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

Bruce Mate
Oregon State University, Hatfield Marine Science Center, Newport, OR 97365-5296
phone: (541) 867-0202 fax: (541) 867 0138 email: bruce.mate@oregonstate.edu

Award Number: N000140910453
http://mmi.oregonstate.edu

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 so it will ultimately 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 functions (including duty cycles) to allow for flexible experimental design, such as longer duration operations or higher density data for shorter periods.

A current prototypic GPS/TDR tag (initially funded by JIP, MMS, and ONR) will be further developed beyond collection of TDR data to provide an accurate depiction of underwater dive behavior and body orientation between surfacings. These 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

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
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	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Oregon State University,Hatfield Marine Science Center,Newport,OR,97365**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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 so it will ultimately 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.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

existing GPS/TDR tag is ready for a field test on whales with the Cornell acoustic dosimeter before moving forward with additional integration.

APPROACH

For the LO tags, Bruce Mate has surveyed the commercial manufacturers of appropriately sized and capable tags as well as guided the design issues for manufacturer-led packaging to achieve the desired product size, shape and features. Bruce Mate and Bill Reiersgaard designed the “screw-on” attachments and entry system. Roger Hill at Wildlife Computers (WC) has guided the electronic packaging of the Spot 5 tag and the batteries into a cast product form.

For the GPS/TDR tag, Bruce Mate has designed and guided the over-all strategy of attachments, housing, deployment system, floatation recovery system and data collection criteria. Roger Hill (WC) has guided the electronic integration of the Fastloc GPS, WC TDR Mk 10 logger functions, WC Spot 5 Argos tag, logic components, and packaging. Bill Reiersgaard has been a consulting mechanical engineer on attachments and tag deployment. Ed Bryant developed an ADF-like device using an uplink receiver to obtain pseudo-ranges from tags and calculate Fast-loc locations from a real-time GPS to effectively guide tag recoveries in the field. Chris Clark and Bill Ellison have provided advice and discussions regarding their future production of an add-on acoustic dosimeter.

Ladd Irvine, Craig Hayslip, Mary Lou Mate, and Barbara Lagerquist have provided core field team talents in tag deployments, documentation and tag recovery.

WORK COMPLETED

We met with maufacturers to evaluate existing transmitter products small enough to fit into our desired criteria. We tested several design prototypes and some of them failed shock simulations of tagging or pressure tests in the OSU pressure “bomb” to simulated depths of 1500m. We settled on a WC design which survived these tests and incorporated a new very low-drag antenna and a conductivity switch which was built into the stops on either side of the antenna base (and did not involve a “stalk” which could add drag or vibration). During September, we tagged 10 "resident" gray whales along the central Oregon coast with one of two sizes of the new LO tag.

RESULTS

All of the tags provided data (survived the shock of application). By the end of October, we are still hearing from 7 tagged whales. Several tags applied close to the midline did not deploy completely and we suspect they may have hit lateral processes of the vertebrae. Most of the tags that stopped working fell into this category and we suspect they are no longer attached.

We have resighted most of the tagged whales and photographed the condition of the tag site to determine if there were any visible adverse effects. One of the relocated whales was photographed without its tag within a few days of when it stopped transmitting (after several weeks of operation) and again 6 weeks after tag loss. None of the photos to date show any significant effects. A comparison of photos shows that one incompletely deployed tag became more completely deployed with time. By sharing our ID photos with other researchers (most notably John Calambokidis), we have identified that 8 of the 10 whales are known from photos by other researchers and have a known sighting history of up to two decades. Thus, we know there is a good chance we will see

more of these same whales over the next few years in the Pacific Northwest so we can further evaluate their healing and any visible impacts. In just two months, some of the tagged whales have visited all of the places where they have ever been seen in their sighting histories. We have supplied our web-access to the Argos locations to most of the gray whale researchers, who might have a chance of relocating the whales. Because we had a late start in tagging these whales, the weather has been a major factor limiting our ability to put out more tags or collect more re-sighting photos to date. We intend to continue tagging and re-sighting efforts in Mexico during the breeding season to increase our sample sizes.

IMPACT/APPLICATIONS

The cost of these tags should be about half of the previous LO tags, but the smaller size d unit is still not as small as it can become. It is too early to determine how long these tags will operate or what effects they may have in the longer term, but we will be continuing the work (tagging and re-sighting efforts) to evaluate these issues. If these tags perform as well as the older Telonics LO tags, then they will become the focus of additional attachment experiments, including some modifications to the attachments and use on smaller species, like beaked whales. With success, WC plans to make these tags broadly available to the scientific community.

TRANSITIONS

The development of the LO tag ("product") was accelerated from the proposed pace of research due to an industrial and conservation/management "need". The tests this summer were entirely paid by Exxon Neftgas Limited (Russia) and the International Union for the Conservation of Nature (IUCN), administering funds for Sakhalin Energy Investment Corporation (SEIC). All of the parties have a long-standing interest in the highly endangered western gray whale (WGW) population, which is found during summer months feeding off of Sakhalin Island, Russia in the southern Sea of Okhosk near oil and gas development activities. The IWC has maintained a consistent interest in these issues and has endorsed the tagging of WGWs with Argos tags when the tag technologies have been tested and demonstrated not to be a substantial risk on whales in the eastern gray whale stock (EGW). Thus, the LO tag tests this summer were funded by the interested parties to determine the efficacy of the new LO tags, so they might be applied to WGWs next sumer (Aug/Sep 2010).

The Joint Industry Program (JIP), composed of 14 worldwide oil and gas companies, has an interest in seeing the GPS/TDR tags re-tested in their present form with the Cornell acoustic dosimeter, but lacks the resources to do that at the present time. As an original co-funding group, the JIP hopes that these tags will help determine the levels of noise that affect the dive behavior and movements of whales in the presence of man-made sounds. I will be soliciting the interests of MMS and NSF, who both have seismic noise-oriented projects to see if they will fund the field work to do this testing in 2010. The Navy may also have noise related projects (ship shock, LFA, or others) that may benefit from this tag technology during its testing phase.

RELATED PROJECTS

The analyses of the EGW data for their biological value is being proposed to the wave energy industries developing along the Pacific NW, who need to know more about how these whales' movements may put them in proximity to their energy projects. The WGW tagging in 2010 is an obvious application of the developments from this project.

PUBLICATIONS

Bailey, H., B. R. Mate, D. M. Palacios, L. Irvine, S. J. Bograd, and D. P. Costa. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. Endangered Species Research. (In press, refereed)

Lord-Castillo, B. K.. D.J. Wright, B.R. Mate, and T. Follett. 2009. A Customization of the Arc Marine Data Model to Support Whale Tracking via Satellite Telemetry. Transactions in GIS. Transactions in GIS, 13:63-83. (Published, refereed)

Robert S. Schick, Patrick N. Halpin, Andrew J. Read, Christopher K. Slay, Scott D. Kraus, Bruce R. Mate, Mark F. Baumgartner, Jason J. Roberts, Benjamin D. Best, Caroline P. Good, Scott R. Loarie, and James S. Clark. 2009. Striking the right balance in right whale conservation. Can. J. Fish. Aquat. Sci. 66(9): 1399–1403. (Published, refereed)

Cotte, C., C. Guinet, I. Taupier-Letage, B. Mate, and E. Petiau. 2009.
Scale-dependent habitat use by a large free-ranging predator, the Mediterranean fin whale. Deep-Sea Research I, doi:10.1016/j.dsr.2008.12.008 (Published, refereed)