Validating the Use of Satellite-linked Mortality Transmitters in Rehabilitated California Sea Lions.

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Interim Project Report

This project addresses the recovery of the Steller sea lion (*Eumetopias jubatus*) research priority in the PCCRC rfp. The project work will contribute to testing the leading causal hypothesis for this species' decline (or failure of the population to recover), as well as to the analysis of seasonality in Steller sea lion dive efforts, mortality, and the relationship of these parameters to fishing activities, through the validation of a new experimental approach for the long-term study of sea lions. This validation will be performed on a surrogate species, the California sea lion (*Zalophus californianus*).

The population of the Steller sea lion (*Eumetopias jubatus*), an apex predator in the North Pacific and Bering Sea ecosystems, has continuously declined over the past two decades along the Aleutian Islands and in the Gulf of Alaska (Merrick et al. 1987, York 1994, Merrick & Loughlin 1997, see also NMFS 1992). Steller sea lions are now listed as threatened within their eastern Alaskan range, and as endangered in their western range, under the Endangered Species Act (Fritz et al. 1995, Fritz & Ferrero 1998, Loughlin 1998). Despite years of productive research, little is known about the extent to which a hypothesized reduction in juvenile survival - in turn possibly related to reduced prey abundance - contributes to the present population trends (Calkins et al. 1998, Didier 1997a,b; Springer et al. 1999, Williams et al. 1999).

Data on survivorship is crucial for the effective monitoring and management of many species of marine endotherms, in particular endangered species and those potentially exposed to detrimental ecological and anthropogenic environmental changes, or climate related regime shifts (see Schumacher 2000). In addition, data on individual survivorship is needed to assess the efficacy of programs designed to ameliorate the impact of such changes and shifts.

Due to wide dispersal or migrations, and the open ocean ranging of marine endotherms, such data is extremely difficult to obtain. Survival of free-ranging animals is typically assessed through mark and recapture studies, or through the use of mortality transmitters (see Siniff & Ralls 1991). Mark and recapture studies are expensive and logistically complex to conduct, and highly disruptive in the rookeries of shy species such as Stellers. In addition, such studies cannot directly distinguish between dispersal / emigration, and mortality (see Siniff & Ralls 1991). Conventional mortality transmitters are externally attached VHF transmitters. Several problems are associated with such devices: on pinnipeds and seabirds, external units typically do not remain attached beyond the annual molt, limiting tracking to a maximum of one year. Battery-size and -

capacity constraints also limit the life span of such units. Implanting mortality transmitters would avoid such problems. Implanted telemetry devices have been successfully used on a wide range of marine endotherms, and circumvent external attachment limitations. However, reception range and thus area coverage from implants is reduced compared to external devices. Transmitting life span is still limited to 2-3 years. A possible solution to extend coverage range for mortality transmitters is the use of satellite-linked devices. Satellite-linked data loggers, using the Service ARGOS system aboard NOAA satellites for obtaining location fixes and transmission of stored data have been successfully and extensively used on oceanic vertebrates. At present however, transmission to a satellite from implanted devices is not feasible (Horning et al. 1999).

To circumvent this problem, the concept of implanted, satellite-linked, delayed transmission life history transmitters was developed at Texas A&M University's Laboratory for Applied Biotelemetry & Biotechnology. Und funding from the North Pacific Marine Research Program, we have developed and are presently testing and refining custom-built implantable life history tag prototypes with Wildlife Computers (Redmond, WA), specifically for the use on sea lions. This cooperative project is geared towards the ultimate goal of implanting a large number of Satellite-linked Life history Transmitters (LHXs) into free-ranging juvenile Steller sea lions. These LHX devices continuously monitor up to five built-in sensors to establish death of an instrumented animal, then store time and date of death in memory. Subsequently, the LHX devices will transmit this data to an orbiting ARGOS satellite, once the positively buoyant device has been released from the decomposing or consumed body. Through the absence of *any* transmissions, until after death and release of the device, battery life is greatly extended to well beyond five years, typically 8-10 years.

One of the problems associated with this concept of "delayed-transmission" satellite-linked life history transmitters, is the impossibility of periodically transmitting an 'alive' signal, which is traditionally used to verify continued operation of the transmitter, and to guarantee the quality of the data obtained. In the absence of such transmissions of 'alive' signals, the accurate assessment of the transmission failure rate of implanted life history transmitters becomes crucial. Mortality data obtained in form of positive 'deceased' signals needs to be corrected by estimates of failure rates. In the LHX project, the use of dual redundant implants is one of several approaches proposed to quantitatively assess instrument and transmission failure rates. Cumulative system failure rates are determined by comparing the ratio of dual versus single hits from two redundant LHX devices implanted into each study animal. A second approach to the assessment of failure rates of the LHX system is the deployment of LHX tags in carcasses under a variety of conditions. Carcass deployments correspond to known mortality events.

A workshop on implantable telemetry devices held at the Alaska Sea Life Center in 1999 (see Horning et al. 1999) recommended the testing of new implantable telemetry devices to be used on Steller sea lions, on a non-endangered surrogate species such as the California sea lion.

Objectives:

The primary objectives of our work are:

1) Refine surgical procedures for intraperitoneal implantation of SMX devices into California sea lions.

2) Validate the absence of post-surgical complications resulting from the implantation procedures on rehabilitated California sea lions.

3) Validate the concept of delayed transmission, implanted mortality transmitters for post-release survival monitoring of free-ranging California sea lions.

4) Contribute to the initial estimation of the failure rate of SMX devices, based on the implantation of dual redundant SMX units into five rehabilitated California sea lions.

5) Contribute to the validation of a new experimental paradigm in the study of marine endotherms by relating body condition, indicators of health and immuno-competence determined prior to release, to individual survival.

Methods:

We will implant dual redundant Satellite-linked Life History Transmitters (LHXs) intraperitoneally into five rehabilitated California sea lions at the Marine Mammal Center in Sausalito, CA. All implanted animals will be released into the wild after observation periods ranging from two to eight weeks. After their release, the LHX devices will be monitored through service ARGOS for up to five years (continued monitoring after end of PCCRC project funded separately).

Progress:

We have developed the first generation LHX devices under separate funding (NPMRP). (See Figures 1 and 2 in Appendix).

We are continuing the testing program on these devices.

A draft protocol for anesthesia and implantation surgery has been developed by Dr. Pam Tuomi, DVM, with input from Drs. F. Gulland, M. Haulena, B. Heath and W. Nelson, and the PI's of this project.

Due to the delayed availability of funding for this project, we were only able to place the order for the LHX tags to be used on California sea lions in October of 2001, and tag production is now scheduled for late spring of 2002 at the earliest.

Due to the delays associated with the funding of this project, as well as another related project for the testing of LHX implants on juvenile Steller sea lions to be held in temporary captivity at the ASLC (funded separately), we have decided to take advantage of recent new developments in satellite transmitter technology that will permit us to significantly reduce the size of the LHX tags. Size reduction to the smallest possible dimensions will minimize any possibility of deleterious effects of the LHX tags on implanted animals, and is therefore considered highly desirable. However, integrating the new, much smaller transmitter boards into the LHX tag design may further delay the production schedule.

If the current production schedule can be maintained, and pending availability of suitable animals at the Marine Mammal Center at Sausalito, CA, we will begin implanting LHX tags into rehabilitated sea lions in the late summer of 2002.

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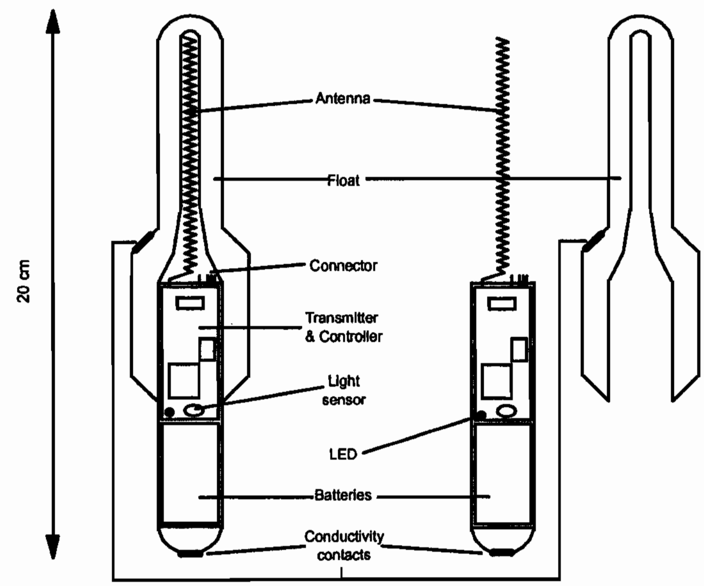

Fig. 1. Schematic of standard LHX tag.
The device measures 20cm in length by 5 cm in diameter. The positively buoyant tag is fully encapsulated in biocompatible physiological resin.

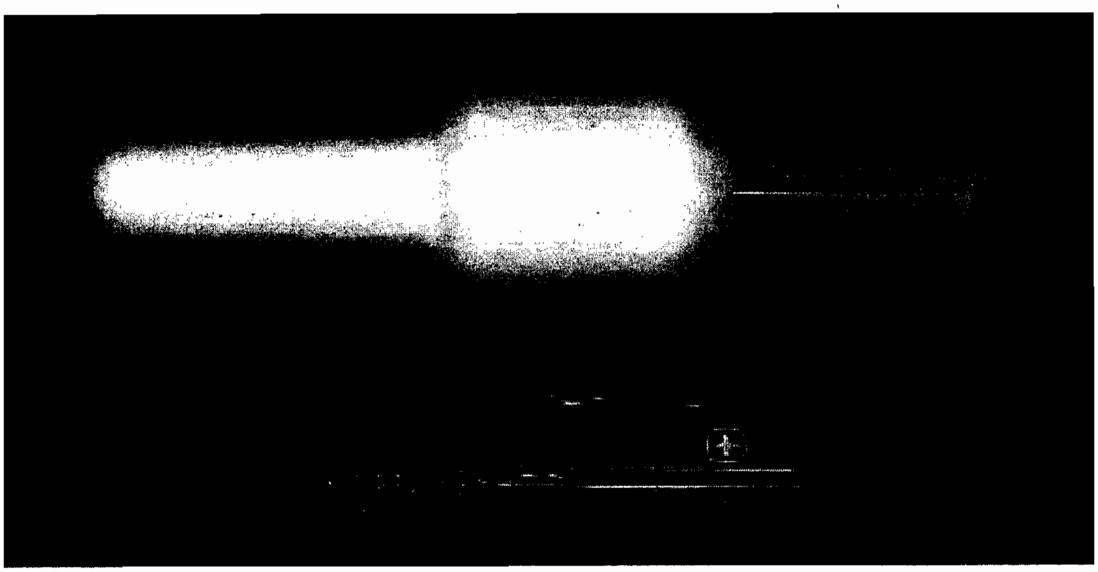

Fig. 2. A prototype standard LHX tag.