Vital rate telemetry in marine homeotherms: a new tool for population monitoring

The Life History Transmitter

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A new tool for the determination of survival, causes of mortality and parturition in individual marine homeotherms

Mortality

1. Lifelong monitoring with spatially and temporally unrestricted resight effort.

LHX tags are intraperitoneally implanted (Fig. 1,2) and record sensor data throughout the life of the homeotherm host [1,2]. Following post-mortem extrusion, the positively buoyant tags uplink via the Argos satellite system to provide data on time and date of mortality, with spatially and temporally unrestricted resight effort [3].

Figure 1. (*Left*) 1st generation LHX-Mk1 tag (on **left**, L 127mm, ∅ 42mm, 118g). 2nd generation LHX-Mk2 tag (on **right**, L 90mm, ∅ 33mm, 65g). Tags are shown in actual size. Mk2 tags are currently under development with NSF funding.

Figure 2. (*Above*) Dorsoventral abdominal radiograph of two LHX-Mk1 tags implanted into a subadult male California sea lion. LHX tags are intraperitoneally implanted under gas anesthesia and aseptic surgical procedures [2]. Two LHX tags are used per host to increase data return rates, and to quantify event detection probability [3]. From 2004 through 2009, four rehabilitated California sea lions and 32 wild-caught Steller sea lions were released with single (*n=4*) or dual (*n=32*) LHX tags.

2. Capabilities of LHX-Mk1 tags.

LHX tags provide spatially explicit post-mortem confirmation of mortality. Data allow the classification of causes of mortality from *algor mortis* (post-mortem cooling). Delayed transmissions and gradual intact body cooling as experimentally simulated on four sea lion carcasses (Fig. 3) indicates non-traumatic death (i.e. disease, starvation, drowning by entanglement).

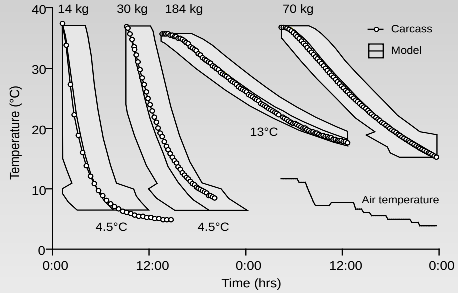

Figure 3. *(Above)* Three sea lion carcasses were cooled in water (14, 30 & 184 kg) and one in air (70 kg). An *algor mortis* model (shaded areas) parameterized for sea lions allows estimation of body mass at death [3].

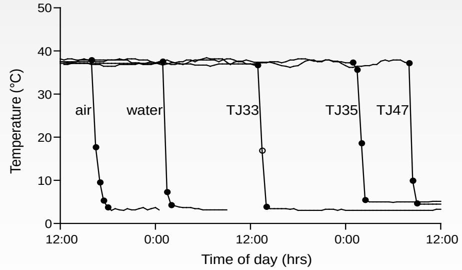

Figure 4. *(Above)* Abrupt cooling and immediate trans-missions are indicative of acute death at sea by massive trauma, likely due to predation [3]. TJ33, 35, 47 data are from Steller sea lion mortality events detected in Alaska.

3. Control studies on tag impacts and reliability.

Through controls and deployments on 4 California sea lions (*Zalophus californianus)* and 32 Steller sea lions (*Eumetopias jubatus*) leading to data returns from ten animals to date we demonstrated that:

- post-mortem data recovery is viable from implanted, archival satellite-linked transmitters [3].
- data recovery probability from dual-tagged individuals is >0.98 [3,7].
- implant surgeries are well tolerated and do not alter post-release foraging behavior [4,5,6].
- post-release survival of implanted animals up to 5 years is not affected by tags or procedures [3,7].
- ante- to post-mortem temperature data and time to onset of transmissions allows the classification of events into traumatic deaths from predation, versus non-traumatic events from any number of causes (i.e. disease, starvation) [3].
- tags provide spatially explicit data on individual mortality with a temporal resolution of 1 day and a spatial resolution for predation events of approximately 10km [3].
- LHX tags provide end-of-life locations that should be suitable to determine large-scale emigration patterns [3,7].
- post-mortem cooling rate data can be used to estimate end of life body mass for non-acute events [3].

4. The next step: parturition detection in 2nd generation LHX-Mk2 tags.

LHX-Mk2 tags are currently under development with NSF (U.S.) funding. LHX-Mk2 tag volume will be reduced by 50% to facilitate use in smaller species (Fig. 1). LHX-Mk2 tags will incorporate thermal parturition detection in female homeotherms to provide vital rate data on <u>*age at primiparity*</u> and <u>*lifetime reproductive success*</u>.

Productivity

References

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