Relations among foraging, disturbances to foraging, and vital rates in southern elephant seals

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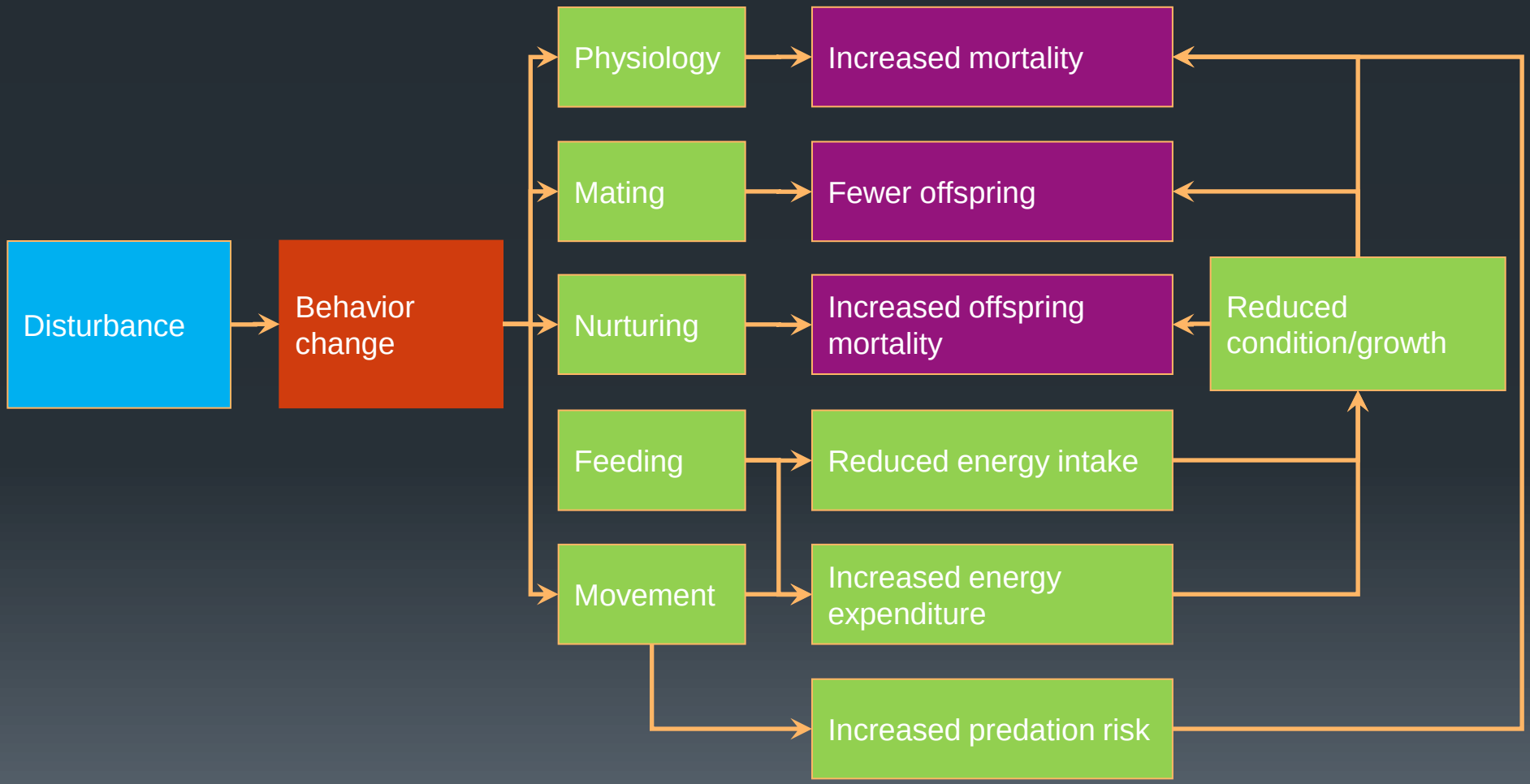
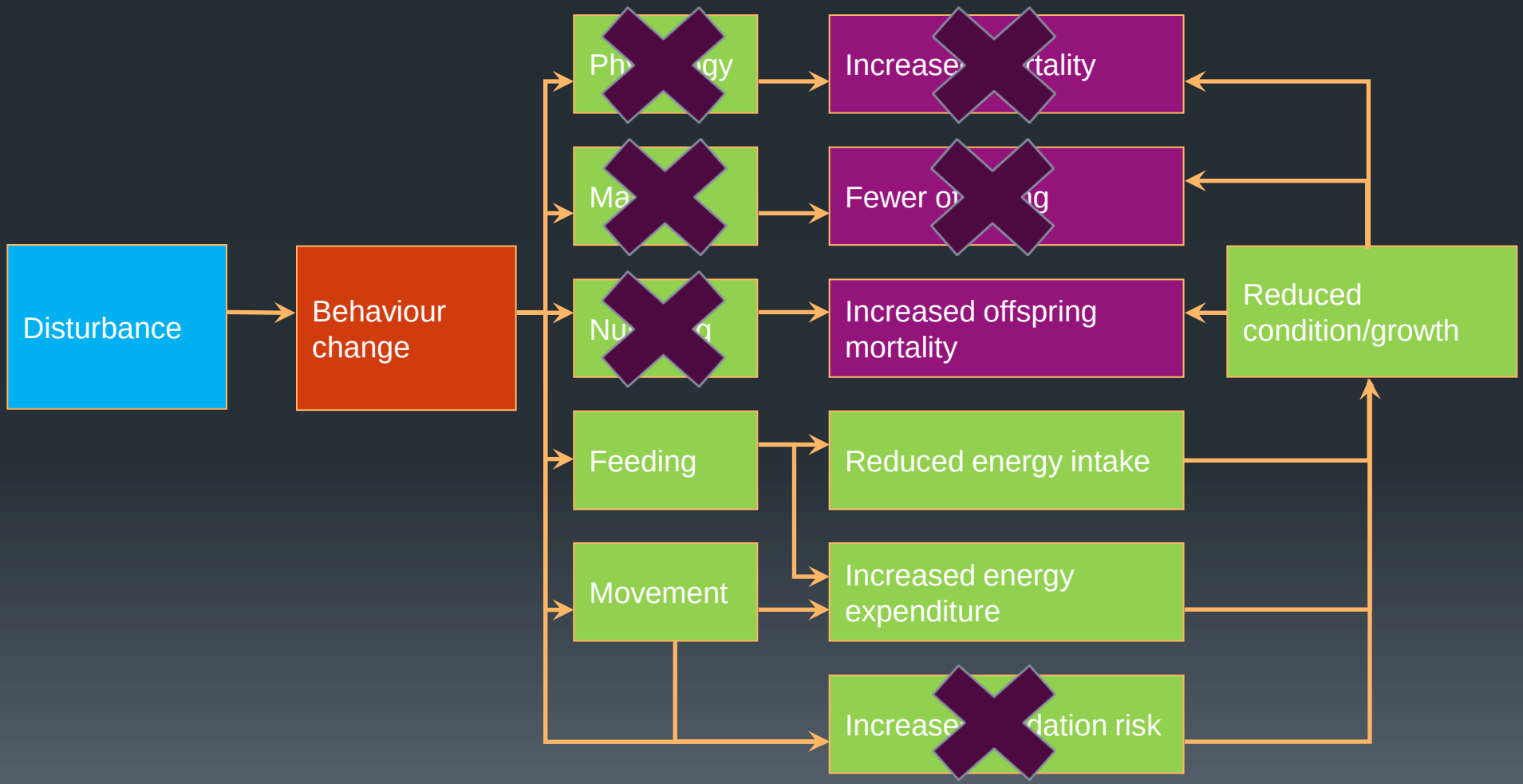
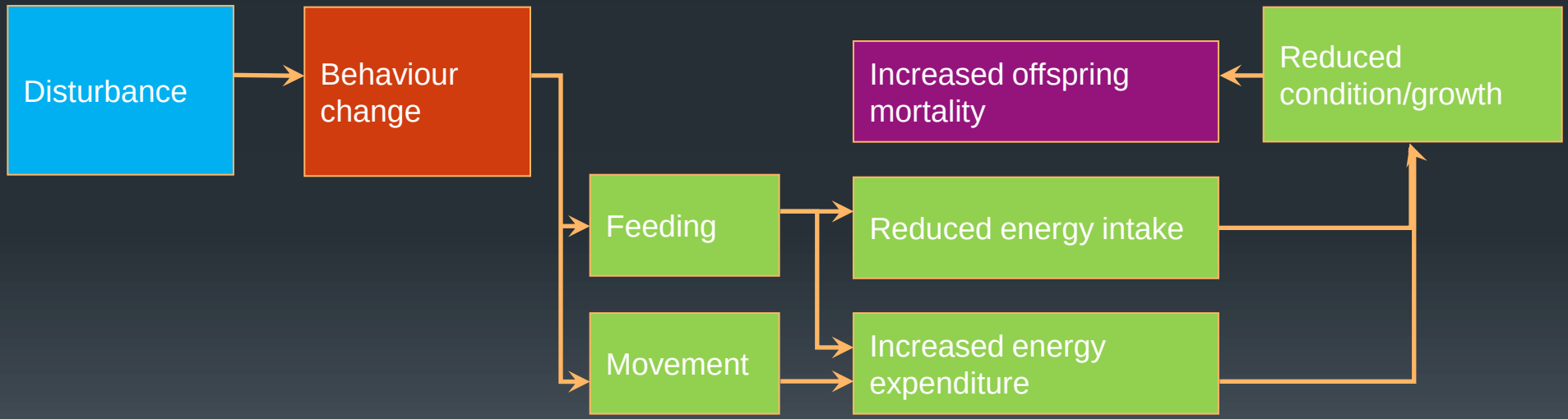
Population Consequences of Acoustic Disturbance (PCAD)



PCAD: Elephant Seals



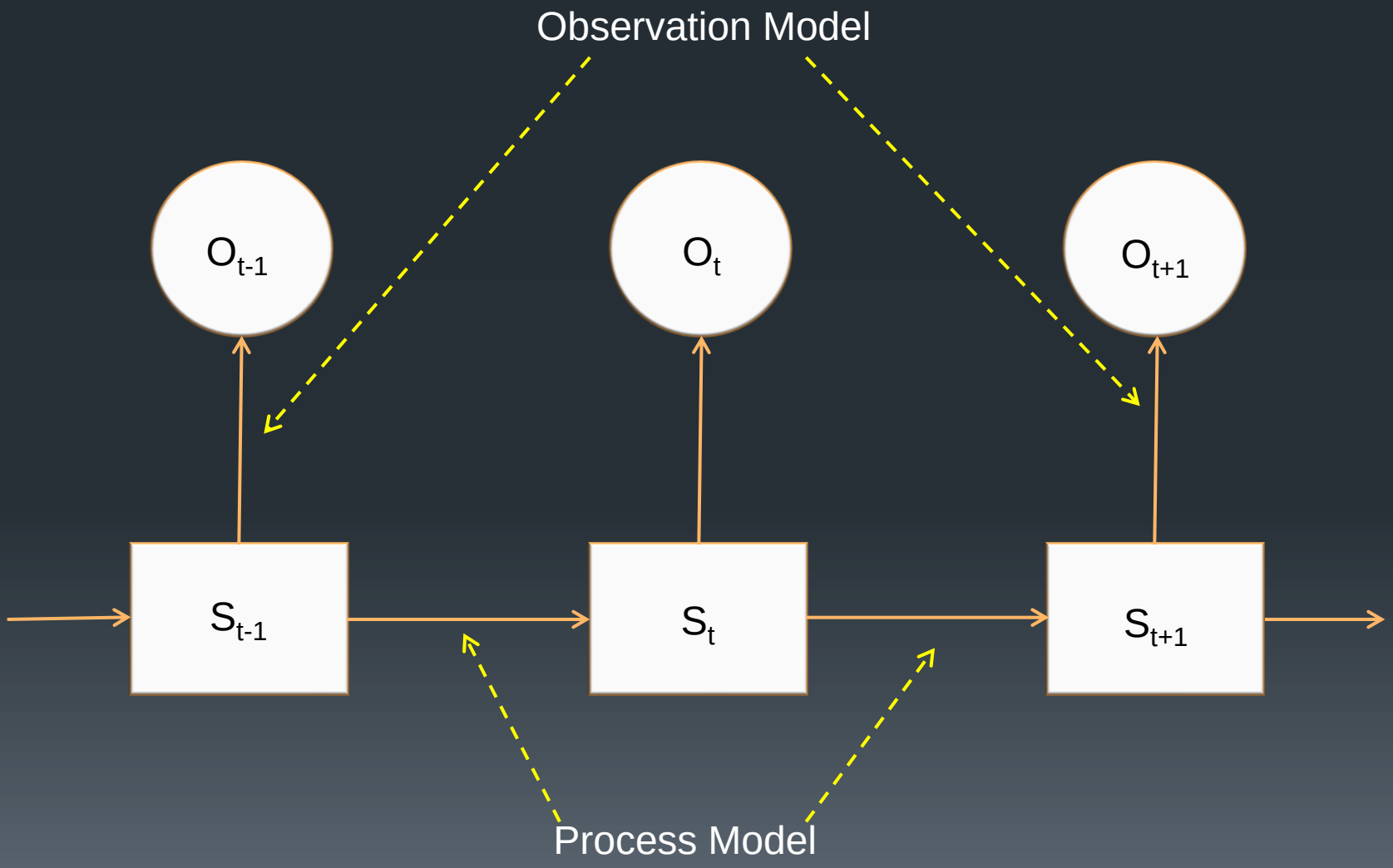
PCAD: Elephant Seals



Condition

- Elephant seals with greater lipid mass are in better condition
  - Can be measured when individuals haul out
  - Require estimates for individuals at sea during foraging trips
- Data are available from Time Depth Recorder (TDR) tags
- Drift dives can be identified and the drift rate calculated
  - Drift rate is a function of the lipid to lean mass ratio (buoyancy)

Estimating Condition: State-space Models



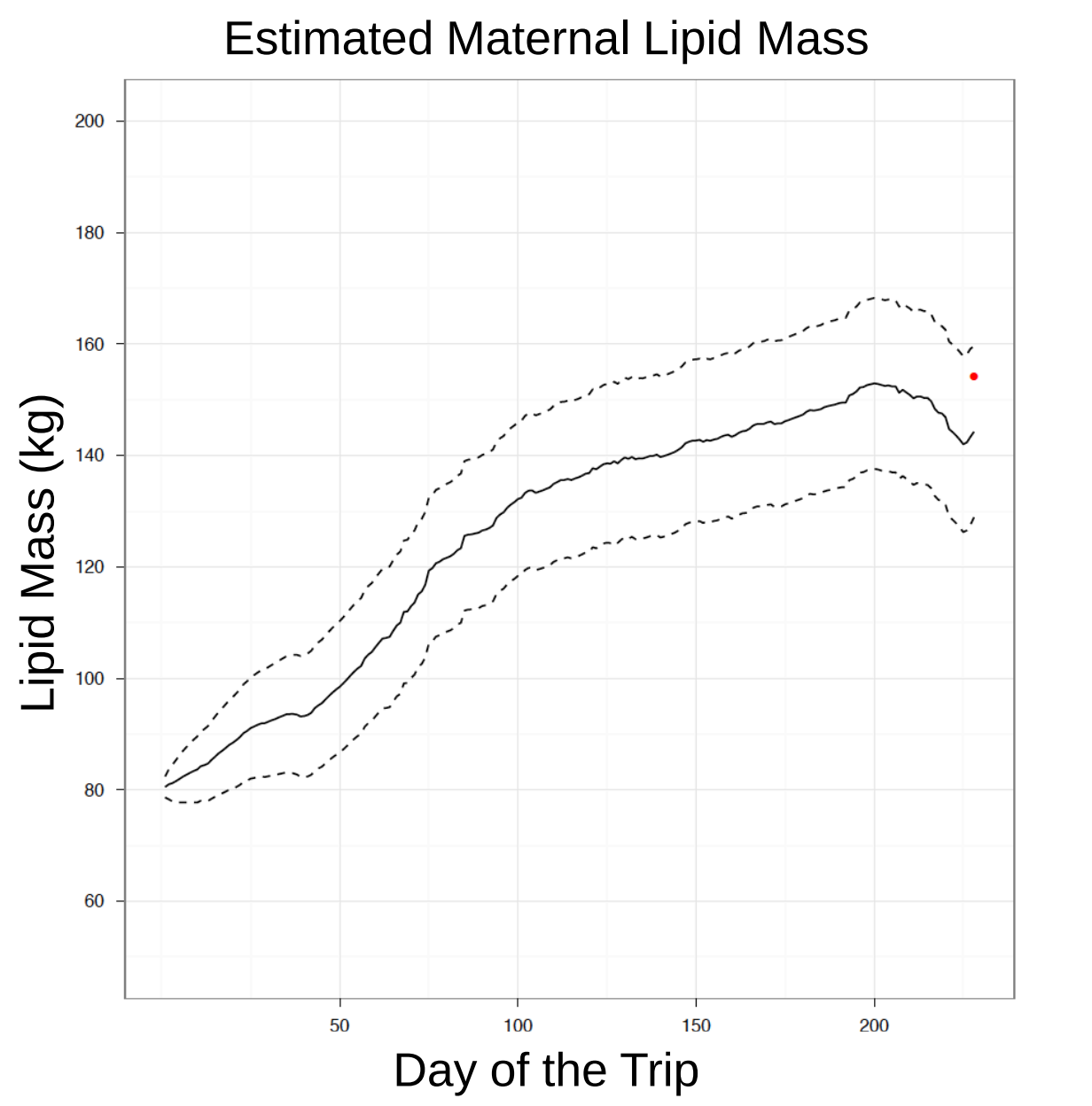
Estimating Condition

- Relationship between drift (D_t) and buoyancy (L_t/R_t) can be used to infer lipid mass (L_t)
  - The observation model
  - $D_t = \alpha_o + \alpha_1 \frac{L_t}{R_t}$

- Lipid mass changes according to the number of drift dives performed (N_t), the rate of transit (T_t) and the current lipid to lean mass (R_t) ratio
  - The process model
  - $L_t = L_{t-1} + \beta_0 + \beta_1 N_t - \beta_2 T_t - \beta_3 \frac{L_{t-1}}{R_{t-1}}$

- Lean mass is assumed to increase linearly for the mother
  - Foetus mass also increases linearly for the last third of the trip

Example Track



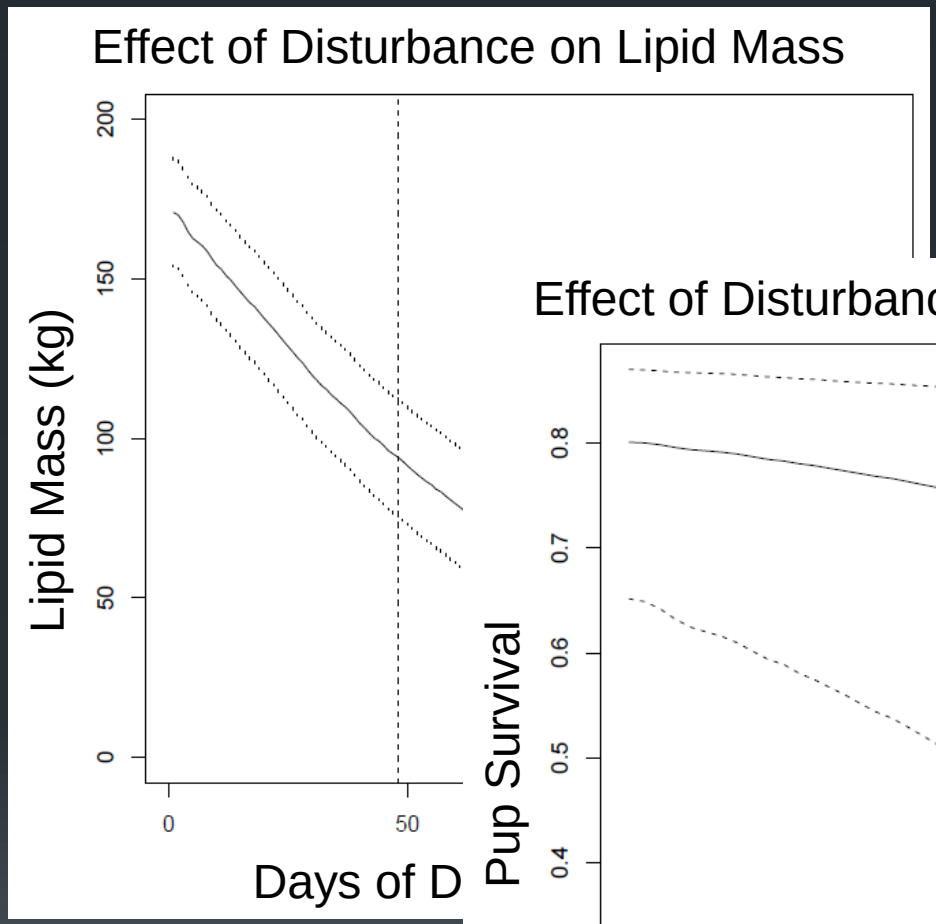
Population Consequences

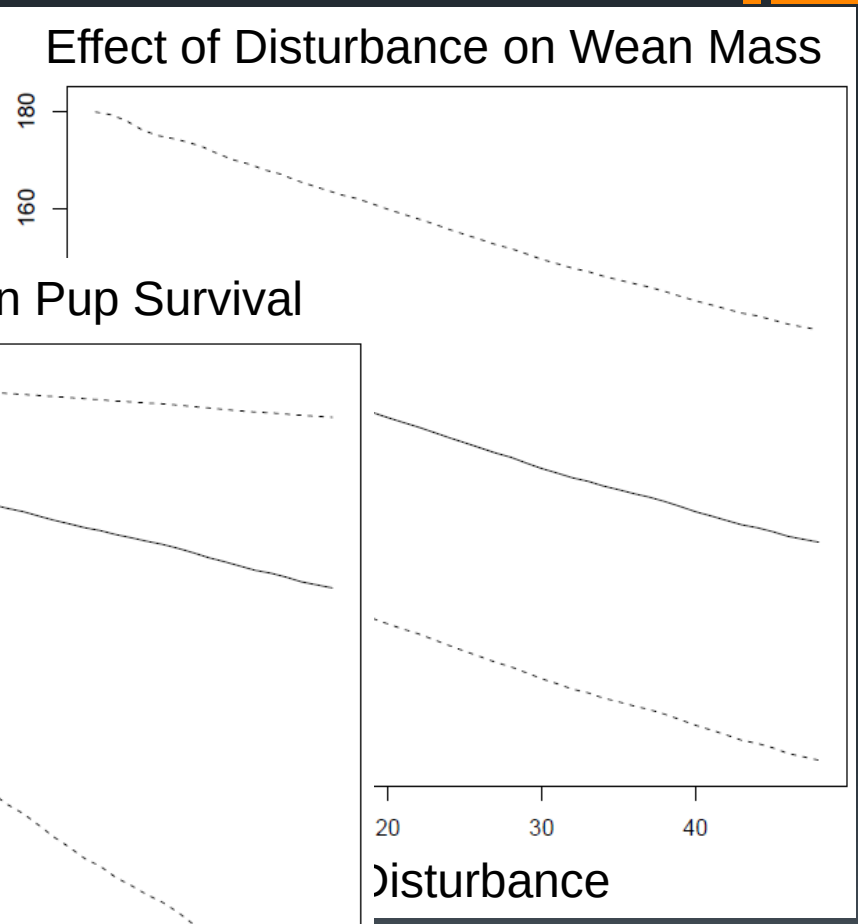
- Elephant seal populations are most sensitive to changes in juvenile and pup survival
- Maternal mass impacts pup survival, and has a knock on effect to juvenile survival
- Disturbances that reduce the condition of breeding females could therefore affect the population

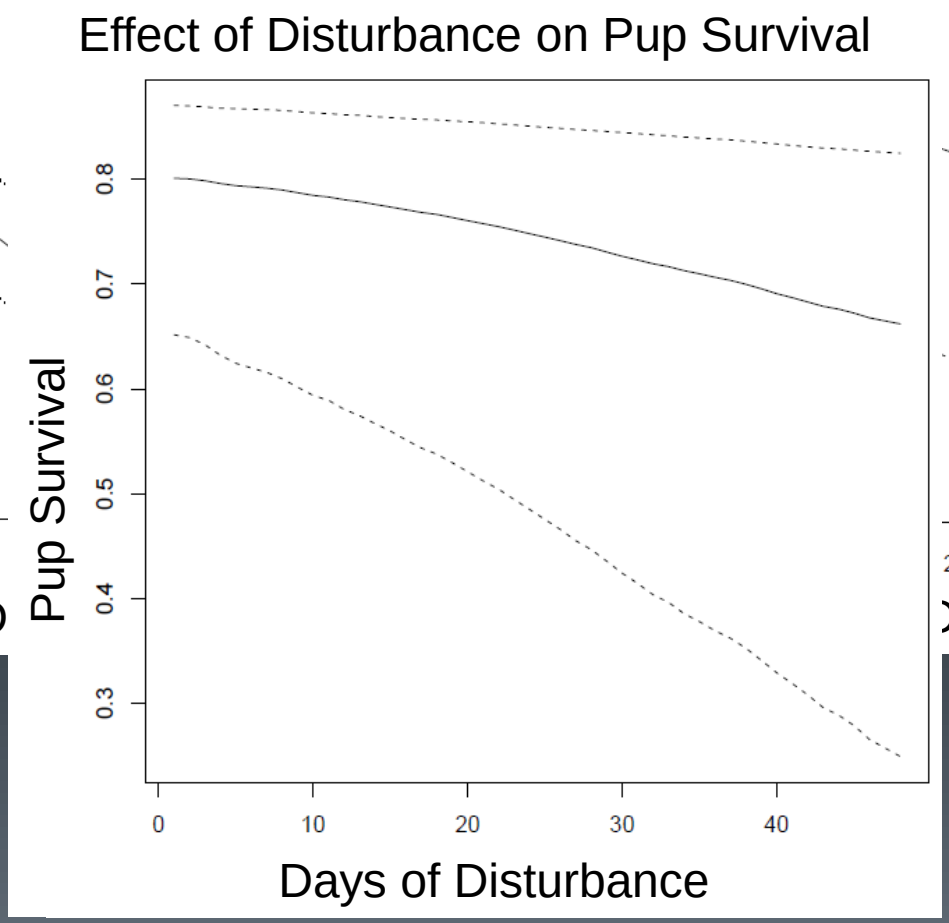
Disturbance

- Disturbed seals will travel farther and feed less
  - Increased transit
  - Decreased drift dives
- Potential disturbances include:
  - Exclusion from foraging areas due to ice concentration
  - Anthropogenic habitat transformation
  - Increased ship traffic

Disturbance: Effects







Disturbance: Effects

- At 47 days of disturbance, pup survival would drop from 0.80 to 0.66
  - If all females are affected to this extent, the population growth rate would be reduced to 0.977
  - This would be equal to a 50% decline over 30 years, if the disturbance is constant
  - 47 days equals 20% or more of a female's foraging trip
    - Unlikely that there will be a continuous disturbance of this magnitude
- After 47 days of disturbance, this female wouldn't pup
  - If all females fail to pup in a year, there would a 20% decline in the population
  - If half failed to breed, there would be a 7.5-10% decline, depending on how the breeding females responded to the disturbance

WARNING: Illustrative example only. Results NOT to be used for management, policy or decision making for southern elephant seals, or any other, species.

Research Outcomes

- Schick, R. S., New, L. F., Thomas, L., Costa, D. P., Hindell, M. A., McMahon, C. R., Robinson, P. W., Simmons, S. E., Thums, M., Harwood, J. and Clark, J. S. (*submitted*) Estimating resource acquisition and at-sea body condition of a marine predator with implications for population health. *Ecology*
- New, L. F., Clark, J.S., Condit, R., Costa, D., Fleishman, E., Frid, A., Hindell, M., Klanjscek, T., Lloyd-Smith, J., Lusseau, D., McMahon, C., Robinson, P., Schick, R., Schwarz, L., Simmons, S., Thomas, L., Tyack, P., Weise, M. and Harwood, J. (*in prep*) The population consequences of disturbance. *Conservation Biology.*
- New, L. F., Schick, R., Clark, J.S., Thomas, L., Hindell, M. A., McMahon, C. R., Costa, D., Simmons, S., Robinson, P. and Harwood, J. (*in prep*) A Comparison of Bayesian and Frequentist Approaches to Fitting State-space Models in Ecology. *Ecological Applications.*