The Life History Transmitter Project

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- Methods:
  How LHX tags work, animal captures, controls

- Results to date:
  LHX tag returns from Nov 2005 – June 2012

- Context:
  Birth and death – are they linked through predation?
  Is P/nP a good metric for making inferences on birth rates?
  A density dependent population model

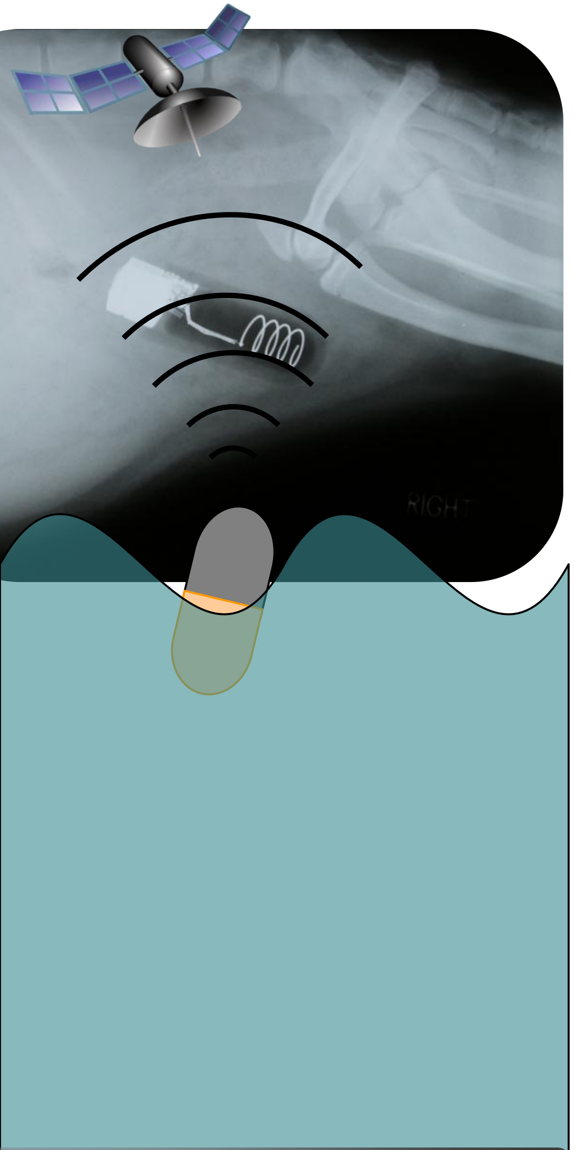
PLoS one

Horning M, Mellish JE. 2012. *Predation on an Upper Trophic Marine Predator, the Steller Sea Lion: Evaluating High Juvenile Mortality in a Density Dependent Conceptual Framework*. PLoS ONE 7(1):e30173.

The impact of predation on Steller sea lions in the Gulf of Alaska

The LHX Project

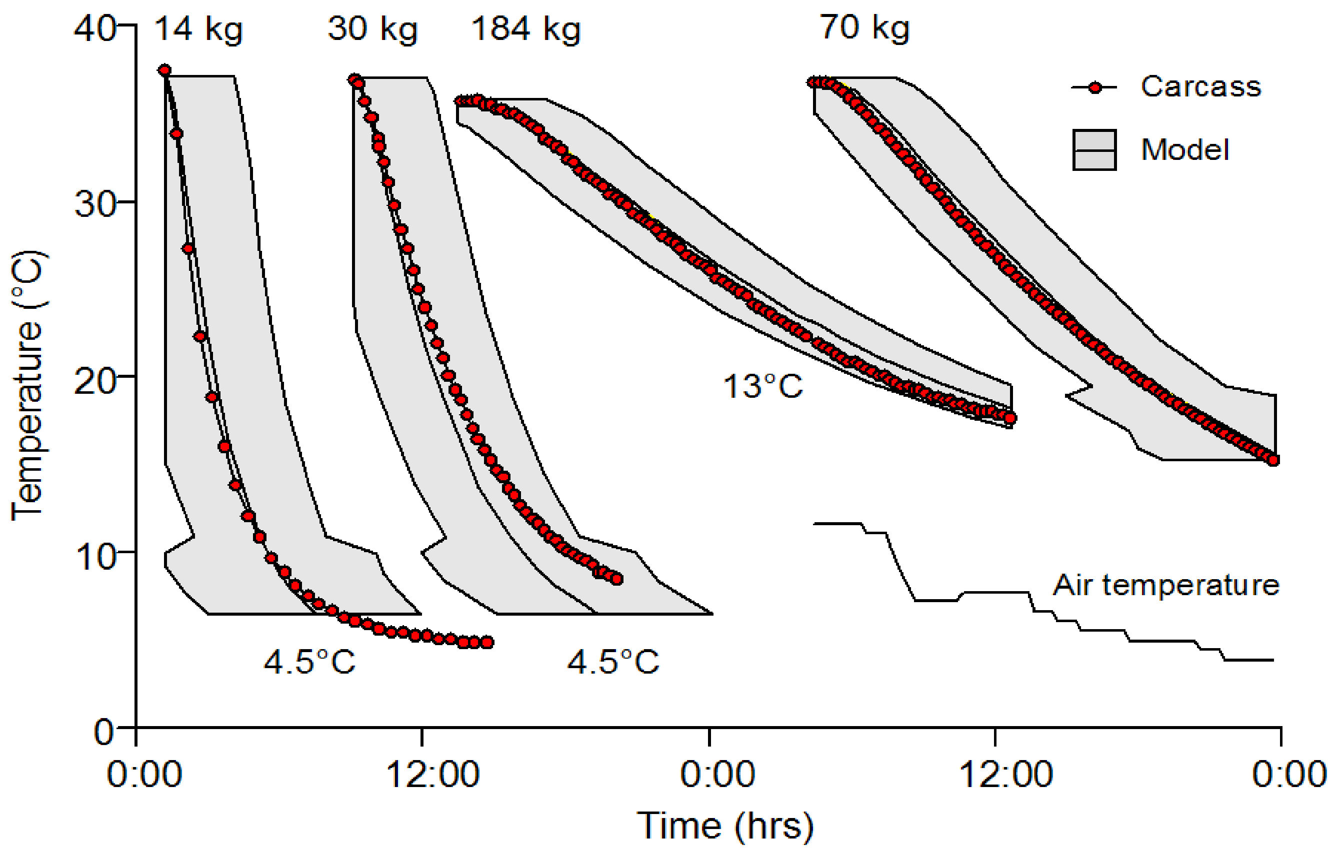
Life History Transmitters – LHX tags



- Life-long implants that monitor vital signs
  (with Wildlife Computers Inc. - Horning & Hill, J. Oceanic Engineering 2005)
- *Post-mortem* satellite-linked data retrieval
- *Known fate data* w. spatio-temporally unlimited re-sight effort
- 2 tags per animal to increase and determine event detection probability
- Determination of causes of mortality from temperature, light and dielectric sensors
  Predation vs other causes
  (Horning & Mellish, Endangered Species Research 2009)

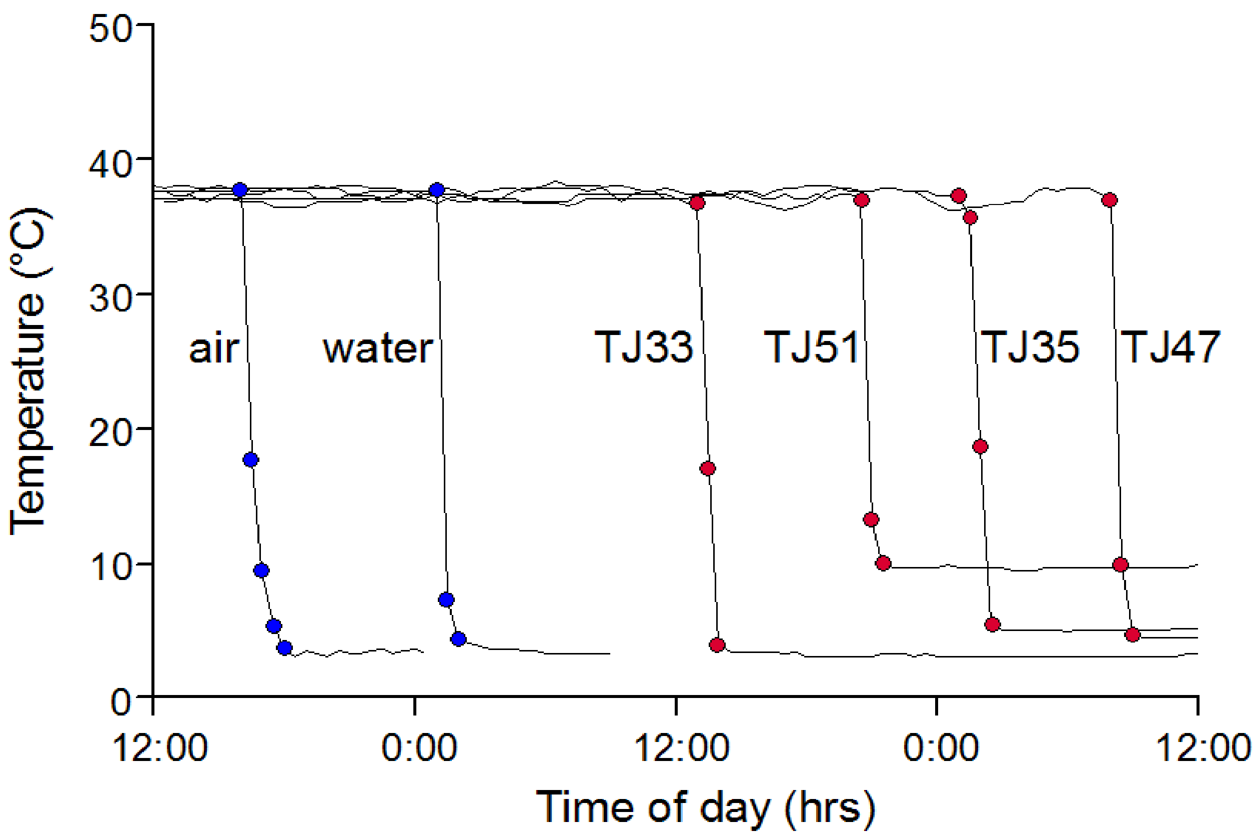
Gradual cooling:

- allows estimation of mass at time of death *(Horning & Mellish, ESR 2009)*
- *with **delayed** light, air, uplinks:* death by disease, starvation, entanglement, drowning…



Precipitous tag cooling, ***immediate*** sensing of light & air, ***immediate*** uplinks:

dismemberment, predation



METHODS

Capturing Steller sea lions in the Gulf of Alaska

CONTROLS

- LHX tags - *studies in quarantined captivity @ASLC:* low morbidity, zero mortality, *<u>full recovery in 45 days</u>*
  (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 (NMFS) - Survival ages 1-5 years:
  LHX 0.413 *(0.26 – 0.64)*
  NMFS 0.412 *(0.27 – 0.55)*
  (***updated*** *from Horning & Mellish, PLoS ONE 2012)*

Timeline

- 36 weaned Steller sea lions released with LHX tags from 2005 through 2011
  (Mellish et al. Aquatic Mammals 2006
  Horning et al. BMC Veterinary Research 2008)
- > 33,000 exposure days monitored
- 10 carcass simulations

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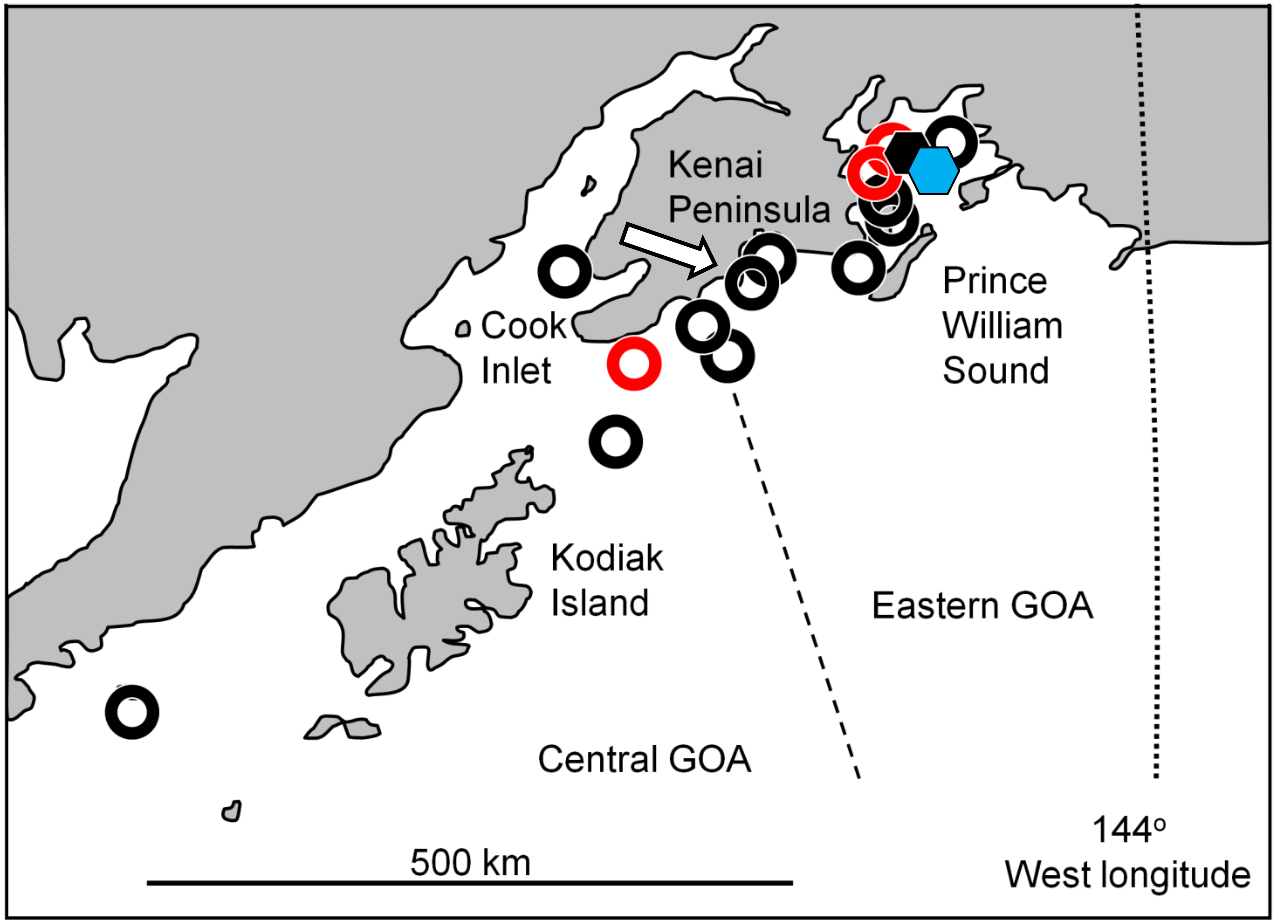
What happened, and where?

- 16 mortalities detected from 14 mo to 4.1 yrs age
- All 14 events with data were due to predation (circles)
- Predation risk is highest for 12-24 months (after weaning) and declines for older animals



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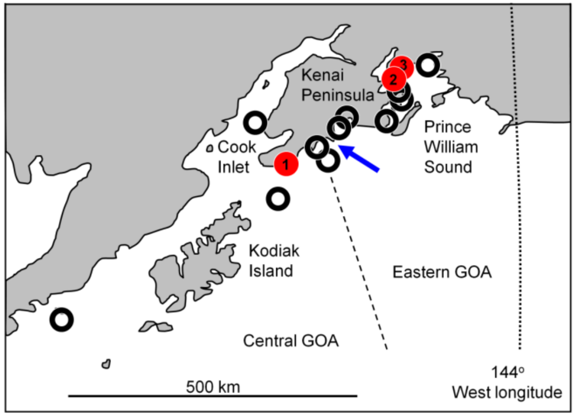
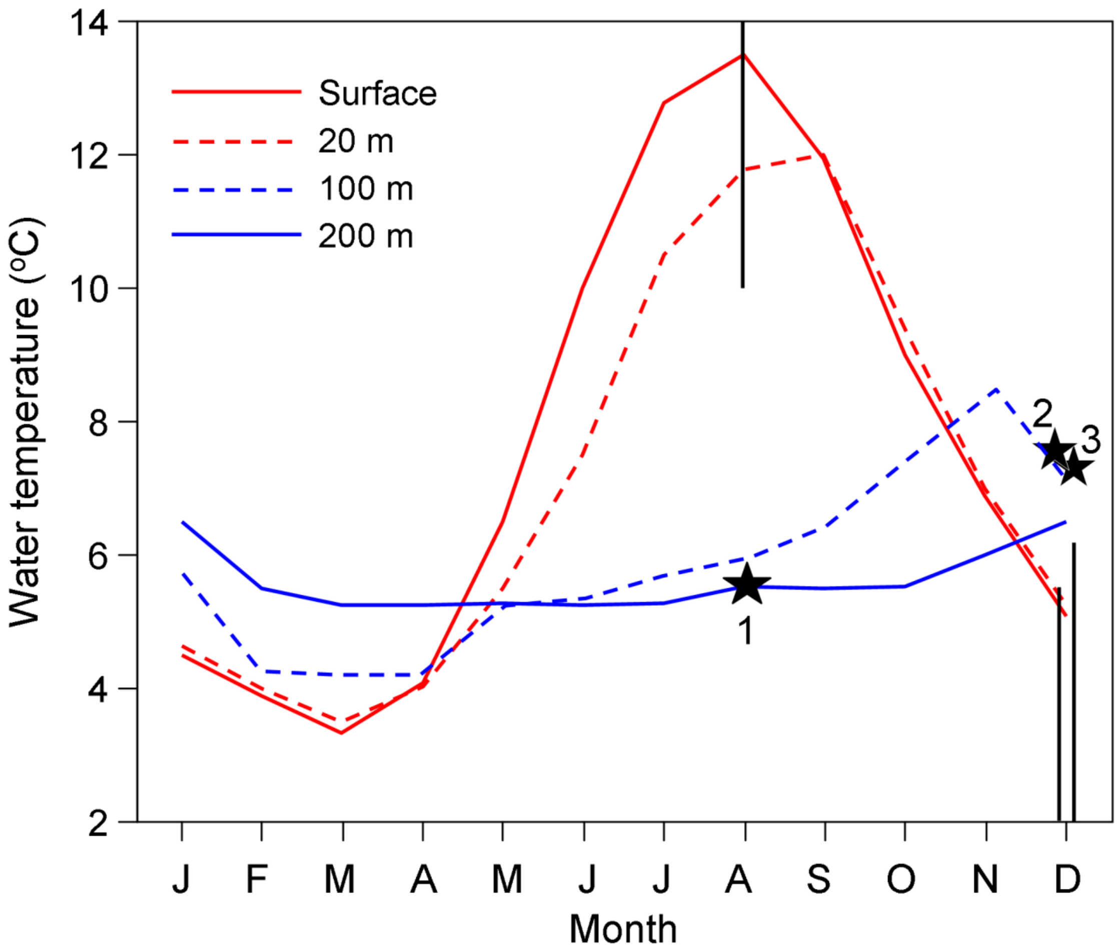
What predators?



- At least 3 in 14 predation events *could* be attributed to Pacific sleeper sharks
- *Lamnid* sharks (white shark, salmon shark) are 8-16°C *above* ambient
- Most of the other 11 events were likely transient killer whales



Updated contemporary *survival schedule* for region:
(survival rate for each year-class – by sex)

- Cumulative juvenile survival rates (12-60 months)
  0.412 (0.26 – 0.64) *controls = 0.413 (0.27 - 0.55)*
  do *not* support *hypothesized* recovery
  and still appear *below* pre-decline rates
  BUT: age-bias!

- *Holmes et al. 2007:*
  Pre-decline estimate: *0.64*
  Peak decline estimate: *0.36 (0.33-0.40)*
  Modeled post-decline: *0.61 (0.59-0.66)*

Updated contemporary *survival schedule* for region:
(survival rate for each year-class – by sex)

- 50.3% of females born are consumed before primiparity
  32.7% survive to primiparity
- Survival schedule supports *natality* >= 0.69
  (*Maniscalco et al. PLoS ONE 2010*)
  for a steady or increasing population
- We find no support for the hypotheses advanced
  by Holmes et al. (Ecol. Appl. 2007)
  of recovered juvenile survival,
  and depressed natality – *right now, in this region*.

So what?

A density-dependent *qualitative* model using the updated survival schedule to evaluate:

- How is predation possibly linked to other vital rates (births)?
- How would that affect other vital rate metrics and the population trajectory?

Model fine print

Modified birth-pulse *Leslie Population Matrix*

using updated contemporary survival schedule

No fecundity schedule, not time variant!

constant natality assumed

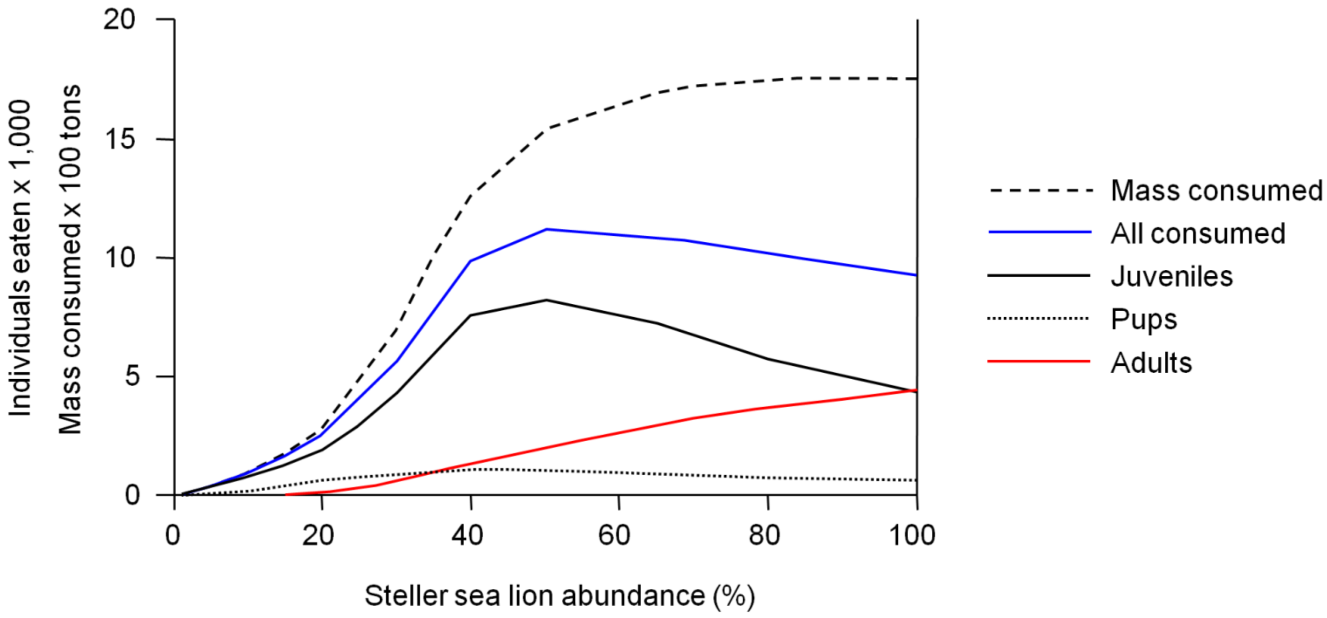
2 components of survival schedule:

- Non-predation mortality held constant
- *Age-structured* consumption by predators *varies with density*!

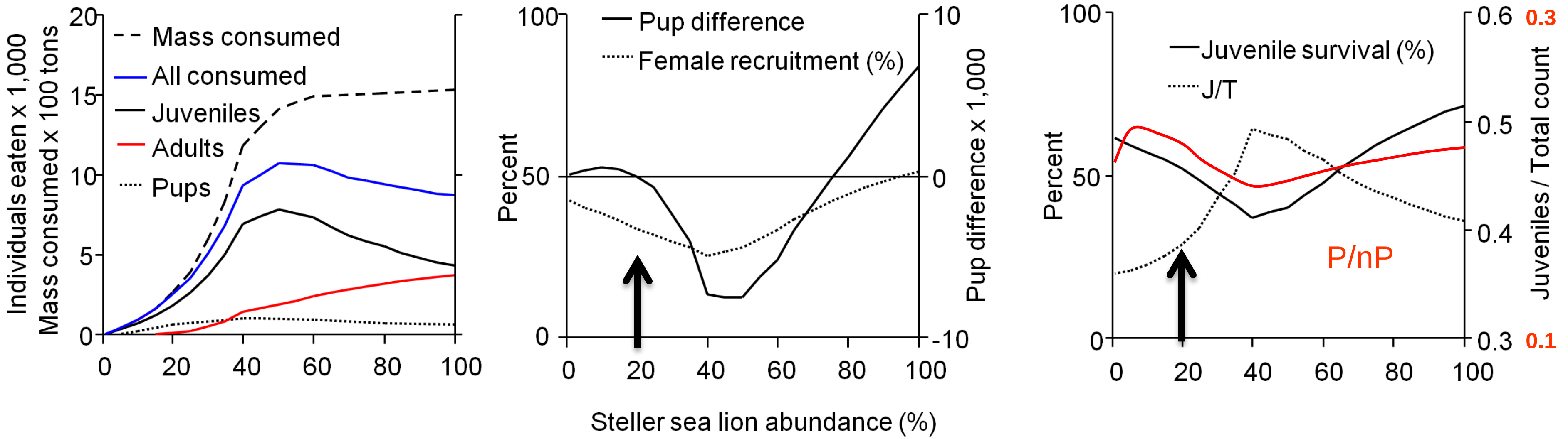
Assumptions:

(1) As there are fewer sea lions, predators shift to eating more younger animals!

(2) Constant birth rate (natality)!



- Pup difference = *Potential trajectory*, matches decline data <70%
- J/T matches retrospective analysis (Holmes et al. 2003, 2007)



- Female recruitment cut in half *without any changes in natality*
- P/nP lowest at steepest decline

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CONCLUSIONS

- Predation *could* effectively reduce the reproductive potential of the population by 50% @ const. natality
- Even theoretical natality = 1 would only shift equilibrium density from current 20% to 30%
- Predation is likely biggest constraint on the recovery of the species in the region
- Escape from ‘*predation-driven productivity*’ pit may only be possible at reduced predation

CONCLUSIONS

- Our findings apply to the present time and the Gulf of Alaska only
- Holmes et al. 2007 model predictions are unrealistic within GOA and certainly outside
- P/nP is a poor estimator of birth rates
- Recruitment, potential trajectory and P/nP are ***all*** linked to and affected by predation

Next steps:

Develop LHX-2 (NSF funding)

50% volume for work on smaller species

Parturition detection:

age at primiparity

lifetime reproductive success

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