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Improved Satellite-Monitored Radio Tags for Large Whales: Dependable ARGOS Location-Only Tags and a GPS-Linked ARGOS Tag to Reveal 3-Dimensional Body-Orientation and Surface Movements

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LONG-TERM GOALS

Two different implantable satellite-monitored radio tag technologies will be developed for whales: 1) a programmable, location-only (LO) Argos tag using contemporary technology will be available in two lengths and be adaptable to testing a variety of attachments. Ultimately, it will be suitable for many scientific users to track local and seasonal movements of medium to large whales over varying time scales (months to a year); and 2) an improved recoverable GPS/TDR tag will include 3-axis accelerometer and compass sensors to document the detailed dive behaviors and foraging ecology of large whales over scales of weeks to months and will be capable of carrying additional acoustic recording devices useful in evaluating future noise response experiments.

The goal of this project is to develop reliable sensing and monitoring technologies to identify the seasonal distributions of large whales, their underwater behavior, their ecological relationships with oceanographic factors, and, ultimately their behavioral responses to man-made sounds.

OBJECTIVES

This research will replace older LO tag technology with two more-efficient versions. The tags will utilize the most proven attachments to date, but are designed to allow for additional experimentation with different entry and attachment types to achieve longer tracking periods while minimizing potential impacts. Both implantable LO designs will consist of modern energy-efficient electronic components and be epoxy cast to lower production costs. By doing so, they should ultimately become widely available. The tags will have user-programmable duty cycles to allow for flexible experimental design, such as longer duration operations or higher density data for shorter periods.

A current GPS/TDR tag (initially funded by JIP, MMS, and ONR) will be further developed to provide an accurate depiction of underwater dive behavior and body orientation between surfacings. The data will be downloaded from recovered tags to evaluate complex foraging behaviors. The addition of an acoustic dosimeter from Cornell (C. Clark) will help interpret responses during future controlled-

exposure experiments (CEE). The existing GPS/TDR tag will be field tested on whales with the Cornell acoustic dosimeter before moving forward with additional sensor integration.

APPROACH

During this funding year, an opportunity arose to use funds from Sakhalin Energy Investment Corporation and ExxonNeftgas Limited to apply the prototype LO tags on eastern North Pacific Gray whales. This opportunity to test the LO tags allowed us to delay spending Year 2 monies with a no-cost extension on Year 1 funds.

Regarding the GPS/TDR tag, the work plan objective was to start this activity during the second year, however, with the influx of the outside funds (above) this development task was put off until next year. The replacement TDR tags from the sperm whale 2008 experiment prepared by Wildlife Computers were going to be used (without a 3-axis accelerometer/compass), but incorporating an acoustic dosimeter, designed by Chris Clarke's lab at Cornell during the Navy/SOCAL BRS experiment in August/September 2010. However, due to the urgent need to tag sperm whales during the Deep Water Horizon oil spill (using older-style Telonics tags to assure data compatibility with the 2001/2005 SWSS taggings) and the impending September work with the LO tags on Western Gray Whales, the SOCAL/BRS work was postponed until 2011.

WORK COMPLETED

Eighteen tags were applied from Sept. to December 2009: nine each of a short 2-cell version and longer 3-cell version. The latter was equal in length to the former Telonics LO tags. We conducted followup relocations and photographed these tagged whales using ARGOS acquired locations during additional surveys along the Oregon Coast through August 2010. The results through April 2010 were summarized for the IWC Scientific Committee meeting in June 2010 (see below and references).

RESULTS

From September to December 2009, 18 eastern gray whales were tagged with Wildlife Computers Spot-5 tags off Oregon and northern California, an area known to be part of the Pacific Coast Feeding Aggregation (PCFA) during the feeding season. Biopsy samples were collected from 14 of the tagged whales. Follow-up observations and photographs of tagged whales were taken from September through August 2010 and will continue.

Twelve tags (six of each type) were fully deployed (5 females and 9 males), protruding <1.3cm. On the summer/fall foraging grounds, tagged whales showed a high degree of variability in their movements and the number of areas used. Of the first 6 whales tagged during 3 consecutive days along the central Oregon coast, 4 whales moved south during the first 2 weeks, and the other 2 whales stayed in the immediate tagging area, indicating whales in the same area at the same time do not subsequently do the same thing. Within 2 weeks, one tagged whale moved south to Cape Blanco and then north to the west coast of Vancouver Island, BC, covering all of its previous known range from 15 years of photo-ID studies.

Point St. George (PSG), near Crescent City, CA was used extensively by tagged whales throughout the fall and winter. By 20 November, all 6 whales with functioning tags (out of 10 deployed by that date) were located within a 10 km radius of PSG. During a re-sighting effort in that area on 25 Nov, an

estimated 35–40 gray whales were observed, including three whales which had been previously tagged, but the tags had come off, meaning that at least 90% of tagged whales were at PSG by late November. The two whales that spent the most time in the PSG area arrived in early October: one remained there for 15 weeks before migrating south in late February, and the other (a fit looking adult male) was still there in June and thus did not migrate south at all. Whales near PSG appeared to be foraging. Defecations were observed. This area may be a "staging area", where animals feed right up to the beginning of their southward migration.

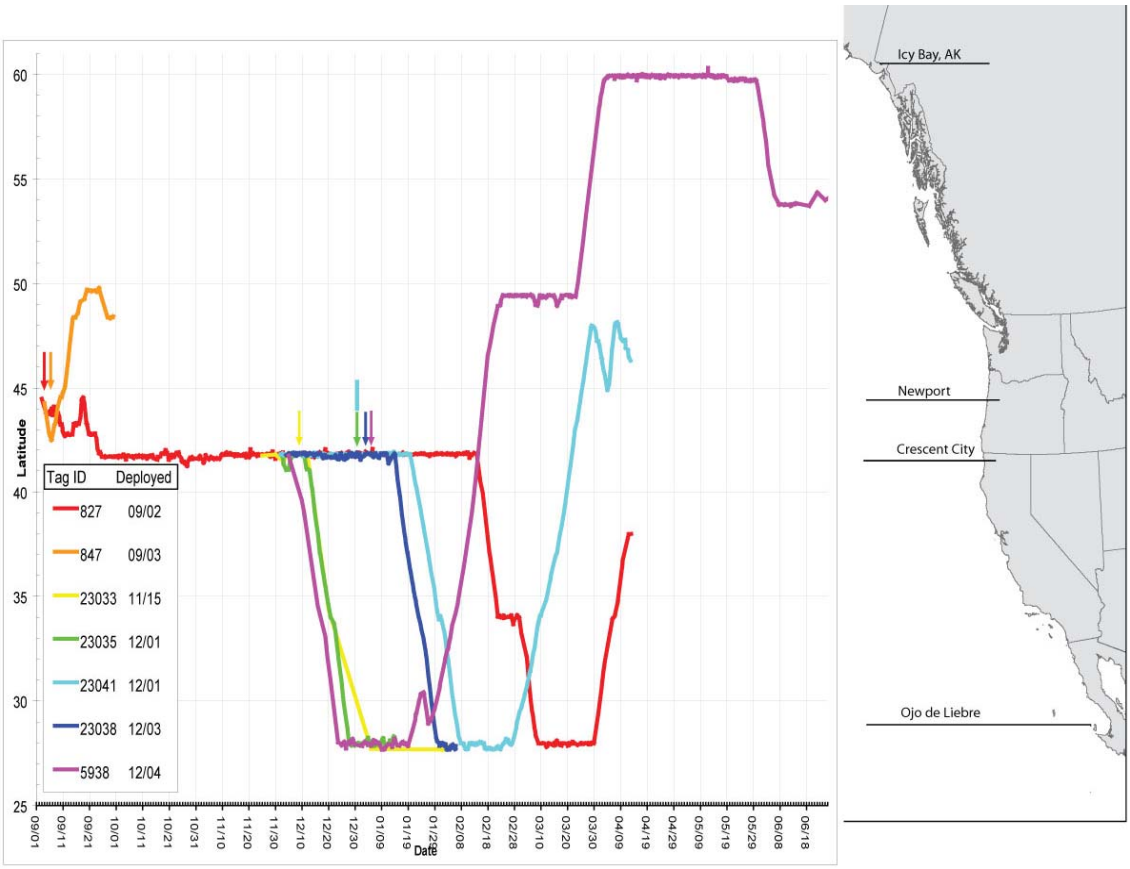
Eight whales began their migration south from PSG over a 71-d period (4 Dec to 13 Feb). Six whales arrived at Laguna Ojo de Liebre, BCS Mexico and went no-where else in the reproductive range. The migration speed was consistently 4+ km/h with a near coast route taking ~18 days. Most whales traveled continuously after starting their migration, except one whale, which stopped for 9 d in the area of San Miguel Island, where it has been seen before. Whales typically spent time immediately outside the mouth of the lagoon before entering and the proportion of time inside the lagoon varied. Three whales stayed in the reproductive area for an average of 22 days before starting their northward migrations between 27 January and 29 March 2010. These data demonstrate that individual (non-calving) whales do not use the lagoons for the entire reproductive season (have a high 'turnover' rate), which precludes estimating the entire population at anytime in the breeding areas.

Whales traveled north at a slightly slower speed (4 km/h) than the southbound migration to arrive at destinations as far north as Icy Bay, AK, considered outside the PCFA. During the 2009 foraging season, tagged whales were highly mobile and varied in the amount of time spent in locations, as noted in past photo ID studies (Darling 1984, Darling et al. 1998, Calambokidis et al. 2002). However, the majority of the field work in previous studies took place before mid-November and winter observations have been rare. Travel speeds while feeding were similar migration speeds, suggesting whales moved directly from one spot to the next without much en route "sampling".

It is possible that the apparent site fidelity to Ojo de Liebre Lagoon may be a feature of all PCFA whales, and that they may represent a genetic subset of the larger eastern North Pacific population. With large numbers of whales breeding in this lagoon (maximum counts 2,200), the mechanism to maintain a genetic subset of the overall population is most likely to be along maternal lines. A mechanism for selective male access to PCFA females (or other feeding locales) has not been suggested for any baleen whale. An OSU gray whale tagging study in 2005 tracked six mother whales tagged in Ojo de Liebre (with calves in attendance) to the Chukchi Sea, showing that they were part of the much larger subpopulation which summers in the Arctic (Mate and Urban 2005). With the PCFA estimated to be composed of approximately 200 individuals, they would be a small percentage of whales using Ojo de Liebre Lagoon, and thus, in 2005, it would have been probable to tag whales that migrated only to the Arctic, even if some PCFA whales were there (maximum of 10% of Ojo de Liebre Lagoon high count, but more likely closer to 1-3% at any one time).

It has often been noted that the total number of gray whale calves found in the three main Mexican breeding lagoons was smaller than the total calf production in the population. Tagged whales spent time both inside and outside Ojo de Liebre lagoon during the breeding season, with a greater amount of time spent outside the lagoon. If some whales rarely, if ever, enter the lagoon, and others spend a large percentage of time outside the lagoon, it would be necessary to include offshore surveys to better estimate population size during the breeding season. However, this is virtually impossible also because of the afore-mentioned turn-over rate for tagged whales demonstrating that the entire population is not present in Mexico at any one time.

Northbound migration was documented for three whales in this study, with two of them arriving at PCFA feeding destinations. Whale 23041 exhibited a great deal of mobility, moving back and forth



Latitude versus date of satellite-monitored locations of Eastern North Pacific gray whales tagged off central Oregon and northern California from Sept.-Dec. 2009. Arrows point to deployment dates for the corresponding tag colors.

repeatedly between the OR and WA coasts. Whale 5938, on the other hand, traveled initially to Vancouver Island where it remained for one month, prior to moving to Icy Bay, AK, where it stayed for >1 month before going back south into British Columbia. Although their sample size was small, Calambokidis et al. (2002) documented an inter-annual re-sighting of one animal between southeast Alaska and Washington, and suggested that either the range of the PCFA extends farther north than the efforts of their study, or that there are other feeding aggregations along the west coast with some interchange among them. It seems likely that PCFA whales may different-sized home ranges and that inter-annual environmental changes may result in animals using different portions of their home ranges from year to year to find adequate food.

IMPACT/APPLICATIONS

The new LO tags cost about $2000, about half of Telonics tags, and require little time for assembly of attachments and penetrating tip (an additional $150). The new tags are user-programmable for duty

cycles and functions, which include "haul-out" histograms (dry time) useful in determining surface-oriented diurnal behaviorals throughout the day. The resulting data are helpful in developing correction factors (probability of sighting) to estimate populations from aerial and ship-board surveys. The smaller tags may be more useful on smaller species than on the larger whales which have been tagged to date.

TRANSITIONS

The rapid development of the LO tag and added funds of the two oil and gas sponsors allowed the proof of concept not only for the lower cost casting technique, but also verified the easily changed attachments and penetrant tips for future experimentation. Both IWC and IUCN science reviews have approved the use of the 3-cell (longer version) tags in September 2010 on Western gray whales. These taggings will further extend the testing on this species. In 2011, we will attempt to tag the same gray whales that were tagged in 2009, so the fate of wound healing can be further followed and to determine whether individual whales tend to repeat the same patterns of seasonal movement. Now that there has been no substantial risk identified in the tagging of gray whales with this technology, it should make it easier to permit future tagging operations using this equipment. Further, Wildlife Computers is already offering these LO tags as a mainstream product, thus fulfilling one of the ONR goals of working with a company who would mass produce the product and make it widely available to other researchers.

"Replacement" GPS/TDR tags (from the previously JIP-funded project that failed due to casting problems) were to have been available for the 2010 Navy SOCAL BRS, but will now be used in 2011. Late in this fiscal year additional efforts will be undertaken with Wildlife Computers to begin the incorporation of the 3-axis accelorometer and compass system to figure out underwater movements. This product is unlikely to be available in 2011, but should be ready by 2012. Additional interest in the products of this ONR project have been expressed by the JIP, trustees of the Deep Water Horizon oil spill, and Australian colleagues planning a 2012 BRS project with humpback whales, using industry seismic sources.

RELATED PROJECTS

The analyses of the EGW data is being proposed to the wave energy industries in the Pacific NW. Tagging WGWs in 2010 is an obvious application from this project.

PUBLICATIONS

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