Acquisition of Oceanographic Measurements from Baleen Whales & Acquisition of Oceanographic Measurements from Baleen Whales: Field Deployments of Tags Developed Under Grant ONR (N00014-13-1-0854)

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LONG-TERM GOALS

To use large baleen whales as oceanographic sampling platforms and understand how they use oceanographic features to navigate and find prey.

OBJECTIVES

- To develop CTD satellite transmitters for baleen whales that can collect and transmit data on location, depth, temperature and salinity at specific depths.
- To develop and test the deployment techniques for two tag designs on bowhead whales, blue whales and/or humpback whales in West Greenland and Iceland.
- To evaluate the reliability and quality of CTD data collected in arctic ice covered waters by slow swimming bowhead whales and from the open ocean by fast swimming blue and humpback whales.

APPROACH

Diving ocean predators can act as "real-time autonomous sampling platforms" in remote or ice covered waters when fitted with satellite transmitters. Sampling of oceanographic data, including salinity (conductivity), temperature and depth, by marine mammals is not only relevant to understand the ecology of the animals, but also in oceanography. It has been used widely with seals and to a lesser extent with narwhals and belugas. These data can be incorporated into existing oceanographic monitoring of e.g. climate change or they can be used as proxies for prey availability and habitat preferences.

This project is carried out in cooperation with Mads Peter Heide-Jørgensen (Greenland Insitute for Natural Resources) and Gisli Vikingsson (Marine Research Institute, Iceland). The study will address the objective by cooperating with the two main manufacturers of satellite transmitters for marine

mammals; Wildlife Computers (WC, www.wildlifecomputers.com), Redmond, WA, USA) and Sea Mammal Research Unit (SMRU, www.smru.st-andrews.ac.uk), University of St. Andrews, Scotland.

WORK COMPLETED

The project developed a prototype CTD tag in 2014 in cooperation with Wildlife Computers and a detailed progress is provided below (Melinda Holland in litt. 28 Sept. 2015):

Circulating Saltwater bath for Development and Production Testing

- In order to speed up the development of the new CT sensor, Wildlife Computers developed, built and confirmed a temperature bath that is stable to 0.001C from -2 to 35C. This allowed testing of the new CT sensor to be confirmed within the lab against a known standard and will be critical for the testing and calibration of the final tags.

Conductivity electronics

- The conductivity sensor is comprised of electronic circuitry and an electrode cell, both of which contribute to the final accuracy and repeatability of the sensor.
- A major accomplishment was the implementation and verification of the electronic circuitry
    - Electronics have been tested continuously for over one month connected to a standard commercially available oceanographic-quality three electrode cell
    - The target accuracy of the final conductivity sensor is 0.05 psu
    - Electronics have proven to be stable to 0.005 psu. This is highly significant because the electronics are not consuming as much of the error budget as originally anticipated. This allows more options for the electrode cell to be evaluate.

Conductivity sensor cell

- There is no commercially-available electrode that is small and robust enough for deployment on marine animals. So various materials and manufacturing methods to make a cell that is suitable are currently evaluated. Besides size and robustness, the manufacturability, long term stability, and costs are also evaluated.
- There are trade-offs in size, accuracy, long-term stability and manufacturability
- Over this past summer, a manufacturing technique involving scientific glass blowing that would allow to quickly evaluate a number of materials and cell designs we investigated. This technique proved too awkward resulting in poor repeatability and was therefore abandoned. .
- Despite this setback, six different custom cells using various electrode materials and other manufacturing techniques are currently being evaluated. Since long-term stability and repeatability are key, this process is taking considerable time.

Incorporating the new conductivity sensor into a tag

- The tag development that was completed in 2014 remains valid. The temperature and depth components from that work along with the tag controller/transmitter etc, are all still valid.
- The risk for building a new tag fall squarely on the ability to produce a repeatable cell with acceptable size and stability.

All permits to conduct the work have been obtained.

RESULTS

The preliminary results for Wildlife Computers development of the saltwater-conductivity tag is summarized below (Melinda Holland in litt. 28 September 2015):

- Developing a CTD Argos tag for large cetaceans is a challenge, and 2014 experienced multiple unexpected setbacks. Learning from those setbacks, a more phased development approach that verifies each component and step in the process was established. The stable water bath allowed accurate testing of each phase to be done in the lab.
- The electronic circuitry has been developed and verified. Its stability exceeded expectations.
- The final design for a suitable electrode has not been established. It was anticipated that we would have this task completed in August 2015. Although one of the six cells currently under evaluation may prove to be suitable, at this point we need to acknowledge the risk that none of the six will be suitable.
- Fortunately there is a good number of other materials and techniques that are on the list of potential solutions. This flexibility is due to the high stability of the electronics. Wildlife Computers is confident, given enough time for evaluation, that a suitable design for the cell will be achieved.

The project has experienced several problems when developing the first CTD Argos satellite tag for large cetaceans and the field deployments have been delayed. Contact is maintained with SMRU (Lars Boehme) for the possibilities of using a new CTD tag currently under development. If Lars Boehmes project does not reach the stage where it can be deployed in the field during spring 2016, we will not be able to test this new tag within the timeframe of our project. The developent of the SMRU project will be followed closely and it is the hope that this new logger will also benefit the present project.

Contingent on the development of the WC and the new SMRU CTD tag some of the well tested SMRU CTD tags (not well designed for cetaceans though) may be deployed for comparison. The data quality will be analysed shortly after deployment to make sure that the tags produce reliable results over days to months. In case of satifying results, the remaining tags will be deployed.

Time Schedule

- October-December 2015: Evaluation of materials/manufacturing methods for the electrode cell. An additional three months of time is allocated because of the experimental nature of this task.
- January-February 2016: Implement the electronic circuitry and electrode cell into a data logger to be used for controlled field experiments.
- March 2016:
    - Controlled field experiments (e.g., testing the logger against a commercially-available CTD in open-water casts)
    - Controlled tests for long-term drift
- April 2016 (Contingent upon the successful results of the controlled-tests): Final design, implementation and controlled-testing of the fully-functional cetacean CTD Argos tag
- April-May 2016: Deployment of tags on bowhead whales in Disko Bay.
- June-July 2016: Deployment of tags on blue and humpback whales in Iceland.

- April-August 2016: Collection of data via satellite from the tagged whales.
- May-September 2016: Analysis of data and preparation of scientific paper and final reporting.

IMPACT/APPLICATIONS

The main outcome of the project will be a newly developed and tested CTD Argos satellite tag from Wildlife Computers that can be deployed on large baleen whales either by pole or by the ARTS. A deployment system for the old and posibly new SMRU CTD tag will be developed and documented for comparison in data quality and tagging duration.

TRANSITIONS

The tags developed will be commercially available from the manufacturers for all research groups interested after completion of this project.

RELATED PROJECTS

Another ONR-funded project lead by Lars Boehme from SMRU with the aim to modify and improve an existing electrode based miniature conductivity-temperature sensor and incorporate it into the proven design of a Satellite Relay Data Logger. The developent of this tag may benefit the present project.