Distribution and demographics of Cuvier's beaked whales in the Southern California Bight

Annual Report
Contract N66604-14-C-0145
Option 5, CLIN 12 &13

Annual report of on-water surveys in conjunction with Moretti et al. (2017), Marine Mammal Monitoring on Navy Ranges (M3R): Passive Acoustic Monitoring on the Pacific Missile Range Facility and Southern California Offshore Range.

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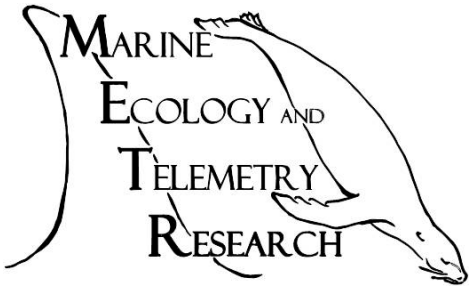

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Summary

The Southern California Offshore Complex (SOCAL) is one of the US Navy's most active training areas, particularly concerning the use of Mid-Frequency Active Sonar (MFAS). Much of SOCAL lies within the Southern California Bight, a productive oceanographic region that hosts a wide variety of marine species. As part of an ongoing study of the distribution and demographics of several marine mammal species within SOCAL, we conducted 27 days of survey effort from 7 January to 13 November 2016, specifically focusing on the Southern California Anti-submarine Warfare Range (SOAR). The primary goal of the surveys was sighting, photographing, and collecting biopsy samples from Cuvier's beaked whales and fin whales. We had 6 sea turtle sightings and 86 sightings of marine mammals, including 12 sightings of an estimated 32 Cuvier's beaked whales. Twenty-three biopsy samples were collected, including three from Cuvier's beaked whales. Three satellite tags were deployed, one each on a Cuvier's beaked whale, fin whale, and Risso's dolphin. The focus on photo-identification and biopsy sampling of Cuvier's beaked whales will help elucidate population structure for this species, an important element of any management and mitigation strategy.

Introduction

The US Navy manages SOCAL, a collection of near shore and offshore training areas which includes much of the navigable water from Santa Barbara Island, CA, to northern Baja California, Mexico, extending several hundred miles to the west. It is among the most heavily used tactical training areas in the world, and is used for a variety of aerial, surface, and subsurface exercises. The Southern California Offshore Range (SCORE) is a subset of complexes within SOCAL centered on San Clemente Island. It includes SOAR, a focal area for exercises involving MFAS within the San Nicolas Basin (Figure 1). Through its N45 and LMR programs, the US Navy has funded directed studies on species assemblages, distribution and demographics, foraging ecology, and behavioral responses to MFAS of marine mammals on and around SOAR since 2006 (Falcone & Schorr 2014). In the beginning, the primary objective of these surveys was to provide visual verification of acoustic marine mammal detections on the SOAR hydrophone array in conjunction with the Marine Mammal Monitoring on Navy Ranges (M3R) program (Moretti et al. 2006). These studies documented a high diversity of species on SOAR year-round, though with some seasonal fluctuations in diversity and density (Falcone & Schorr 2014). Photo-ID studies of both Cuvier's beaked fin whales were initiated to better understand the structure of these poorly-known populations. As the surveys progressed, a major goal became the deployment of dive-reporting satellite tags to study both the distribution and diving behavior of both these species, and also to assess any changes associated with MFAS use.

Both satellite tagging and photo-ID data from these studies have indicated high site fidelity within the Southern California Bight for several species, including Cuvier's beaked whales on SOAR and fin whales in the greater Southern California Bight (Falcone & Schorr, 2014, Schorr et al. 2014). Both findings were somewhat unexpected. Fin whales were believed to range broadly along the US West Coast with no population substructure, and individual Cuvier's beaked whale were not expected to preferentially use SOAR, as this species, and beaked whales in general, have been documented to strand in association with MFAS in other regions of the world (e.g. Cox et al. 2006, D'Amico et al. 2009). Therefore, understanding the ecology, behavior, and population dynamics of these two populations in a region of such intense Navy training is critical to effective management, including realistic estimation of permitted

takes. It can also provide an important comparison to unexposed populations in other regions. This contract specifically supported data collection and processing for Cuvier's beaked whales, though data collection from fin whales is also briefly summarized.

Methods

Surveys were conducted using a 6.3m rigid-hulled inflatable boat (RHIB), powered by two 75 hp outboard motors and equipped with a raised bow pulpit. The RHIB was launched from a shore base each morning and surveyed throughout daylight hours as conditions permitted. Surveys focused on SOAR were based at Wilson Cove on the northeast side of San Clemente Island. The RHIB was initially launched at Dana Point at the start of the survey period and remained moored in Wilson Cove for a period of 7-10 days, or until poor weather or conflicting range operations prevented further surveys at SOAR. When SOAR was available for our use, staff from the Naval Undersea Warfare Center's (NUWC) M3R program would monitor hydrophones from the Range Operations Center on North Island in San Diego and direct the RHIB via radio or satellite phone into areas where marine mammal vocalizations were detected. While the RHIB could be directed towards any vocalizations for visual verification, they were preferentially directed to those likely to be beaked whales when conditions were suitable for working with these species (typically winds at Beaufort 3 or less). In general, detections classified as small odontocetes were bypassed in favor of those from beaked or baleen whales.

Each time a group of cetaceans was encountered, the species, time, latitude, longitude, group size and composition, and overall behavioral state were recorded. For encounters with beaked whales, detailed records of surfacing patterns were also collected for as long as contact with the group was maintained. Photographs were taken for species verification where questionable, and for individual identification for species where this methodology is being employed during this study or by collaborators (beaked, fin, blue, humpback, minke, brydes, and killer whales; bottlenose and Risso's dolphins). Remote tissue biopsies were collected from species of interest both to this study (beaked and fin whales), and also on behalf of collaborators at the Southwest Fisheries Science Center (SWFSC) for use ongoing assessments of offshore populations and stress hormone analyses. Finally, a limited number of satellite tags were deployed, as this effort was focused more on population monitoring that is better supported by photo-ID and biopsy data.

The tags deployed were of the Low Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) SPLASH10-A design (Andrews et al. 2008, Schorr et al. 2014). Sighting data were collected using a custom-built access database with integrated GPS. Individual identification photographs of fin whales and beaked whales are processed and compared using methods described in Falcone and Schorr (2014) to build photographic sighting histories.

Additional surveys in 2016 were conducted in conjunction with tag development supported by the Department of Defense Environmental Security Technology Certification Program (ESTCP). While survey effort and overall sightings in this report relate only to surveys conducted under this contract, detailed sighting and photo-ID sections on Cuvier's beaked whales include data from both studies to improve sample sizes.

Results and Discussion:

A total of 27 daily surveys were conducted in four different months of 2016, with most survey effort occurring within SOAR (Table 1, Figure 1). Four survey days were canceled due to inclement weather conditions. Survey effort was conducted for the first time during the month of February, and we nearly doubled the previous amount of effort in April. Cuvier's beaked whales have been sighted in all months where effort has been undertaken (Figure 2).

Table 1. Summary of survey effort by day, January 2016-November 2016. *"Total" for Species is the number of unique species identified throughout the study, and thus not a summation across days. **Three biopsy samples and one satellite tag were deployed during effort supported by a different project, but the data will be summarized here.

Date	Effort (Hrs)	Distance (km)	Number of Sightings	Number of Species*	Number of Biopsies**	Number of Tags**
09-Jan-16	2.9	111				
10-Jan-16	9.7	187	1	1		
11-Jan-16	9.9	126	3	2		1
12-Jan-16	6.2	163	2			
15-Jan-16	4.8	148	1	1		
21-Feb-16	3.6	97				
22-Feb-16	6.8	116	6	5	1	
23-Feb-16	11.7	189	5	5	1	
24-Feb-16	11.9	222	10	7	5	
25-Feb-16	8.3	161	5	2		
26-Feb-16	7.4	80	6	2	3	1
27-Feb-16	6.9	196	4	3	2	
01-Apr-16	4.5	100	2	1		
02-Apr-16	11.3	198	6	6	1	
03-Apr-16	4.0	75	1	1		
04-Apr-16	8.6	128	5	4	2	
05-Apr-16	12.9	200	5	4		
06-Apr-16	9.2	126	2	2		
07-Apr-16	8.4	126	3	3	1	
08-Apr-16	8.9	156	3	2		
10-Apr-16	9.6	137	4	2	5	
19-Aug-16	3.3	98				
20-Aug-16	6.0	123	3	2		
26-Aug-16	5.4	135	2	2		
05-Nov-16	9.2	152	1	1		
10-Nov-16	11.6	194	5	2	2	
13-Nov-16	9.5	155	1	1		
Total: 27	**212.3**	**3900.7**	**86**	**12**	**26****	**3****

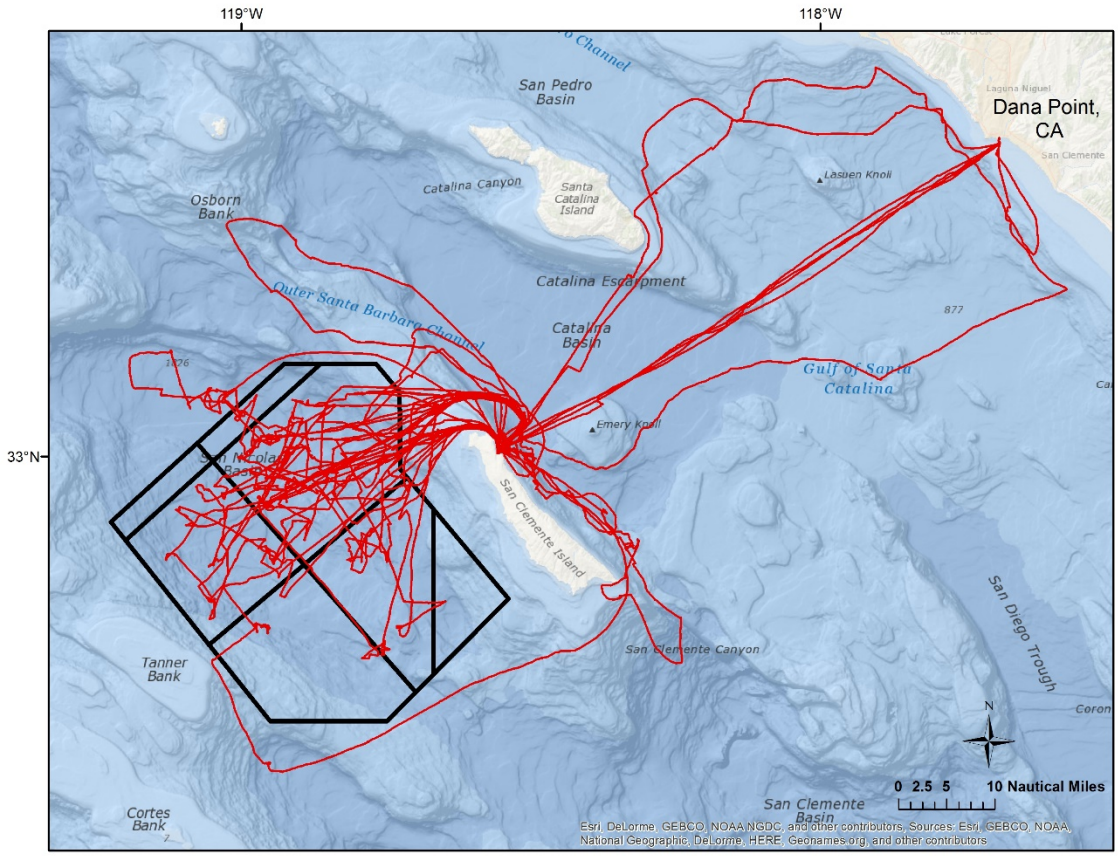
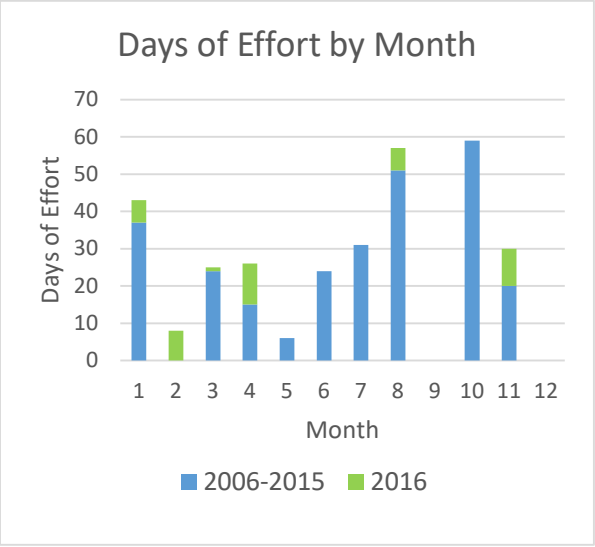


Figure 1. Vessel track lines from surveys conducted January 2016 through November 2016. Black lines west of San Clemente Island are the SOAR range boundaries.



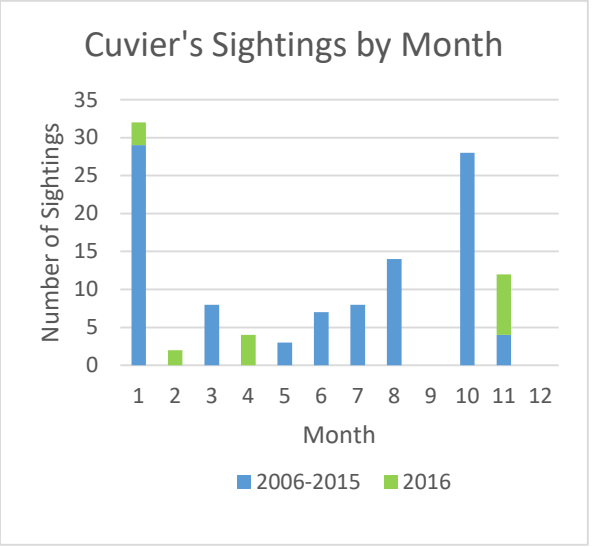


Figure 2. Plot of number of survey days conducted (left) and number of Cuvier's beaked whale sightings (right) by month from 2006-2016, with effort from 2016 indicated by green and historical data by blue.

During surveys funded by this project in 2016, 86 sightings of twelve cetacean species were recorded, along with six sightings of juvenile loggerhead turtles (Figures 3A and 3B, Appendix I).

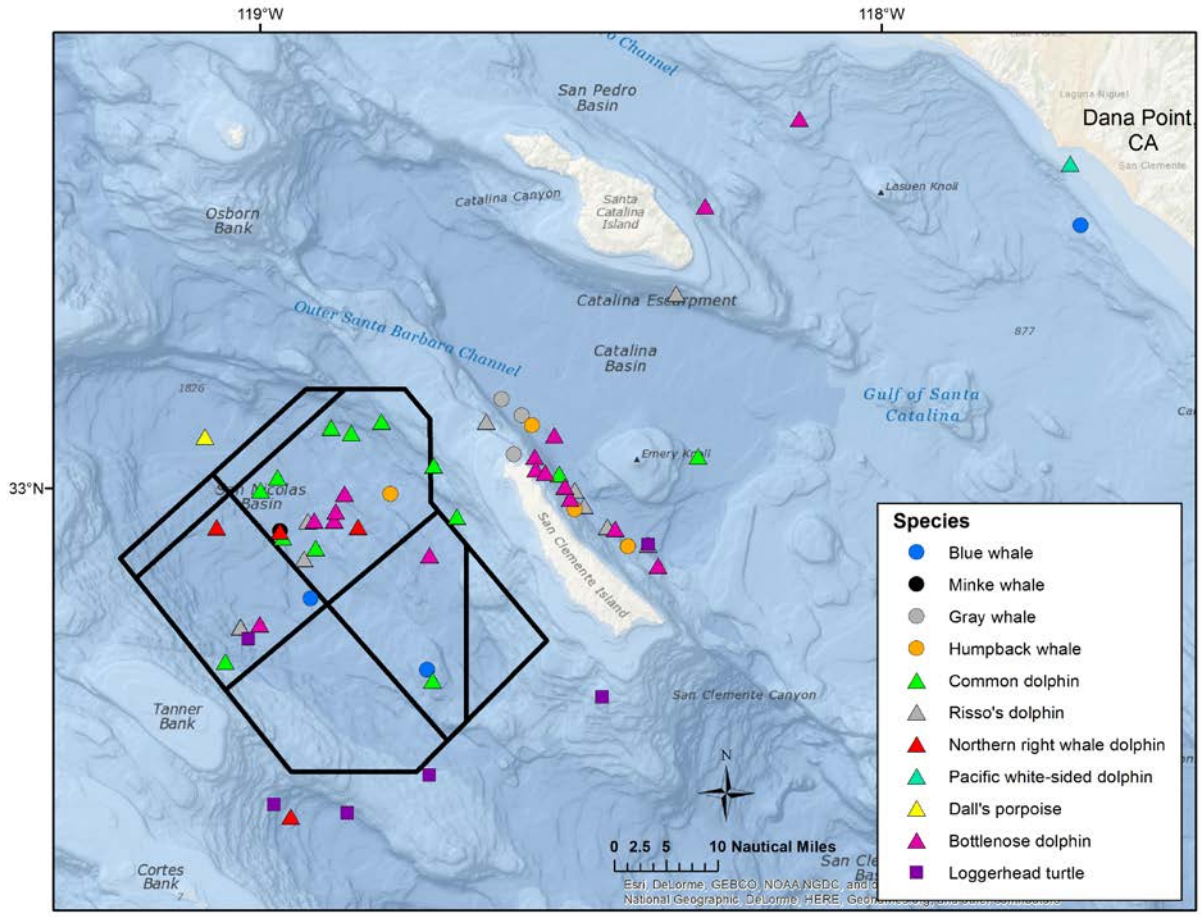


Figure 3A. Sighting locations by species for all small odontocetes, baleen whales (except fin whales, next figure), and turtles encountered during field efforts associated with this project during 2016. The black lines indicate SOAR.

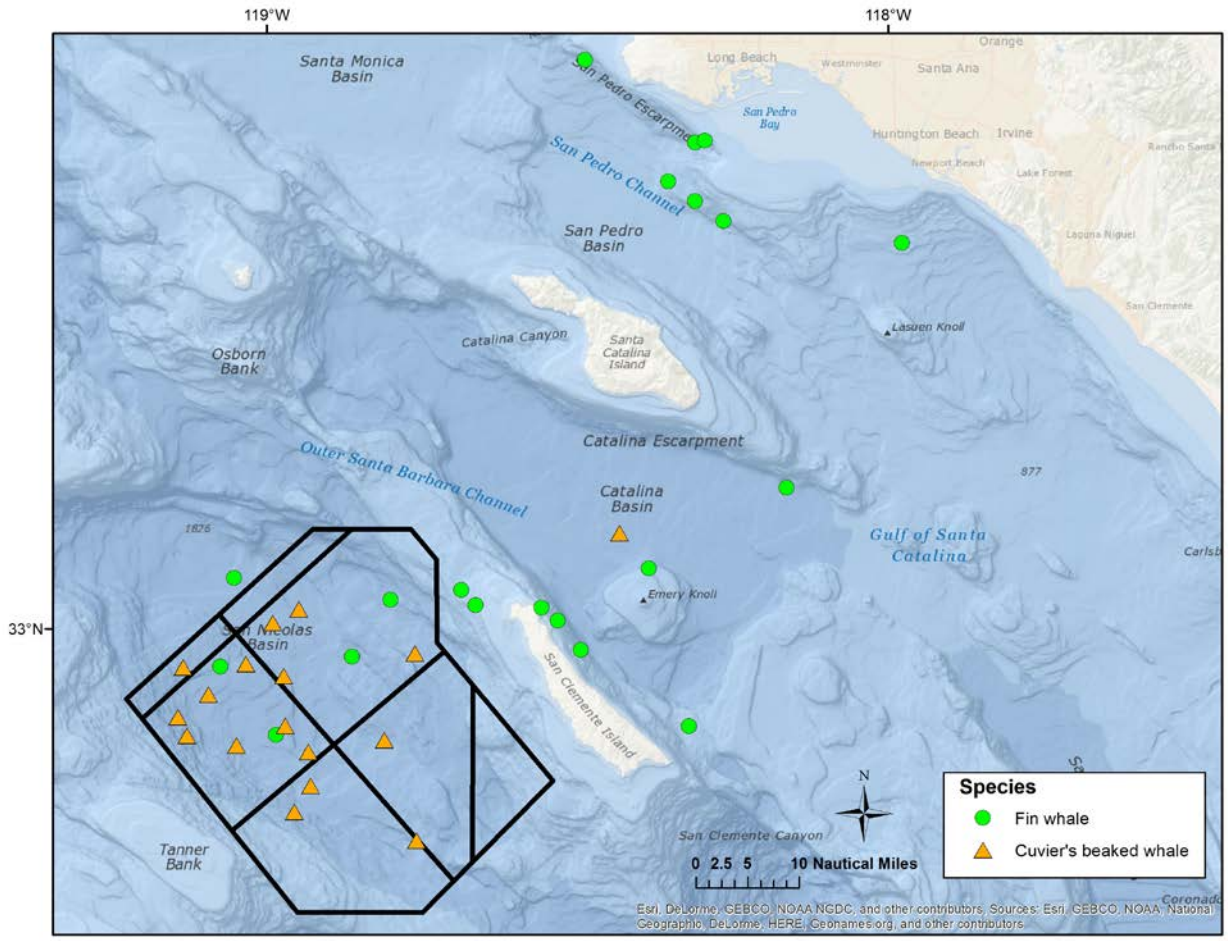


Figure 3B. Sighting locations for Cuvier's beaked whales and fin whales during field efforts associated with this project during 2016. The black lines indicate SOAR.

Cuvier's beaked whales were encountered during all field efforts, with the largest number of sightings occurring during November (Figure 2). In the 212 hours of effort associated with this project, 12 sightings totaling 32 whales were made, for an average of one sighting per 17.7 hours of effort. Median group size was two, with a range of one to five individuals. We had five additional Cuvier's sightings totaling 17 whales during ESTCP-supported effort. Photo-IDs and biopsy samples collected during both efforts are summarized in Table 2.

Table 2. Details of Cuvier's beaked whale sightings. Note, sightings are compiled from two projects: the US Navy Fleet funded project that is the focus of this report ("SCORE"), plus five sightings from a project funded by the Environmental Security Technology Certification Program (ESTCP).

Date	Project	Sighting	Est. Group Size	Num Calves	Est ID	Total Samples	Total Tags
11-Jan-16	SCORE	2	2	0	2		1
11-Jan-16	SCORE	3	1	0	1		
15-Jan-16	SCORE	1	2	0	2		
23-Feb-16	SCORE	3	3	0	1		
24-Feb-16	SCORE	5	2	0	2	1	
02-Apr-16	SCORE	5	1	0	1		
05-Apr-16	SCORE	4	5	2	3		
06-Apr-16	SCORE	2	3	0	3		
07-Apr-16	SCORE	3	1	0	1		
07-Nov-16	ESTCP	3	4	0	3		
10-Nov-16	SCORE	4	5	0	4	2	
10-Nov-16	SCORE	5	5	unk	5		
11-Nov-16	ESTCP	1	6	0	5		
11-Nov-16	ESTCP	2	1	0	0		
11-Nov-16	ESTCP	4	3	0	3		1
11-Nov-16	ESTCP	7	3	1	3		
13-Nov-16	SCORE	1	2	0	1		
			49		43	3	2

Identification photos were collected from 43 of the estimated 49 individual Cuvier's beaked whales encountered in 2016. In total, 28 unique individuals were identified, with three of these whales sighted on two different days, and another three on three different days. Sixteen (57%) of these whales had been sighted in previous years. Of these, five have been tagged prior to 2016, four with satellite tags as part of this work, and one with a suction cup tag as part of the SOCAL BRS project. Previous year matches ranged from 2007-2015, and the high number of resightings in this sampling period, both within and between years, will significantly improve mark-recapture abundance estimates currently under development for this population.

There were three adult females photographed in 2016 that had been sighted with calves in previous years, one of which was associated with her second calf. Additionally, a fourth adult female, first identified in 2015 without a calf, was sighted with a calf this year. These sightings of known females with and without calves over time (n = 37) are providing critically needed calving and weaning rate data for Population Consequences of Disturbance (PCOD) models currently being developed for this species on SOAR.

Biopsy samples collected with this effort were transferred to NOAA's Southwest Fisheries Science Center for archiving and processing. We have received sex data back, and all three of the sampled Cuvier's

beaked whales were genetically confirmed to be female. While one of these whales had a calf in a previous year and thus was already known to be an adult female, the other two fell into the difficult to distinguish class of females and larger subadults of either sex. These confirmed sex whales are vital to adapting a method of determining the age and sex from photos alone, which is also a required parameter for PCOD modeling.

Fin whale sightings were noticeably low during 2016, with only 11 sightings during SCORE field efforts (Figure 4, Appendix I) and 9 during ESTCP field efforts, resulting in an estimated 17 IDs. These low sighting rates may be related to the strong El Niño conditions which continued through early 2016, and they emphasize the importance of networking with whale watch operators along the mainland coast, as well as other researchers in the area. Opportunistic photo contributions from these sources greatly augment the limited samples sometimes collected during dedicated effort, given the patchy and unpredictable distribution of fin whales. The MarEcoTel fin whale catalog is much larger than the Ziphius catalog, and when data from 2015 are finalized will exceed 800 individuals from regions ranging from Northern Baja California to British Columbia.

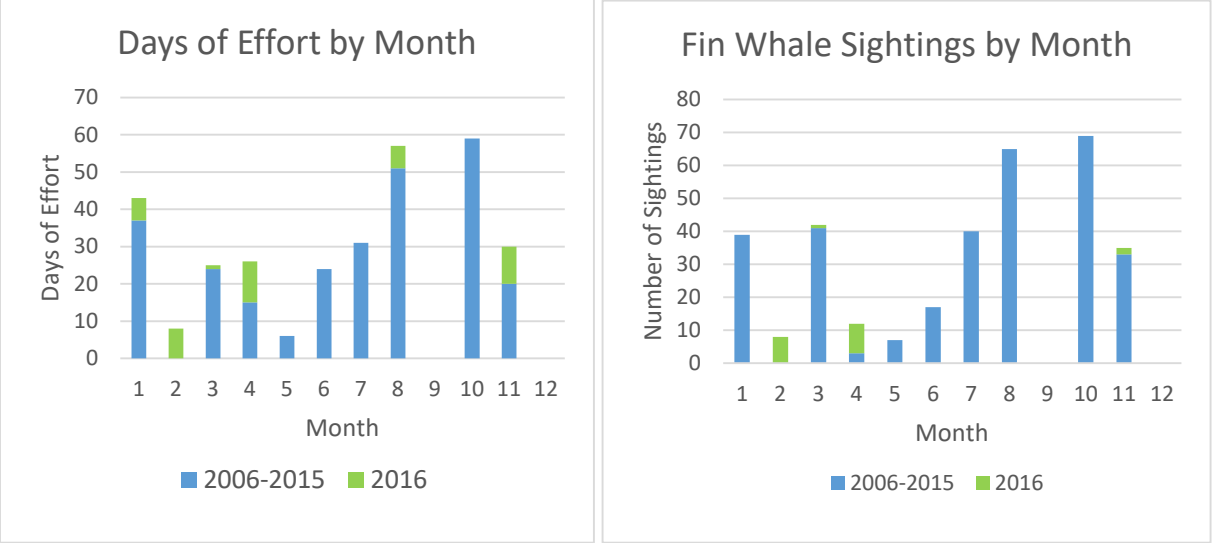


Figure 4. Plot of number of survey days conducted (left) and number of Fin whale sightings (right) by month from 2006-2016, with effort from 2016 indicated by green and historical data by blue.

Three satellite tags were deployed as part of this effort, one each on a Cuvier's beaked whale, Risso's dolphin, and fin whale. Transmission durations ranged from 12-40 days (Table 3). Data was processed as described in Falcone and Schorr (2014). While uplinks were received from the fin whale for more than 23 days, no locations were ever generated using the traditional least-squared method of the Argos system. This was most likely due to surfacing behavior. Fin whales sometimes bring their dorsal fin clear of the water only on the final breath before a dive; this behavior mode does not allow for sufficient Argos transmissions in sequence to successfully generate a location estimate. We will be exploring the Kalman filtering option for this individual to see if locations can be generated from the available uplinks using that method.

Table 3. Details on satellite tags deployed during this effort.

Tag ID	Species	Tag Type	Date	Trans. Dur. (days)
BpTag075	Fin Whale	Spot6	4/12/2016	23.3
GgTag015	Risso's Dolphin	Mk10-A	2/26/2016	11.7
ZcTag045	Cuvier's Beaked Whale	Mk10-A	1/11/2016	39.6

The Cuvier's beaked whale, ZcTag045, was tagged on SOAR in January. During 40 days of tracking, 84% of location estimates were within the SOAR boundary, and all location estimates were within the SoCal Range Complex (Figure 5). Sonar use during the time the tag was active is being compiled and will be compared to the location estimates of the tagged whale to assess overlap, and any possible behavioral responses.

Despite the relatively short transmission duration of GgTag015, the individual traveled widely within the bight, covering a total of 833 km in 11.7 days, returning to within 7km of the tagging location on the day the tag stopped transmitting (Figure 5). Ninety-eight percent of all location estimates were within the SoCal Range Complex, with 25.7% occurring within the boundaries of SOAR.

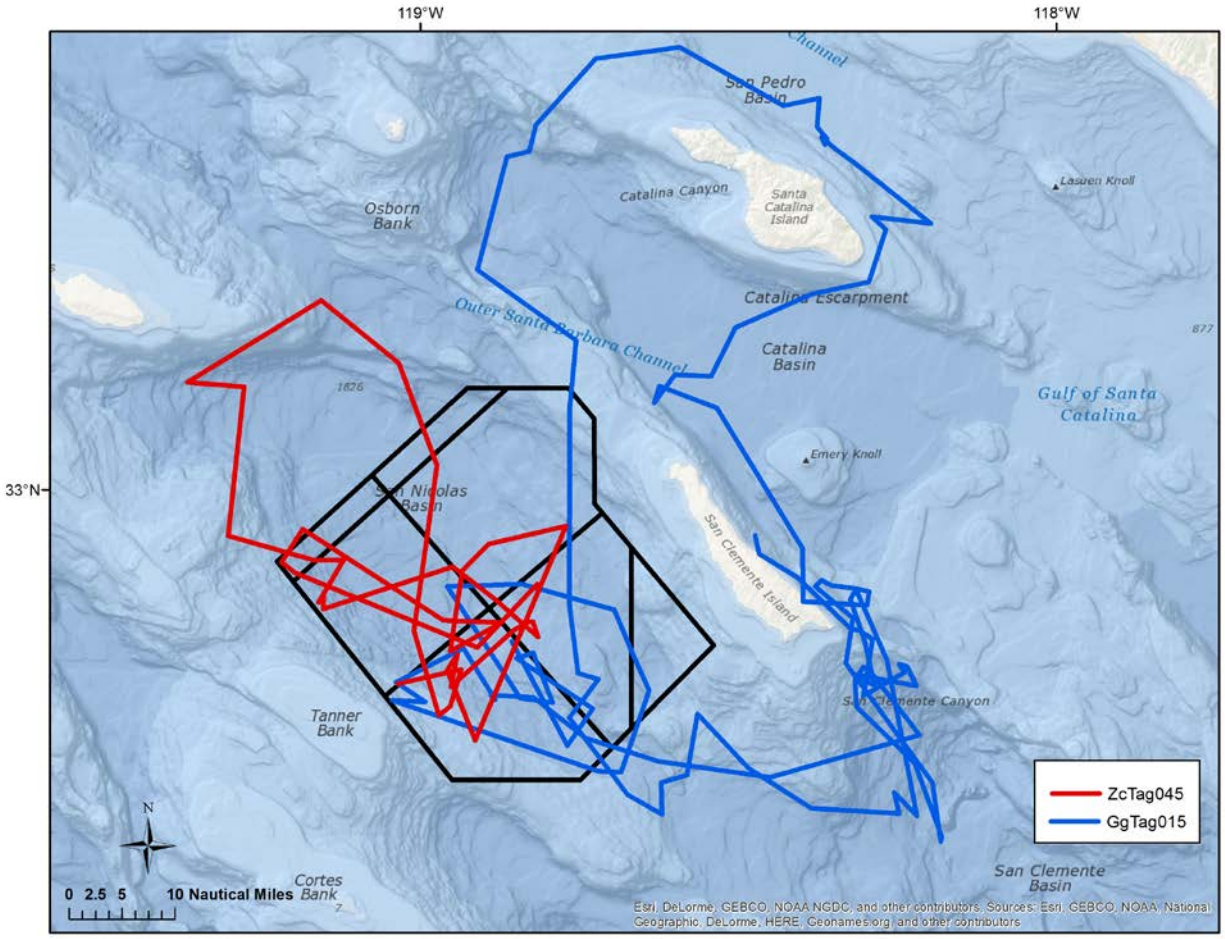


Figure 5. Filtered tracklines of a satellite tagged Cuvier's beaked whale (red) and Risso dolphin (blue) during the 2016 monitoring effort.

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Appendix I. Sighting details from encounters during Fleet-supported effort in 2016.

Date	Species	Lat	Lon	Group size	Estimated ID's	Samples collected	Tags deployed
24-Feb-16	Minke Whale	N32 58.28	W118 29.60	1	1		
05-Apr-16	Minke Whale	N32 56.51	W118 58.06	1	1		
10-Nov-16	Sei or Bryde's Whale	N32 47.43	W119 03.21	1			
02-Apr-16	Blue Whale	N32 51.03	W118 55.10	1			
20-Aug-16	Blue Whale	N32 45.23	W118 43.87	1	1		
26-Aug-16	Blue Whale	N33 21.29	W117 40.74	1	1		
23-Feb-16	Fin Whale	N33 04.11	W119 03.12	2	1		
24-Feb-16	Fin Whale	N32 58.27	W118 29.62	1	1		
25-Feb-16	Fin Whale	N33 01.70	W118 33.42	1			
25-Feb-16	Fin Whale	N33 01.90	W118 39.79	1	1		
25-Feb-16	Fin Whale	N33 00.66	W118 31.87	1	1		
25-Feb-16	Fin Whale	N33 02.34	W118 48.01	1	1		
01-Apr-16	Fin Whale	N33 04.86	W118 23.07	1	1		
01-Apr-16	Fin Whale	N33 11.40	W118 09.76	1			
02-Apr-16	Fin Whale	N32 56.93	W119 04.43	1	1	1	
04-Apr-16	Fin Whale	N32 52.06	W118 19.18	1	1	1	
06-Apr-16	Fin Whale	N32 57.71	W118 51.74	1			
10-Jan-16	Delphinus species	N33 01.85	W118 43.19	30			
11-Jan-16	Delphinus species	N32 57.69	W118 40.98	350			
22-Feb-16	Delphinus species	N33 05.41	W118 48.24	60			
22-Feb-16	Delphinus species	N33 04.47	W118 51.16	1			
23-Feb-16	Delphinus species	N33 00.87	W118 58.28	38			
26-Feb-16	Delphinus species	N33 01.14	W118 31.06	250			
02-Apr-16	Delphinus species	N32 55.14	W118 54.58	3			
08-Apr-16	Delphinus species	N32 56.00	W118 57.75	1500			
08-Apr-16	Delphinus species	N33 04.90	W118 53.08	50			
20-Aug-16	Delphinus species	N32 44.36	W118 43.32	1			
26-Aug-16	Delphinus species	N33 02.60	W118 17.67	170			
05-Nov-16	Delphinus species	N32 59.82	W118 59.92	500	3		
10-Nov-16	Delphinus species	N32 48.73	W119 01.87	20			

10-Nov-16	Delphinus species	N32 45.92	W119 03.32	400			
12-Jan-16	Gray Whale	N33 07.21	W118 36.68	1			
22-Feb-16	Gray Whale	N33 02.74	W118 35.48	2			
25-Feb-16	Gray Whale	N33 05.89	W118 34.73	4			
24-Feb-16	Risso's Dolphin	N32 48.71	W119 01.86	10			
24-Feb-16	Risso's Dolphin	N32 55.42	W118 22.48	45	8	1	
24-Feb-16	Risso's Dolphin	N32 54.25	W118 55.73	8	3		
26-Feb-16	Risso's Dolphin	N32 59.84	W118 29.59	16	15		
26-Feb-16	Risso's Dolphin	N32 58.58	W118 28.68	5	5		
26-Feb-16	Risso's Dolphin	N32 59.15	W118 30.02	30	25	1	2
27-Feb-16	Risso's Dolphin	N33 15.76	W118 19.81	6	1		
03-Apr-16	Risso's Dolphin	N33 05.41	W118 38.11	2			
04-Apr-16	Risso's Dolphin	N32 56.85	W118 26.44	7	3		
07-Apr-16	Risso's Dolphin	N32 59.56	W118 51.83	11	5		
10-Apr-16	Risso's Dolphin	N32 57.33	W118 55.36	4	3	1	
10-Apr-16	Risso's Dolphin	N32 57.37	W118 52.81	4	3	1	
22-Feb-16	Northern Right Whale Dolphin	N32 56.86	W118 50.50	17			
24-Feb-16	Northern Right Whale Dolphin	N32 33.28	W118 57.01	14			
02-Apr-16	Northern Right Whale Dolphin	N32 56.84	W119 04.15	8			
05-Apr-16	Northern Right Whale Dolphin	N32 56.48	W118 58.05	8			
27-Feb-16	Northern Right Whale Dolphin	N33 26.28	W117 41.74	5			
22-Feb-16	Humpback Whale	N33 05.09	W118 33.75	1			
23-Feb-16	Humpback Whale	N32 59.51	W118 47.39	1			
24-Feb-16	Humpback Whale	N32 58.28	W118 29.60	1			
04-Apr-16	Humpback Whale	N32 55.25	W118 24.47	2	1		
23-Feb-16	Dall's Porpoise	N33 04.18	W119 05.28	4		1	
12-Jan-16	Bottlenose Dolphin	N33 04.31	W118 31.55	6			
22-Feb-16	Bottlenose Dolphin	N33 01.54	W118 33.34	32	20	1	
24-Feb-16	Bottlenose Dolphin	N32 48.96	W119 00.01	11	7	1	
24-Feb-16	Bottlenose Dolphin	N32 53.70	W118 21.53	30	18	2	
26-Feb-16	Bottlenose Dolphin	N32 59.14	W118 30.02	18	8	1	
26-Feb-16	Bottlenose Dolphin	N33 00.12	W118 30.53	18	10	1	
27-Feb-16	Bottlenose Dolphin	N33 29.90	W118 07.88	11	2	1	

27-Feb-16	Bottlenose Dolphin	N33 22.85	W118 16.99	7	7	1
02-Apr-16	Bottlenose Dolphin	N33 02.57	W118 33.45	8		
04-Apr-16	Bottlenose Dolphin	N32 56.72	W118 25.66	2	2	
04-Apr-16	Bottlenose Dolphin	N33 01.27	W118 32.43	18	12	1
05-Apr-16	Bottlenose Dolphin	N32 54.56	W118 43.60	28		
05-Apr-16	Bottlenose Dolphin	N32 58.13	W118 52.65	7		
07-Apr-16	Bottlenose Dolphin	N32 59.56	W118 51.83	30	7	1
10-Apr-16	Bottlenose Dolphin	N32 57.37	W118 52.81	6		
10-Apr-16	Bottlenose Dolphin	N32 57.37	W118 54.74	45	30	3
24-Feb-16	TURTLE, LOGGERHEAD	N32 47.74	W119 01.12	1		
24-Feb-16	TURTLE, LOGGERHEAD	N32 43.03	W118 26.96	1		
24-Feb-16	TURTLE, LOGGERHEAD	N32 33.56	W118 51.55	1		
24-Feb-16	TURTLE, LOGGERHEAD	N32 34.26	W118 58.66	1		
24-Feb-16	TURTLE, LOGGERHEAD	N32 55.41	W118 22.50	1		
24-Feb-16	TURTLE, LOGGERHEAD	N32 36.66	W118 43.63	1		
20-Aug-16	Unidentified Large Cetacean	N32 45.10	W118 43.41			
08-Apr-16	Unidentified Medium Cetacean	N33 03.08	W118 55.05	1		
11-Jan-16	Cuvier's Beaked Whale	N32 57.98	W118 45.64	1	1	
11-Jan-16	Cuvier's Beaked Whale	N32 50.94	W118 48.57	2	2	
15-Jan-16	Cuvier's Beaked Whale	N33 07.76	W118 25.86	2	2	
23-Feb-16	Cuvier's Beaked Whale	N33 01.56	W118 56.84	3	1	
24-Feb-16	Cuvier's Beaked Whale	N32 45.11	W118 57.27	2	2	1
02-Apr-16	Cuvier's Beaked Whale	N32 54.66	W119 05.57	1	1	
05-Apr-16	Cuvier's Beaked Whale	N32 42.77	W118 45.50	5	3	
06-Apr-16	Cuvier's Beaked Whale	N32 51.32	W119 07.65	3	3	
07-Apr-16	Cuvier's Beaked Whale	N32 50.52	W119 02.86	1	1	
10-Nov-16	Cuvier's Beaked Whale	N32 49.98	W118 55.91	5	5	
10-Nov-16	Cuvier's Beaked Whale	N32 52.11	W118 58.15	5	4	2
13-Nov-16	Cuvier's Beaked Whale	N33 00.47	W118 59.34	2	1	