FINAL REPORT
Provide a Vessel to Conduct Observations and Deploy Sound Source and a Vessel for Passive Acoustic Monitoring for a Behavioral Response Study of Cetaceans off Southern California in 2011 and 2012

John Calambokidis
Cascadia Research Collective
218½ W. 4th Avenue
Olympia, Washington 98501
phone: (360) 943-7325 fax: (360) 943-7026 email: Calambokidis@cascadiaresearch.org

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http://www.SOCAL-BRS.org

LONG-TERM GOALS

The long term goal of the SOCAL Behavioral Response Study is to determine how cetaceans respond to naval sounds, specifically mid-frequency sonar, to better evaluate impacts and develop strategies for mitigation. The 2011 and 2012 field seasons were the 2nd and 3rd year of this multi-year study. The goal of these specific grants were to provide a vessel to serve as an observational platform and as a base of operations for a sound source and also support for chartering a vessel for use of a towed array to be used in the Behavioral Response Study conducted off Southern California in summer and fall 2011 and 2012. Other components of this work were included in other separate grants to the various groups involved in the collaborative study and this report addresses just the vessels to serve as a base of operations and the primary platform for the observation and sound source and a vessel for operation of a towed acoustic array.

OBJECTIVES

These grants provided essential support for the SOCAL-BRS operations in summer and fall of 2011 and 2012. These were the 2nd and 3rd year of the multi-year SOCAL Behavioral Response Study for southern California which began in 2010 to examine the impacts of anthropogenic sounds on local marine mammal species and represents a collaborative effort among a number of parties including Cascadia, Southall Environmental Associates, Woods Hole Oceanographic Institute (WHOI), Southwest Fisheries Science Center (SWFSC), University of St. Andrews (SA), Naval Undersea Warfare Center (NUWC). Overall objectives of the SOCAL BRS are to obtain new data on the response of a variety of species of marine mammals to Navy sonar to aid the Navy and NOAA in assessing the impact of these activities and ways they might be mitigated.

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APPROACH

The approach of the SOCAL-BRS involved a multi-disciplinary collaboration supported by ONR and N45, this report is for the grants that funded primary vessel support the projects field effort in 2011 and 2012. This encompassed two charters as described below.

A larger vessel for two 14-day periods to serve the following:

1. Visual observations to sight target and non-target species and monitor behavior during the planned two legs of experimental operations in July-September 2011 and July-October 2012
2. A platform from which to operate a sound source for use in the BRS playbacks in 2011 and 2012,.
3. Serve as a base of operations for small boat operations to sight animals and deploy tags as well as conduct photo-ID in 2011 and 2012
4. Provide housing and food for up to 15 personnel participating in the BRS during the field effort.

Support for a second vessel for one of these 14-day periods for the following:

1. A platforms for operation of Passive Acoustic Monitoring (PAM) to be operated by Southwest Fisheries Science Center.
2. To provide an experienced visually observer to operated from the PAM vessel.

The field effort was conducted in 2011 and 2012 and involved the charter of the vessel *Truth* (Figure 1) out of Santa Barbara, California as the base of operations for both years and for the PAM vessel, the sailboats *Green Dragon* in August 2011and *Jenny Lane* (Figure 2) in September 2011and the *Derreck M Baylis* (Figure 3) in 2012.

This primary vessel (*Truth)* was used in both 2011 and 2012 because it had proved and ideal and cost-effective platform in 2010 and met the following requirements:

- Area of operations to extend from Moro Bay to San Diego and offshore to include waters west of San Clemente and around San Nicolas and Catalina Islands
- Cruising speed of at least 10 knots and range of 400 nmi of more.
- Operations generally involve daylight ops (12 hours) but transits occurring at night as needed to either return to a sheltered area or harbor or shift to a new area. Occasional night operations tracking a tagged whale.
- Most overnights will be spent either in harbor, anchored, or drifting with up to half the nights underway most of the night either transiting or tracking a whale.
- Fuel usage averaging 200 gal/day (adequate for average of 100 nmi per day travel) included in charter with additional fuel charged as a surcharge.
- Ability to put 3 observers on top of wheelhouse with unobstructed visibility forward and to the sides with a 3-4 foot railing added for safety with canvas to provide wind break on railing and intercom or other means of easy communication with bridge and sundeck area behind bridge.
- Carry at least 150 gallons of gasoline (in bladders, drums, or fuel caddies) in a location that allows refueling RHIBs at night while at anchor or at dock (gasoline itself will be paid for by research group)

- Provide adequate bunks for 15 personnel plus crew.
- Provide adequate food and cook to feed number of people specified above including accommodating special dietary needs.

Figure 1. Vessel Truth chartered under this grant for leg 1 and 2 of the SOCAL-12 BRS showing scientific crew and RHIBs used for tag deployments.

Figure 2. Sailboat Jenny Lane charterd for Leg 2 of the SOCAL-11 BRS with towed PAM operated by SWFSC.

Figure 3. Sailboat Derreck M Baylis charterd for Leg 1 of the SOCAL-12 BRS showing visual observers and towed PAM operated by SWFSC.

Figure 4. RHIB approaching group of Baird's beaked whales and succseesful deployment of a Dtag and playback on 1 August 2012.

WORK COMPLETED

The work under these grants were conducted in 2011 and 2012. Support for *Truth* in Leg 1 and Leg 2 of 2012 as well as the PAM sailboat came from this grant and was compleed as follows:

- 2011: Leg 1 involving the *Truth*, 2 RHIBs, and PAM sailboat *Green Dragon* from 29 July to 7 August 2011 and Leg 2 involving the *Truth*, 2 RHIBs, and Pam sailboat *Jenny Lane* from 17-30 September 2011
- 2012: Leg 1 involving the *Truth,* two RHIBs, and passive acoustic monitoring (PAM) from the sailboat *Derreck M Baylis* from 26 July to 8 August 2012 and Leg 2 involving the *Truth* and two RHIBs (with PAM from *Truth*) 12-25 October 2012

Vessels chartered under this grant performed well during the BRS effort in 2011 and 2012 and overall the BRS continues to be extremely successful. The platform *Truth* chartered under this grant met all the requirements and was an outstanding platform that helped make the cruise as successful as it was. It allowed the BRS to be conducted over wide-ranging areas with a flexible itinerary to best take advantage of weather openings and encounters with different species. Additionally two satellite tags for use on the BRS in 2011 were purchased under the 2011grant. One was successfully deployed on a Risso's dolphin during the BRS and the other was unfortunately lost during a second deployment attempt where the tag did not attach.

The *Baylis* as a platform for the PAM work (conducted by SWFSC) in 2012 represented a major improvement over the vessels used in 2010 and 2011. The vessel was larger and more capable and with two captains was able to operate longer hours typically heading out to the study area ahead of the other vessels to begin the search for beaked whales. During operations in the Catalina Basin, this platform was able to repeatedly locate areas of beaked whale activity which allowed us to focus efforts in that area. It lead to the successful finding and tracking of a Cuvier's beaked whale group and the short-term deployment of several tags. This achieved one of the main goals of the PAM effort. While results of the observations, tag deployments, and playbacks completed will be more appropriately covered under reports for other components of the overall BRS project but some of the key accomplishments of the work completed are briefly summarized in the Results.

RESULTS

Results and accomplishments of the SOCAL-BRS including the 2011 and 2012 field work supported under this grant have exceeded expectations and provided new information on the response of a number of species to playback of mid-frequency sonar sounds. These grants represent just one component of a larger collaborative effort and results of the Behavioral Response Study are the focus of continuing analysis under other grants that are part of the SOCAL-BRS.

From the 2011 field effort, 38 tags of four types were deployed on 35 individuals of four species. In 2011, 18 playbacks on three species were completed. This included a deployment and playback on Cuvier's beaked whales representing a key accomplishment of this work. From the 2012 field effort, 26 tags of four types were deployed on 20 individuals of nine species. In 2012, six playbacks were conducted on 8 focal animals of six species. This included the first deployment of a suction cup archival tag and first playback on a Barid's beaked whales representing a key accomplishment of this work (Figure 3).

Even though the SOCAL-BRS study is not yet completed, a number of scientific publications have already been completed on the results to date including:

Southall, B.L., D. Moretti, B. Abraham, J. Calambokidis, S.L. DeRuiter, and P.L. Tyack. 2012. Marine Mammal Behavioral Response Studies in Southern California: Advances in Technology and Experimental Methods. *Marine Technology Society Journal* 46(4): 46-59.

Goldbogen, J.A., B.L. Southall, S.L. DeRuiter, J. Calambokidis, A.S. Friedlaender, E.L. Hazen, E.A. Falcone, G.S. Schorr, A. Douglas, D.J. Moretti, C. Kyburg, M.F. McKenna, and P.L. Tyack. In Press. Blue whales respond to simulated mid-frequency military sonar. *Proceedings of the Royal Society B.* 280: 20130657. http://dx.doi.org/10.1098/rspb.2013.0657

Goldbogen, J.A., A.S. Friedlaender, J. Calambokidis, M.F. McKenna, M. Simon, and D.P. Nowacek. 2013. Integrative approaches to the study of baleen whale diving behavior, feeding performance, and foraging ecology. *BioScience* 63:90-100.

DeRuiter, S.L., B.L. Southall, J Calambokidis, W.M.X. Zimmer, D. Sadykova, E.A. Falcone, A.S. Friedlaender, J.E. Joseph, D. Moretti, G.S. Schorr, L. Thomas, and P.L. Tyack. 2013. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. *Biological Letters* 9: 20130223. http://dx.doi.org/10.1098/rsbl.2013.0223

Goldbogen, J.A., J. Calambokidis, A.S. Friedlaender, J. Francis, S.L. DeRuiter, A.K. Stimpert, E. Falcone, and B. Southall. 2012. Underwater acrobatics by the world's largest predator: 360° rolling maneuvers by lunge feeding blue whales. *Biology Letters* 9:20120986.

Presentations on the findings of the BRS to date have been made to a number of groups as well as before the 2013 Biennial Conference on the Biology of Marine Mammals in Duedin, NZ in December 2013 including:

Southall, B, Calambokidis, J. Moretti, D, Barlow, J, DeRuiter, S, Goldbogen, J, Friedlaender, A, Hazen, E, Stimpert, A, Arranz, P, Falcone, E, Schorr, G, Douglas, A, Kyburg, C, Tyack, P. 2013. Measuring Cetacean Reponses to Military Sonar: Behavioral Response Studies in southern California (SOCAL-BRS). Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.

Arranz, P, DeRuiter, SL, Stimpert, AK, Neves, S, Friedlaender, AS, Goldbogen, JA, Visser, F, Calambokidis, J, Southall, BL, Tyack, PL. 2013. Echolocation behavior of foraging Risso's dolphins from DTag recordings. Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.

Hazen, E, Goldbogen, J, Friedlaender, AS, Calambokidis, J, DeRuiter, S, Stimpert, AK, Bograd, SJ, Nowacek, DP, Southall, B. 2013. Blue whale (*Balaenoptera musculus*) lunge kinematics as a function of fine-scale metrics of krill schools. Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.

Stimpert, AK, DeRuiter, S, Southall, B, Falcone, E, Moretti, D, Friedlaender, A, Schorr, G, Calambokidis, J. 2013. Acoustic and diving behavior of a tagged Baird's beaked whale

(Berardius bairdii) exposed to simulated sonar. Abstract (Proceedings) 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, NZ, December 2013.

IMPACT/APPLICATIONS

SOCAL-BRS effort demonstrated a successful model for conducting behacvioral response studies and showed that both the current research team, the region, and the methods employed were ideal and achieved a much higher level of success than had been anticipated. The study promises to provide important new data on the behavioral response of cetaceans to Navy sonar and other sounds.

TRANSITIONS

Work will be continuing on ths multi-year project but already the project has yielded a number of key findings and publications. The overall SOCAL-BRS project has transitioned into primary funding from the Navy's Living Marine Resources (LMR) Panel and most funding for the completion of the project will be coming through that program.

RELATED PROJECTS

This specific grant was to provide vessels to serve as an observational platform and as a base of operations for a sound source to be used in the SOCAL Behavioral Response Study conducted off Southern California in summer in 2011 and 2012. Other components of this work were included in other separate grants to the various groups including Cascadia Research, Southall Environmental Associates, Woods Hole Oceanographic Institute (WHOI), Southwest Fisheries Science Center (SWFSC), University of St. Andrews (SA), and Naval Undersea Warfare Center (NUWC).