

This presentation reflects ongoing research and all content should be considered preliminary. Please do not cite the presentation or its content without explicit permission from the senior author.

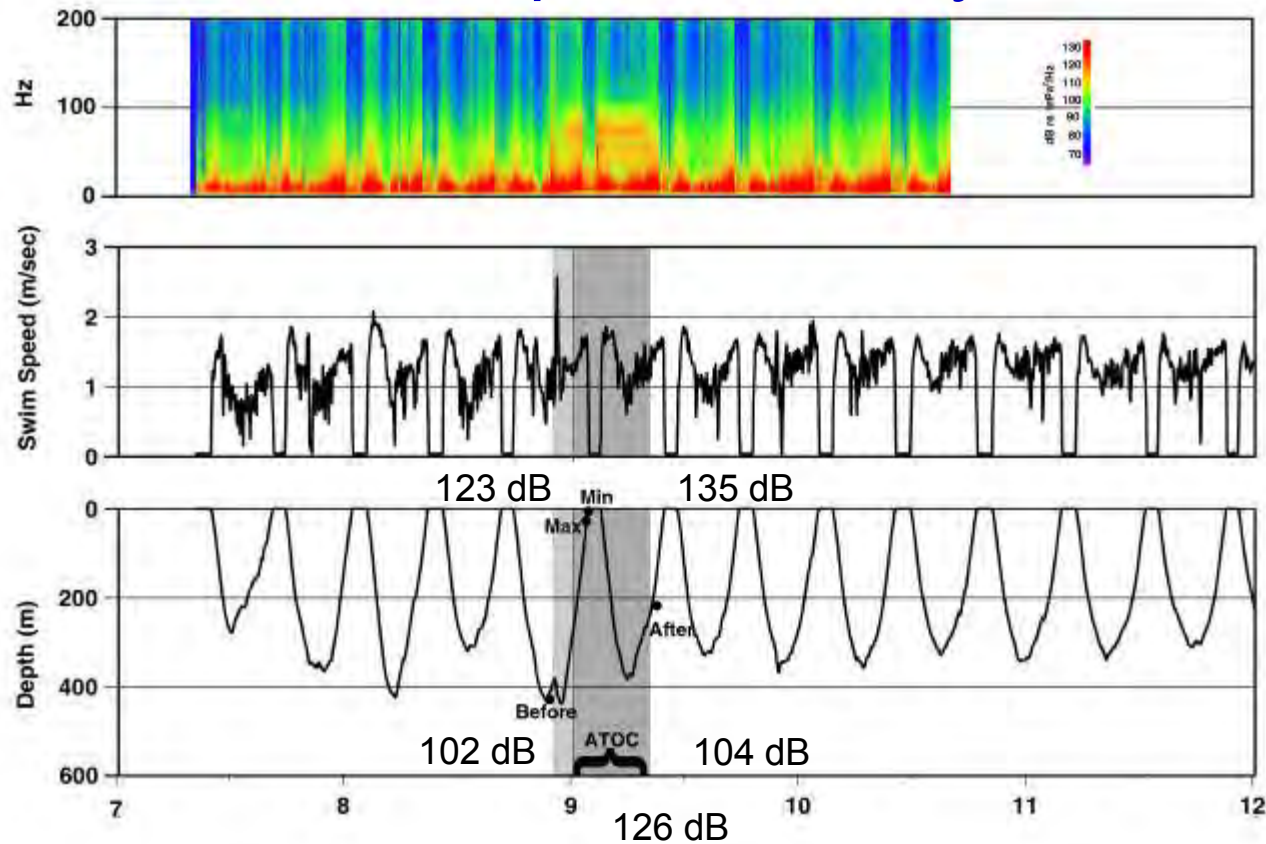
Environmental Variation and Experimental Manipulation as Proxies for Disturbance in Elephant Seals



Daniel Costa¹, Lisa Schwarz¹, Patrick Robinson¹, Daniel Crocker¹,
Marm Kilpatrick¹, Clive McMahon², Mark Hindell³, Leslie New⁴,
Rob Schick⁵, Len Thomas⁴, John Harwood⁴, Jim Clark⁵



Proven Experimental System

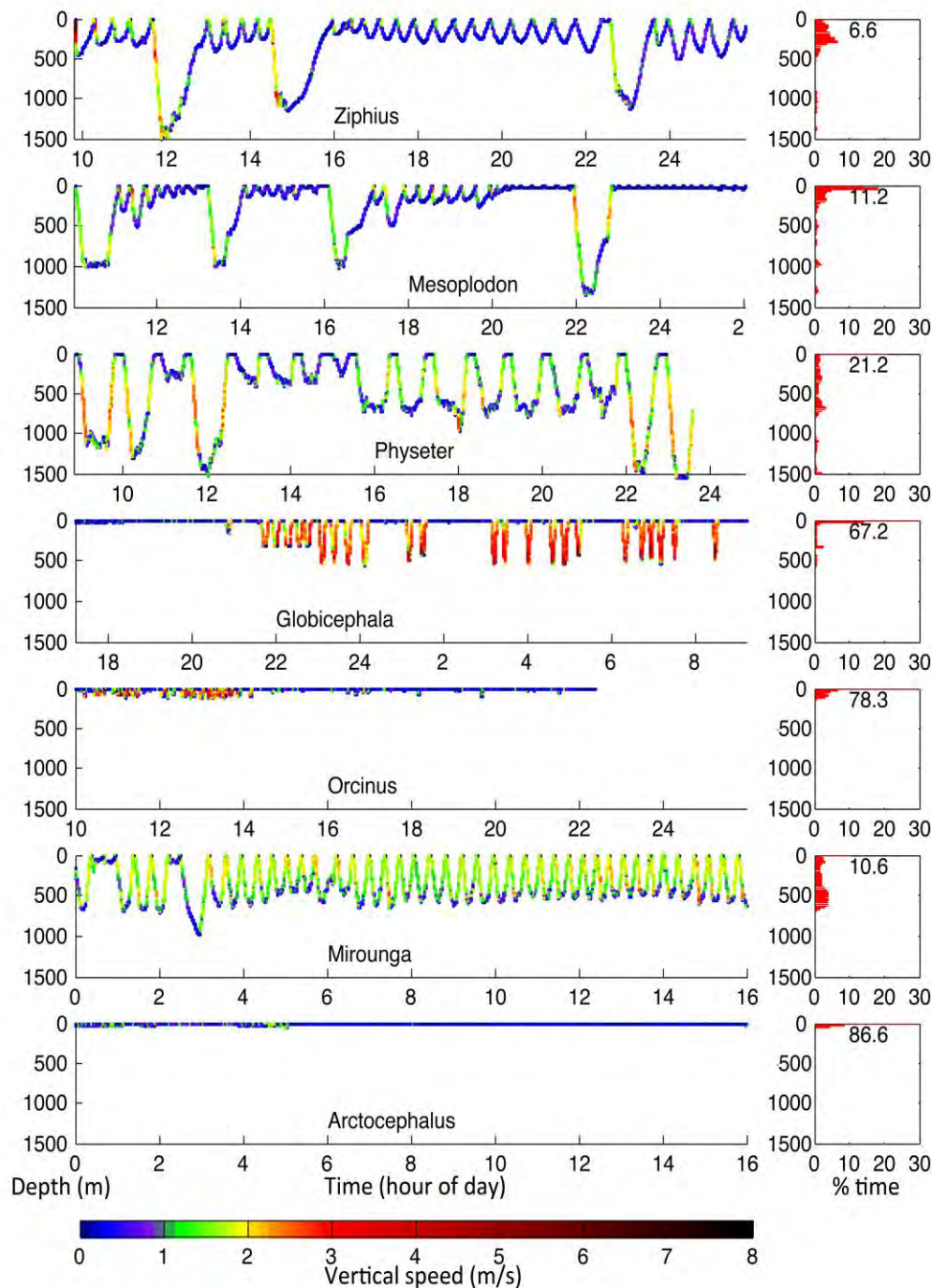


Costa, Crocker, Gedamke, Webb, Houser et al. 2003 JASA

Burgess, Tyack, LeBoeuf, and Costa 1998. Deep Sea Res



Beaked whales



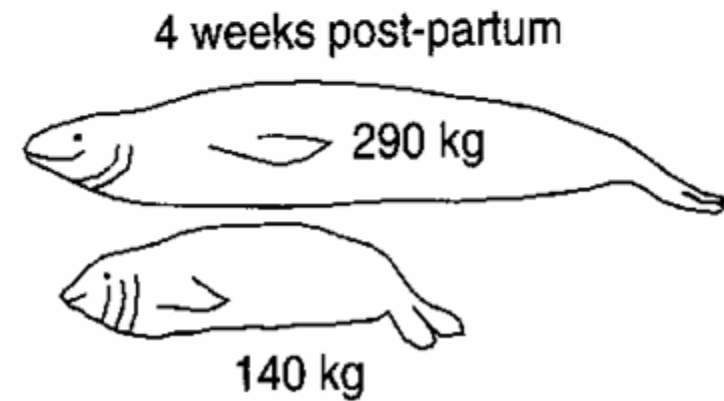
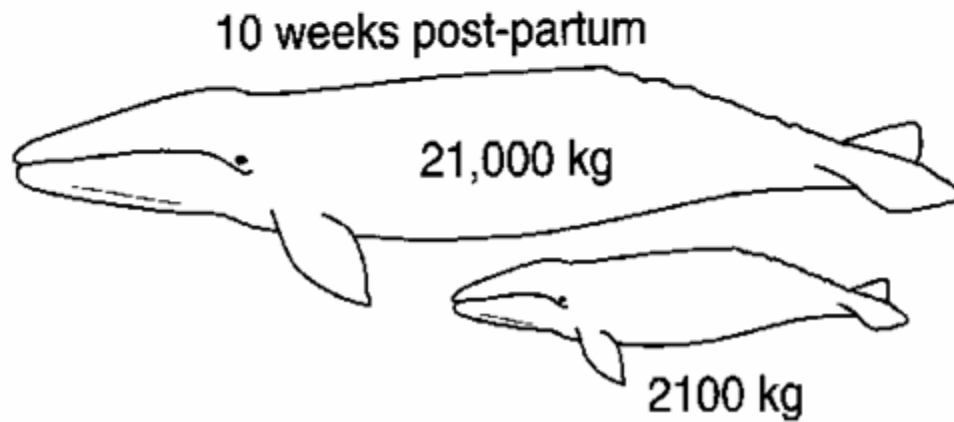
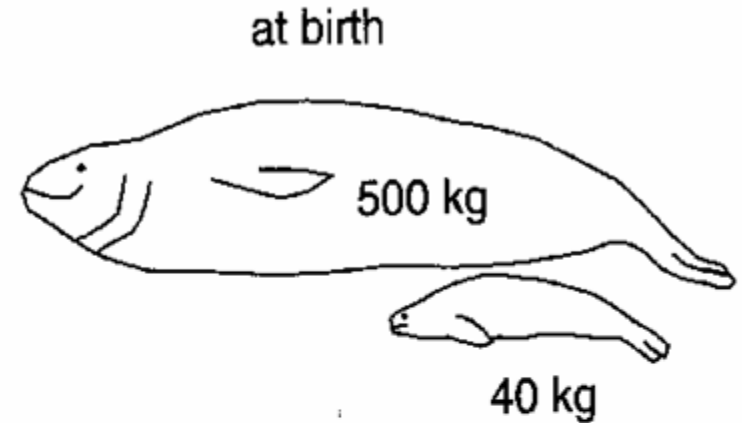
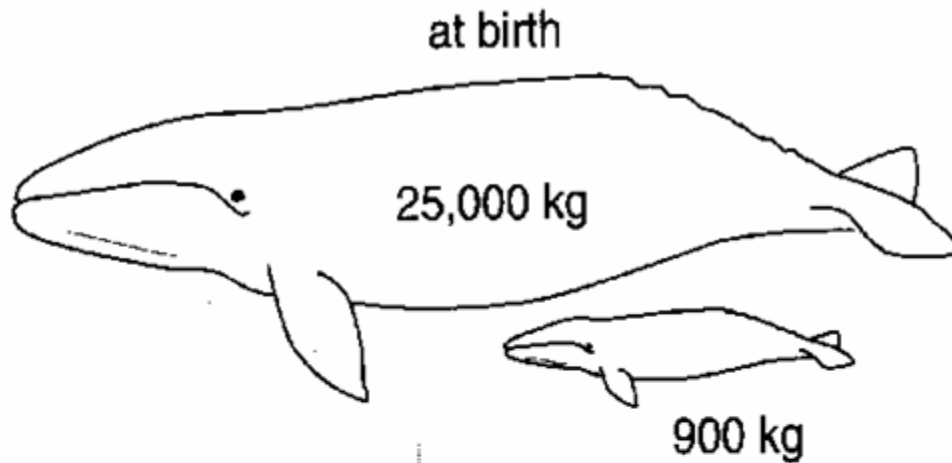
Diving Behavior
Comparable to
Beaked Whales

Elephant Seal

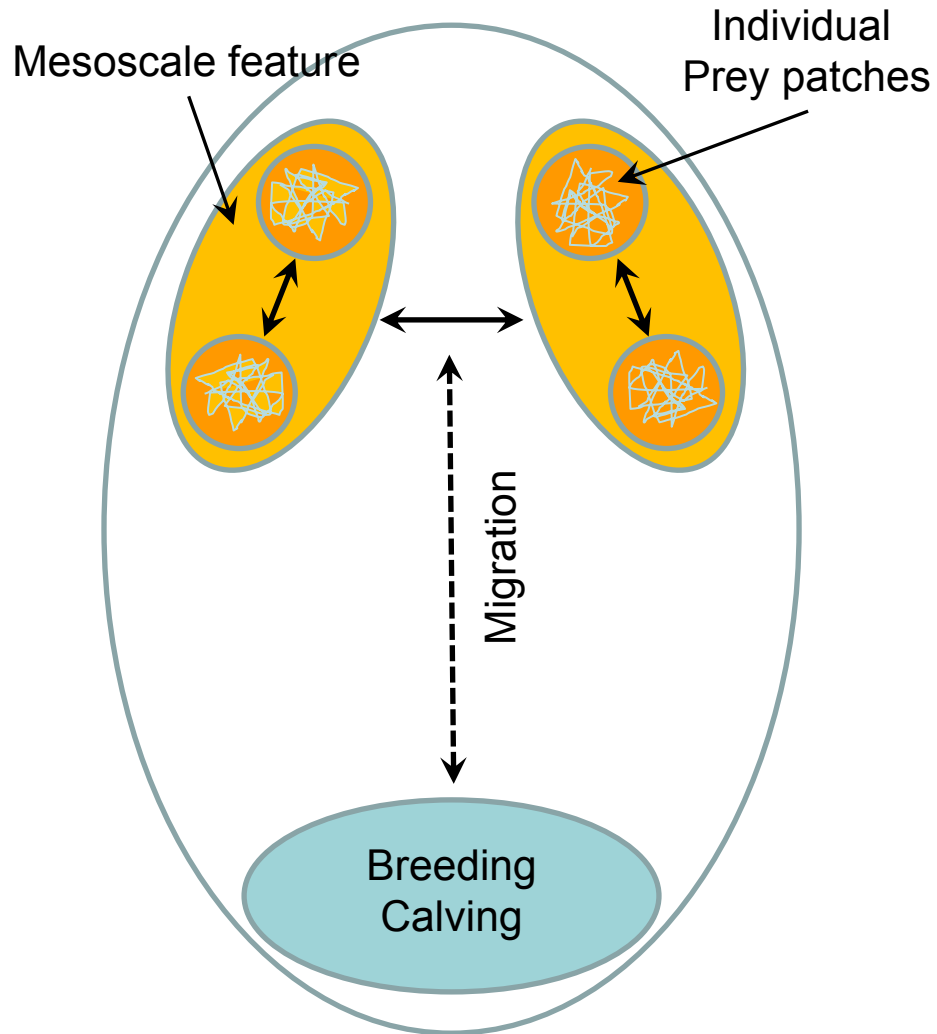


Hooker et al
submitted PRS

Elephant seals can be used as a Model Capital Breeder

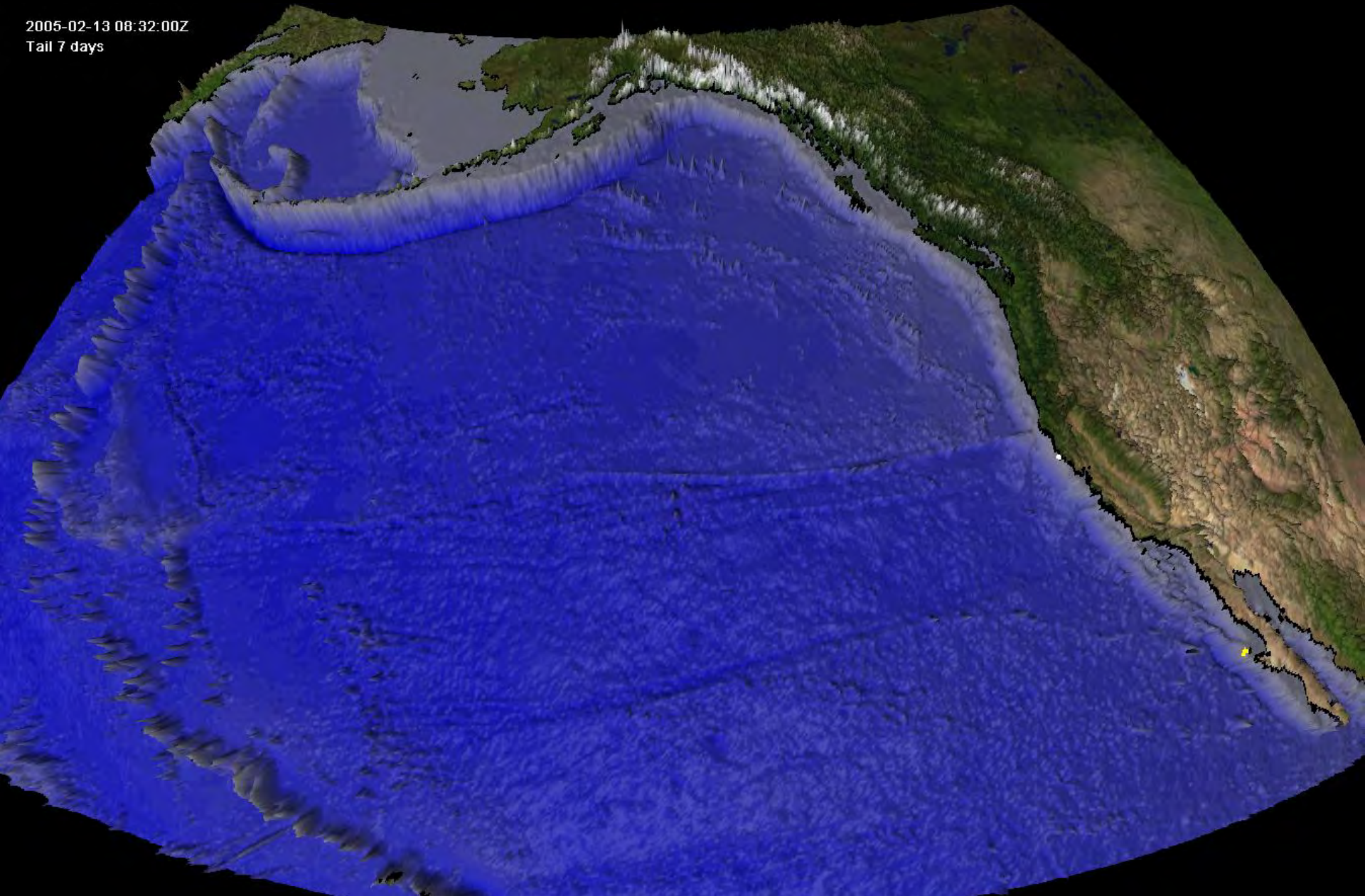


Linking At-Sea Foraging Behavior to Reproductive Success

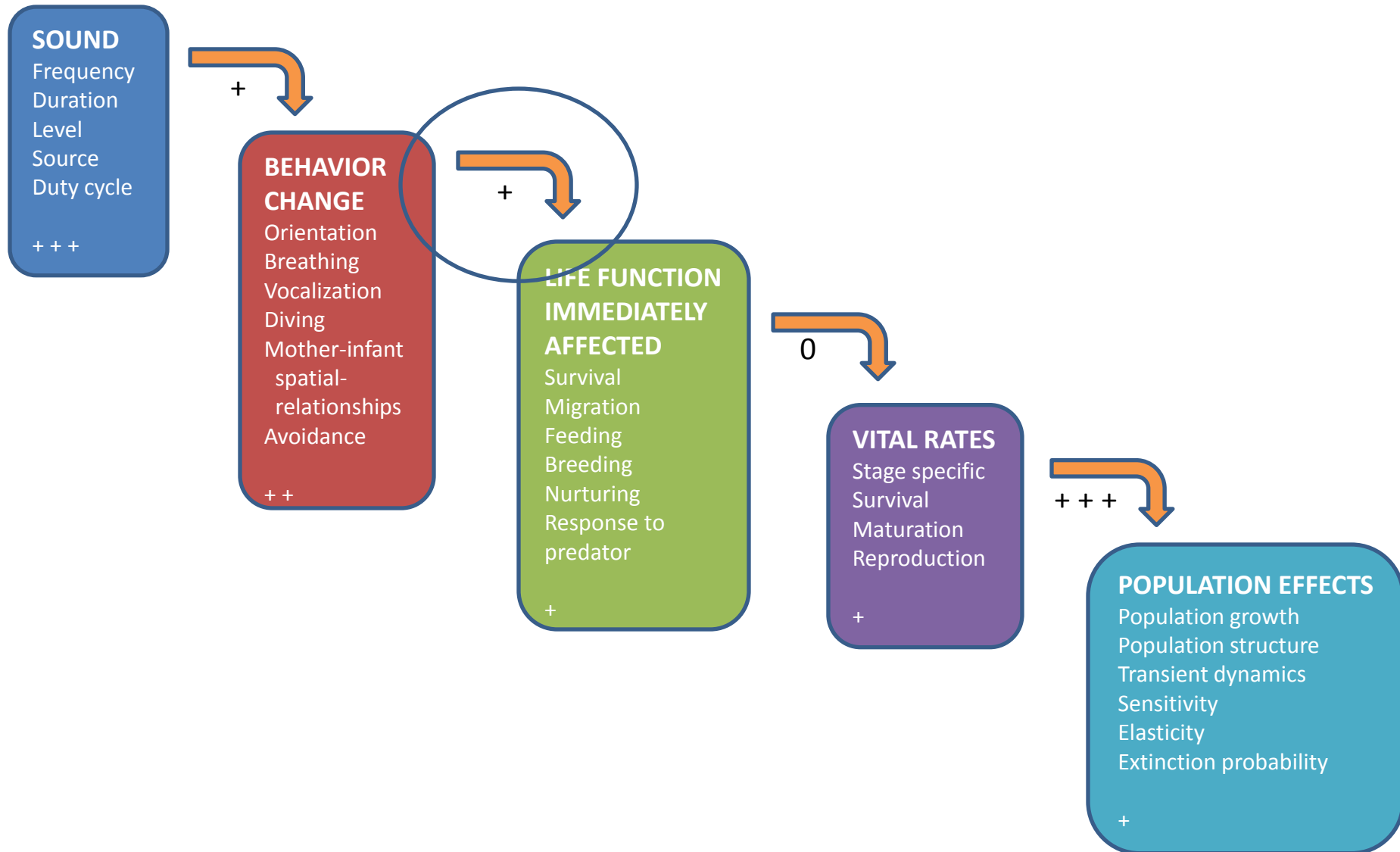


Elephant Seal Migration

2005-02-13 08:32:00Z
Tail 7 days



PCAD conceptual framework



Connecting Reproductive Success.....



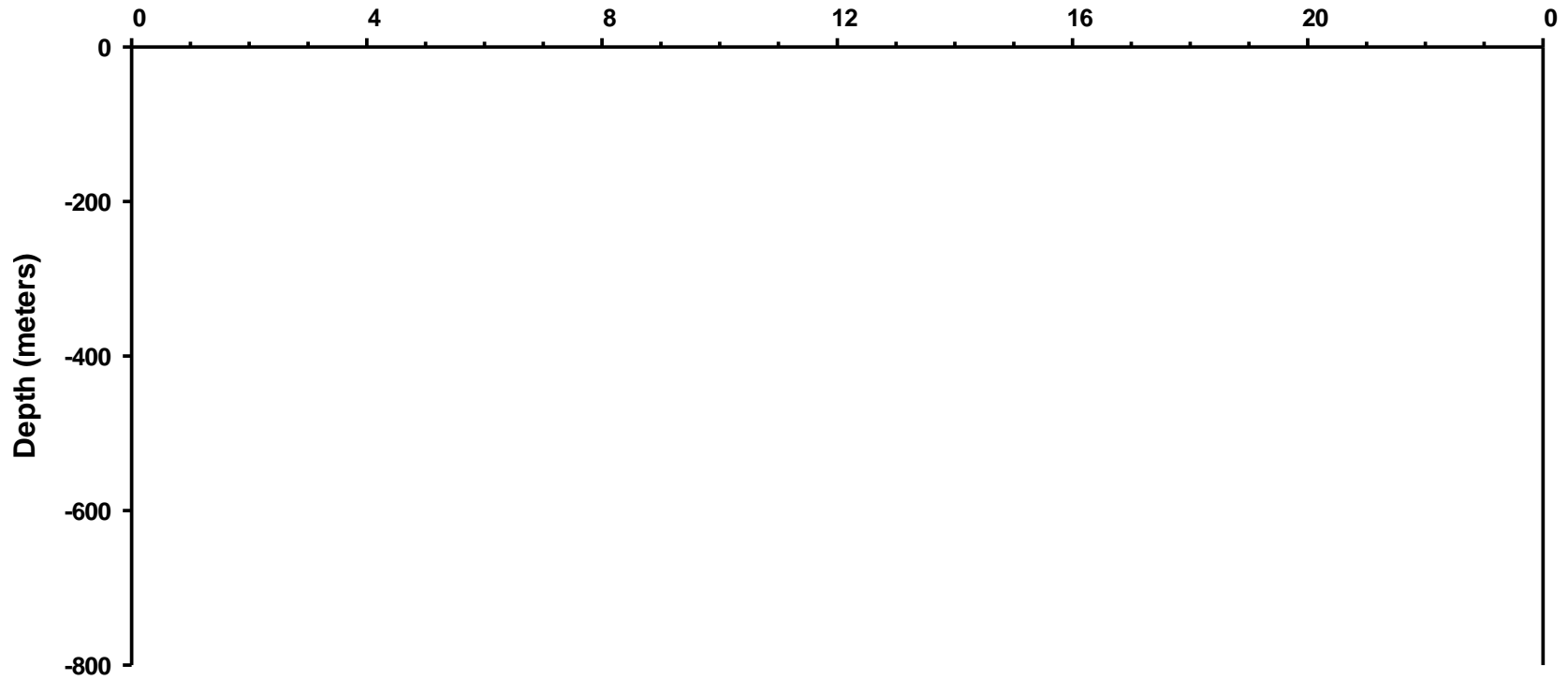
...With Foraging Success



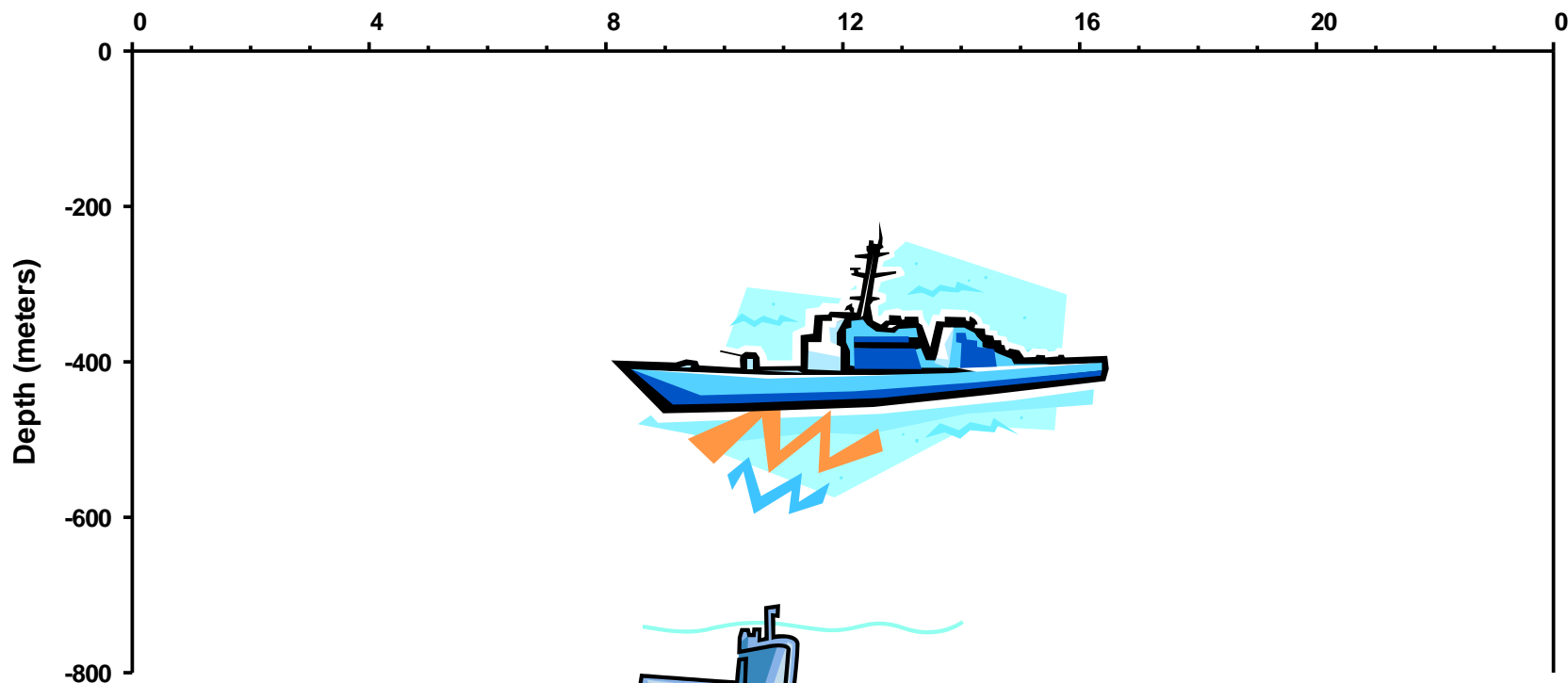
...and Alterations in Foraging Success



An Elephant Seals Day at Sea



Response to Acoustic Disturbance



2004-2010

233 Adult females

4-14 yrs old

Body composition-

Mass fat and lean

Energy content

At-sea migration track

Trip duration & location

Diving behavior

Depth, Duration, Pattern

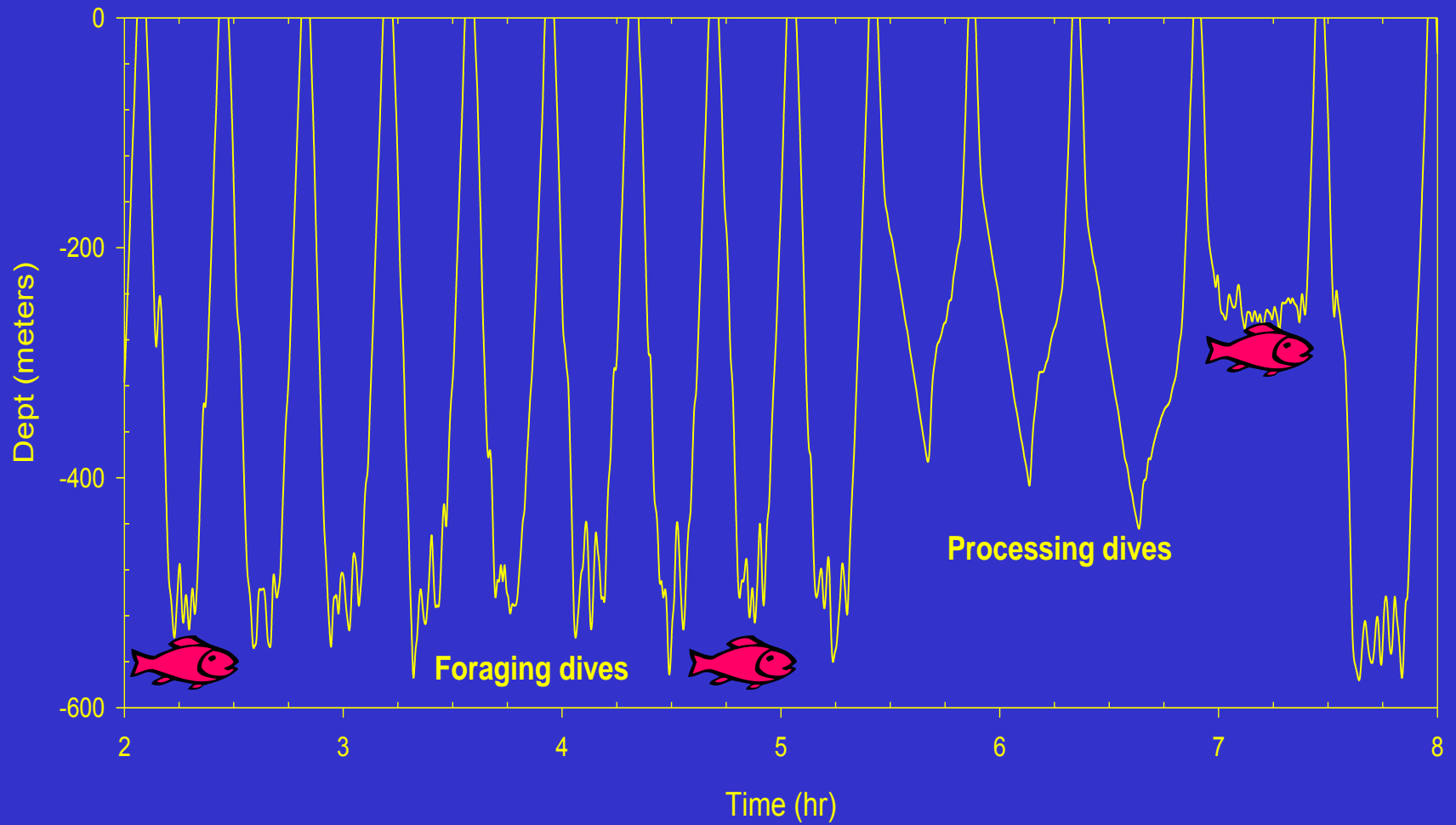
Vital parameters

Survived- Pregnant

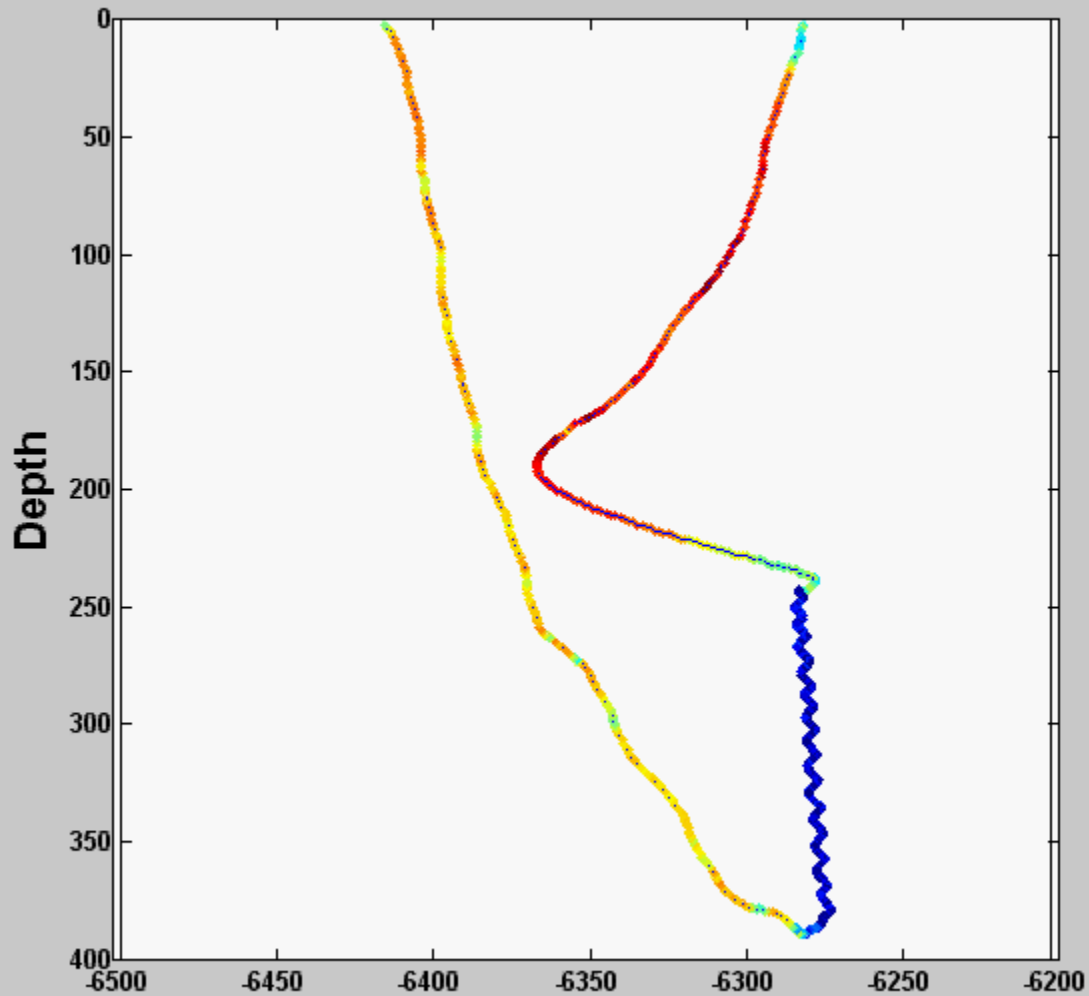
Pupped- mass

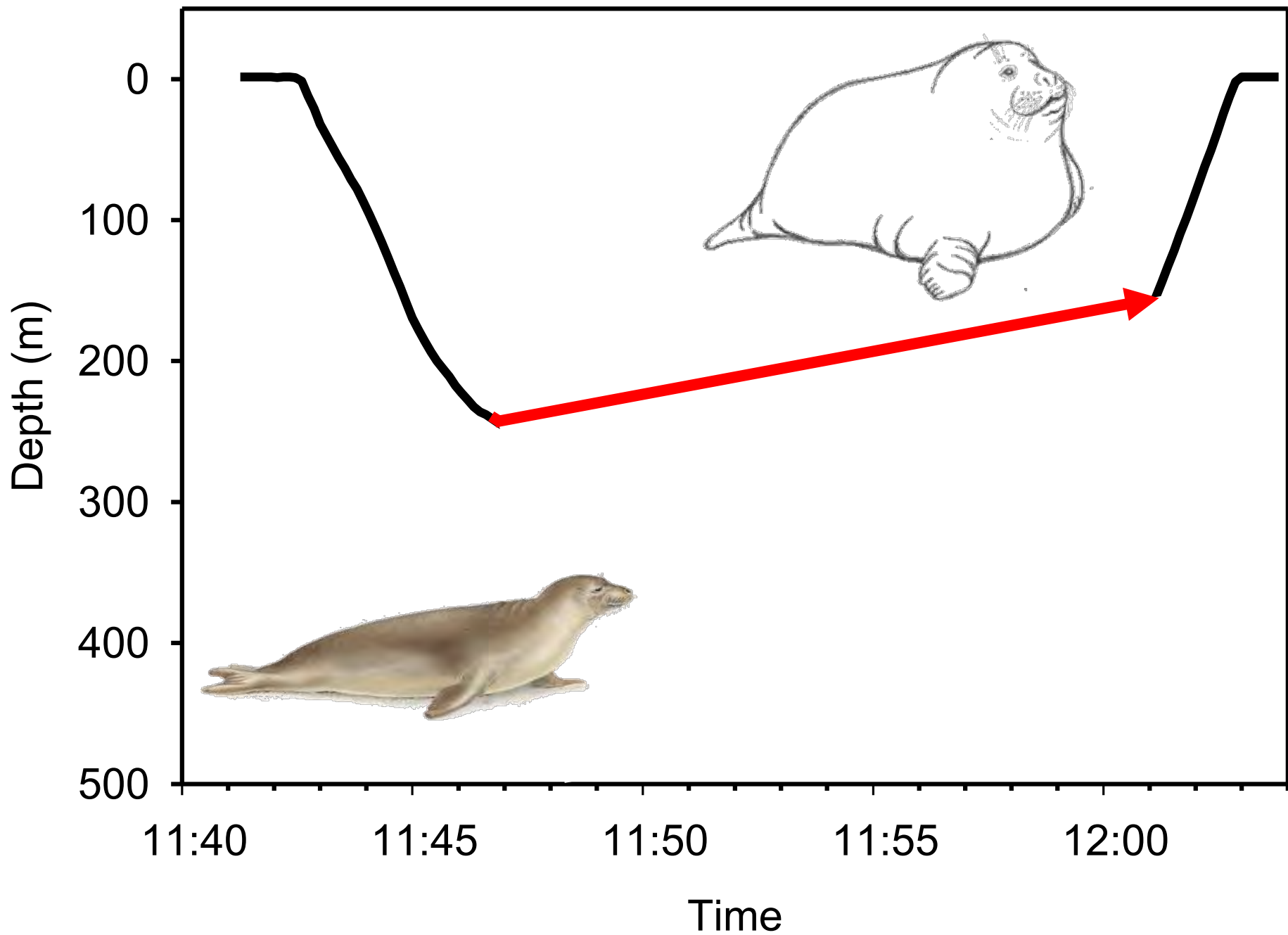


Female Elephant Seal Diving Pattern

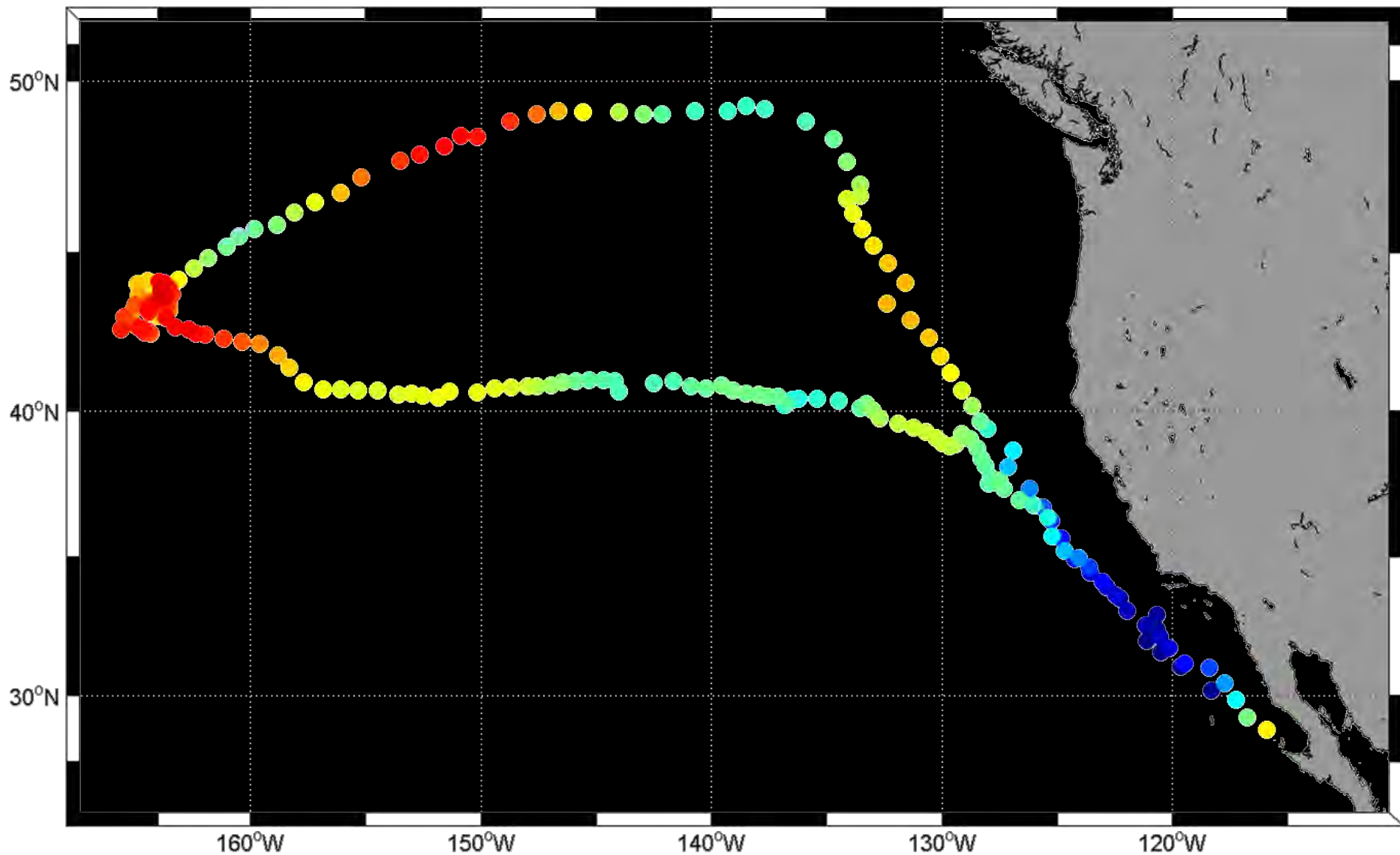


Drift Dive → Buoyancy → Health

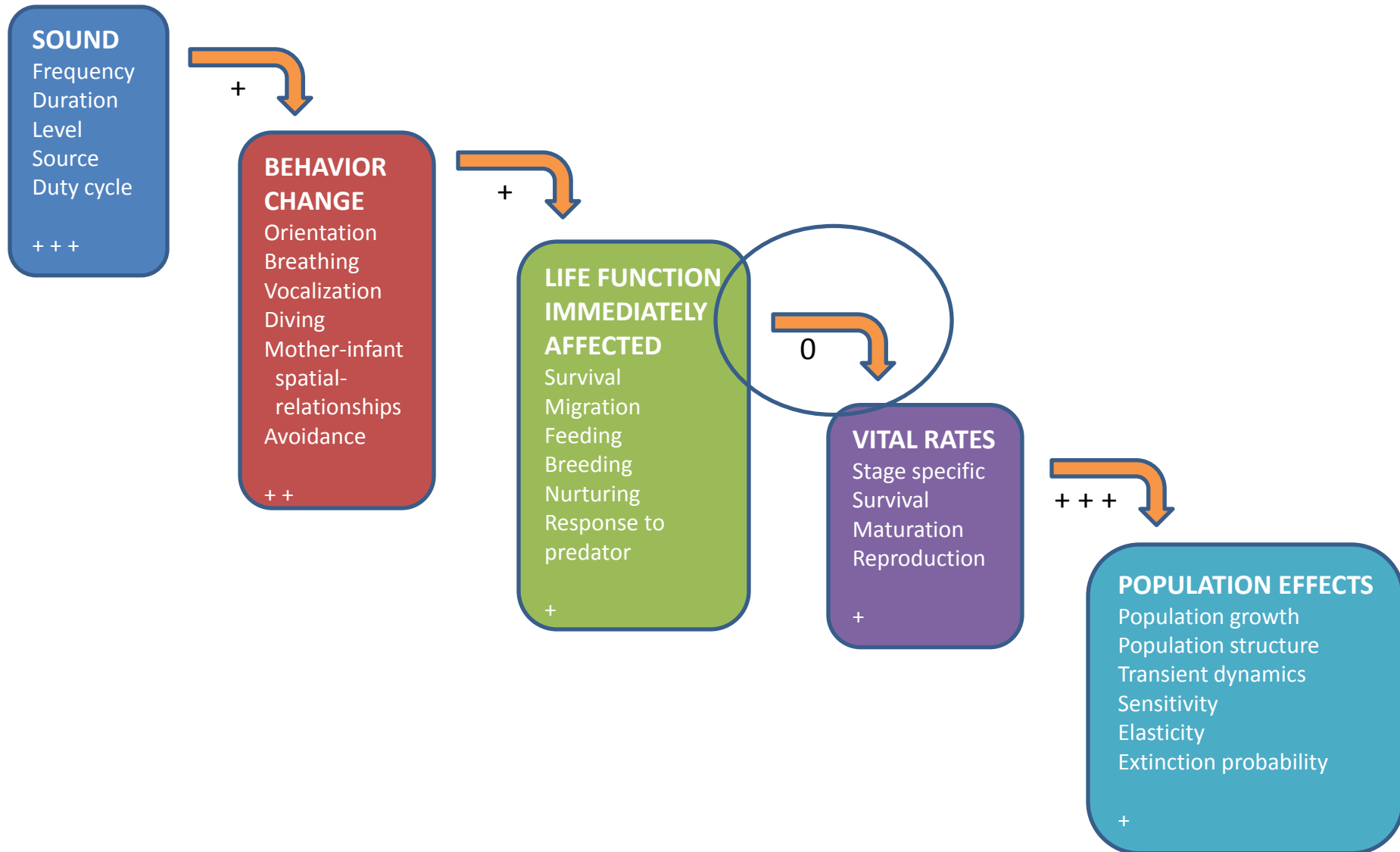




Δ Drift Rate



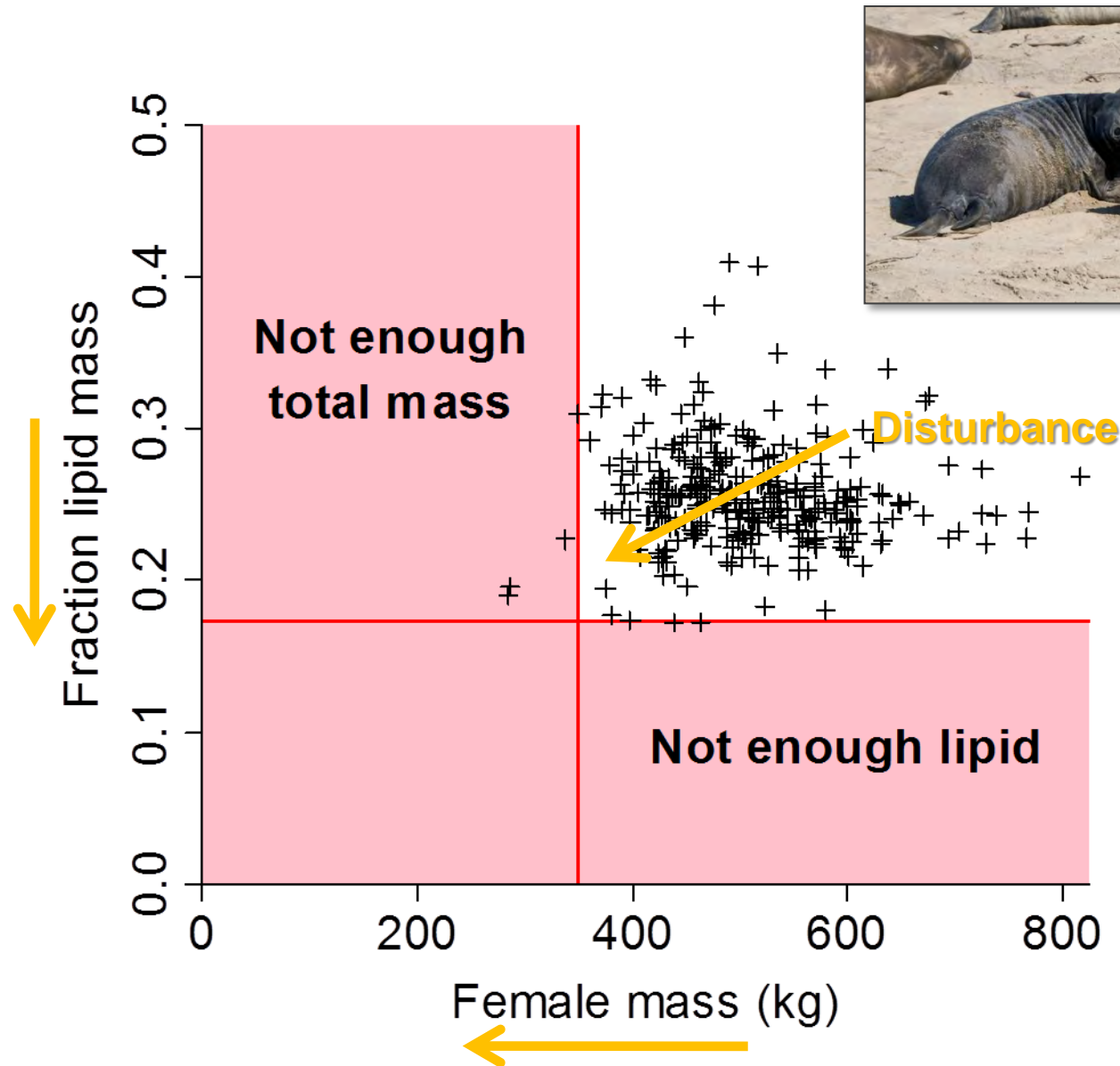
PCAD conceptual framework

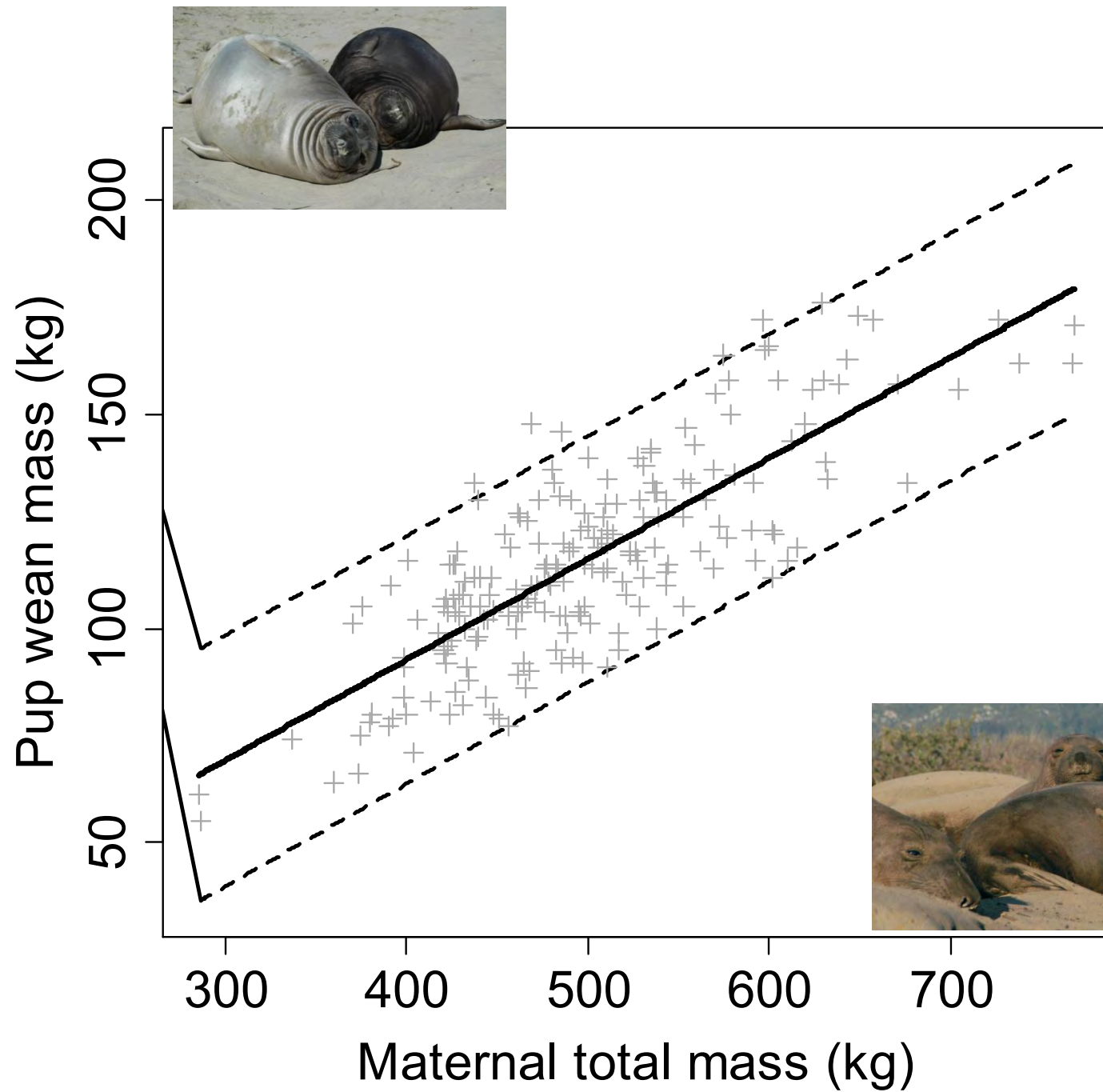


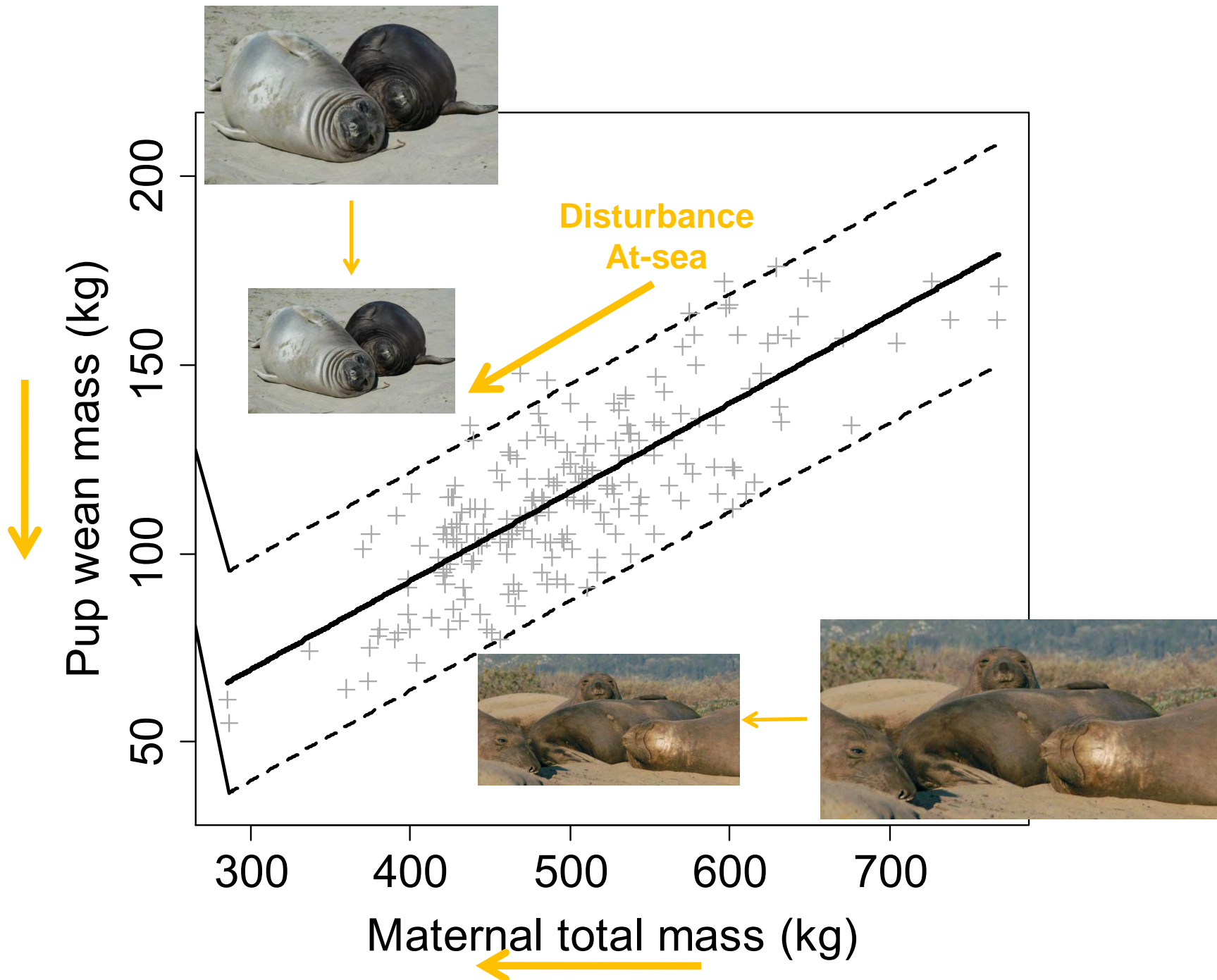
Connecting Female Mass Gain to Reproductive Success & Pup Survival and Recruitment



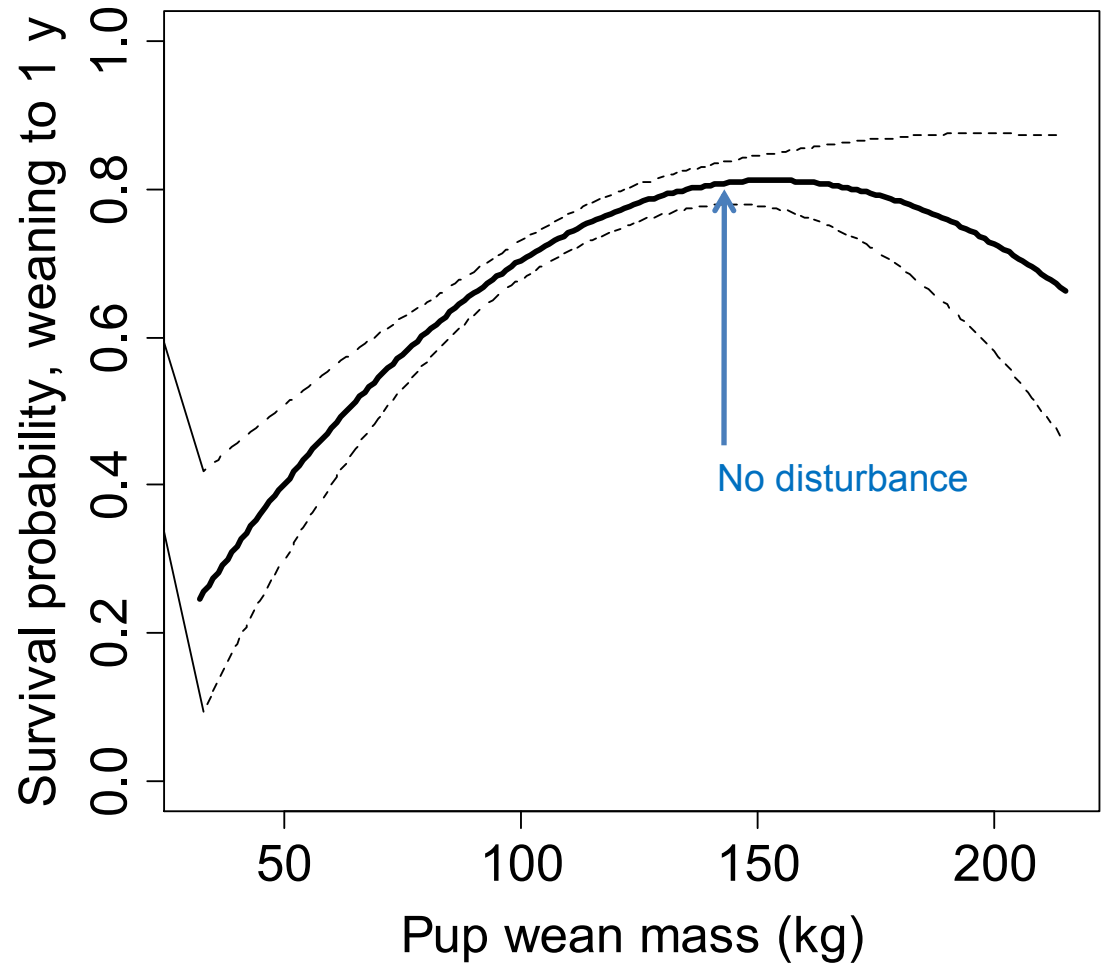
Foraging Success (Mass) and Reproductive Output







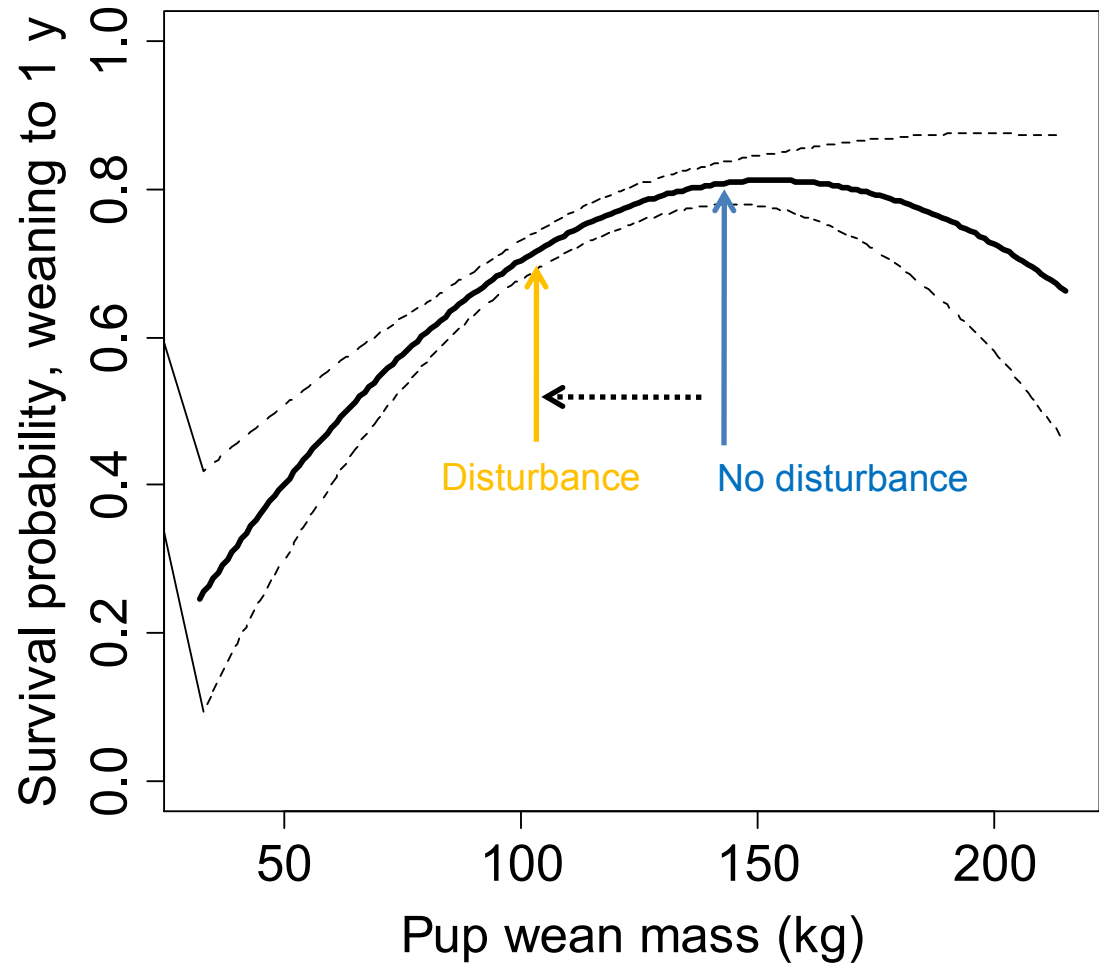
Survival is a function of weaning mass



Survival is a function of weaning mass



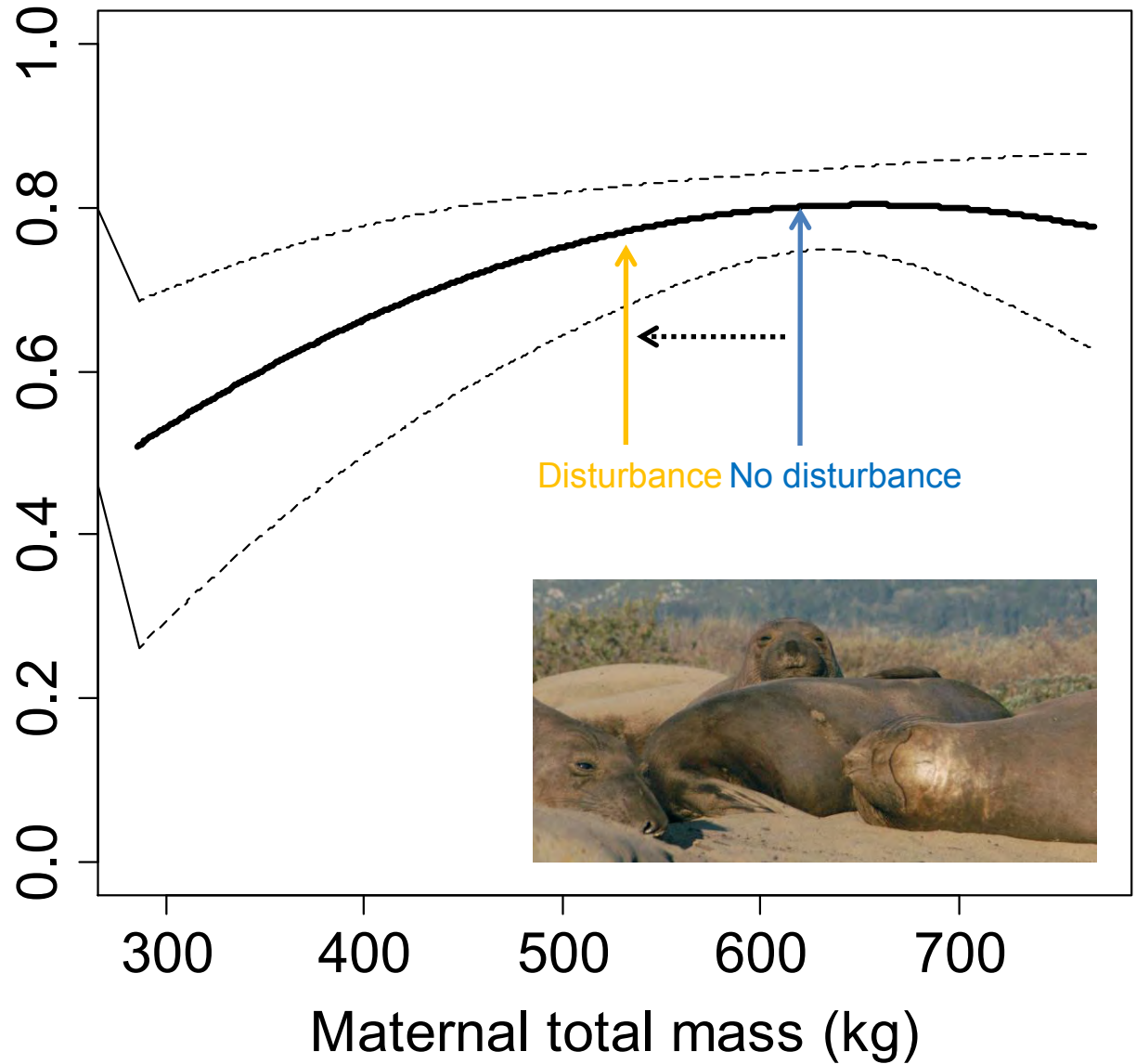
Disturbance



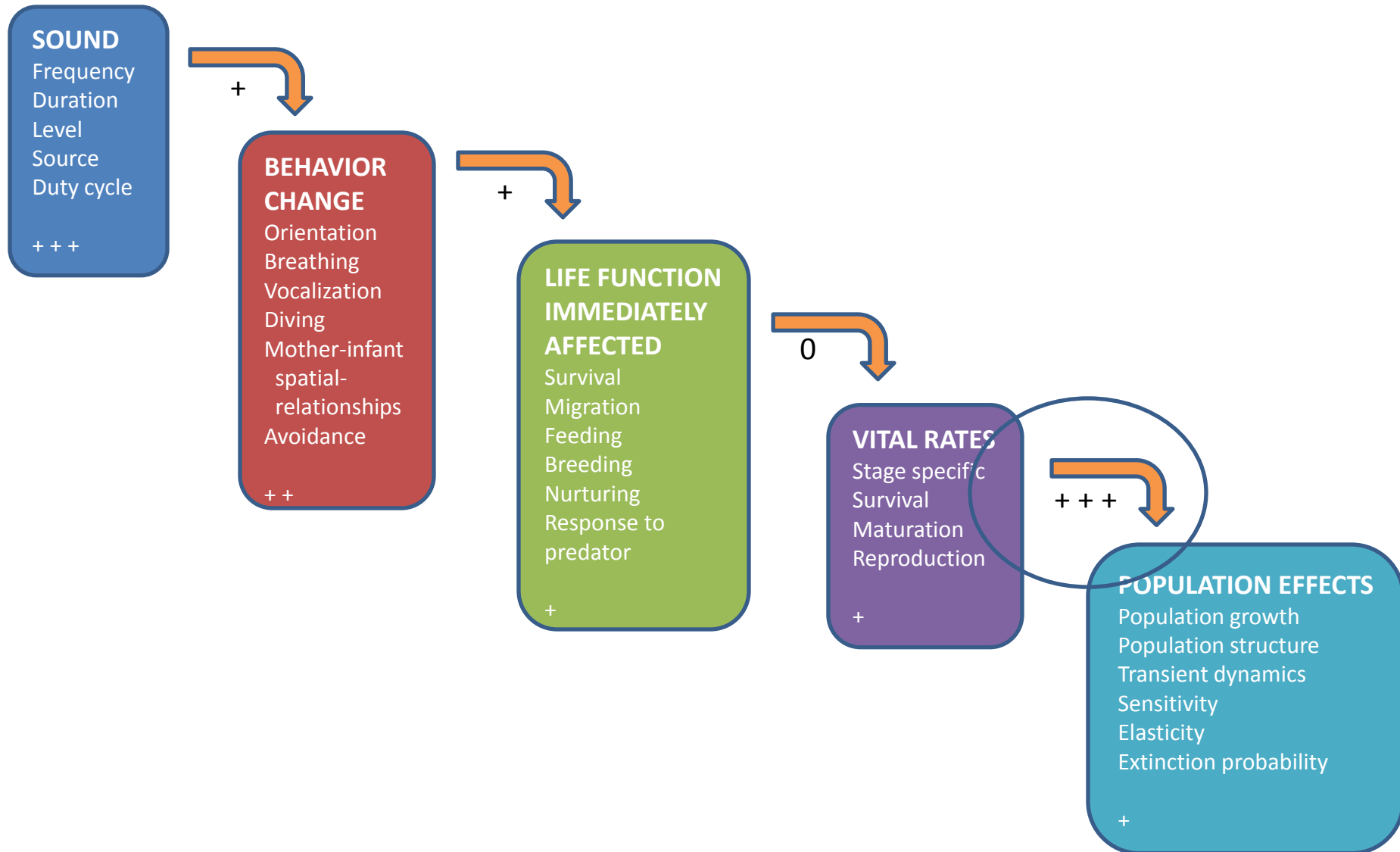
Integrated Response

Maternal Mass Predicts Pup Survival

Pup survival probability, weaning to 1 yr



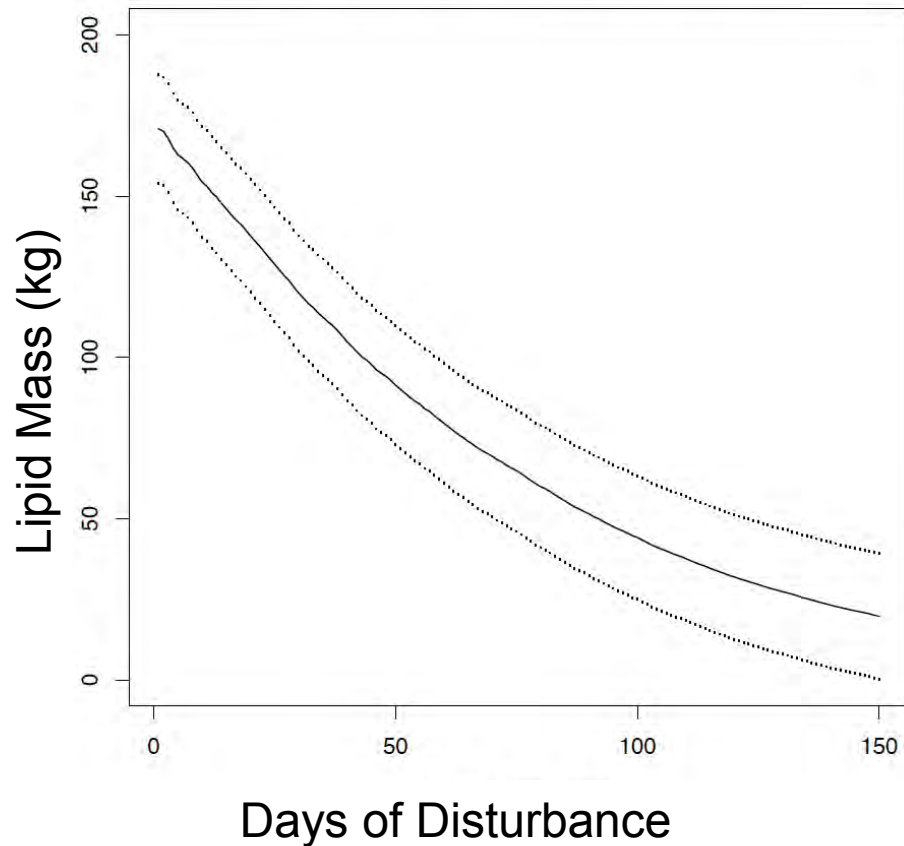
PCAD conceptual framework



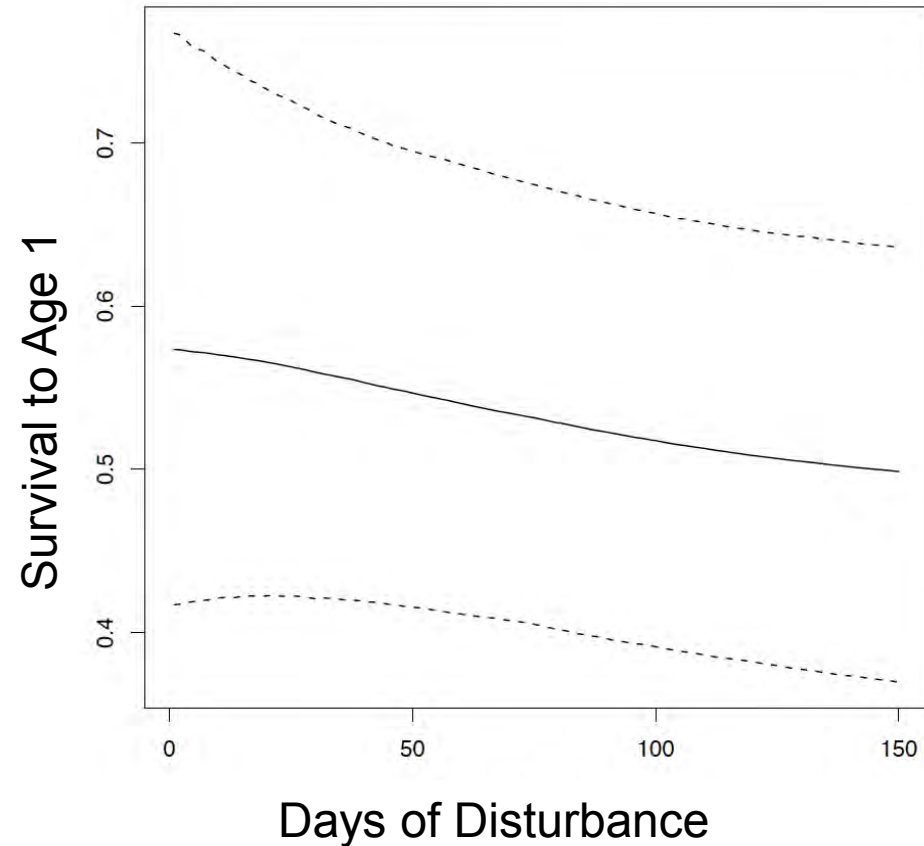
Population Level Effect



Effect of Disturbance on Lipid Mass



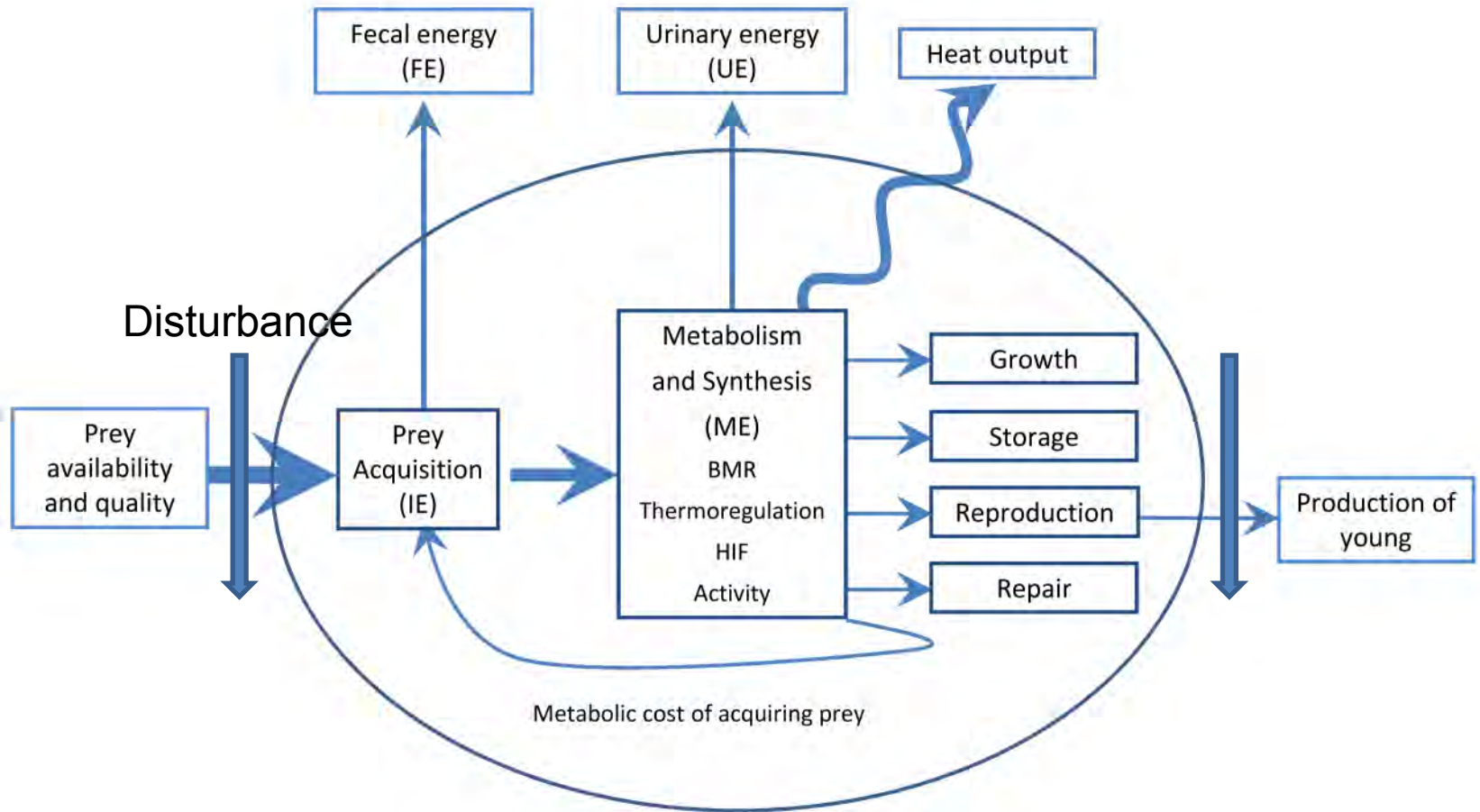
Effect of Disturbance on Survival



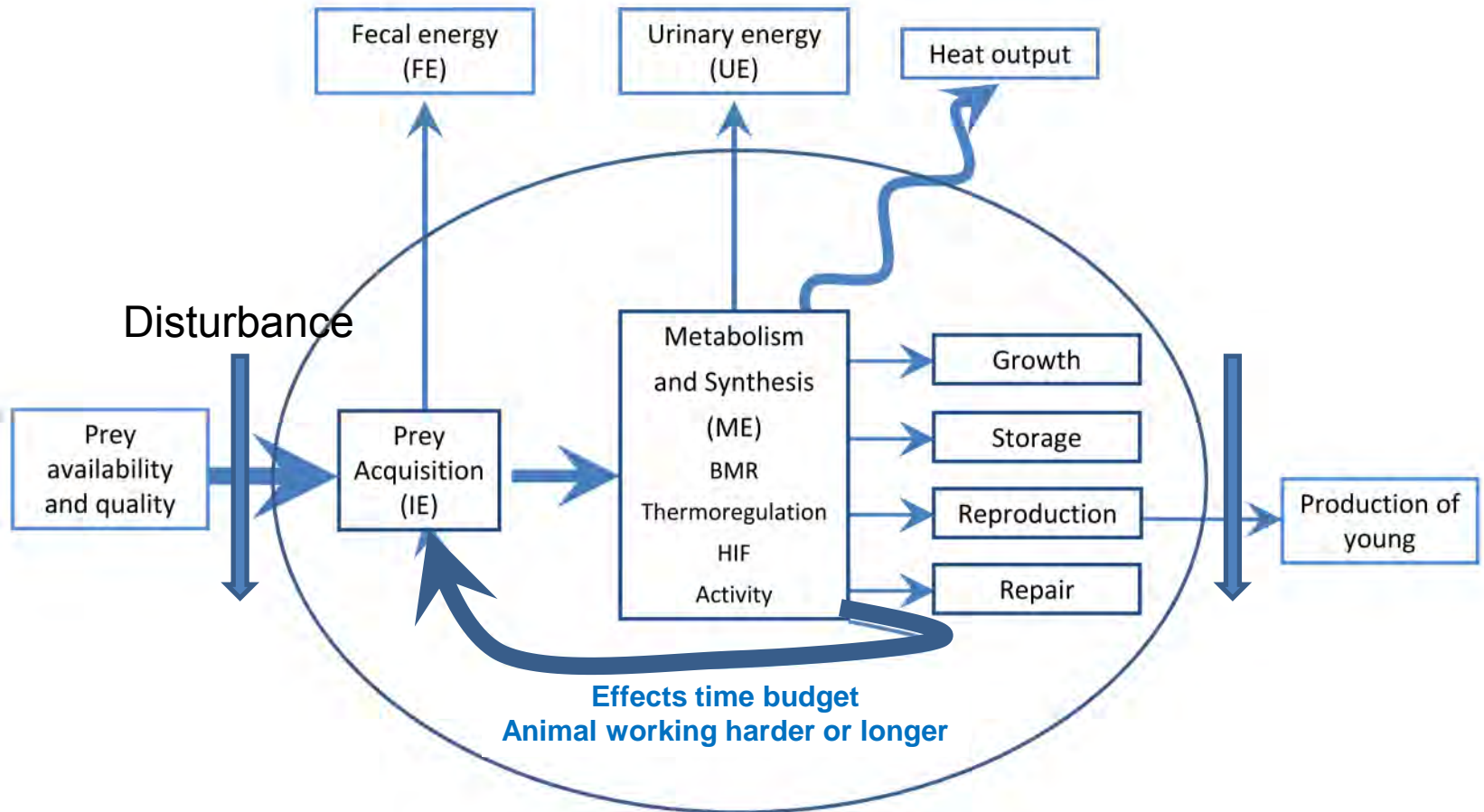
Measurements of Resilience to Disturbance



Bioenergetic Model



Bioenergetic Model

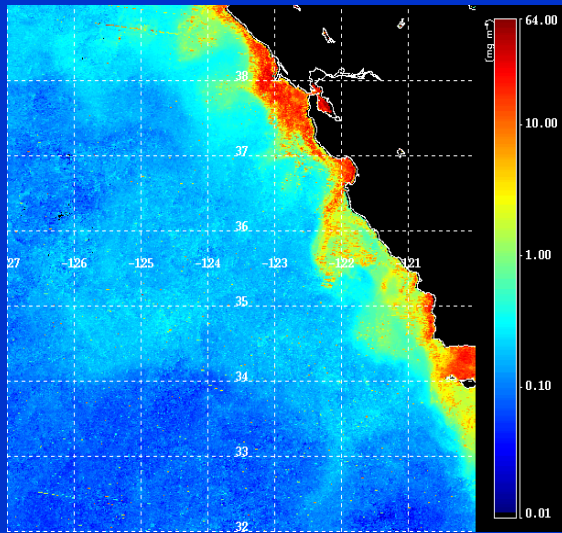


Marine Habitats Are Spatially and Temporally Variable

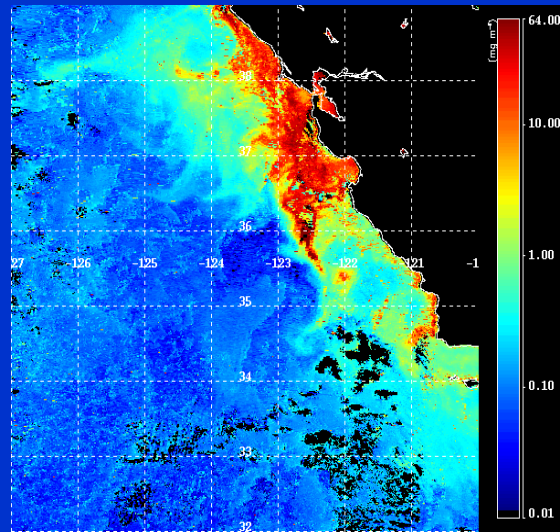
SeaWifs Chlorophyll

El niño

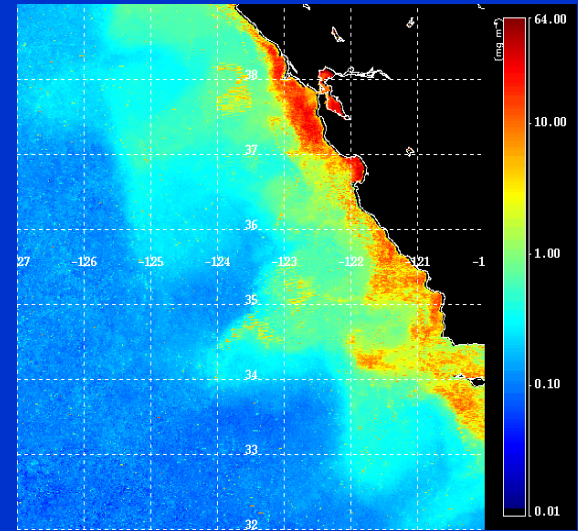
Spring 1998



Summer 1998

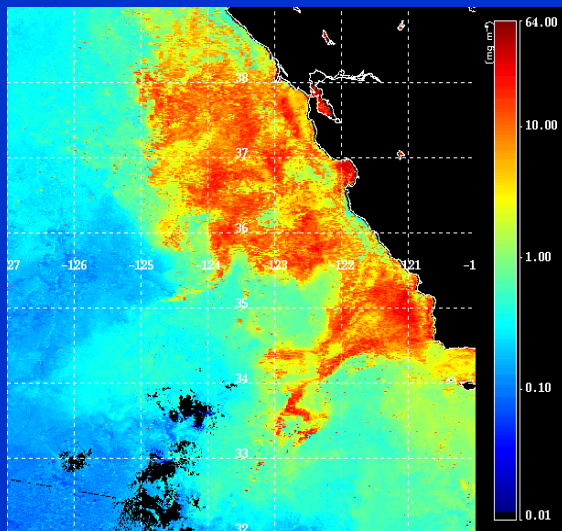


Fall 1998

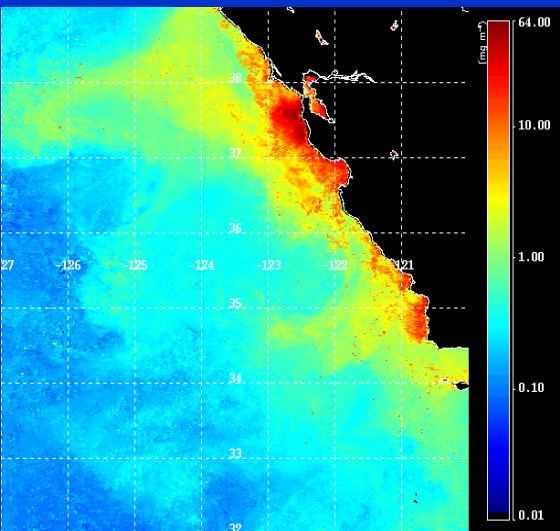


La niña

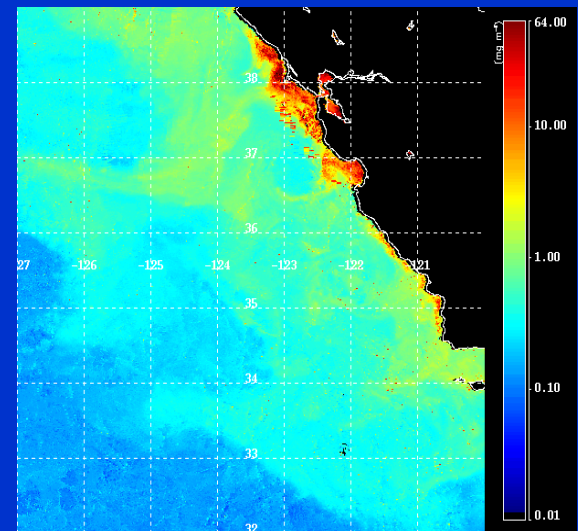
Spring 1999



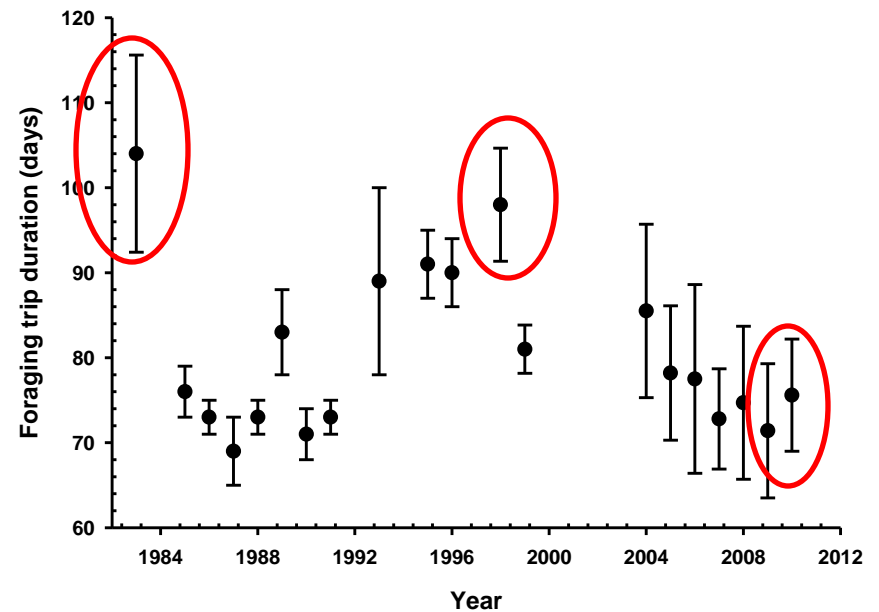
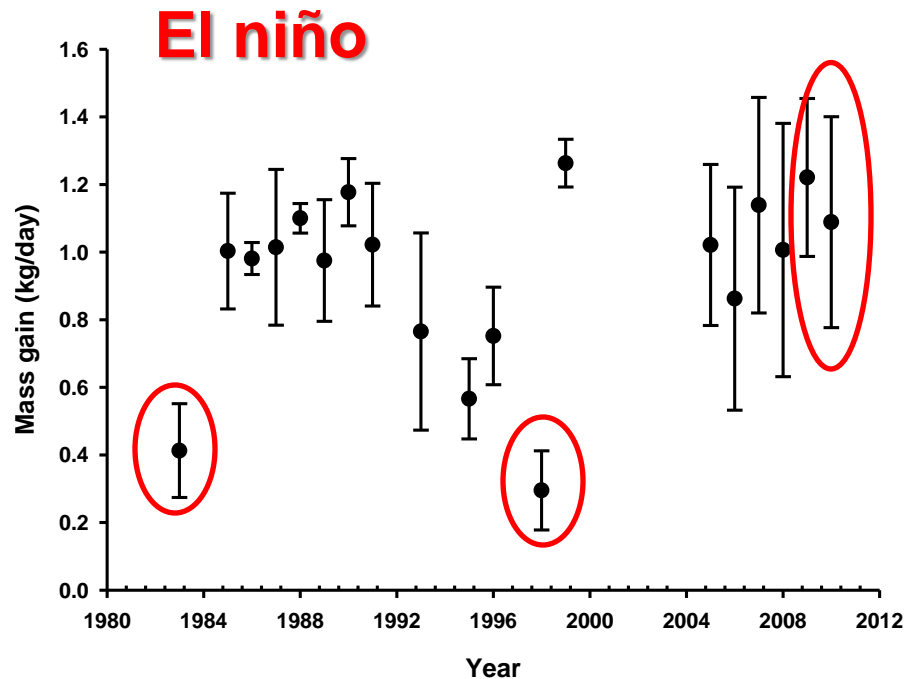
Summer 1999



Fall 1999



Response to Interannual Environmental Variability

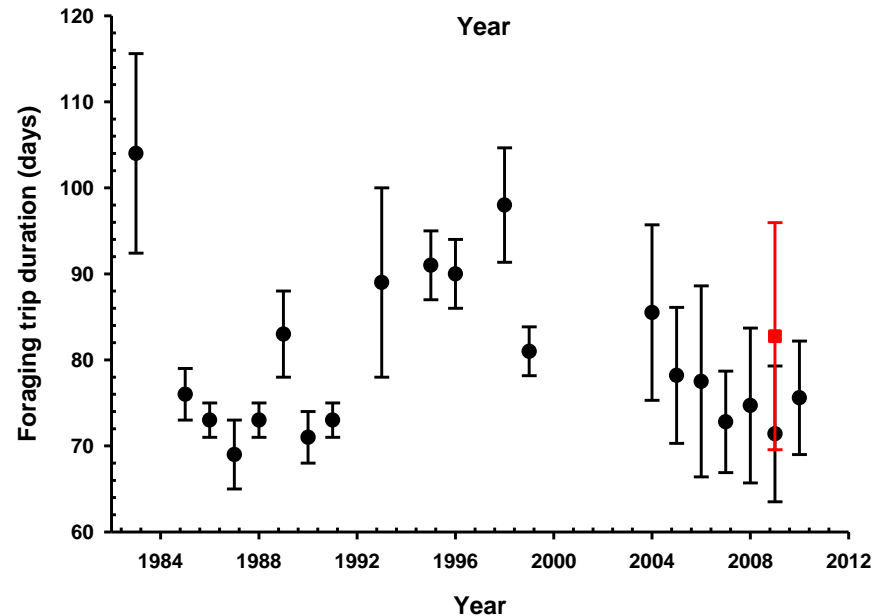
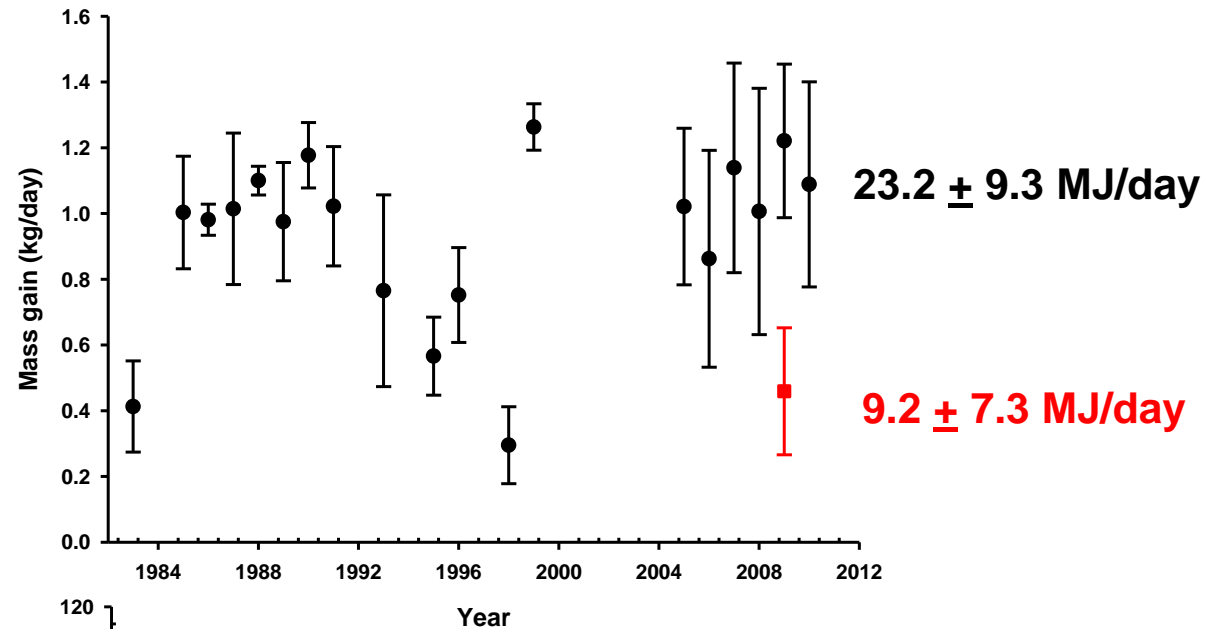
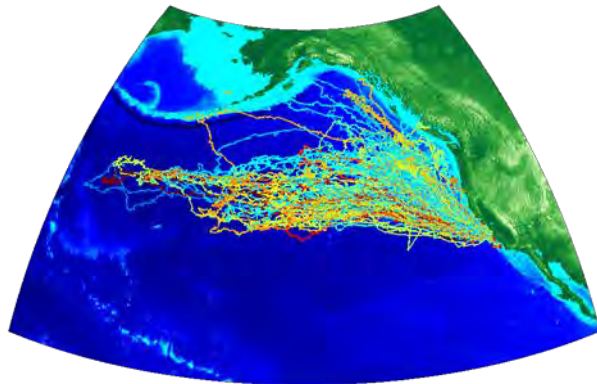


Experimental Disturbance



Acoustic Data Logger Decreased the
Foraging Ability

Experimental Perturbation Decreases Foraging Success



Females in Drag Experiment One Year Later

2010

Season mean = 85.5 (43-123 kg)

G1234: 21.5 kg mass gain

GX874: 32.2 kg mass gain

GM780: 32.2 kg mass gain

GX871: 50.1 kg mass gain

2011

Looks healthy with pup

Sighted with pup

Sighted, looks healthy with pup

Has not been sighted since instrument recovery



Future Directions

What capacity do these animals have to compensate for lost foraging opportunities?

How does disturbance affect activity budgets (foraging, transit, rest, etc.)?

What are the energetic consequences (mass/lipid) associated with these changes in time-activity budgets?

Test predictions of the ONR-PCAD model against actual disturbance data (ENSO events, pup growth and survival, adult survival)

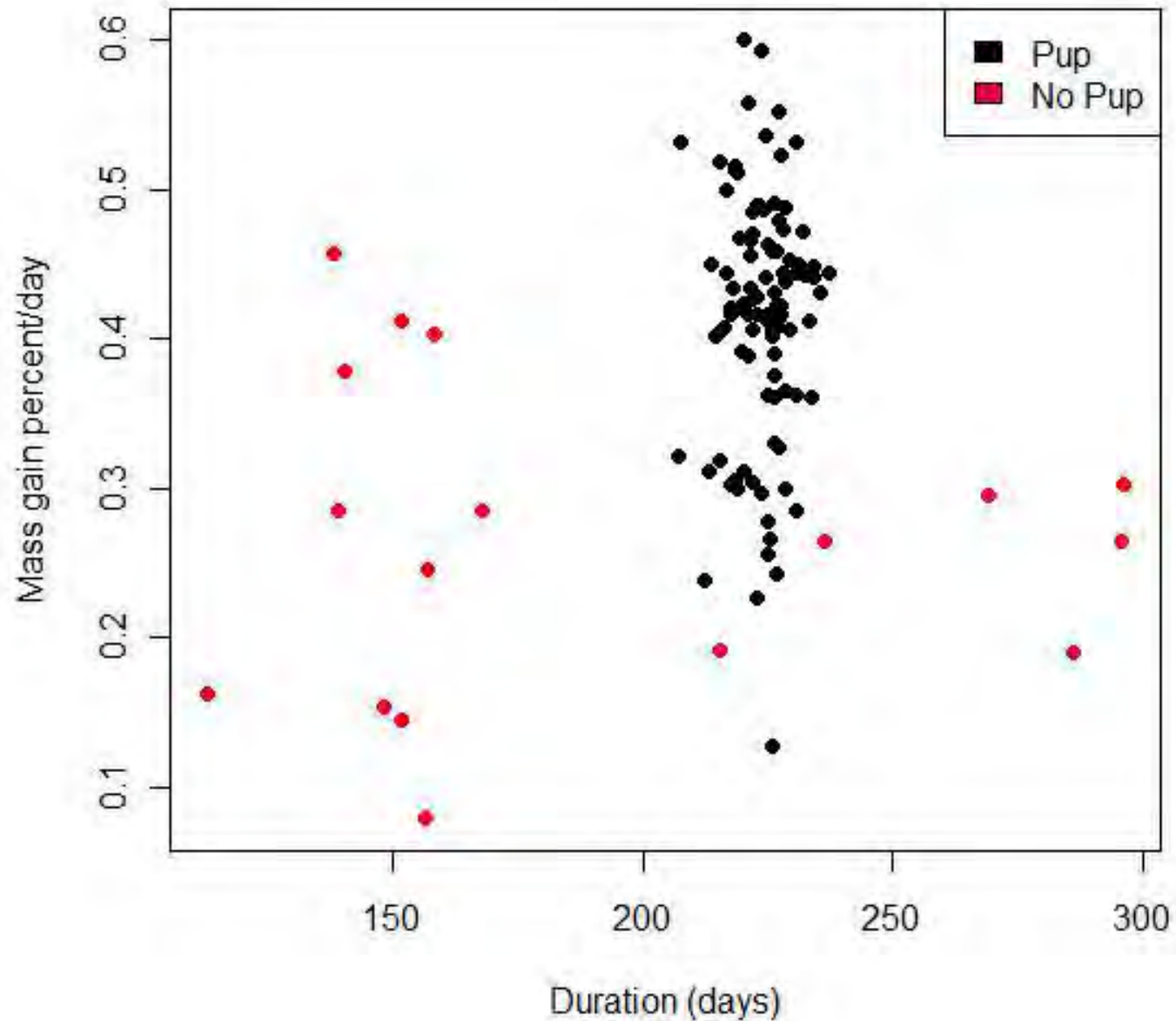
What is the threshold in female condition where they fail to reproduce?

- Blastocyst fails to implant

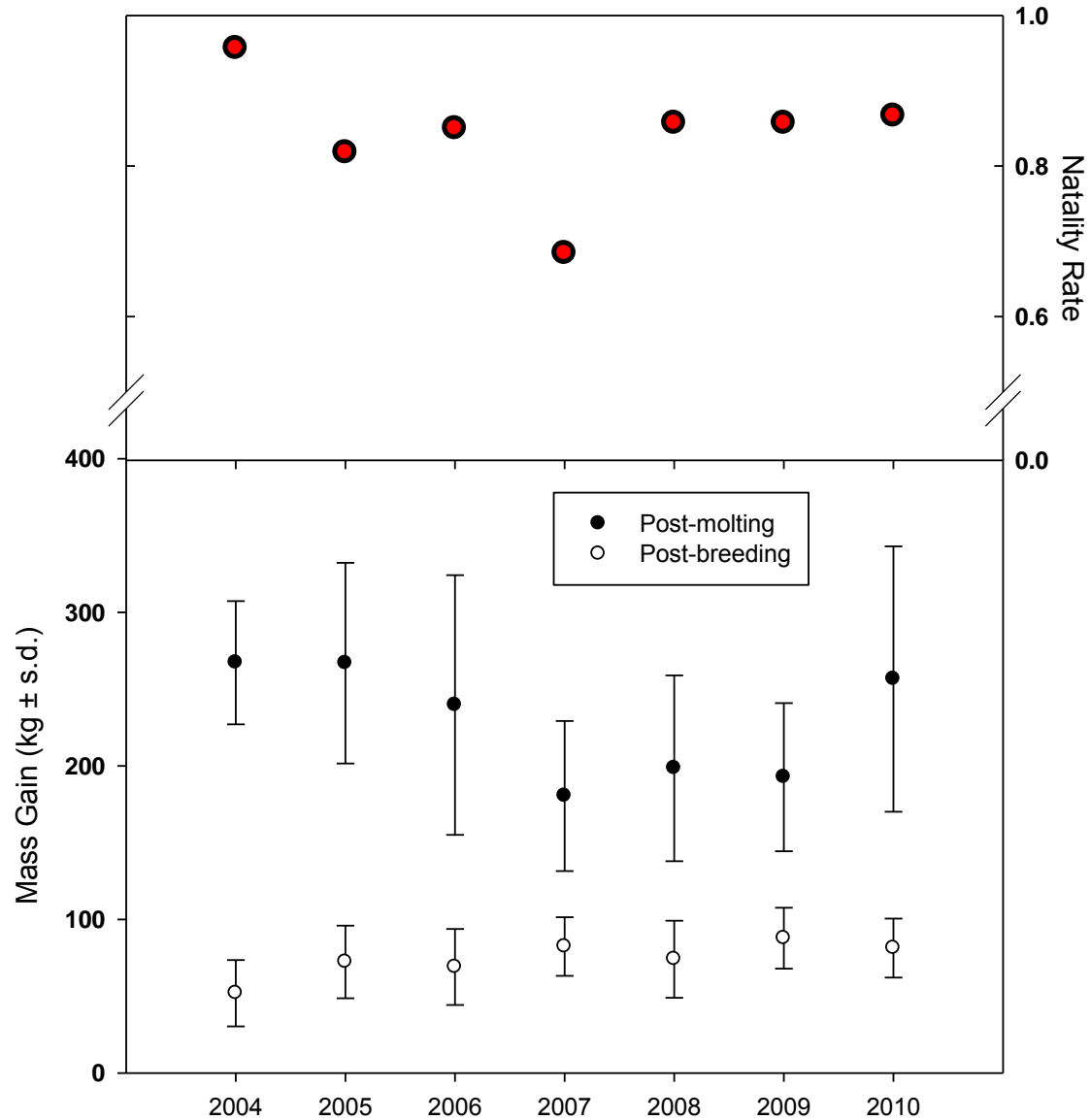
- Fetus aborts

How well do stress hormones correlate/predict body condition and foraging success over a foraging trip?

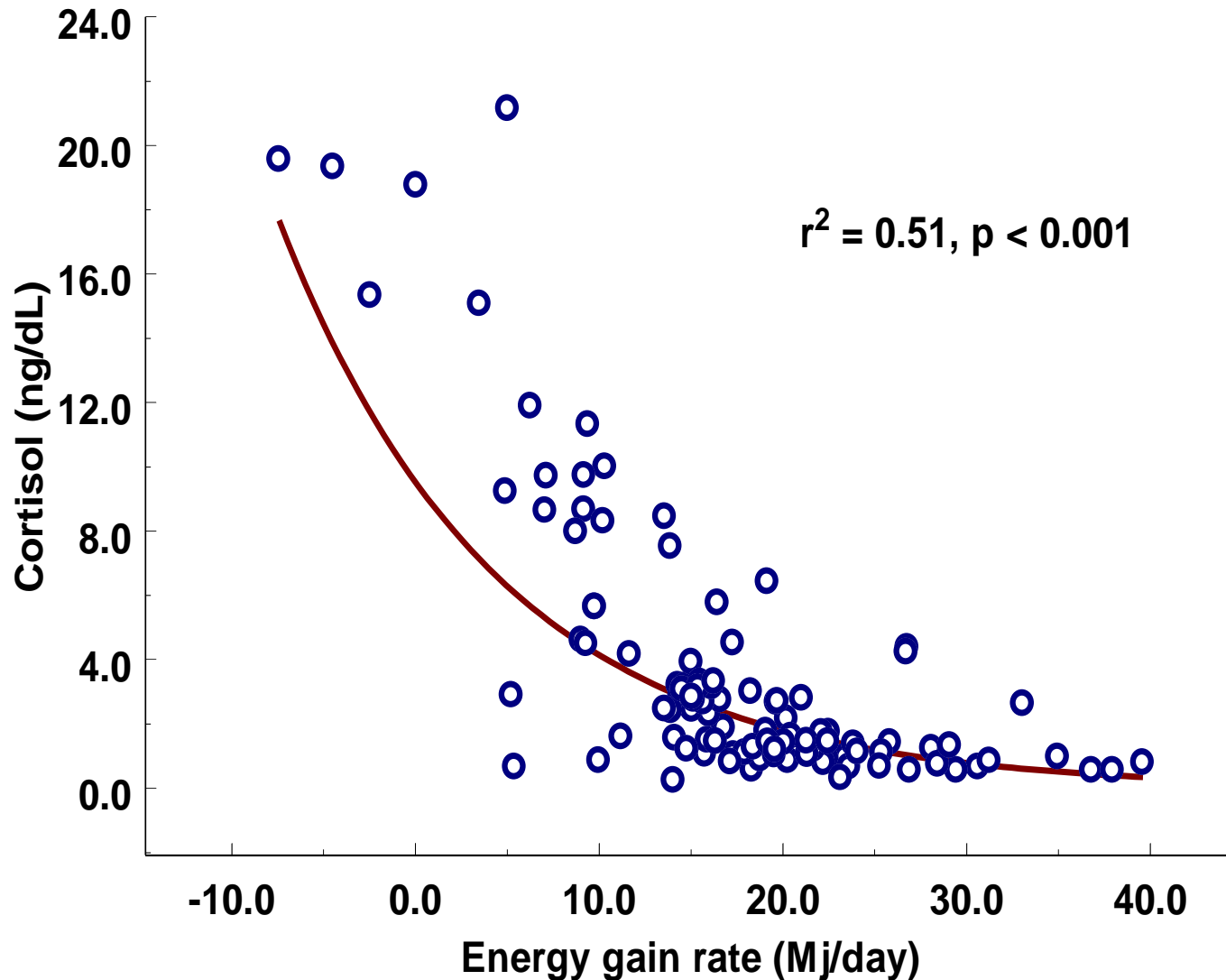
Non-Pregnant Seals



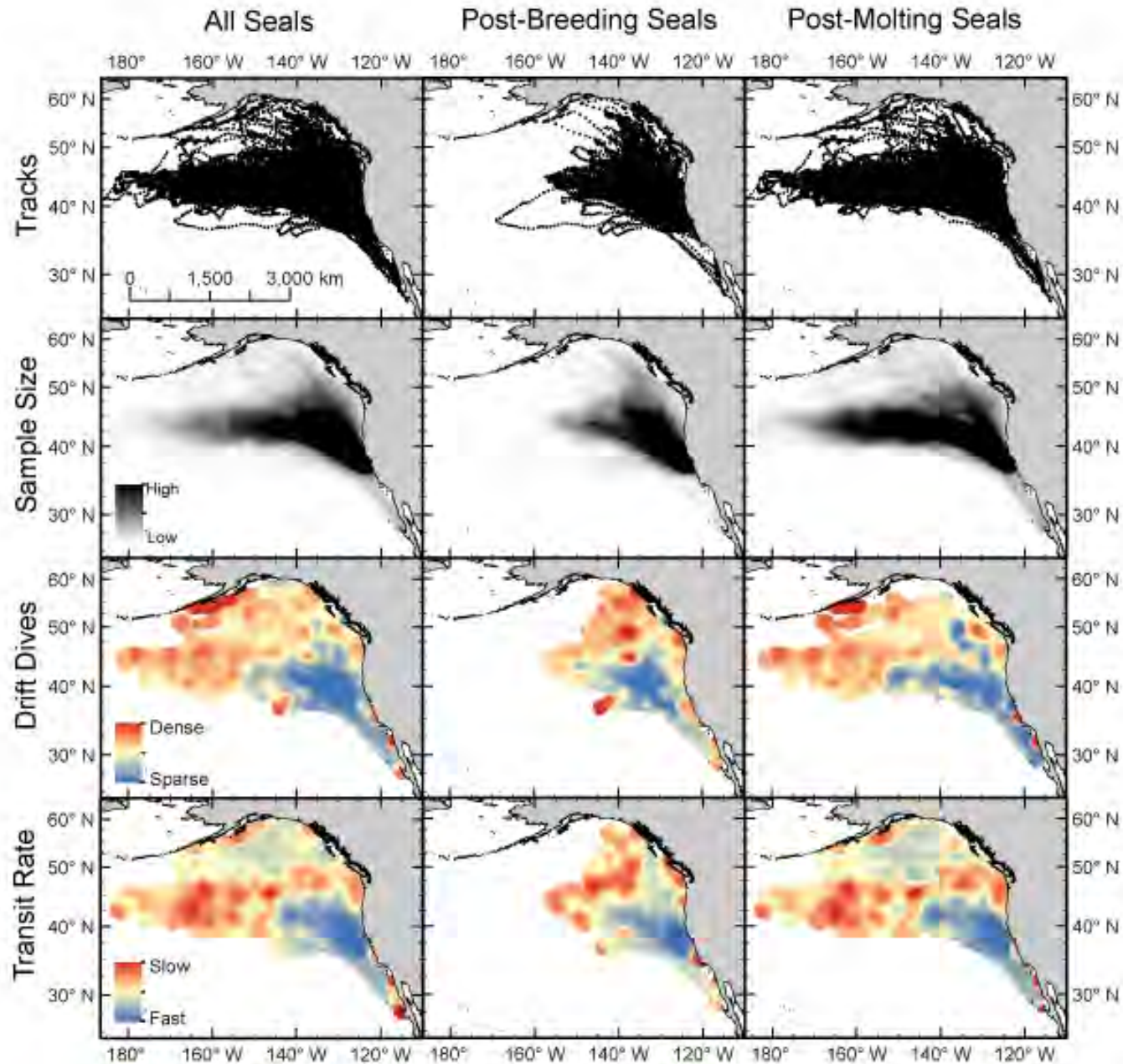
Reproductive Threshold



Condition Relates to Stress Hormones



Spatially Explicit Model and Effects of Disturbance



Research Productivity

Estimating resource acquisition and at-sea body condition of a marine predator with implications for population health. Ecology in review

R. S. Schick, L. F. New, L. Thomas, D. P. Costa, M. A. Hindell, C. R. McMahon, P. W. Robinson, S. E. Simmons, M. Thums, J. Harwood, and J. S. Clark.

Key foraging habitat of a mesopelagic predator of the northeast Pacific Ocean: insights from a data-rich species, the northern elephant seal.

PLoS Bio submitted. Robinson, P.W., Costa, D.P., Crocker, D.E., Gallo-Reynoso, J.P., Champagne, C.D., Fowler, M.A., Goetsch, C., Goetz, K., Hassrick, J.L., Huckstadt, L.A., Kuhn, C.E., Maresh, J.L., Maxwell, S.M., McDonald, B.I., Peterson, S.H., Simmons, S.E., Teutschel, N.M., Villegas-Amtmann, S., Yoda, K.

The importance of non-independent tag loss in survival rate estimates of southern elephant seals. in ms. L. K. Schwarz, M. A. Hindell, C. R. McMahon, D. P. Costa

Environmental influences on demographic rates of Antarctic fur seals

L. K. Schwarz, M. E. Goebel, D. P. Costa, A. M. Kilpatrick

THANK YOU!



**E&P Sound and
Marine Life Programme
Office of Naval Research**

