

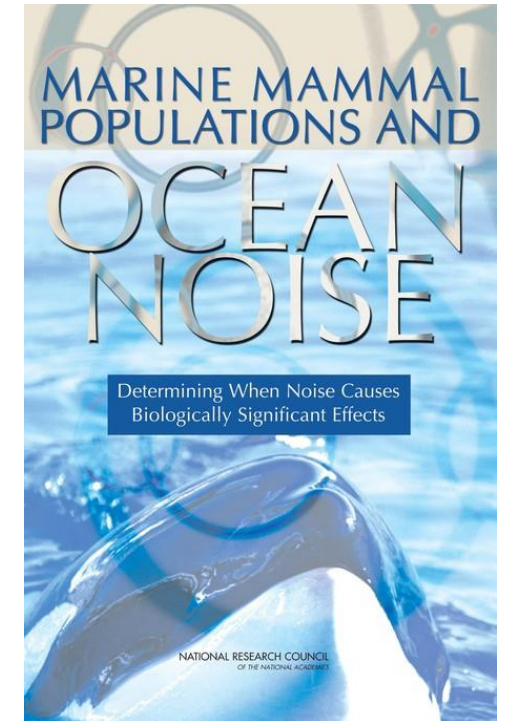
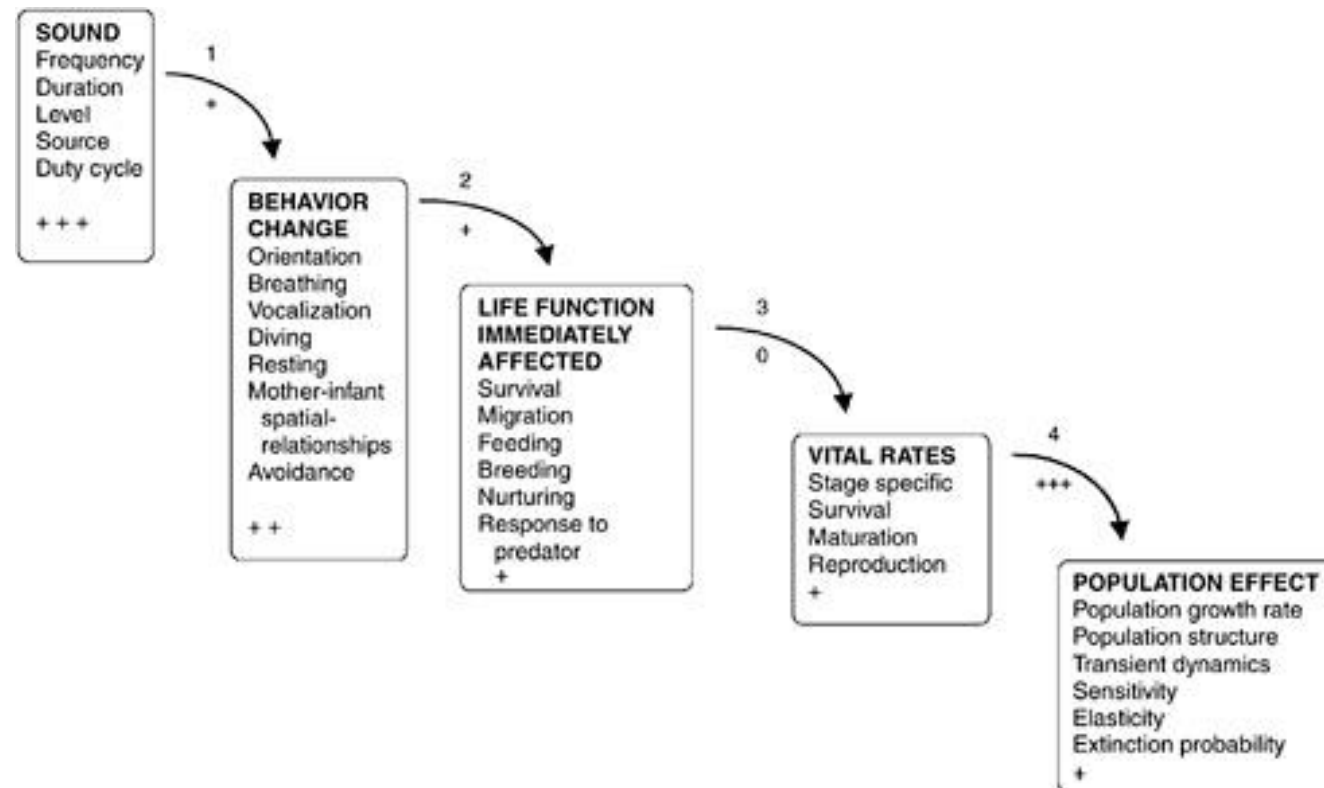
# BRIDGING THE GAP BETWEEN BEHAVIOUR, HEALTH, AND POPULATION CONSEQUENCES

Dr Leslie New  
12 Dec 2015



# History

- Marine Mammal Populations and Ocean Noise
  - NRC 2005
  - Estimated 10 years until usable



# ONR Working Group

## ■ Population Consequences of Acoustic Disturbance (PCAD)

- Identify and use most robust data sets
- Span:
  - Taxonomic groups
  - Reproductive strategies

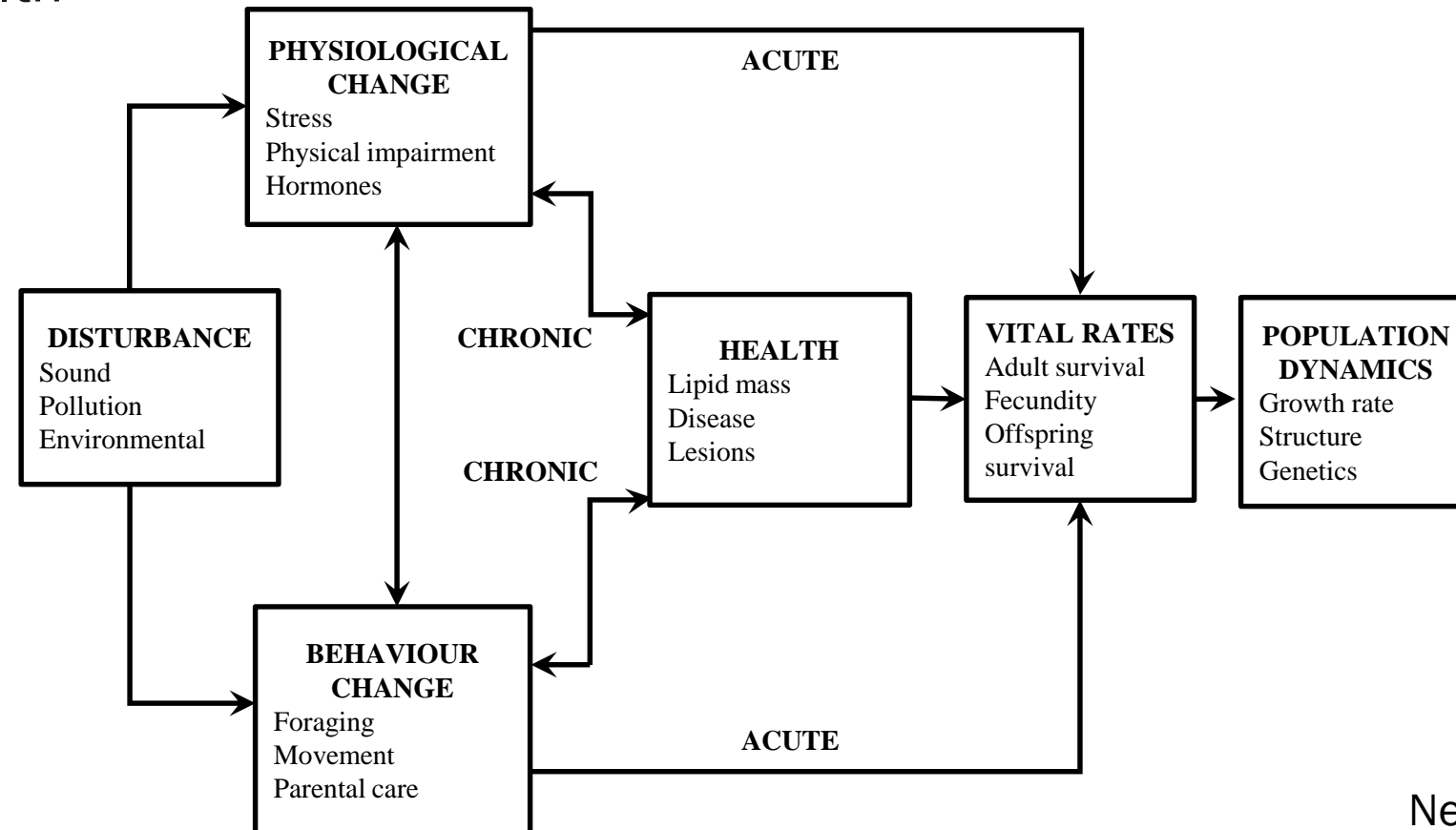
## ■ Chose:

- Elephant seals
- Coastal bottlenose dolphins
- North Atlantic right whale
- Beaked whales



# New Conceptual Model

- Population Consequences of Disturbance (PCoD)
  - Disturbance doesn't have to be acoustic
  - Physiological, as well as behavioural changes
  - Health



# Elephant Seals

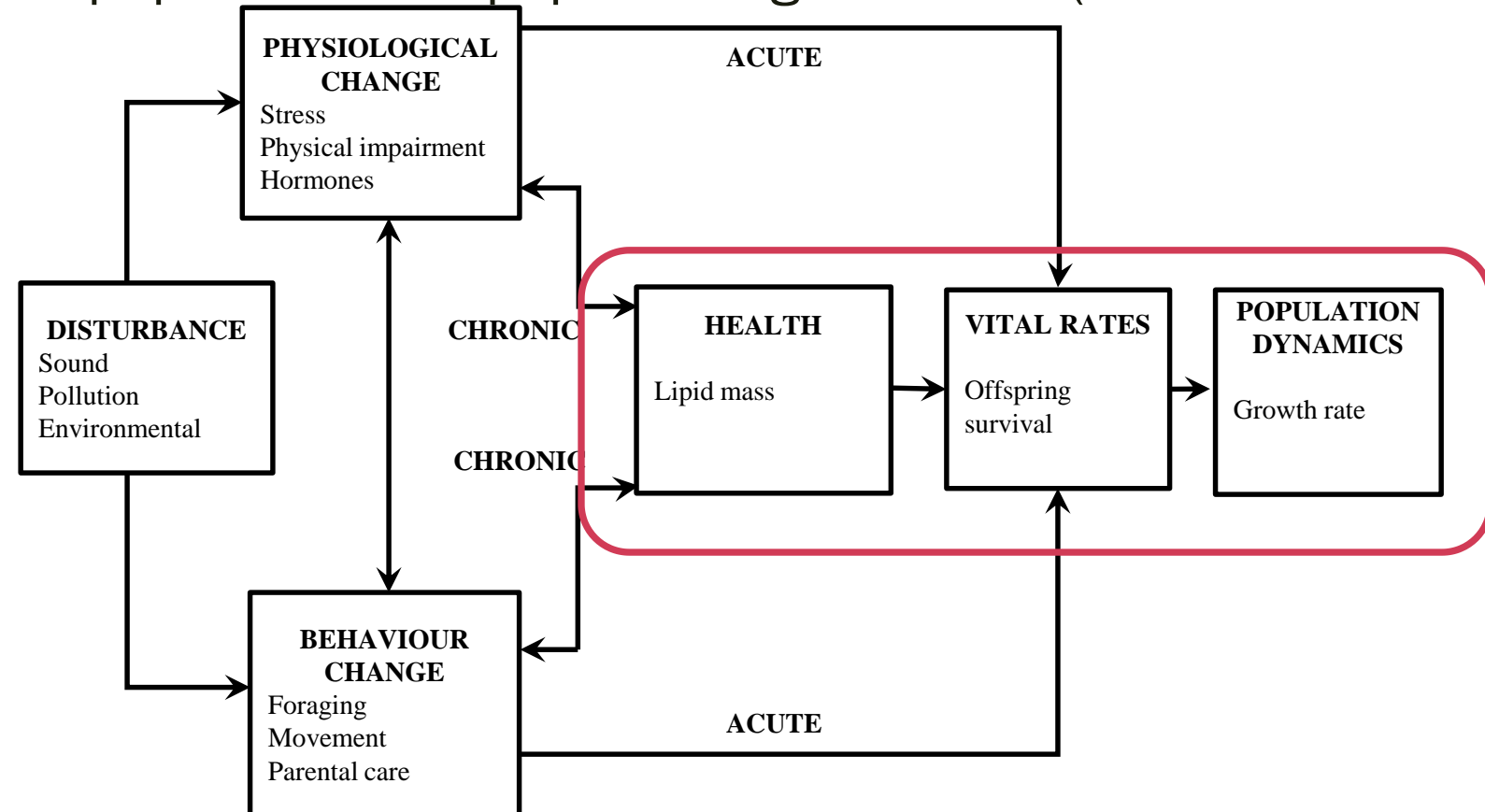
- What we know:
  - Mother's mass determines wean mass (Arnbom et al. 1993)
  - Wean mass is related to pup survival (McMahon et al. 2003)
  - Role of pup survival on population growth rate (McMahon et al. 2005)



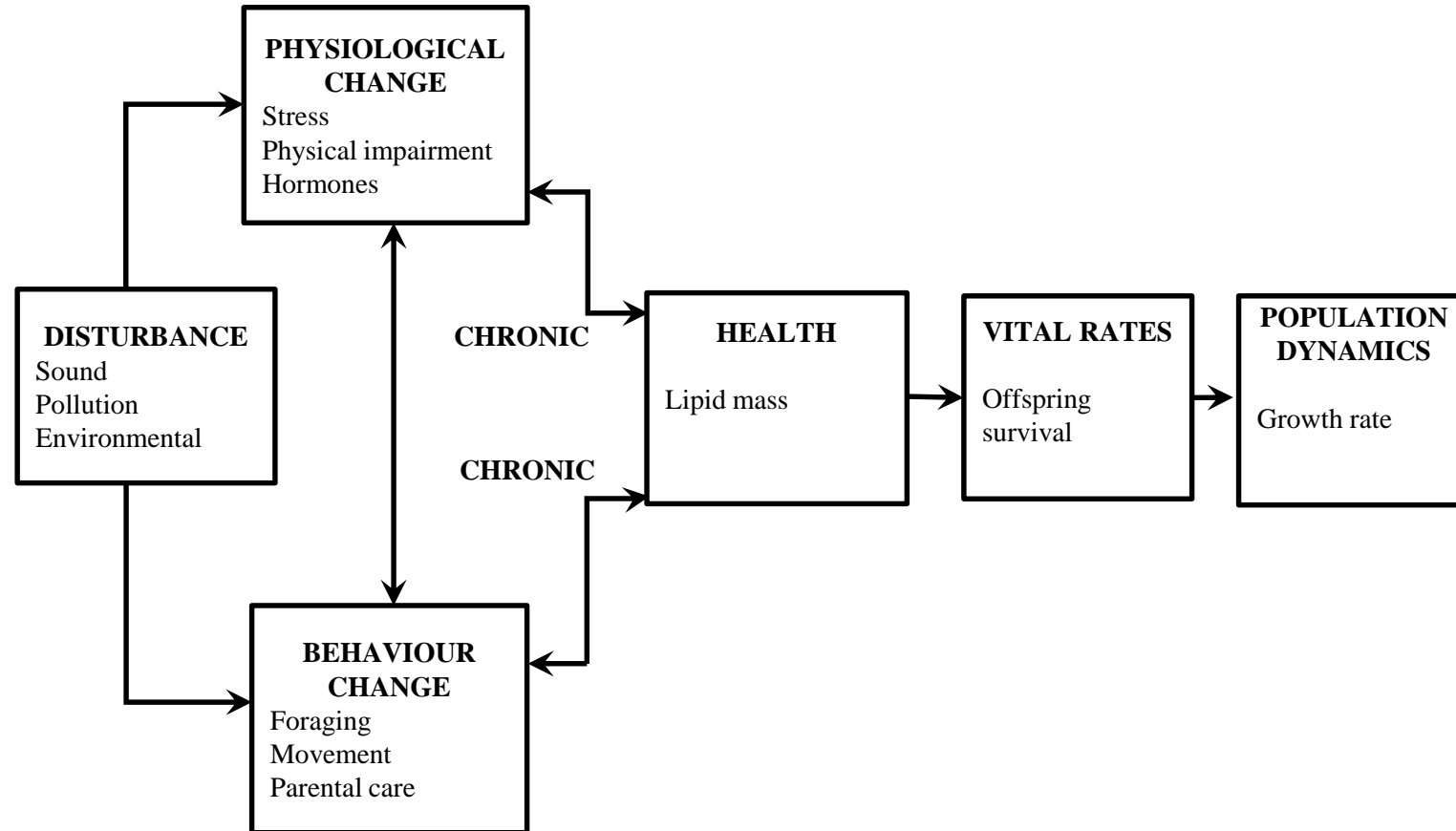
# Elephant Seals

## ■ What we know:

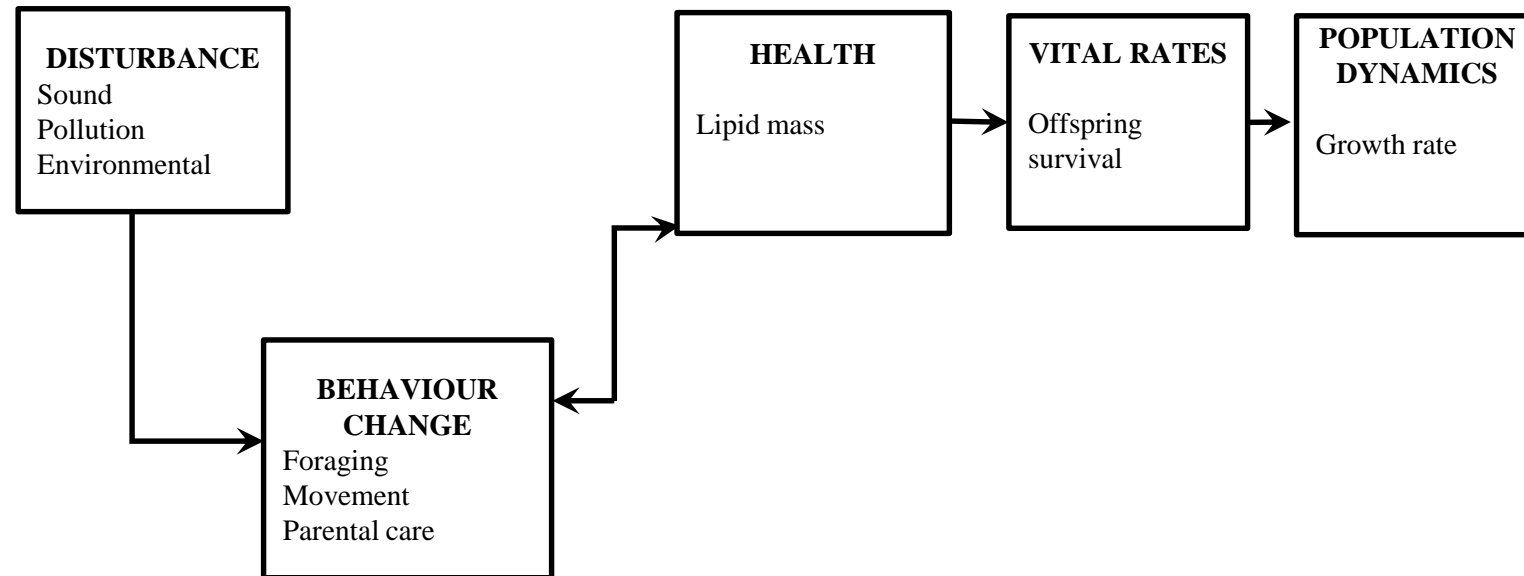
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# All the Rest



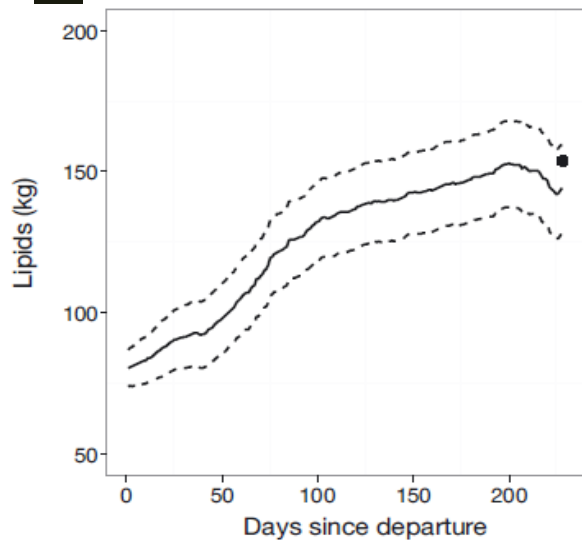
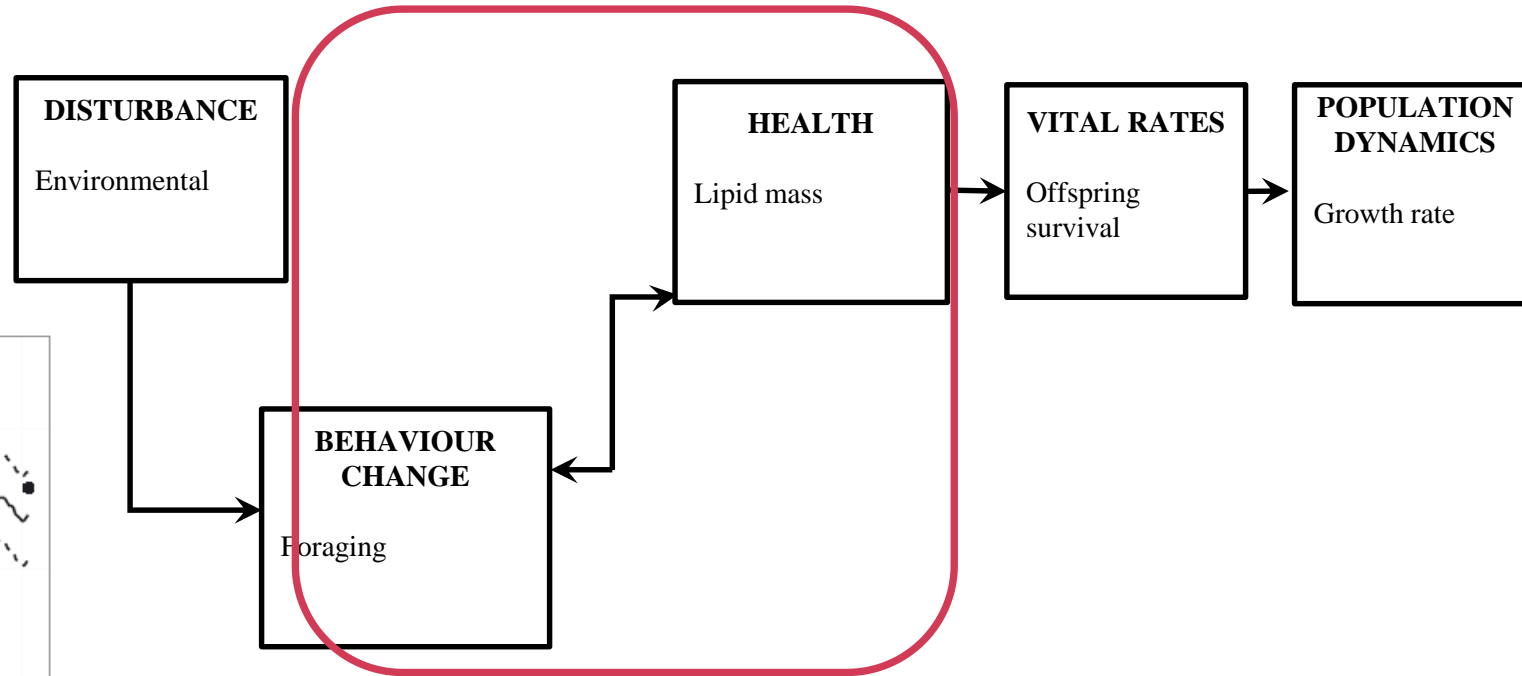
# All the Rest



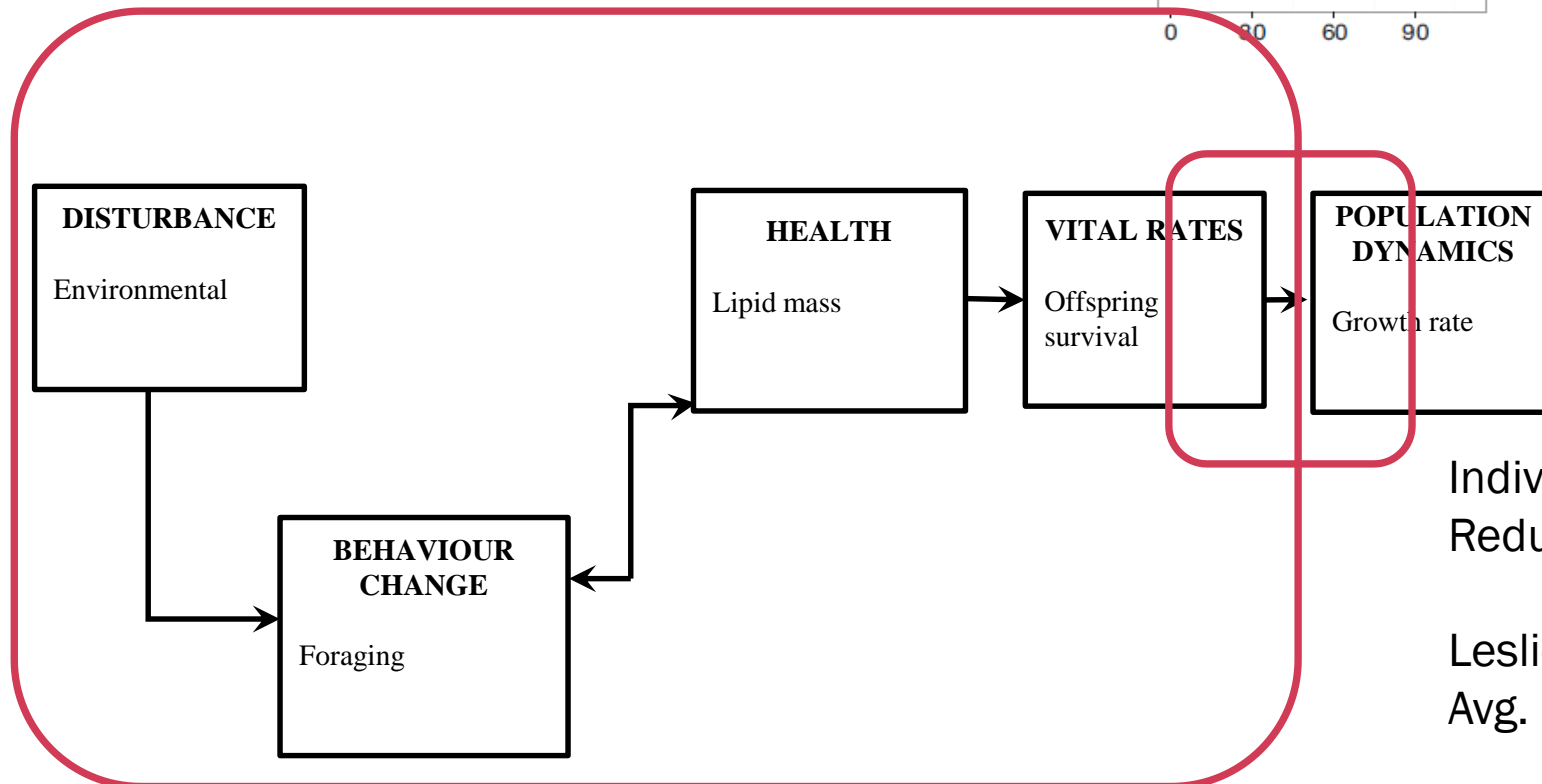
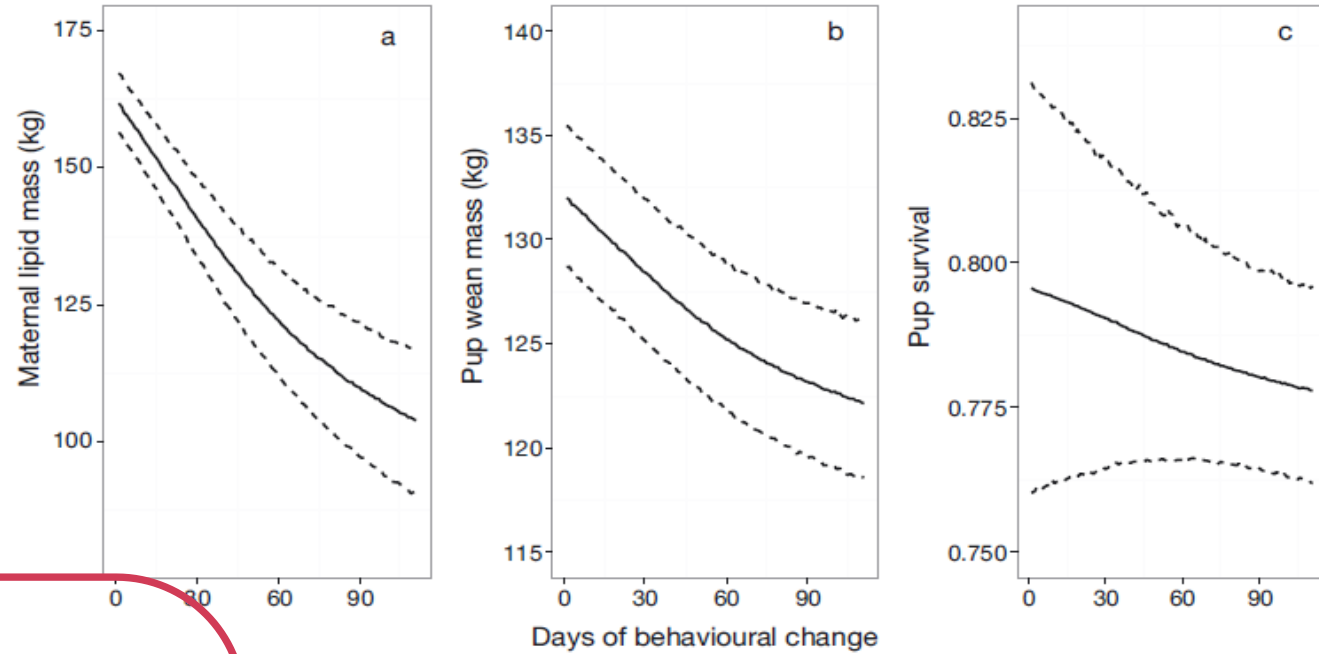


# Putting It Together

$$L_{i,t} = L_{i,t-1} + \alpha_0 + \alpha_1 S_{i,t} + \alpha_2 V_{i,t} + \alpha_3 \frac{L_{i,t-1}}{R_{i,t-1}}$$



# Putting It Together

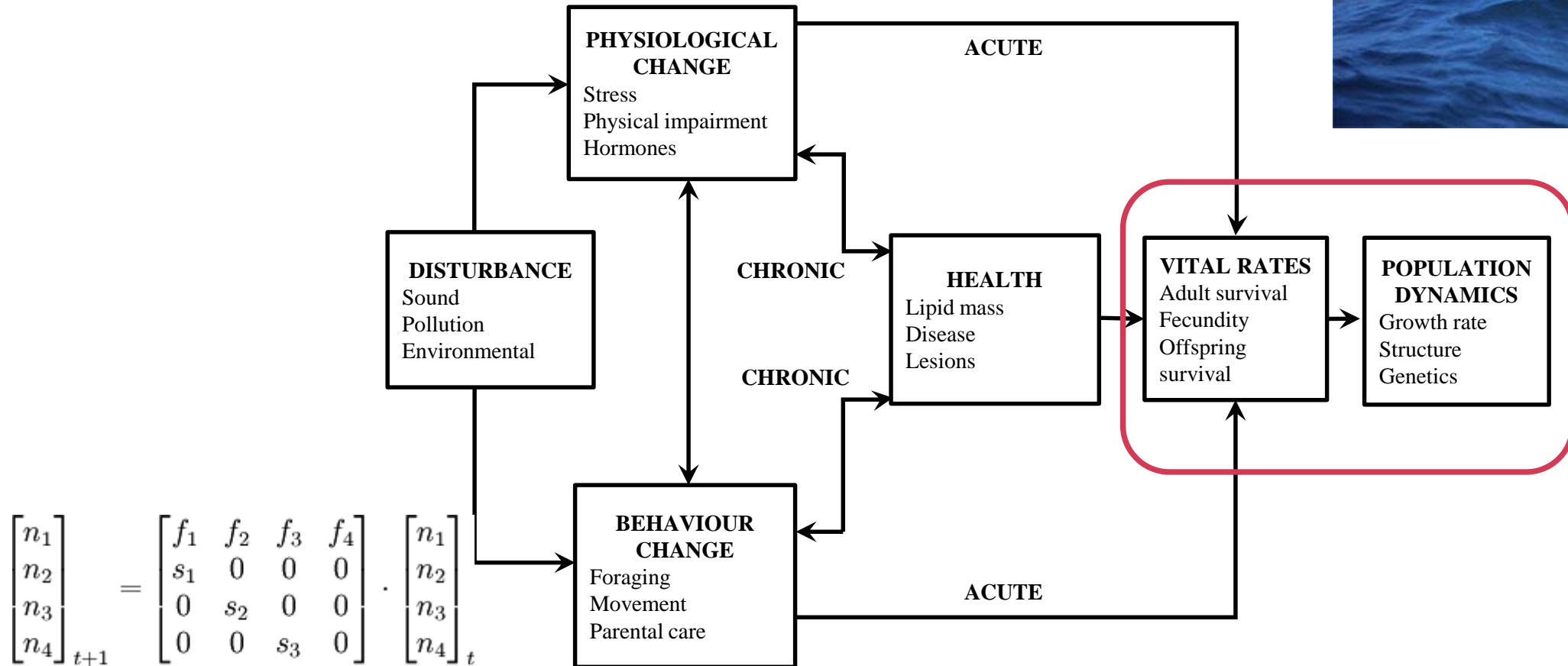


Individual Fitness:  
Reduced by 0.3% (95% CI: -0.5%, -0.06%)

Leslie Matrix:  
Avg. 10% Population decline over 30 years

# Vital Rates and Population Dynamics

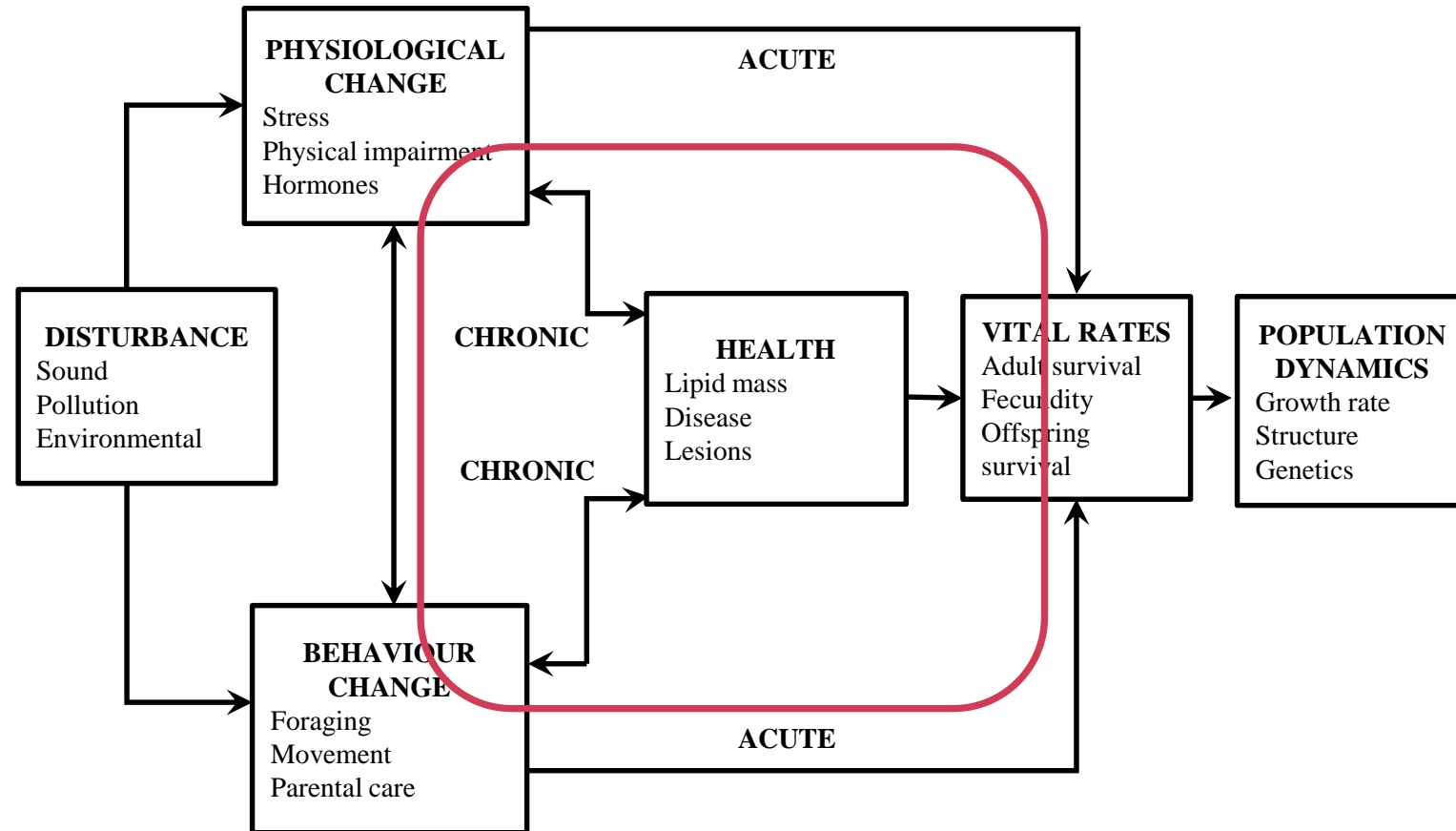
- We know how to link them
  - e.g., matrix population models
  - Not always easy





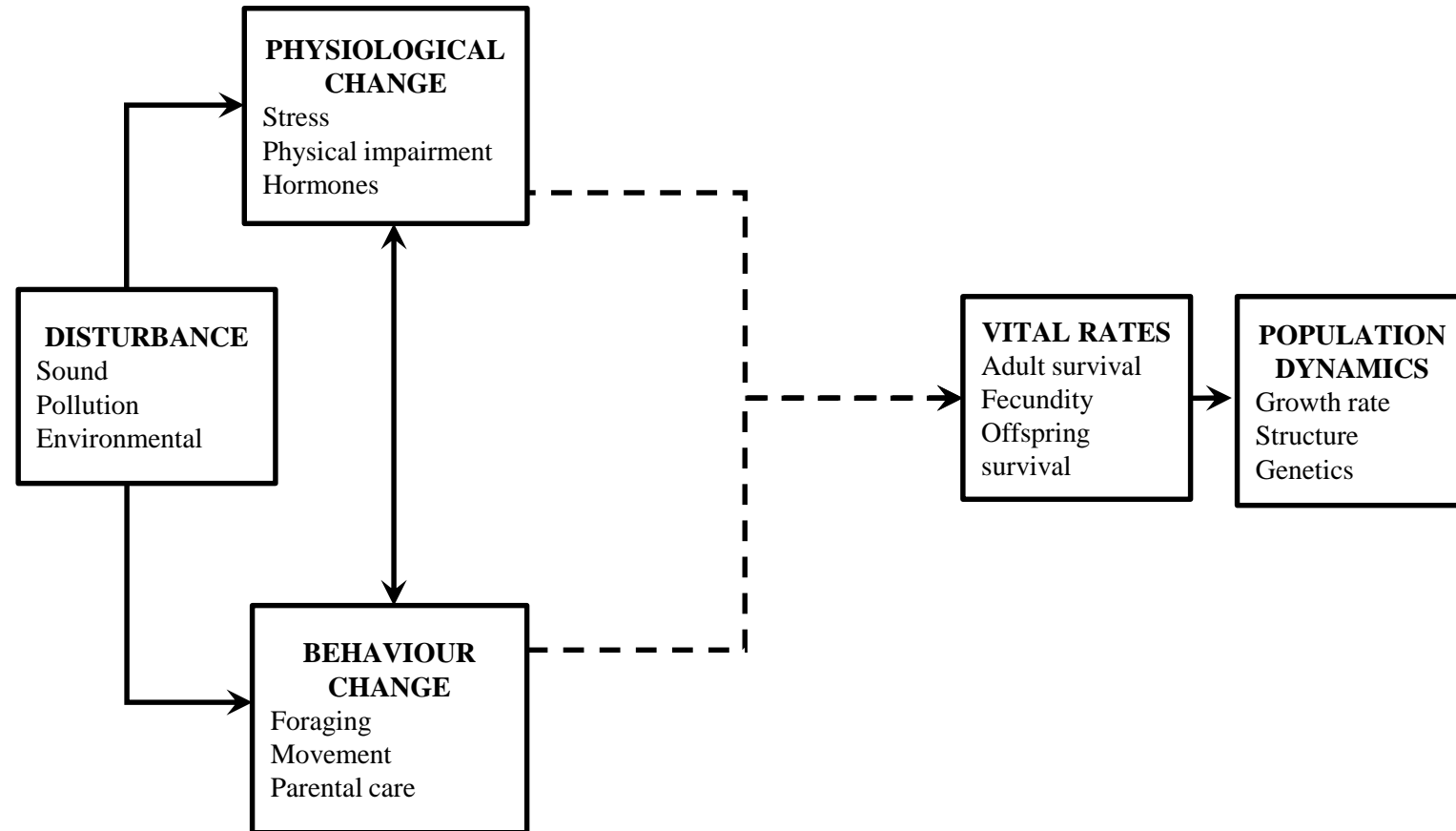
# Data Hungry

- Certain links will be difficult to quantify for most populations
  - Not enough data



# PCoD lite

- Link directly to vital rates
  - Published relationships



# PCoD lite

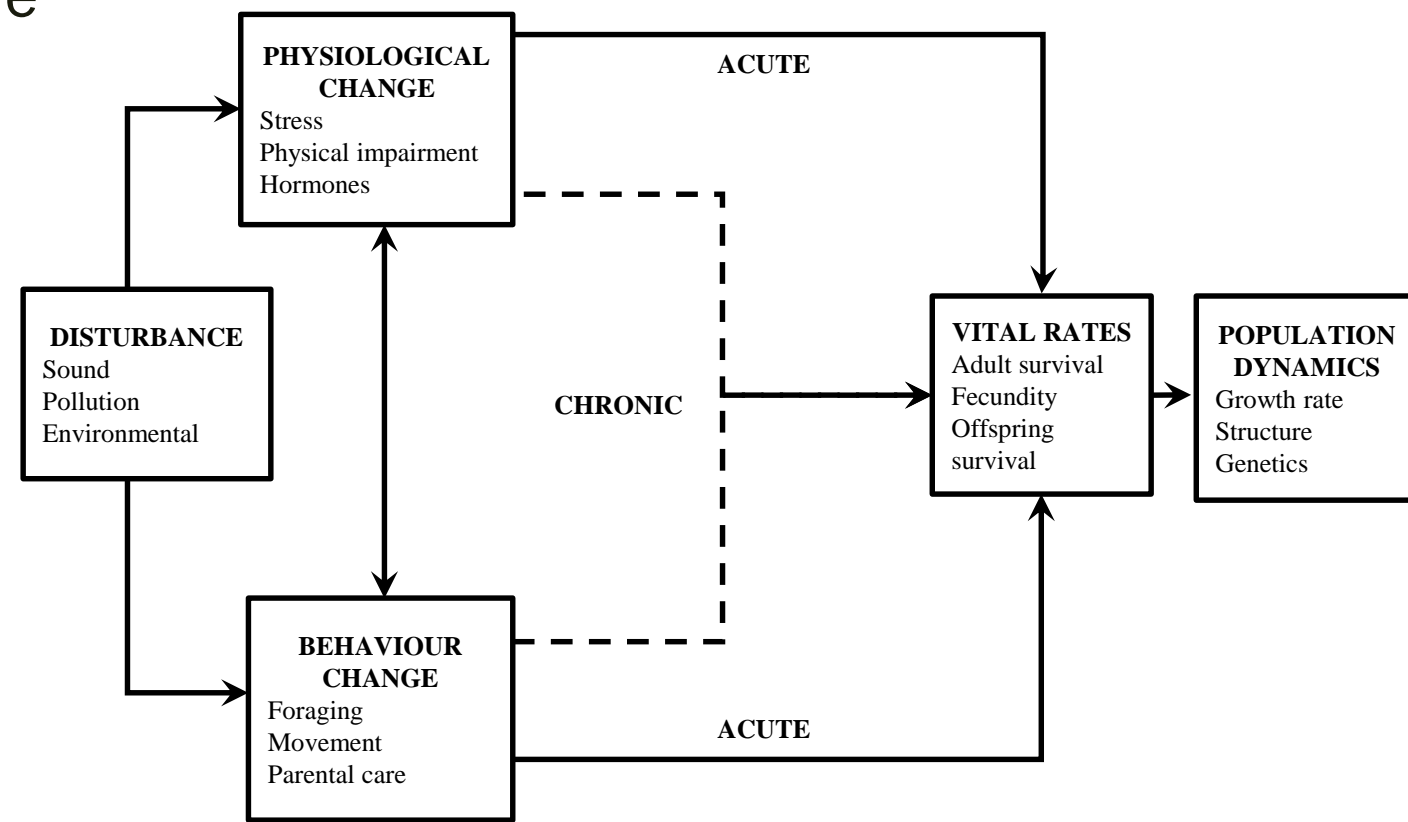
- Link directly to vital rates
  - Published relationships
- Example: killer whales
  - Disturbance could affect
    - Time spent in foraging areas
    - Ability to forage
  - Chinook abundance affects survival (e.g., Ford et. al 2010)



# Interim PCoD

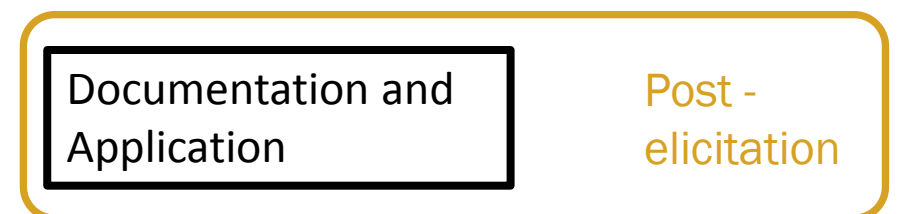
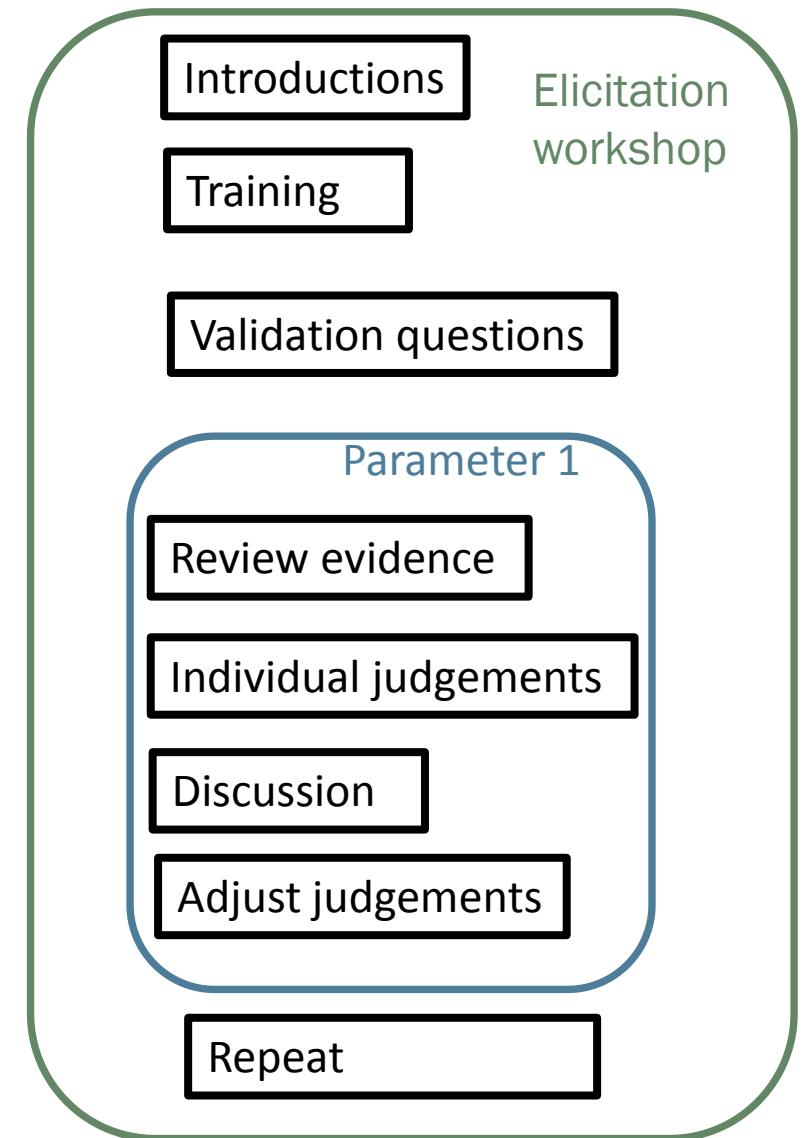
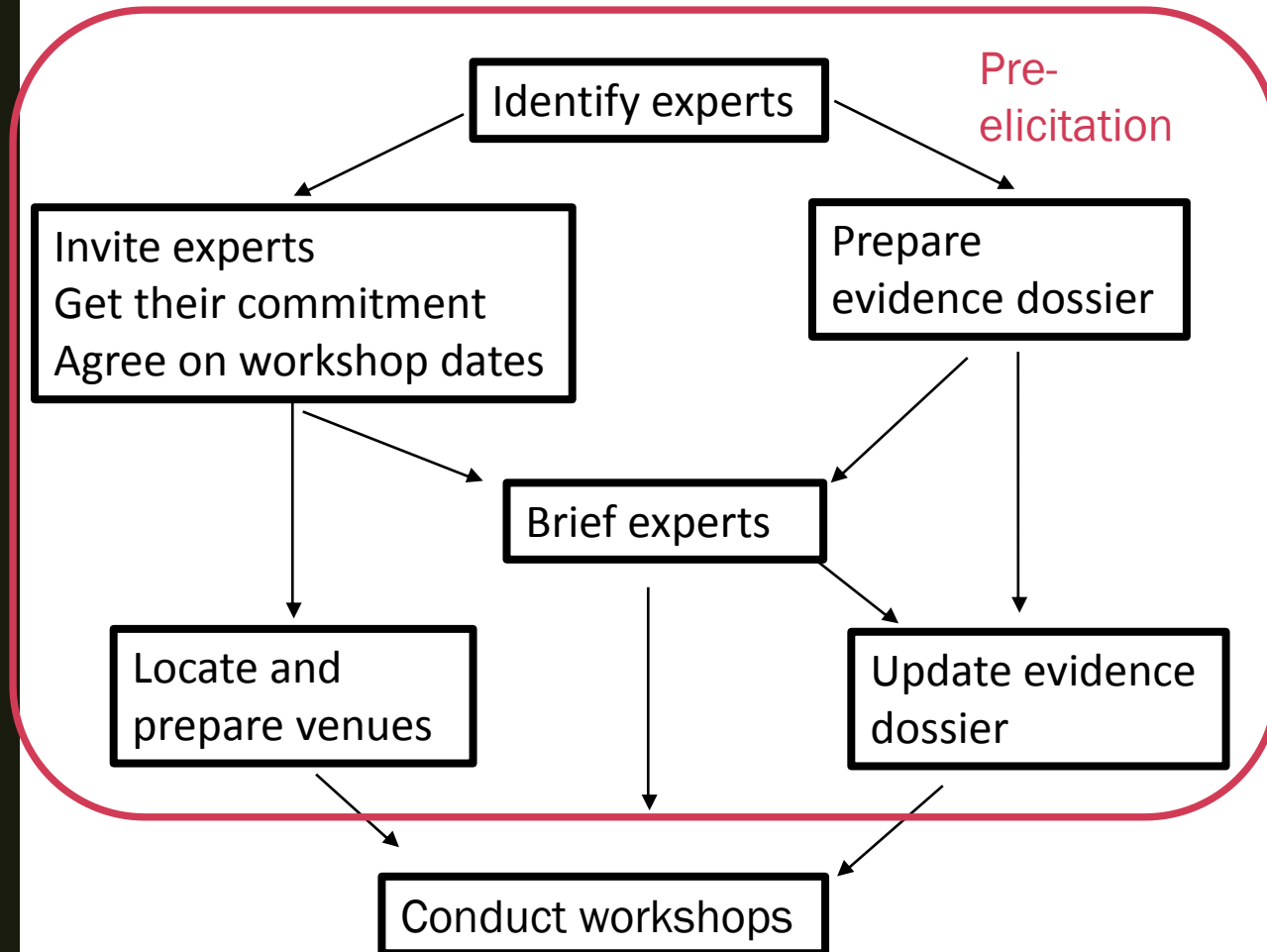
- Use expert judgement to fill knowledge gaps
  - Can address a variety of questions
  - Rigorous approaches to expert elicitation
  - Reliable and practicable
  - Quantifies uncertainty

■ Only used until data are available



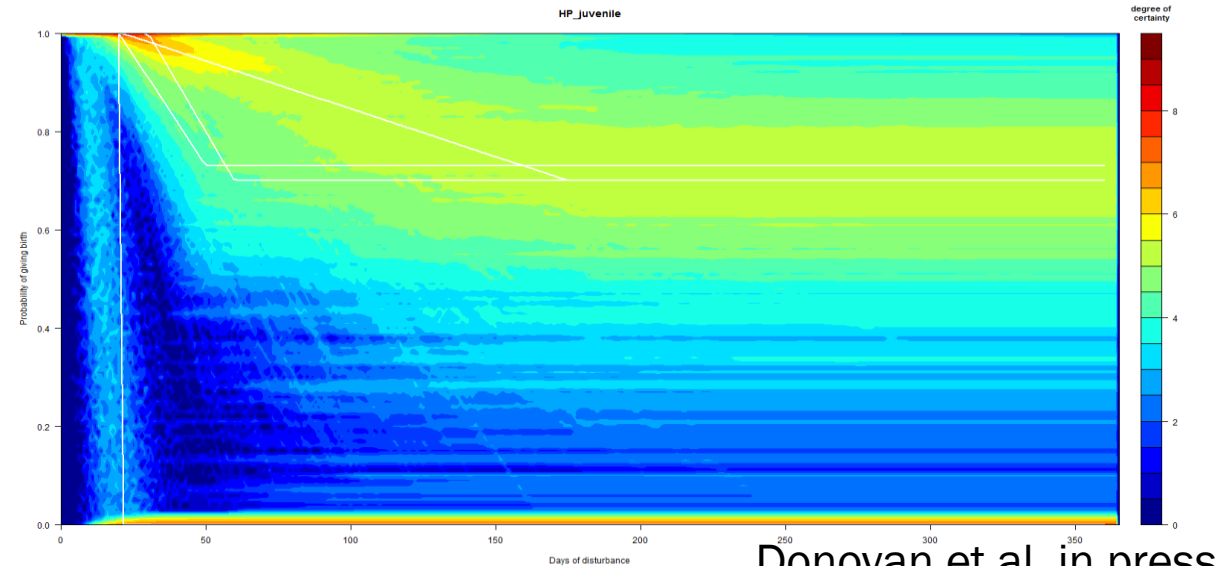
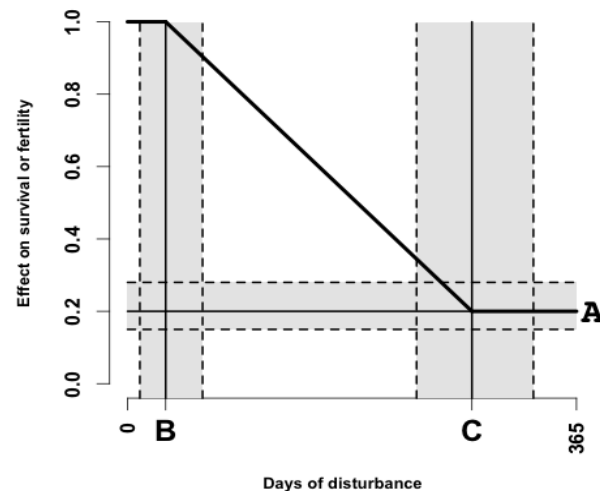


# Expert Elicitation



# Elicitation Results

- Experts are asked for:
  - Best estimate
  - Lowest and highest plausible values
  - Their certainty in their response
  
- Information is combined to form a distribution



# Off-shore Wind

- EE to define relationship between disturbance and vital rates
- Simulate disturbed and undisturbed populations
  - 500-1000 times
  - Over 1-20 year period
  - Results from EE in disturbed simulations only
  - Uncertainty in both
- Compare the distributions of the two populations
  - Difference represents the theoretical loss of animals
  - Compare to the PBR



# (Interim) PCoD and Uncertainty

- Uncertainty accounted for includes:
  - The number of animals disturbed per day as a result of different kinds of activity
  - The size and status of the population that is likely to be affected
  - The duration of the disturbance response
  - The vulnerability of different components of the population
  - Variations among experts in the parameter estimates
  - Environmental stochasticity
  - Demographic stochasticity

# Acknowledgements

## ■ Contributors:

- C. G. Booth, M. Burgman, J. S. Clark, D. P. Costa, C. Donovan, E. Fleishman, J. Harwood, M. A. Hindell, S. L. King, T. Klanjšček, D. Lusseau, S. Kraus, C. R. McMahon, P. W. Robinson<sup>5</sup>, R. S. Schick, L. K. Schwarz, S. E. Simmons, L. Thomas, P. Tyack

## ■ Funders:



# References

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- New, L.F., Clark, J.S., Costa, D.P., Fleishman, E., Hindell, M.A., Klanjscek, T., Lusseau, D., Kraus, S., McMahon, C.R., Robinson, P.W., Schick, R.S., Schwarz, L.K., Simmons, S.E., Thomas, L., Tyack, P. and Harwood, J. (2014) Estimating the long-term fitness of southern elephant seals on the basis of short-term measures of behaviour. *Marine Ecology Progress Series*, 496: 99-108.
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