Where did this happen?

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**vital rate telemetry**: survival/mortality, reproduction

- **LHX tags**: how do they work?
- **LHX tags in Steller sea lions**: what have we learned?
- **cold and old**: the enigmatic Pacific sleeper shark
Where did this happen?

Vital rate transmitters in juvenile Steller sea lions

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LHX tags

How do they work?

- Life-long implants that monitor vital signs
  

  LHX-1: 42 x 123mm, 118g
  LHX-2: 33 x 97mm, 54g

  Sensors: temperature, light, dielectric (surrounding medium) accelerometers, “parturition detection”

- *Post-mortem* satellite-linked data retrieval (Argos)

- *Known fate data*: spatio-temporally unlimited re-sight effort → high resolution data – better than 1 day

- 2 tags per animal to increase and determine event detection probability, ideally

- Determination of causes of mortality from temperature, light and dielectric sensors
  
  *(Horning & Mellish, Endangered Species Research 2009)*

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Controls

- LHX tags - *studies in quarantined captivity @ASLC*: low morbidity, zero mortality, **full recovery in 45 days**

- Survival confirmed >45d for all released animals

- No differences in dive behavior from LHX tags or captivity
  (Mellish et al., JEMBE 2007; Thomton et al., ESR 2008)

- $P_{detect} > 0.98$ (carcass simulations & live returns)
  $\rightarrow$ **likely no mortalities undetected in study group**
  (Horning & Mellish, PLoS ONE 2012)

- No differences detected in survival to brand re-sight controls – Mean annual survival ages 1-5 years:
  LHX 0.82 (95%: 0.71 – 0.89) captive
  FR (ctrl) 0.83 (95%: 0.72 – 0.90) non-captive
  (Shuert et al., PLoS ONE 2015)

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• 45 weaned Steller sea lions released with dual LHX tags in PWS/KF from 2005 through 2014  
  (Mellish et al. Aquatic Mammals 2006  
  Horning et al. BMC Veterinary Research 2008)

• > 65,000 monitoring days

• 80 juveniles monitored via external satellite transmitters

• 10 carcass tests with dual LHX tags

• Data from >130 Argos transmitters (*internal + external*)

• Longest monitoring 14 years (to age 15)  
  Longest confirmed survival >14 years  
  Three oldest females confirmed with pups
‘Non-traumatic’ death:
Tag stays in whole carcass

**Gradual cooling with delayed extrusion**

- delayed sensing of light, air, and transmits: death by disease, starvation, entanglement, drowning...
- allows estimation of mass at time of death from cooling rates

*(Horning & Mellish, Endangered Species Research 2009)*
PREDATION:
Tag comes out of carcass

Rapid cooling with immediate extrusion

- immediate sensing of light, air, and transmits: dismemberment, predation

Examples from 11 deceased Steller sea lions:

(Horning & Mellish, Fishery Bulletin 2014)
• 20 mortalities detected from 14 mo to 4.1 yrs age

• All 18 events with data were due to predation (circles)
Where did this happen?

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Results - 3 of 18 predation events

Time of day

Temperature (°C)

TJ52
1 tag

TJ64
2 tags

TJ63
2 tags

(SST)

Horning & Mellish, Fishery Bulletin 2014

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Somniosus pacificus

Sluggish, benthic scavengers?

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Predation locations
95% confidence range
\( n = 12 \)

excluded:
location delays >5d

(Bishop, Brown et al. in prep)
Utilization Distributions (UD): juvenile Steller sea lion space use

Next:
Combining space use and predation locations

From n=84 juvenile SSL (1-3 yrs) satellite tracked for avg. 77 days between 2000 and 2014

(Bishop et al., Movement Ecology 2018)
Next:
Combining space use and predation locations

From randomly resampled predation location ranges and their individually associated seasonal UDIs

(Bishop, Brown, Sattler et al. in prep)
*The LHX Project*

**what predators?**

*Not a spatial analysis!*

Reclassified UD levels by % of simulated predation locations associated with UD level

*Does not suggest a specialist predator!*

**But:** more time dry or shallower diving is associated with slightly higher probability of predation: Near haulouts/surface: *killer whales?*

(Bishop, Brown, Sattler et al. in prep, Dubel et al. in prep)
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harbor seals in western Aleutian Islands

surgical unit on back deck of R/V Norseman

inside surgical unit
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Aleutian Island harbor seals

10 harbor seals released with dual LHX tags between Adak and Attu in 2016

3 returns to date:
1 non-predation
2 predation

pilot project with NMFS/MML

Photo by S. Steingass
Somniosus pacificus

New project: catch, keep, study, tag & release

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Somniosus pacificus

New project: catch, keep, study, tag & release

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New project: catch, keep, study, tag & release

Shark preyed on by offshore killer whales
Alaska SeaLife Center
Oregon State University
Alaska Dept. Fish & Game
California State University Long Beach
Wildlife Computers, Inc.

Markus Horning
JoAnn Mellish (Steller sea lions)
Amy Bishop, Ally Dubel, Renae Sattler (Steller sea lions & sleeper sharks)
Peter Boveng (harbor seals)
Chris Lowe (sleeper sharks)

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Veterinarians:
Marty Haulena, Pam Tuomi, Carrie Goertz, Kathy Woodie,
Shawn Johnson, Rachel Berngartt, Stacie DiRocco, et al.

Permits: NMFS # 1034-1685; 881-1668; 881-1890, 14325, 14335, 14336, 19309, DFO-SA, ADFG ARP #CF-18-041, etc..


