The effects of placement location and degree of implantation on satellite tag attachment duration for humpback whales

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Introduction

Argos satellite telemetry of large whales has become a common tool to characterize migrations, habitat use, and interactions with human activities. Tag placement typically has been chosen to maximize antenna orientation and above-water exposure time for optimal transmissions. However, little consideration has been given to how tag placement and the degree of implantation affect tag attachment duration. As subcutaneous implant tagging gains wide-spread use as a tool for monitoring the movements of large whales, it becomes necessary to assess the performance of tag placement in order to maximize attachment duration and minimize impact to animals. As pioneers of the technique since 1986, we have a large collection of tag deployments that allow us to conduct such an investigation. We are particularly interested in humpback whales, as tags on them don't appear to last as long as on other large whales.

For this study we analyzed placement data for 172 subcutaneous implant tags deployed on humpback whales (*Megaptera novaeangliae*) from 1997 to 2016 in the North Pacific, Antarctica, and off equatorial West Africa. We developed a statistical model to predict tag attachment duration for varying tag placement positions.

Methods

- 172 Argos satellite tags of three types were deployed on humpback whales from 1997 to 2016: 114 Telonics ST-15 and ST-21 tags (implantable portion: 1.9 cm diameter × 26.3 cm long), 49 Wildlife Computers SPOT5 and SPOT6 tags (implantable portion: 2.0 cm diameter × 27.2 cm long), and 9 Telonics ST-27 tags (implantable portion: 1.9 cm diameter × 20.7 cm long).
- Field notes and photographs were taken during tagging to assess tag placement, tag penetration, and establish a photo ID for each whale.
- For each tag deployed we recorded three placement metrics: length of tag exposed (inches), distance down from whale's midline, and distance from the leading edge of the dorsal hump. These data were refined later using photographs taken at the time of tagging or during subsequent resightings. Attachment duration was calculated as the total time (days) between deployment and the last received transmission and therefore represents a minimum duration.
- A generalized linear model (GLM) was performed to relate attachment duration with tag type and tag placement metrics (distance from dorsal hump, length of tag exposed, and distance down from the midline).

Results

- The distance from dorsal hump ($P = 0.002$) and length of tag exposed ($P = 0.01$) were negatively correlated with attachment duration, but the relationship was weak (adjusted $R^2 = 7.3\%$).
- Neither tag type nor distance down from the midline was significantly related to attachment duration (P values > 0.40); both variables were removed from the model.
- Tags placed closest to the dorsal hump and embedded more deeply had longer attachment durations (Figures 1 and 2).
- Model predictions using pre-set values for distance from dorsal hump and length of tag exposed are shown in Figure 3.

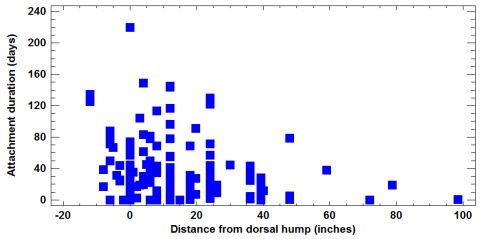

Figure 1. Attachment duration for satellite tags on humpback whales as a function of distance from the leading edge of the dorsal hump. Negative values represent distance of tags placed aft of the leading edge of the dorsal hump.

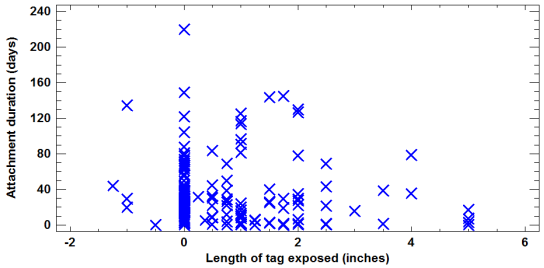

Figure 2. Attachment duration for satellite tags on humpback whales as a function of length of tag exposed. Negative values represent the depth that tags are embedded beyond their stops.

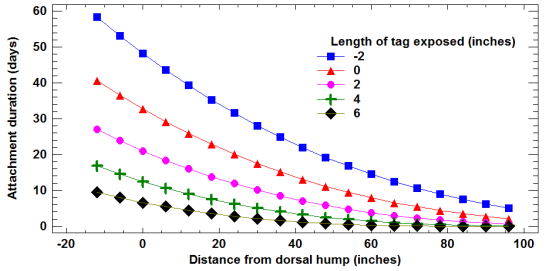

Figure 3. GLM prediction of attachment duration for satellite tags on humpback whales at pre-set values of distance from dorsal hump and length of tag exposed.

Examples of tag placement relative to leading edge of dorsal hump

Tag placed approximately -20 inches from leading edge of dorsal hump

Tag placed approximately at leading edge of dorsal hump

Tag placed approximately 20 inches forward of leading edge of dorsal hump

Tag placed approximately 40 inches forward of leading edge of dorsal hump

Tag Exposure Examples

Tag embedded 0.5 inch beyond stops

Tag embedded to stops

Tag exposed 0.75 inches

Tag exposed 4 inches

Conclusions

Our analyses reveal that complete implantation in the dorsal hump region can improve tag attachment duration on humpback whales

Because the dorsal hump is made up of dense collagen fibers rather than muscles, movements there are not as extensive as in more muscular regions where flexion might hasten tag loss and cause tissue damage. Thus, the dorsal hump may act to retain tags for longer periods of time than regions farther forward along the dorsum, while minimizing possible tag impacts.

As large-scale cetacean tagging programs become wide-spread, researchers need to optimize the cost-benefit ratio by maximizing attachment duration while minimizing impact on the animals. Determining where to implant tags is one variable that researchers can control. In order to further evaluate optimal tag placement future studies of the tissues in which tags are implanted would be valuable.

Acknowledgements

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