consummate and consumed predators

sea lions, sharks, killer whales…. who eats whom?

Markus Horning

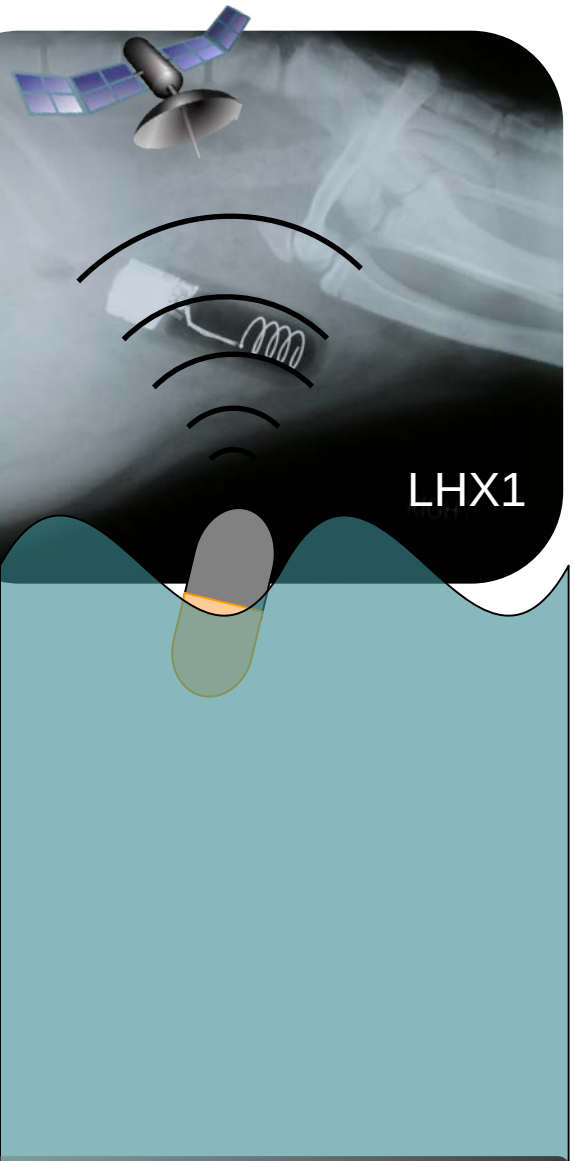
Alaska SeaLife Center

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

Vital rate transmitters in juvenile Steller sea lions

How do they work?



- Life-long implants that monitor vital signs

  (with Wildlife Computers Inc. - Horning & Hill, J. Ocean. Engin. 2005)

  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)

Controls

- LHX tags - *studies in quarantined captivity @ASLC:* low morbidity, zero mortality, ***full recovery in 45 days***
  (Mellish et al., JEMBE 2007; Horning et al., BMC Vet. Res. 2008; Petrauskas et al., J. Exp. Zool. 2008; Walker et al., AABS 2009)
- 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)
  → *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)

=908 LHX female
released 2005 (age 1.5)
resight w. pup 2018 (age 15)

Timeline

- 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

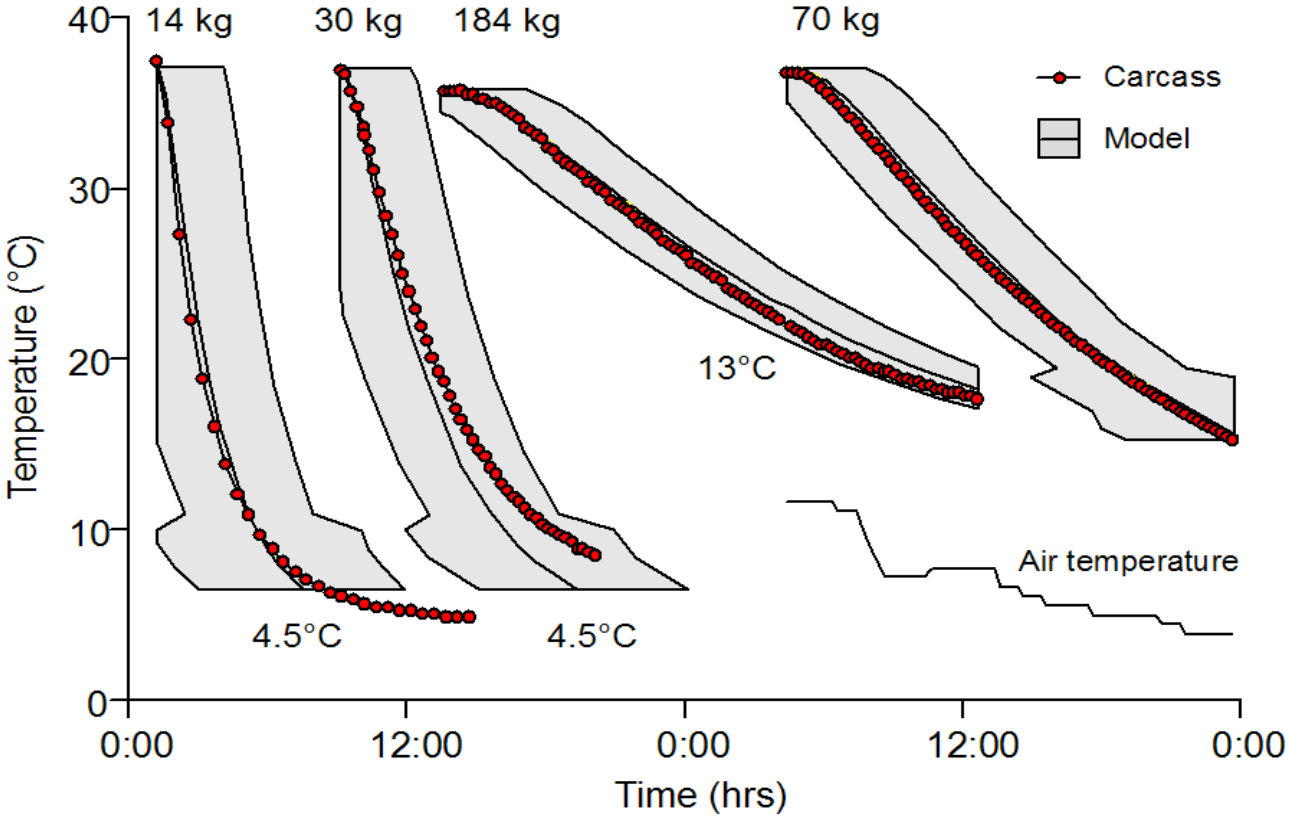
What can they tell us?

'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

Examples from 4 sea lion carcass cooling tests:



(Horning & Mellish, Endangered Species Research 2009)

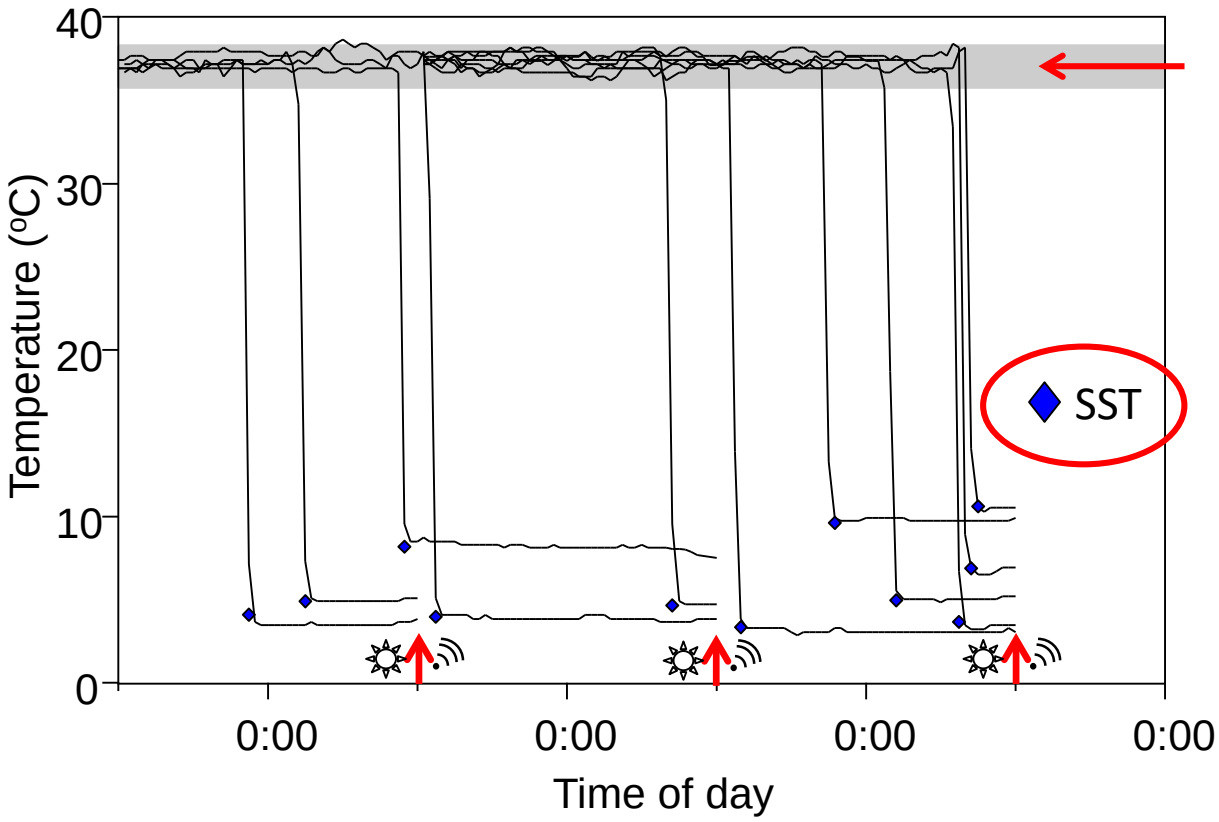
What can they tell us?

PREDATION:
Tag comes out of carcass

<u>Rapid cooling with immediate extrusion</u>

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

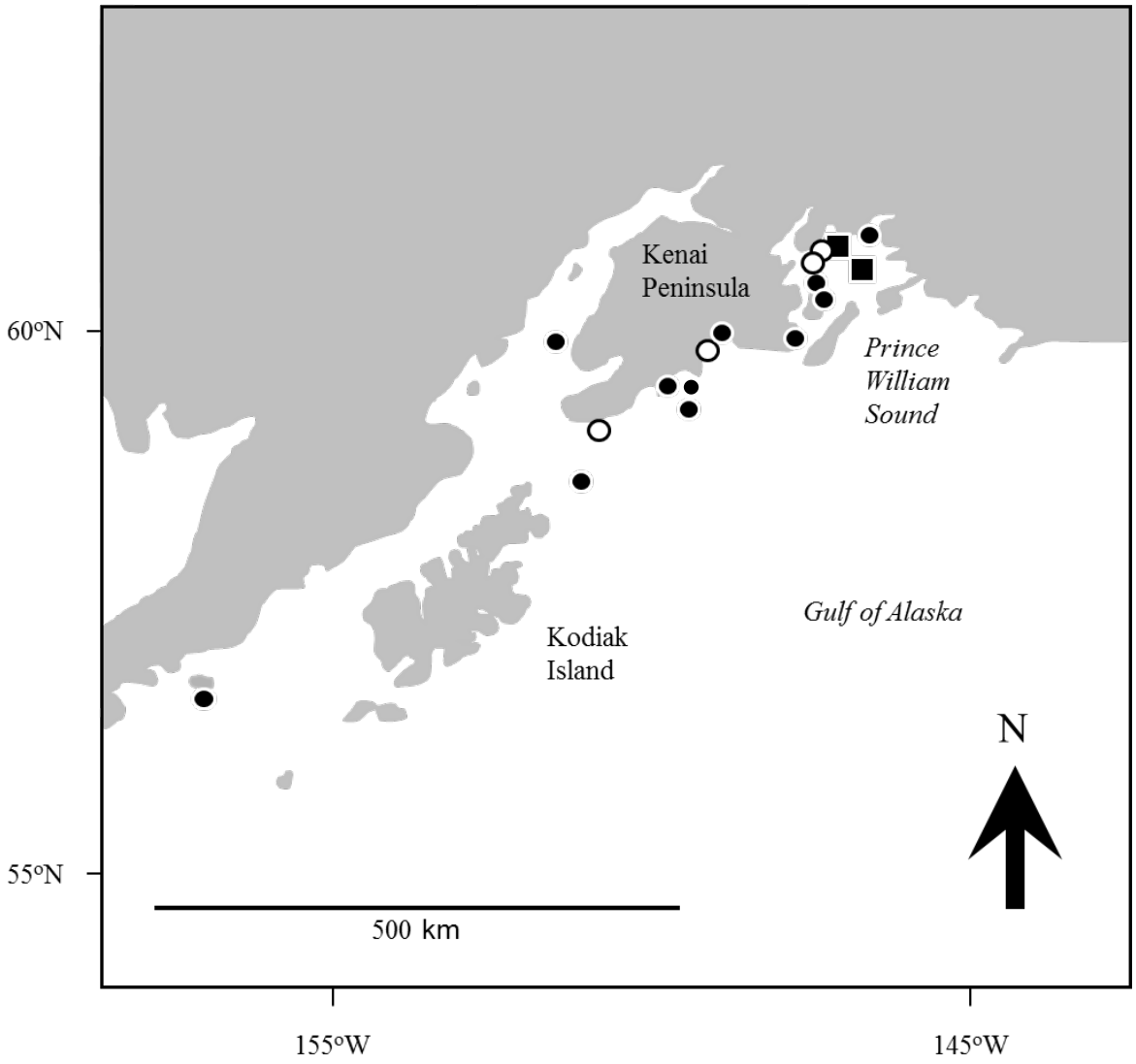
Examples from 11 deceased Steller sea lions:



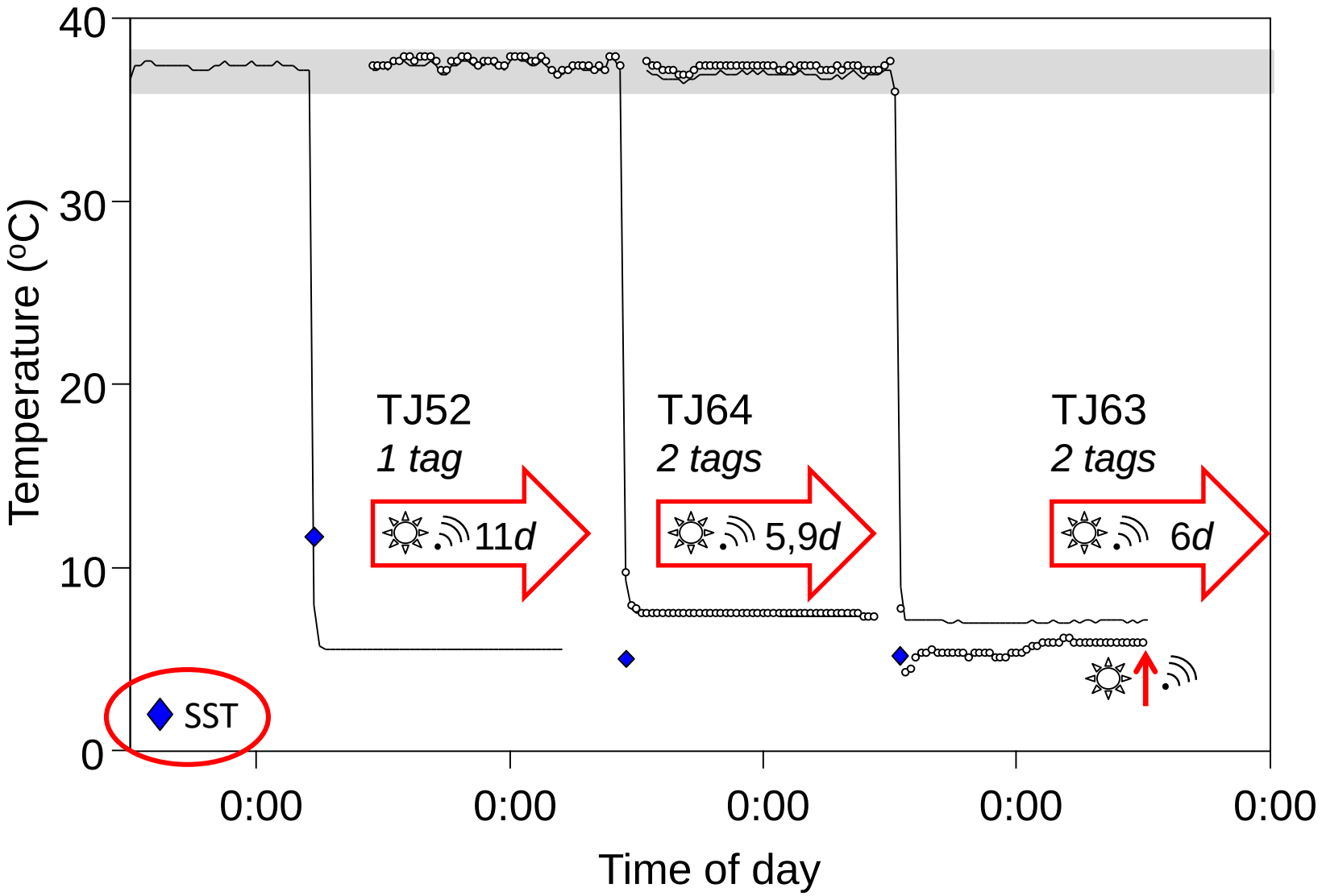
(Horning & Mellish, Fishery Bulletin 2014)

Results - locations of detected events

- 20 mortalities detected from 14 mo to 4.1 yrs age
- All 18 events with data were due to predation (circles)



Results - 3 of 18 predation events



(Horning & Mellish, Fishery Bulletin 2014)

Somniosus pacificus *Pacific sleeper shark*

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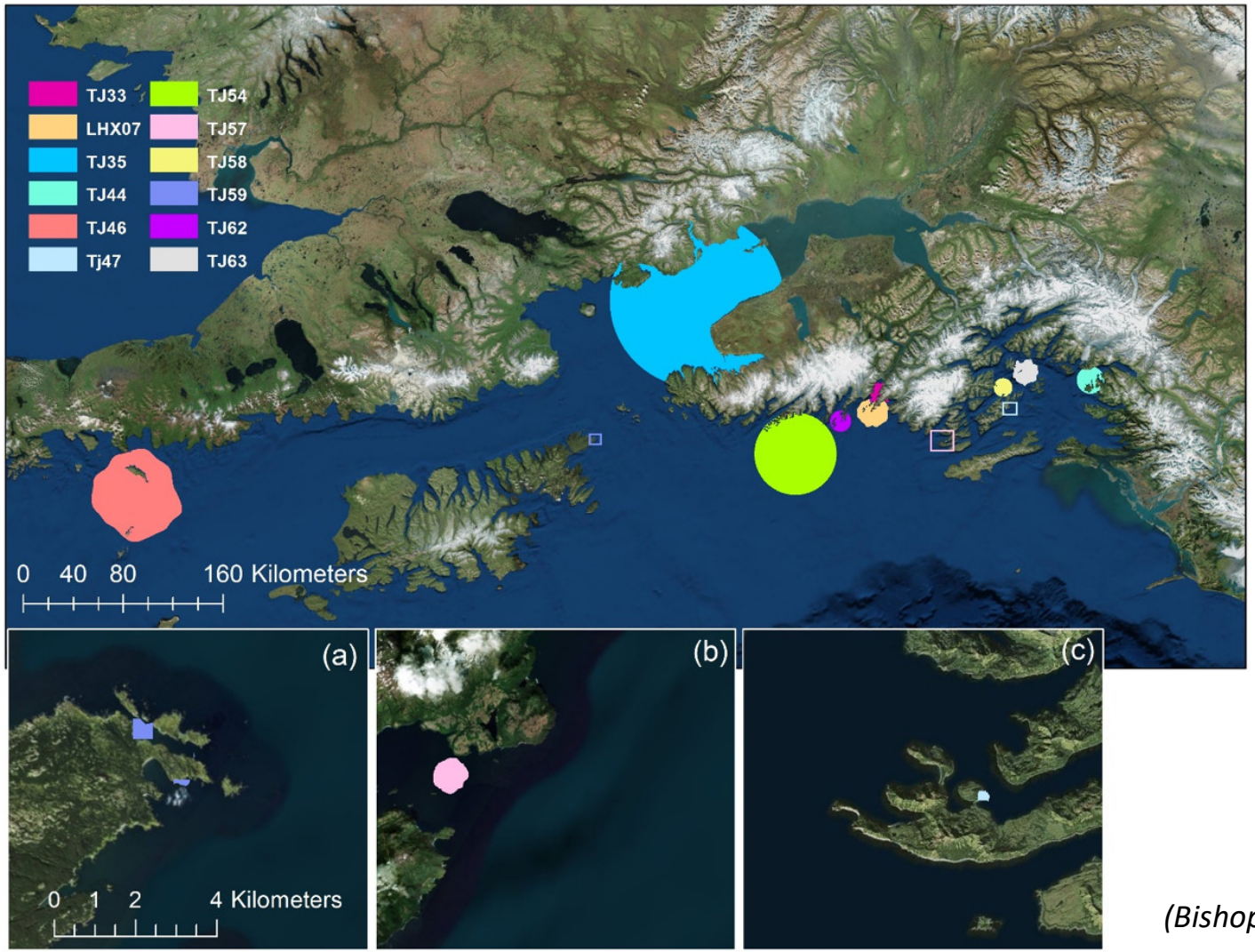
what predators?



Predation locations

95% confidence range

n = 12

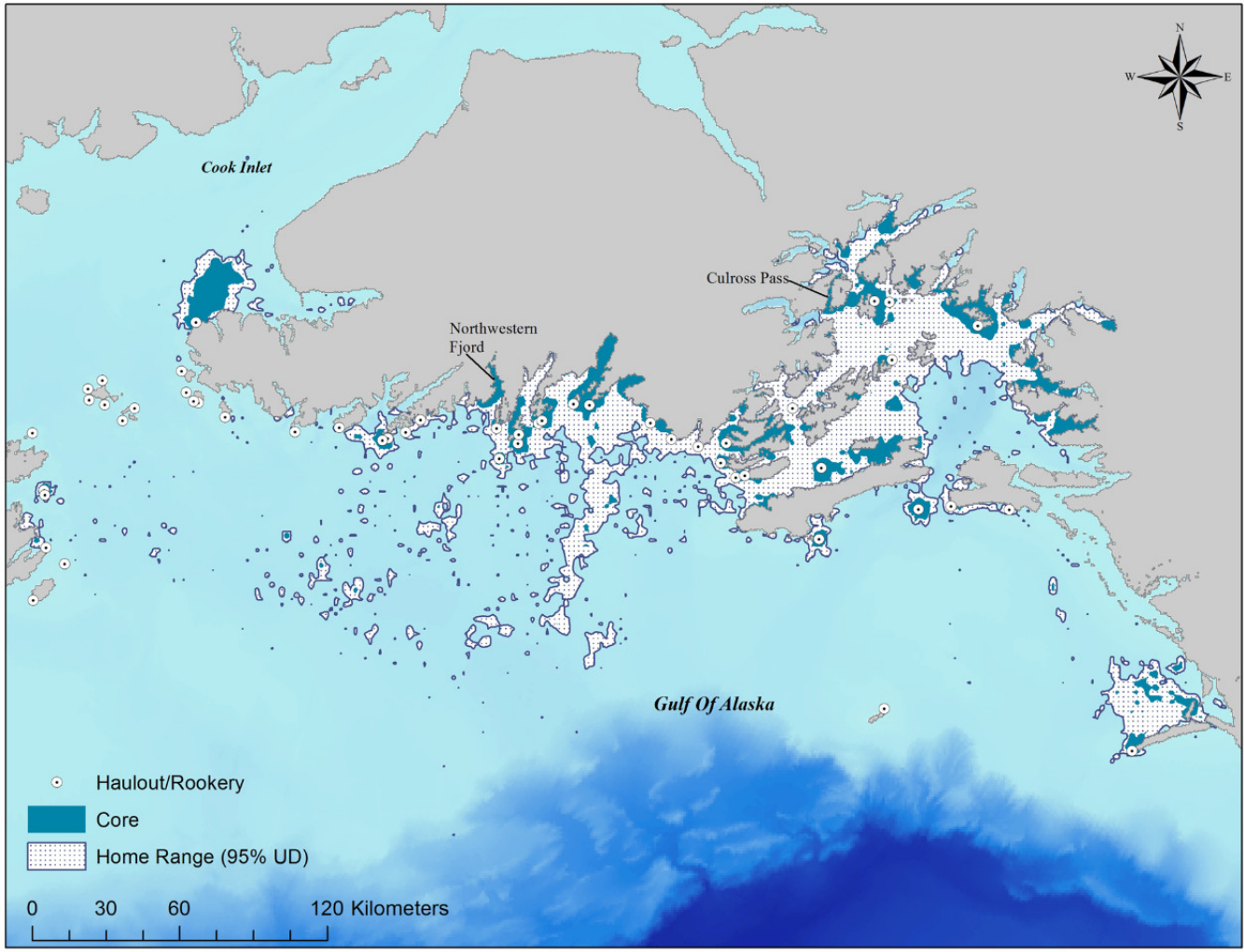
excluded:
location delays >5d

(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

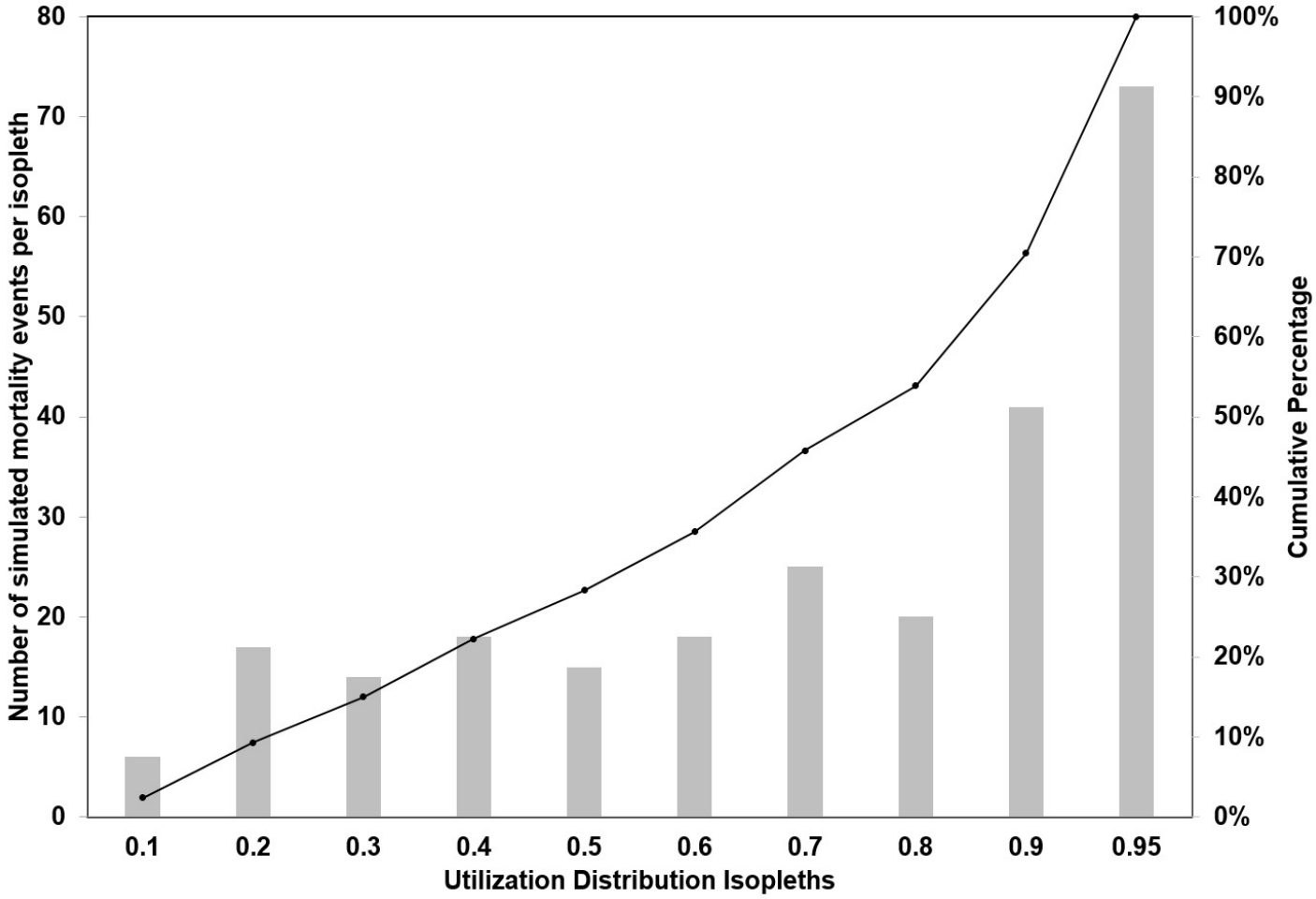


(Bishop et al., Movement Ecology 2018)

what predators?

Next:
Combining space use and predation locations

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



(Bishop, Brown, Sattler et al. in prep)

what predators?

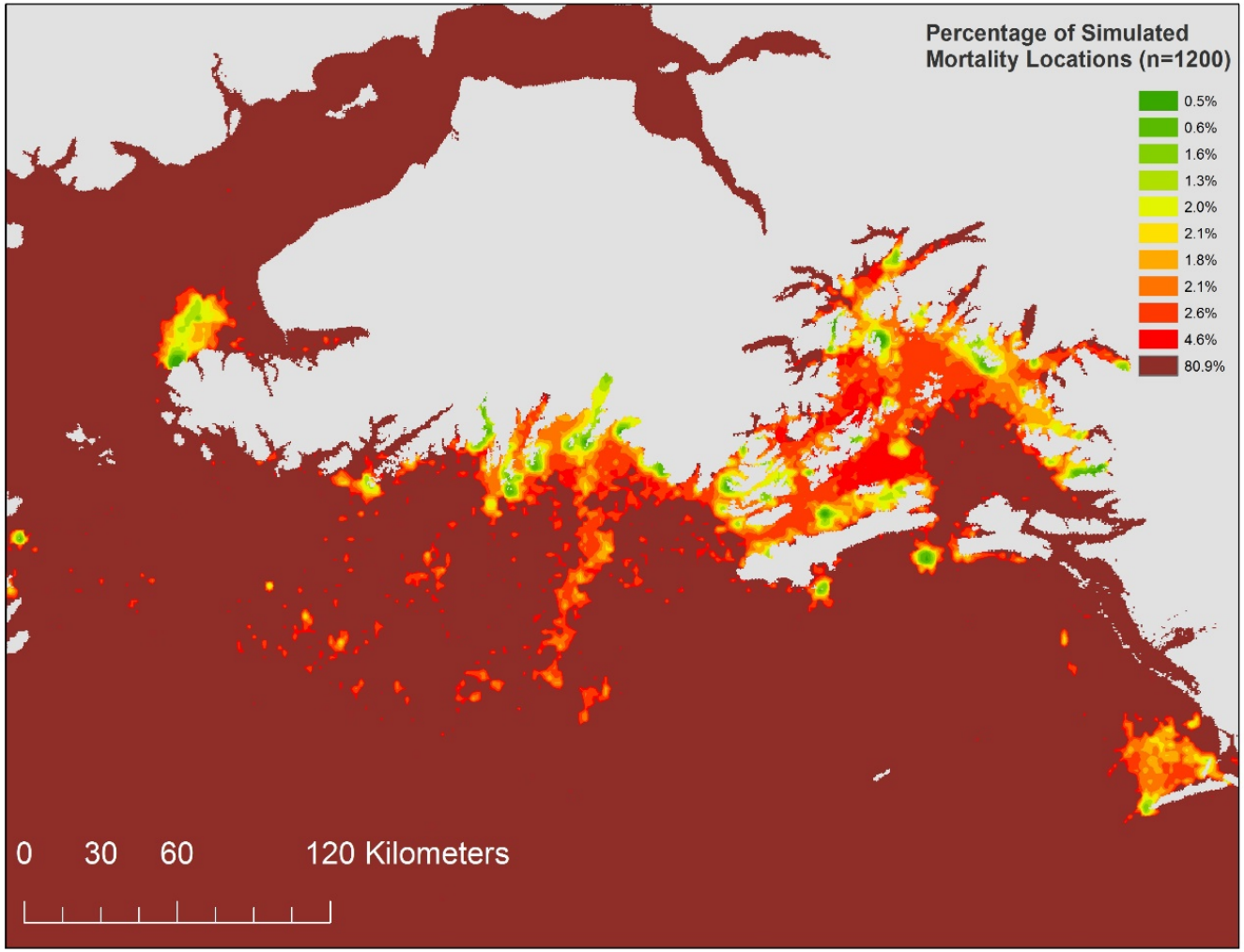
Not a spatial analysis!

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??

Possible predation risk heat map (*conceptual!*)



(Bishop, Brown, Sattler et al. in prep, Dubel et al. in prep)

harbor seals in western Aleutian Islands

inside surgical unit

surgical unit on back deck
of R/V Norseman

Aleutian Island harbor seals

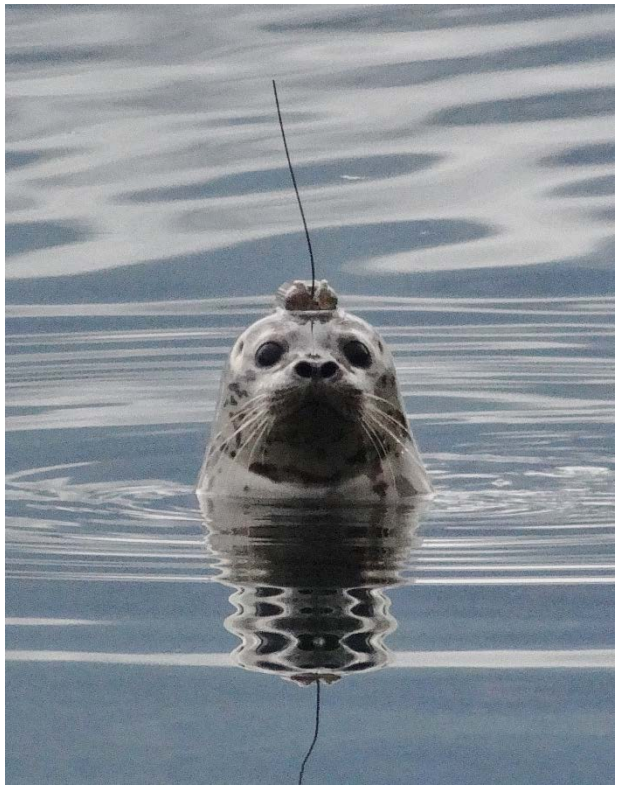


Photo by S. Steingass

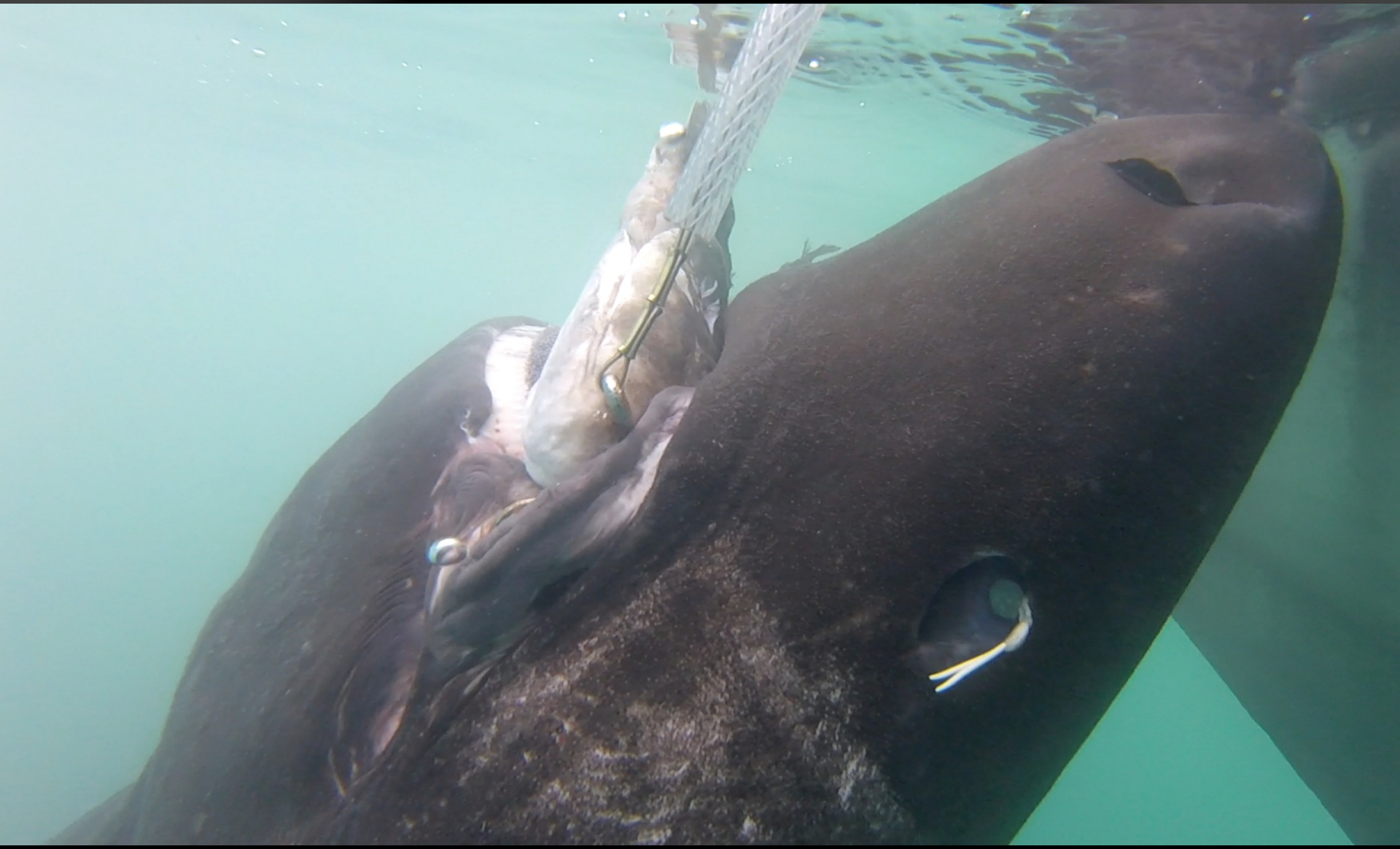
pilot project with NMFS/MML

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

3 returns to date:
1 non-predation
2 predation

Somniosus pacificus

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



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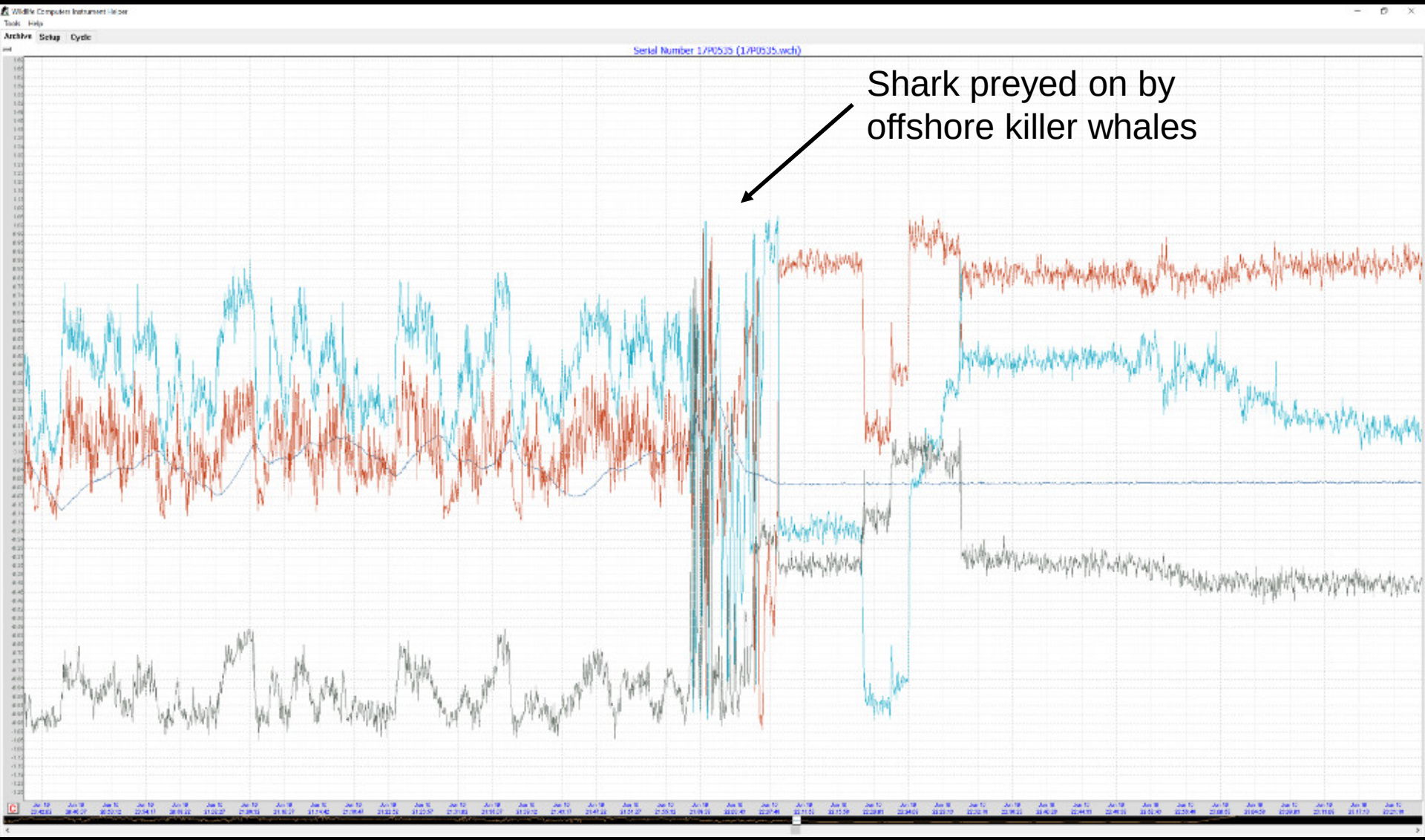

Markus Horning Alaska SeaLife Center

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)

Alaska SeaLife Center
Oregon State University
Alaska Dept. Fish & Game
California State University Long Beach
Wildlife Computers, Inc.

National Science Foundation
North Pacific Research Board
Pollock Conservation Cooperative
NOAA
North Pacific Fisheries Foundation

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..

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