into three periods, following the methods of Bearzi et al. (1999): "morning" (08:01-11:59)(n = 71 sightings, individuals = 22,777), "early afternoon" (12:00-15:59)(n = 191, individuals = 52,926), and "late afternoon" (16:00-19:59)(n = 85, individuals = 19,164). Sighting rates were highest in the early afternoon (4.1 indiv/km) followed by late afternoon (3.9 indiv/km) and morning (3.3 indiv/km). Mean group size was highest in the "morning" (321 ± 455.8), followed by "early afternoon" (277 ± 354.5) and "late afternoon" (225.5 ± 276.0). During the "morning", initial group behavior was most frequently surface-active mill (44%) followed by travel (29%) and surface active travel (13%). During the "early afternoon", travel (35%) occurred most frequently, followed by surface-active mill (33%) and surface-active travel (24%). During the "late afternoon", surface-active mill (35%) occurred most frequently, followed by travel (28%) and surface-active travel (27%). Social and apparent foraging behaviors typically occurred during surface-active behavior states. Results suggest that groups of common dolphins of both species aggregate in larger numbers and are generally exhibiting more surface-active mill behavior during the morning than early and late afternoon, potentially corresponding with socializing and foraging strategies. Further data gathering and multivariate analyses are underway to elucidate more specific diurnal trends and behavioral correlations.

APPENDIX G: JOURNAL MANUSCRIPT

Bryde's Whale (*Balaenoptera brydei/edeni*) Sightings in the Southern California Bight

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Sightings of the typically-tropical Bryde's whale (*Balaenoptera brydei/edeni*) have been considered an extralimital occurrence in the Southern California Bight (SCB); thus, this species has frequently been excluded from species lists associated with SCB management documents. In the past 40 years, only two visual sightings of Bryde's whales were documented in California waters, most recently in 1991. This is despite extensive systematic ship/vessel and aerial surveys and recent presumed recordings of Bryde's whale calls in the SCB. Bryde's whales can be difficult to differentiate in the field from fin (*B. physalus*) and sei whales (*B. borealis*) given the subtle differences in external physical characteristics. Between August 2006 and September 2010, we photo-documented five sightings of single Bryde's whales in the SCB. Two of the five sightings occurred in October 2008 and September 2010 during 33,880 km of aerial survey monitoring of marine mammals. The remaining three sightings occurred during small vessel surveys that included offshore SCB waters: two in June 2006 and one in September 2010. These sightings, combined with recently recorded calls from Bryde's whales, suggest that Bryde's whale numbers may be increasing in the SCB. These may be related to climate change, large-scale oceanographic events (e.g., El Niño Southern Oscillation (ENSO) events) and resulting changes in prey distribution and availability. We suggest that the Bryde's whale should be considered as a species normally present in the SCB and that photo-documentation or genetic sampling is critical to confirm species for stock management purposes.

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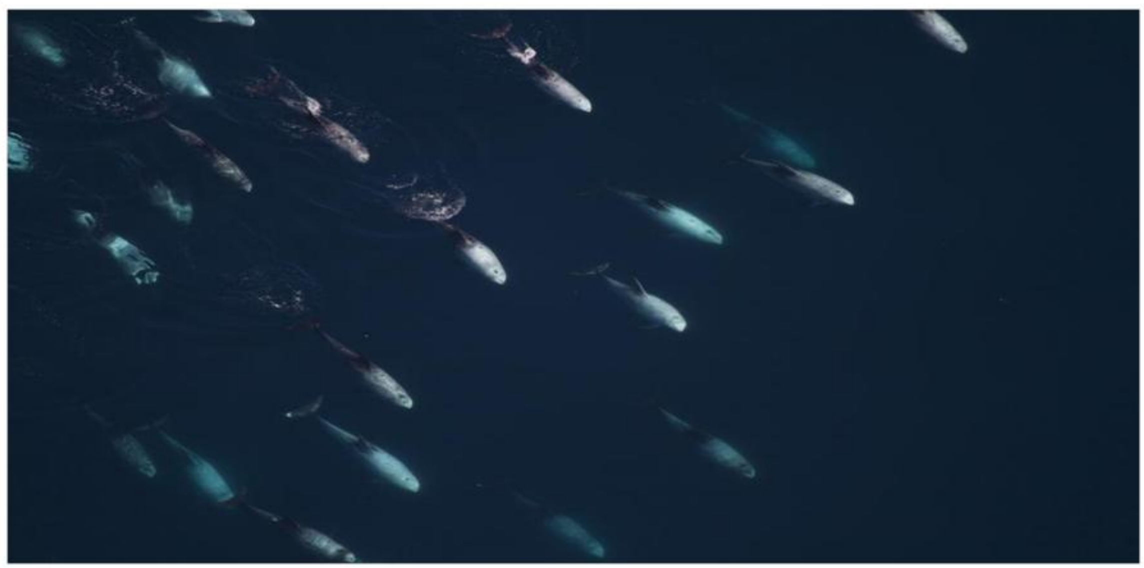
APPENDIX H: REPORT

Density and Abundance of Marine Mammals Derived from 2008-2011 Aerial Survey Data Within the Navy's Southern California Range Complex

Final Report



March 2012

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Acronyms and Abbreviations

BSS	Beaufort Sea State
ft	foot/feet
GPS	Geographic Positioning System
km	kilometer(s)
km^2	square kilometers
m	meters
NMFS	National Marine Fisheries Service
SCB	Southern California Bight
SOCAL	Southern California
South of SCI	South of San Clemente Island
SWFSC	Southwest Fisheries Science Center
U.S.	United States

ABSTRACT

A set of 12 aerial surveys in the marine waters around San Clemente Island, CA, were conducted between October 2008 to May 2011 to provide both observations of marine mammal behavior and data suitable for developing marine mammal density estimates. The primary platform used was a *Partenavia* P68-C or P68-OBS (glass-nosed) high-wing, twin-engine airplane. Density and abundance estimates were made using line-transect methods and the software DISTANCE 6.0. During these surveys, 20 species of marine mammals were sighted. Due to limited sample sizes for some species, species sightings were pooled to provide four estimates of the detection function for baleen whales, large delphinids, small delphinids, and California sea lions. Estimates of density and abundance were made for species observed a minimum of eight times on effort. For the warm-water season (May-October) during 2008-2011, there were an estimated average of 13 blue whales (*Balaenoptera musculus*), 66 fin whales (*B. physalus*), 135 Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), 2537 Risso's dolphins (*Grampus griseus*), 585 bottlenose dolphins (*Tursiops truncatus*), 30,034 common dolphins (*Delphinus* spp., mostly *D. delphis*), and 2534 California sea lions (*Zalophus californianus*) present. During the cold-water season (November-April), there were an average of 37 fin whales, 232 Pacific white sided dolphins, 935 Risso's dolphins, 244 bottlenose dolphins, 16,303 common dolphins, and 1,962 California sea lions present. Blue whales were not observed during the cold-water season.

INTRODUCTION

Ship-based surveys of the entire U.S. West Coast exclusive economic zone have been conducted by the National Marine Fisheries Service (NMFS) since the early 1980s (with more extensive and consistent coverage since the early 1990s). These surveys have provided estimates of abundance and density for U.S. waters of California, Oregon, and Washington, and in some cases information on abundance trends of certain species occurring there (e.g., Barlow 1995, 2003, 2010; Barlow and Forney 2007; Barlow and Gerrodette 1996; Barlow and Taylor 2001; Forney 1997, 2007; Forney and Barlow 1998). These surveys generally provide data and associated densities over a very large geographic area or strata. Smaller-scale density estimates specific to ocean areas associated with Navy at-sea training ranges are needed but such data are more limited.

Carretta et al. (2000) conducted extensive year-round aerial surveys of the area around San Clemente Island in 1998 and 1999; however, density estimates are now over 13 years old and may not reflect current distribution and density.

METHODS

Data Collection

Three types of aircraft were used. Most (58) of the 69 survey days were conducted from a small high-wing, twin-engine *Partenavia* P68-C or P68-OBS (glass-nosed) airplane equipped with bubble observer windows; the remaining 11 survey days occurred from an Aero Commander (9 days) or a Bell 206 helicopter (2 days) both of which had flat observer windows (**Table 1**). Survey protocol was similar to previous aerial surveys conducted to monitor for marine mammals and sea turtles in Hawaii, Southern California, and elsewhere as described below (and detailed in Mobley 2004, 2007, 2008a,b; Smultea and Mobley 2009; Smultea et al. 2009). No sea turtles were observed; however, sea turtles have been seen during similar surveys in Hawaii (e.g., Smultea et al. 2009).

For this report, surveys were conducted in October and November 2008; June, July and November 2009; May, July and September 2010; and February, March, April, and May 2011 (**Table 1**).

Survey effort involved four modes as described below (see **Table 2**):

1. *Search* - to locate and observe marine mammals and sea turtles via both *systematic* line-transect and *connector* aerial survey observation effort. Connector effort included observation effort between adjacent systematic transect lines.
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 a species of interest is located.

Table 1. List of Southern California aerial surveys from 2008 to 2011.

Survey Year	Survey Dates	Cold-Water Survey Days	Warm-Water Survey Days	Aircraft	Observer Windows	Southern California Sub-region Surveyed
2008	October 17-21	0	5	P	B	SCI, Santa Catalina Island
2008	November 15-18	4	0	P	B	San Nicolas Basin, SCI, S SCI
2009	June 5-11	0	6	P	B	Santa Catalina Basin, San Nicolas Basin
2009	July 20-29	0	8	P	B	Santa Catalina Basin, San Nicolas Basin
2009	November 18-23	6	0	P	B	Santa Catalina Basin, San Nicolas Basin, SCI
2010	May 13-18	0	5	P	B	Santa Catalina Basin, San Nicolas Basin
2010	July 27 - August 3	0	5 2	P H	B F	Santa Catalina Basin, San Nicolas Basin
2010	September 23-29	0	6	P	B	Santa Catalina Basin, San Nicolas Basin
2011	February 14-19	4	0	P	B	Santa Catalina Basin, San Nicolas Basin, Silver Strand
2011	March 29 - April 3	3	0	P	B	Santa Catalina Basin, San Nicolas Basin
2011	April 12-20	9	0	AC	F	Santa Catalina Basin, San Nicolas Basin, Silver Strand
2011	May 9-14	0	6	P	B	Santa Catalina Basin, San Nicolas Basin, Silver Strand

Key:

AC = Aero Commander fixed wing

B = Bubble center row window

F = Flat window

H = Bell 206 helicopter

P = Partenavia fixed wing

SCI = San Clemente Island

S SCI = ocean area south of San Clemente Island; Santa Catalina Basin (representing the area between SCI and the California mainland); San Nicolas Basin (area west of SCI)

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 • Short “connector” lines • Transits	Until MM seen then switch to Identify or Focal Follow Mode	Time and location of sighting • Species, group size, min. no. calves • Bearing and declination angle to sighting • Behavior state • Initial reaction (yes or no and type) • Heading of sighting (magnetic) • Dispersion distance (min. and max. in estimated body lengths)
Identify	~85	~305	Circling at ~305 m radius	<5 min	• Photograph to verify species • Estimate group size, min. no. 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 • Dispersion distance • Aircraft altitude (ft) (automatic WAAS GPS) • Distance of aircraft to MM (declination angle) • Reaction (yes or no and type) • Bearing and distance to vessels <10 km away or other nearby activity • Surface and dive times (whales) • Respirations (whales) • Individual behavior events (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, min. no. calves • Bearing and declination angle to sighting • Behavior state and heading • Initial reaction (yes or no and type)

Key: MM = marine mammal

4. *Shoreline Survey* - involving circumnavigating clockwise around San Clemente Island approximately 0.5 kilometer (km) from shore to search for potentially stranded or near-stranded animals.

One pilot (2008-2010) or two pilots (2011) and three professionally trained marine mammal biologists (at least two with over 10 years of related experience) were aboard the aircraft. Two biologists served as observers in the middle seats of the aircraft; the third biologist was the recorder in the front right co-pilot seat (2008-2010) or in the rear bench seat (2011). Surveys were flown at speeds of approximately 100 knots and altitudes of approximately 227-357 meters (m) (800-1000 feet [ft]). In practice, however, altitude at the time of sightings averaged 261 ± 49 m based on readings from a WAAS-enabled GPS. When the plane departed the survey trackline during Identify or Focal Follow modes, the pilot usually returned to the transect line within 2 km of the departure point. Occasionally, the return point was several kilometers from the departure point.

Established line-transect survey methodology was implemented (see Carretta et al. 2000; Buckland et al. 2001; Mobley 2004, 2008a,b). Parallel transect lines were positioned primarily along a WNW to ESE orientation generally perpendicular to the bathymetric contours/coastline to avoid biasing of surveys by following depth contours (**Figure 1**). The study area overlapped transect lines of previous aerial surveys conducted 1-2 times per month over approximately 1.5 year in 1998-99 by the National Marine Fisheries Service/Southwest Fisheries Science Center (NMFS/SWFSC) on behalf of the Navy (Carretta et al. 2000) (**Figure 1**; see **Figures 2 and 3** for comparison of our and the Carretta et al. [2000] study areas). However, transect lines were different from and spaced closer together than the 22-km line spacing used by Carretta et al. (2000). We followed transect lines spaced approximately 14 km apart between the coast and San Clemente Island (the SANTA CATALINA BASIN sub-area) (4180 km^2) (**Figure 1**). Our transect lines were spaced 7 km apart to the west (the SAN NICOLAS BASIN sub-area) (8,361 square kilometers [km^2]) and south of San Clemente Island (the South of SCI sub-area) (4,903 km^2). Total distance surveyed in Beaufort sea state (BSS) 0-4 conditions was 16,476 km.

We used the following hardware and software for data collection, including basic sighting and environmental data (e.g., BSS, observation effort, visibility, glare, etc.): (1) BioSpectator on a Palm Pilot TX (pull-down menus or screen keyboard) or an Apple iPhone or iTouch in 2008 and 2009; (2) a customized Excel spreadsheet on a Windows-based mini-laptop computer (2010, 2011); or customized Mysticetus Observation Platform software on a mini-laptop computer (2011). Each new entry was automatically assigned a time stamp, a sequential sighting number, and a GPS position. A Suunto handheld clinometer was used to measure declination angles to sightings when the sighting was perpendicular to the aircraft.

Photographs and video were taken through a small opening porthole through either the co-pilot seat window (2008-2010) or the rear left seat bench window (2011). One of three Canon EOS digital cameras with Image Stabilized (IS) zoom lenses was used to document and verify species for each sighting during Identify Mode as feasible/needed (40D with 100-400 mm ET-83C lens; 20D with 70-200 mm 2.8 lens and 1.4X converter; D50 with 100-400mm lens). A Sony Handycam HDR-XR550 or a Sony Handycam HDR-XR520 video camera was used to document behaviors during Focal Follow mode. Observers used Steiner 7 X 25 or Swarovski 10 X 32 binoculars as needed to identify species, group size, behaviors, etc. Environmental data

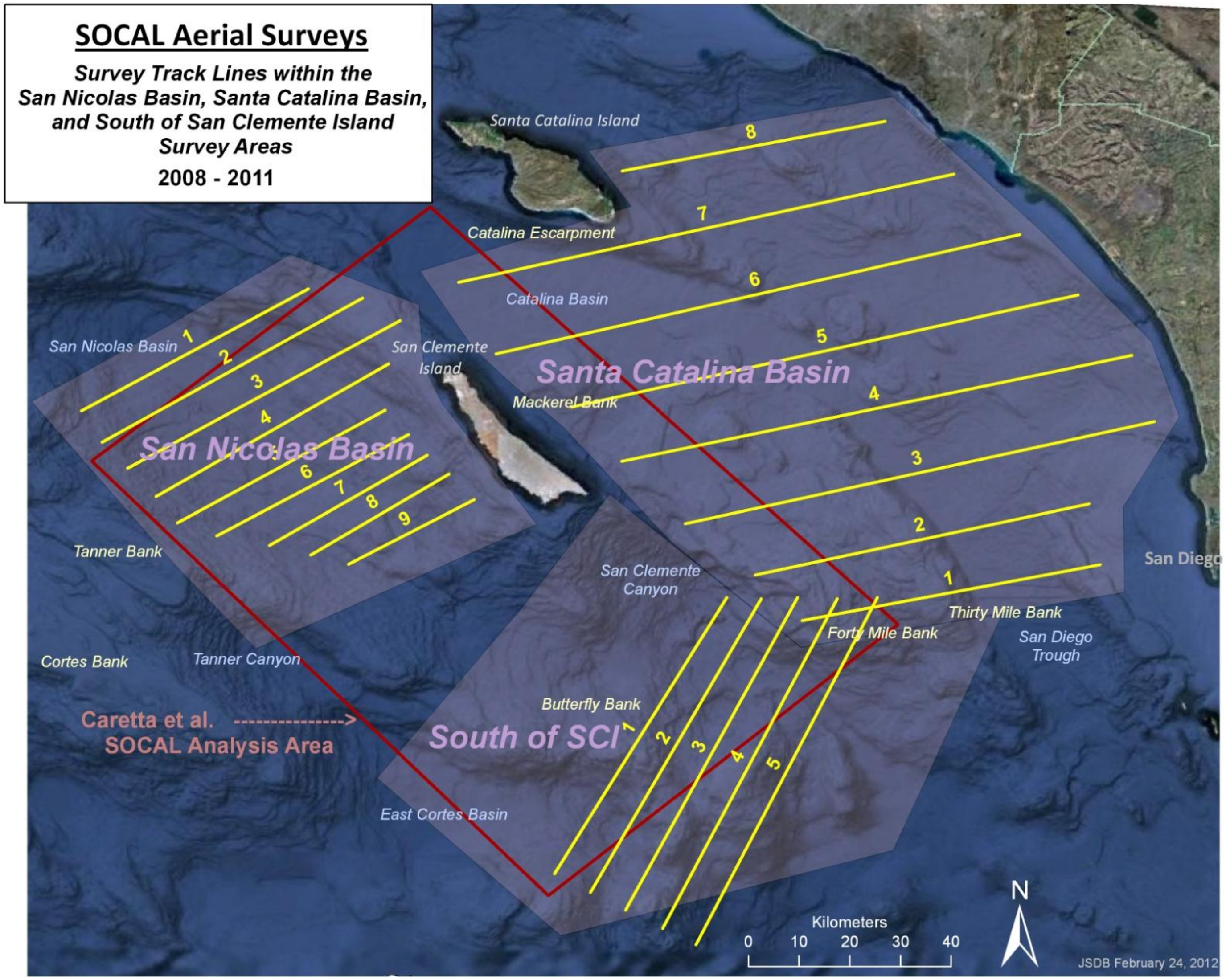

Figure 1. Systematic survey tracklines within Southern California 2008 - 2011. The red line is the boundary of the aerial survey study area of Carretta et al. (2000).

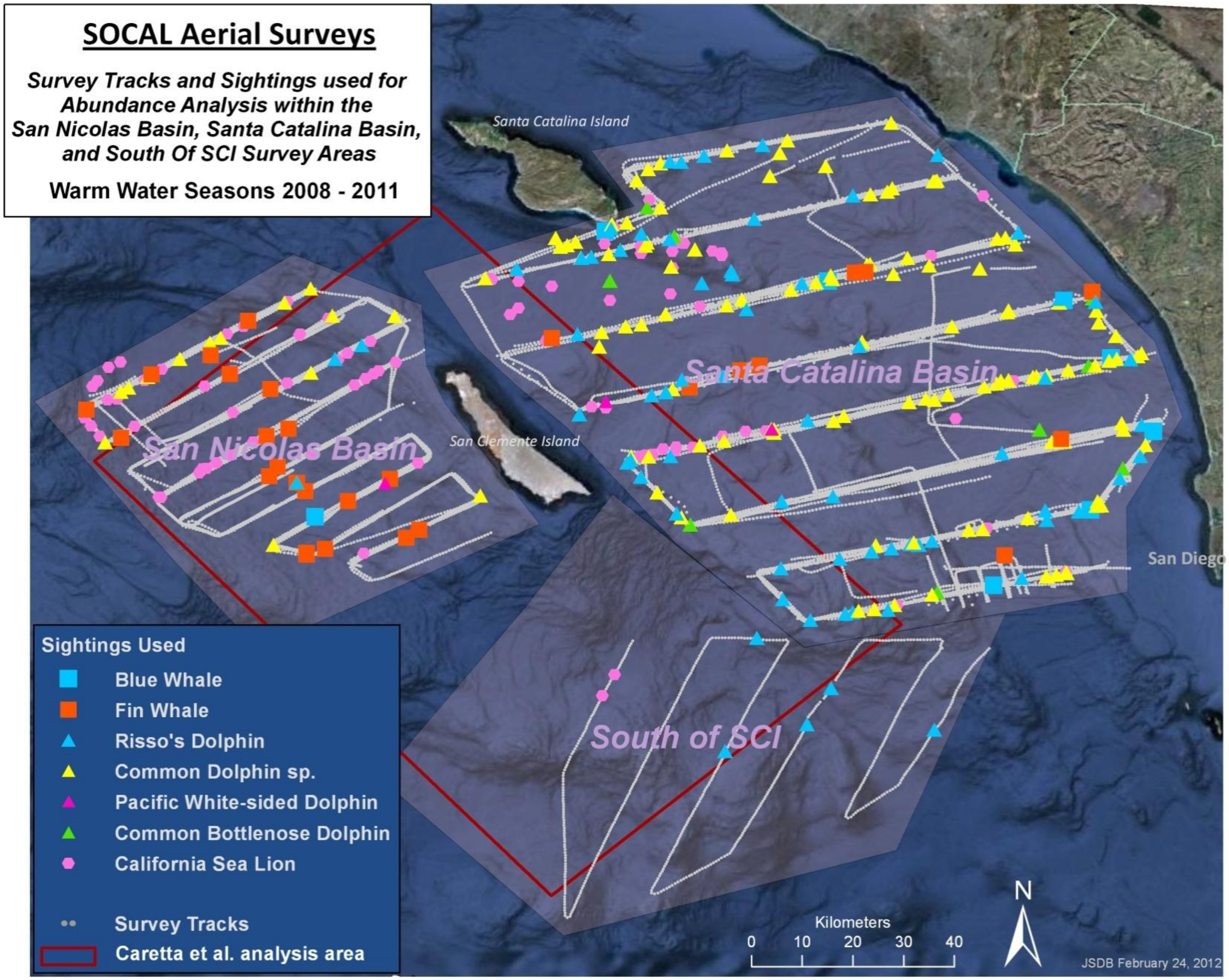

Figure 2. Survey tracks and sightings used for abundance analysis, warm-water seasons 2008 - 2011.

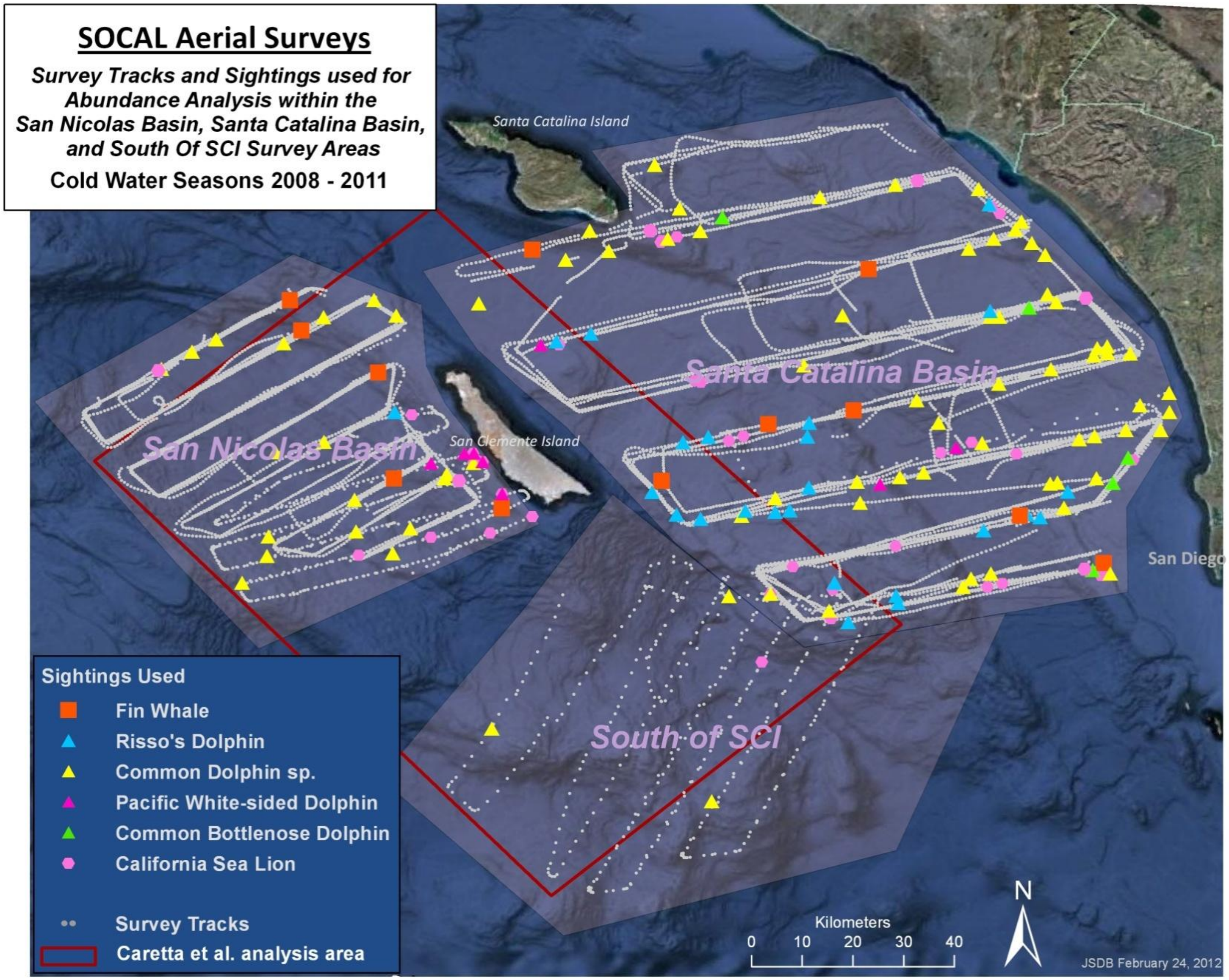

Figure 3. Survey tracks and sightings used for abundance analysis, cold-water seasons 2008 - 2011.

including BSS, glare and visibility conditions, were collected at the beginning of each leg type and whenever conditions changed. GPS locations of the aircraft were automatically recorded at 10-second intervals on a Garmin 495 aviation WAAS-enabled GPS as well as by a handheld Garmin 78S GPS and the aircraft WAAS GPS. Sighting and effort data were merged with the GPS data using Excel after the survey based on the timestamp information to obtain aircraft positions and altitudes at the times of the recorded events and to calculate distances to sighted animals.

Data Analysis

We used standard line-transect methods to analyze the aerial survey data. Estimates of density and abundance (and their associated coefficient of variation) were calculated using the following formulae:

$$\hat{D} = \frac{n\ \hat{f}(0)\ \hat{E}(s)}{2\ L\ \hat{g}(0)}$$

$$\hat{N} = \frac{n\ \hat{f}(0)\ \hat{E}(s)\ A}{2\ L\ \hat{g}(0)}$$

$$C\hat{V} = \sqrt{\frac{\hat{\mathrm{var}}\,(n)}{n^2} + \frac{\hat{\mathrm{var}}\,[\hat{f}(0)]}{[\hat{f}(0)]^2} + \frac{\hat{\mathrm{var}}\,[\hat{E}(s)]}{[\hat{E}(s)]^2} + \frac{\hat{\mathrm{var}}\,[\hat{g}(0)]}{[\hat{g}(0)]^2}}$$

where D = density (of individuals),
n = number of on-effort sightings,
f(0) = detection function evaluated at zero distance,
E(s) = expected average group size (using size bias correction in DISTANCE),
L = length of transect lines surveyed on effort,
g(0) = trackline detection probability,
N = abundance,
A = size of the survey area,
CV = coefficient of variation, and
var = variance.

Line-transect parameters were calculated using the software DISTANCE 6.0, Release 2 (Thomas et al. 2010). Only survey lines flown during systematic (the main line-transect survey lines) and connector (the connecting lines at the ends of the main lines) leg types at a planned altitude of 1,000 ft and a speed of 100 kt with both observers on-effort were used to estimate line-transect parameters. We used a strategy of selective pooling and stratification to minimize bias and maximize precision in making density and abundance estimates (see Buckland et al. 2001). Due to low sample sizes for most species, we pooled species with similar sighting characteristics in estimating the detection function [f(0)], with the goal of producing statistically robust values with sample sizes of at least 60-80 sightings for each group. The four species groups were: (1) baleen whales, (2) large delphinids, (3) small delphinids, and (4) California sea lions (see **Table 3**).

Table 3. Estimates of the detection function [f(0)] for the four species groups.

Species Group	Species Included	n	f(0)	%CV
Baleen whales	*Balaenoptera musculus, B. physalus, B. borealis, B. brydeii/edeni, B. acutorostrata, Balaenoptera* sp., *Megaptera novaeangliae, Eschrichtius robustus*	76	0.8131	20
Large delphinids	*Grampus griseus, Tursiops truncatus, Orcinus orca*	102	2.2071	10
Small delphinids	*Delphinus delphis, D. capensis, Delphinus* sp., *Lagenorhynchus obliquidens, Lissodelphis borealis*, unidentified small delphinid	256	1.4917	16
California sea lion	*Zalophus californianus*	133	4.6110	32

We used all data collected in sea state conditions of BSS 0-4, and we did not stratify estimates by sea state or other environmental parameters. We produced stratified (in terms of sighting rate and group size) estimates of density and abundance for the three survey sub-areas and two seasons using the pooled f(0) species group values described above. The exception to this rule was for California sea lions, which had an adequate sample size for estimation of f(0). The seasons were defined as warm water (May through October) and cool water (November through April) after Carretta et al. (2000).

A significant proportion of sightings were not identified to species (although most of these were identified to a higher-level taxonomic grouping, e.g., unidentified baleen whale, unidentified small delphinid, unidentified pinniped, unidentified *Balaenoptera* sp., or unidentified *Delphinus* sp.). We prorated these sightings to species using the proportions of species in the identified sample and adjusted our sighting rates appropriately. To avoid potential overestimation of group size, we used the size-bias-adjusted estimate of average group size available in DISTANCE.

Truncation involved the most distant 5 percent of the sightings for each species group. We also used left truncation at 250 m, due to indications that poor visibility below the aircraft resulted in missed detections near the transect line (the 250-m cut-off was based on examination of the sightings by distance plots). This helps to avoid an issue of underestimating f(0) due to absence of data immediately near the transect line. We modeled the data with half-normal (with hermite polynomial and cosine series expansions), hazard rate (with cosine adjustment), and uniform (with cosine and simple polynomial adjustments) models, selecting the model with the lowest value for Akaike's Information Criterion.

We did not have data available to make empirical estimates of trackline detection probability [g(0)]. However, since our surveys were similar to those of Carretta et al. (2000), we used their values for g(0) to correct for uncertain trackline detection. Estimates of density and abundance were produced only for those species with at least eight useable, on-effort sightings in the line-transect database (an arbitrary cut-off, based on past experience).

RESULTS

Out of a total of 59,287 km flown, 26 percent (15,406 km) were made during on-effort periods for line transect in good sea conditions, during systematic or connector lines, and thus available to estimate density and abundance. Out of 1,637 marine mammal groups sighted during all survey states (on-effort, off-effort), 38 percent (n = 626) were used to estimate density and abundance in this report (**Table 4**; **Figures 2 and 3**). We sighted at least 20 species of marine mammals, although not all sightings were identified to the species level (**Table 4**). Abundance was estimated for the most commonly sighted marine mammals as follows (with the number of useable sightings in parentheses): blue whales (n = 8), fin whales (n = 36), Risso's dolphins (n = 87), bottlenose dolphins (n = 16), Pacific white-sided dolphins (n = 11), common dolphins (n = 197, including both species), and California sea lions (n = 133). Line-transect estimates of density and abundance (and their associated coefficient of variation) are shown in **Table 5**.

Table 4. Marine mammal species observed during the Southern California surveys, with total sightings (nT) and sightings available for line transect estimation (nD).

Species	nT	nD
Blue whale - *Balaenoptera musculus*	65	8
Fin whale - *B. physalus*	75	36
Sei whale - *B. borealis*	1	0
Bryde's whale - *B. brydeii/edeni*	2	1
Minke whale - *B. acutorostrata*	10	5
Humpback whale - *Megaptera novaeangliae*	10	7
Gray whale - *Eschrichtius robustus*	14	4
Sperm whale - *Physeter macrocephalus*	1	1
Cuvier's beaked whale - *Ziphius cavirostris*	4	2
Killer whale - *Orcinus orca*	2	2
Pacific white-sided dolphin - *Lagenorhynchus obliquidens*	20	11
Risso's dolphin - *Grampus griseus*	208	87
Bottlenose dolphin - *Tursiops truncatus*	51	16
Short-beaked common dolphin - *Delphinus delphis*	52	33
Long-beaked common dolphin - *D. capensis*	22	7
Common dolphin - *Delphinus* sp.	389	157
Northern right whale dolphin - *Lissodelphis borealis*	10	4
Dall's porpoise - *Phocoenoides dalli*	2	1
California sea lion - *Zalophus californianus*	344	133
Harbor seal - *Phoca vitulina*	15	1
Northern elephant seal - *Mirounga angustirostris*	5	5
Unidentified (Unid.) baleen whale	39	16
Unid. delphinid	209	53
Unid. pinniped	47	17
Unid. marine mammal	40	19
TOTAL	**1,637**	**626**

Table 5. Estimates of individual density (Di), abundance (N), and coefficient of variation (%CV) for marine mammals in the overall Southern California survey area and the three sub-regions for the warm-water (May through October) and cold-water (November through April) seasons.

	WARM-WATER SEASON			COLD-WATER SEASON		
Species	**Di ($\#/km^2$)**	**N**	**%CV**	**Di ($\#/km^2$)**	**N**	**%CV**
Blue whale - *Balaenoptera musculus*	**0.00074**	**13**	**70**	**0.00000**	**0**	**n/a**
Santa Catalina Basin	0.00124	11	40	0.00000	0	n/a
San Nicolas Basin	0.00047	2	99	0.00000	0	n/a
South of SCI	0.00000	0	n/a	0.00000	0	n/a
Fin whale – *B. physalus*	**0.00376**	**66**	**45**	**0.00085**	**15**	**62**
Santa Catalina Basin	0.00177	15	56	0.00370	32	81
San Nicolas Basin	0.01219	51	33	0.00120	5	43
South of SCI	0.00000	0	n/a	0.00000	0	n/a
Pacific white-sided dolphin - *Lagenorhynchus obliquidens*	**0.00769**	**135**	**94**	**0.01316**	**231**	**179**
Santa Catalina Basin	0.00530	45	100	0.00940	80	101
San Nicolas Basin	0.02154	90	86	0.03600	152	256
South of SCI	0.00000	0	n/a	0.00000	0	n/a
Risso's dolphin - *Grampus griseus*	**0.14451**	**2,537**	**76**	**0.05115**	**898**	**78**
Santa Catalina Basin	0.19985	1,693	31	0.10780	913	45
San Nicolas Basin	0.01403	59	85	0.00520	22	111
South of SCI	0.16006	785	110	0.00000	0	n/a
Bottlenose dolphin - *Tursiops truncatus*	**0.03332**	**585**	**72**	**0.01333**	**234**	**77**
Santa Catalina Basin	0.06915	585	72	0.02880	244	77
San Nicolas Basin	0.00000	0	n/a	0.00000	0	n/a
South of SCI	0.00000	0	n/a	0.00000	0	n/a
Common dolphins - *Delphinus* spp.	**1.71075**	**30,034**	**50**	**0.92305**	**16,205**	**52**
Santa Catalina Basin	3.18990	27,028	36	1.63580	13,863	38
San Nicolas Basin	0.58430	2,442	52	0.05470	2,288	61
South of SCI	0.11505	564	61	0.03090	152	57
California sea lion - *Zalophus californianus*	**0.14434**	**2,534**	**72**	**0.05308**	**932**	**87**
Santa Catalina Basin	0.11240	952	43	0.22780	1,930	89
San Nicolas Basin	0.31082	1,300	63	0.00780	32	84
South of SCI	0.05743	282	108	0.00000	0	n/a

Note: ***The first line for each species is the overall density and abundance for the entire study area, and the next three lines are stratified by the three survey sub-regions. Note that these estimates will be combined with the 2012 line-transect data to be included in the final summer 2012 Annual Report.***

Identification of common dolphins to species level was often not possible during flights, and for this reason extensive photos were taken of common dolphin schools for later detailed examination. We examined a sample of these photos later to see if we could identify the species, and in many cases we could. Short-beaked common dolphins predominated these sightings. Based on the preliminary sample of photos in which we were able to determine species, 96 percent of common dolphins sighted were *D. delphis* and only 4 percent were *D. capensis*.

DISCUSSION

Potential Biases of the Estimates

As is true of any statistical technique, there are certain assumptions that must hold for line-transect estimates of density and abundance to be accurate. Below we go through the various assumptions of line transect and other issues that may cause bias in our estimates.

Assumption 1: Certain Trackline Detection. Target animals on and very near the trackline must be detected to avoid estimates that are biased low (Buckland and York 2009). This is a central assumption of basic line-transect theory. However, in reality, it is often violated, especially by diving animals like marine mammals. This can be addressed by incorporating a factor into the line-transect equation that accounts for the proportion of missed animals (the detection function, g(0)). We have done this in the present study by using g(0) factors from studies of the target species, but these often only account for part of the potential bias. Both availability bias (the proportion missed due to being on a dive and unavailable at the surface) and perception bias (the proportion missed despite the fact that they were available to be seen by the observers) should ideally be included. However, obtaining appropriate data to model these can be difficult. Since our estimates do not usually account for both of these types of bias, this results in underestimation to some extent.

The inability to see all animals directly under the aircraft also clearly affects the trackline detection. We have strived to minimize the effects that this limitation may have on the resulting density and abundance estimates, by use of the 250 m left truncation approach. It is uncertain how much remaining bias from this factor may affect our estimates. We plan to try to use a belly observer in future surveys for this project to clarify this issue.

Assumption 2: No Responsive Movement. Although it often stated that there must be no responsive movement to the survey platform, this is not strictly true. However, any responsive movement must occur after detection by the observers, and such movement must be slow relative to the speed of the survey platform (Buckland and York 2009). In our case, the use of a fast-moving aircraft as survey platform minimizes the chances of this being a significant issue. This is much more of a concern with vessel surveys, and in aerial surveys is generally not considered a problem.

Assumption 3: No Distance Errors. Obviously, distances must be measured accurately to avoid inaccuracies in the resulting estimates (Buckland and York 2009), although in practice, distances are difficult to measure at sea. It is likely that every marine mammal line-transect survey has suffered from some inaccuracy in distance measurement. However, small and random errors generally do not cause significant problems. It is large and/or directional errors that are of serious concern. We have no indications that large or directional errors in distance measurement were an issue in this study.

Other Factors

Besides the above-listed issues a few other factors may cause some bias in the resulting line-transect estimates. Line placement is a factor that should be considered, as duplicate sightings on different lines on the same day can cause bias. This happened twice and was evident from the similarity of sighting data and timing, recorded activity of the animals (i.e., traveling in a direction consistent with the other sighting location), and the observed aircraft tracks (which included circling sightings) inspected on daily maps. In both cases, the sighting with the least complete data was eliminated from the data set so that the animal/group was only used once. Although we cannot be certain that there are no other instances of this in the data, the high speed of the aircraft in relation to animal movement makes it unlikely to be more than a rare event. Our data checking procedures further reduce the likelihood of such instances remaining in the data set. Lack of independence of detections and non-uniform distribution of animals can cause issues in some cases. Specific strategies used in this study to handle issues related to obtaining samples sizes appropriate for modeling the detection function may result in some bias (e.g., prorating unidentified sightings, left truncation, and pooling of Beaufort sea states). However, we have no reason to think that these are major issues and believe that they are not factors in causing any major bias in our estimates.

CONCLUSIONS

This report provides the most current small-scale estimates of density and abundance within portions of the offshore marine waters in southern California. In particular, densities derived for the cold-water season represent seasonal data and analysis that is notably absent within the region over the last 13 years. Abundance of marine mammals is known to fluctuate from year to year based on changing and dynamic oceanographic conditions in southern California (e.g., El Niño southern oscillation events, prey availability/distribution, etc.). Thus, density and abundance estimates may change as we obtain more data from future surveys and perfect a strategy of selective pooling and stratification to maximize precision and minimize bias. For instance, NMFS in their spatial habitat models and density estimates generally prefers to pool multi-year survey data to reduce the impact of inter-annual variation. However, based on historical data such as Carretta et al. (2000), we believe that the current estimates reported here are generally reflective of numbers of marine mammals within the Navy's Southern California Range Complex during the survey periods.

Overall, our results are in general agreement with those of Carretta et al. (2000), who surveyed a largely overlapping area using similar methods in the late 1990s. Our results indicate that the study area continues to be used by a substantial number of marine mammal species during both the warm- and cold-water seasons. However, numerically, the region is dominated by only a few species. For great whale species (i.e., blue and fin), abundance was estimated to be in the tens. Pacific white-sided and bottlenose dolphins numbered in the hundreds, and Risso's and common dolphins, as well as California sea lions, numbered in the thousands (for common dolphins, in the tens of thousands). Other species were not seen too infrequently in the 2008 to 2011 surveys to derive density or abundance estimates.

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