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# Translating conceptual to parameterized models for multiple taxonomic groups

Len Thomas<sup>1</sup>, John Harwood<sup>1</sup>,  
James S. Clark<sup>2</sup>, Leslie New<sup>1,3</sup>, Rob Schick<sup>2</sup>



University of St. Andrews,  
Centre for Research  
into Ecological and  
Environmental  
Modelling



Duke University,  
Nichols School of  
the Environment  
and Earth  
Science

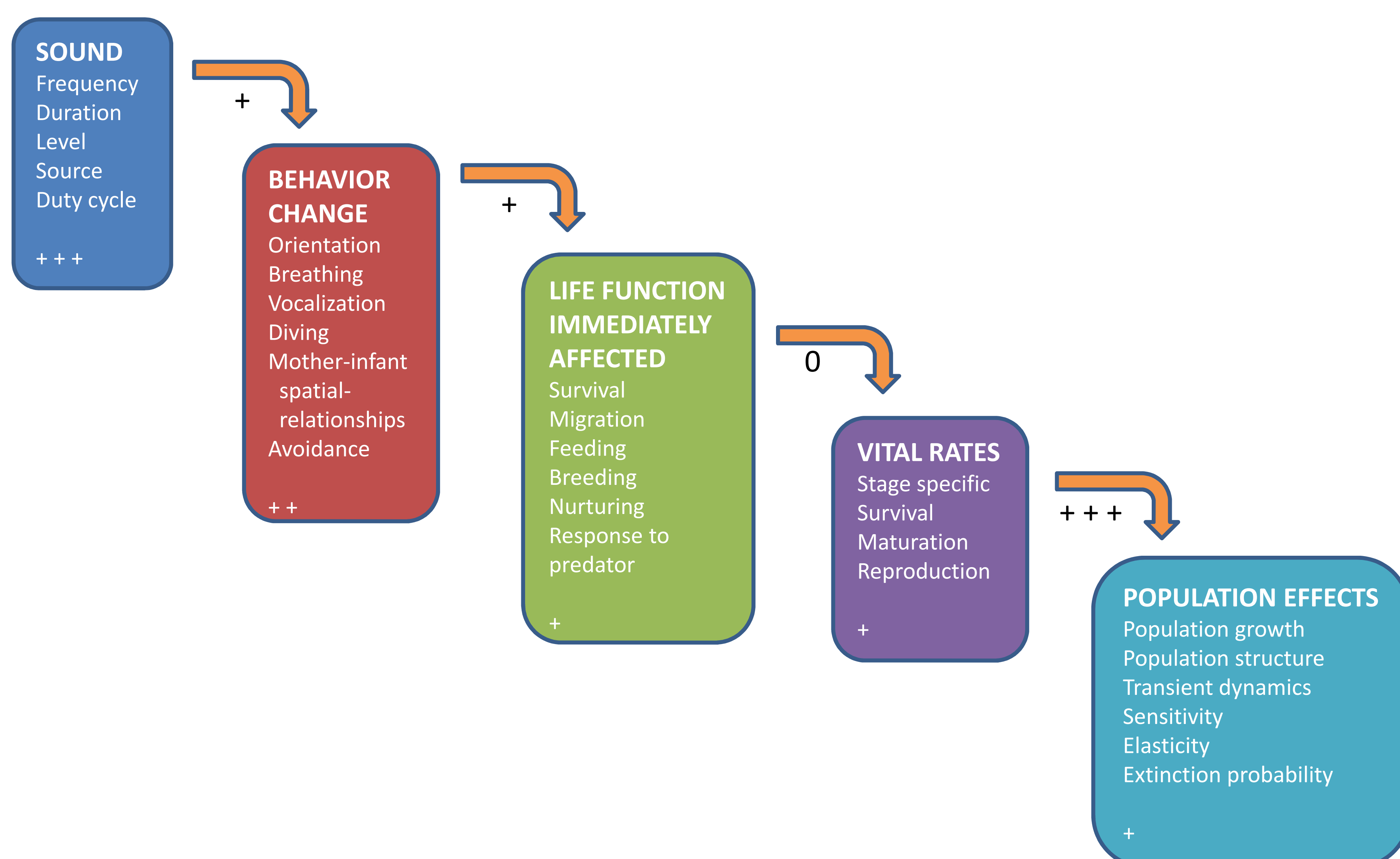


Marine  
Mammal  
Commission

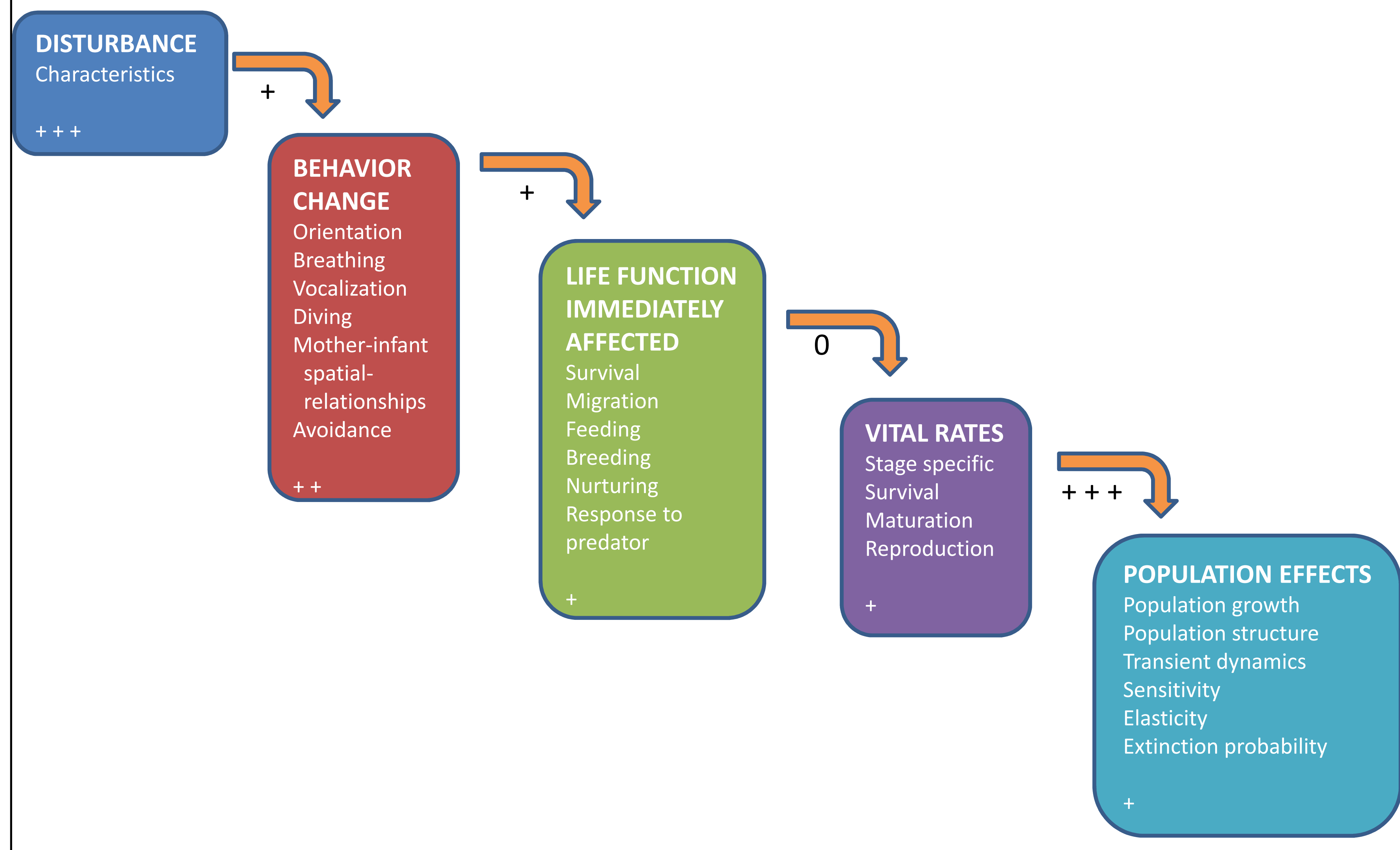


Symposium: Population Consequences of Acoustic  
Disturbance to Marine Mammals.  
Washington DC. Oct/21/2011

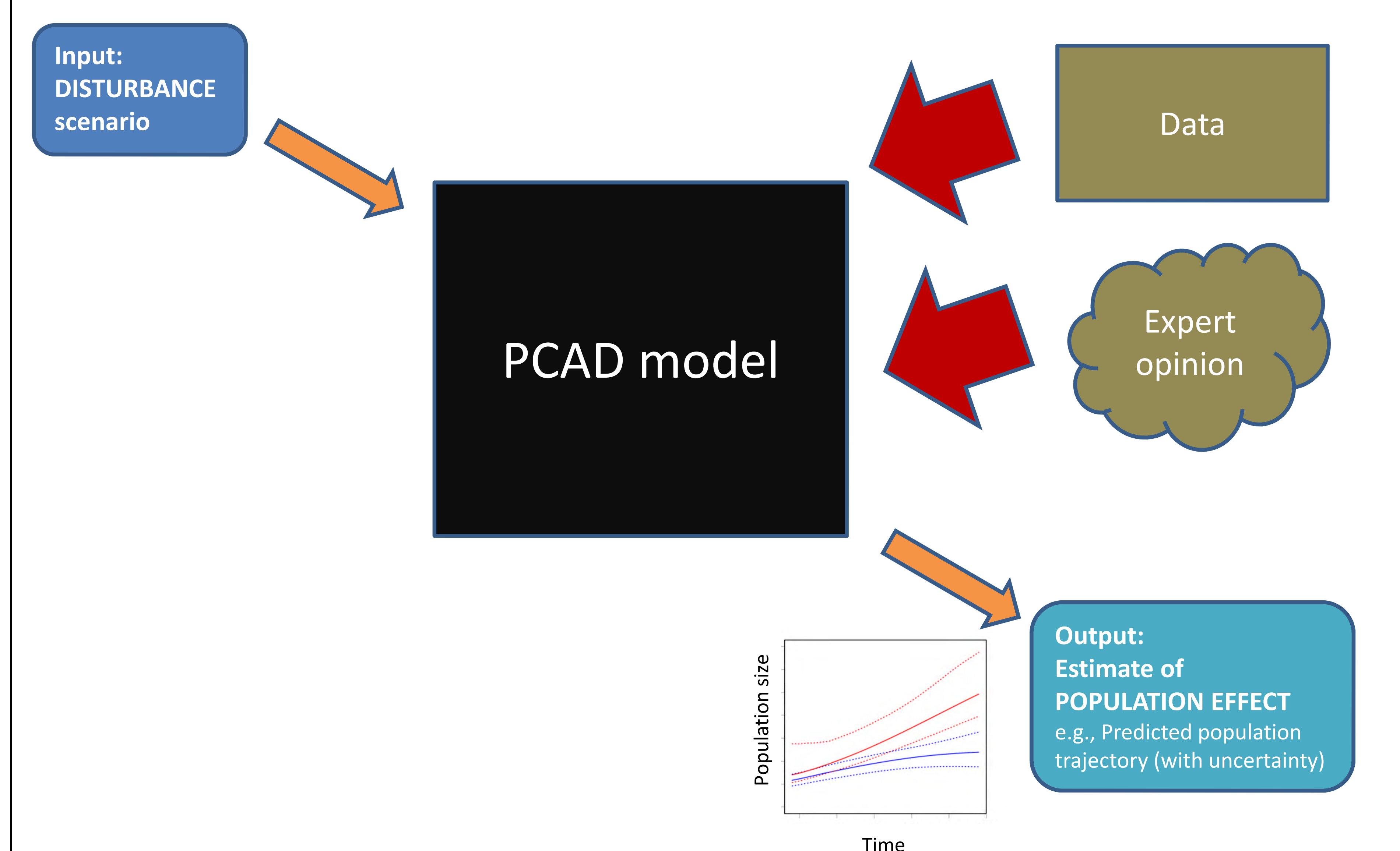
## PCAD conceptual framework



... can be applied more generally



From conceptual to quantitative



## Challenges

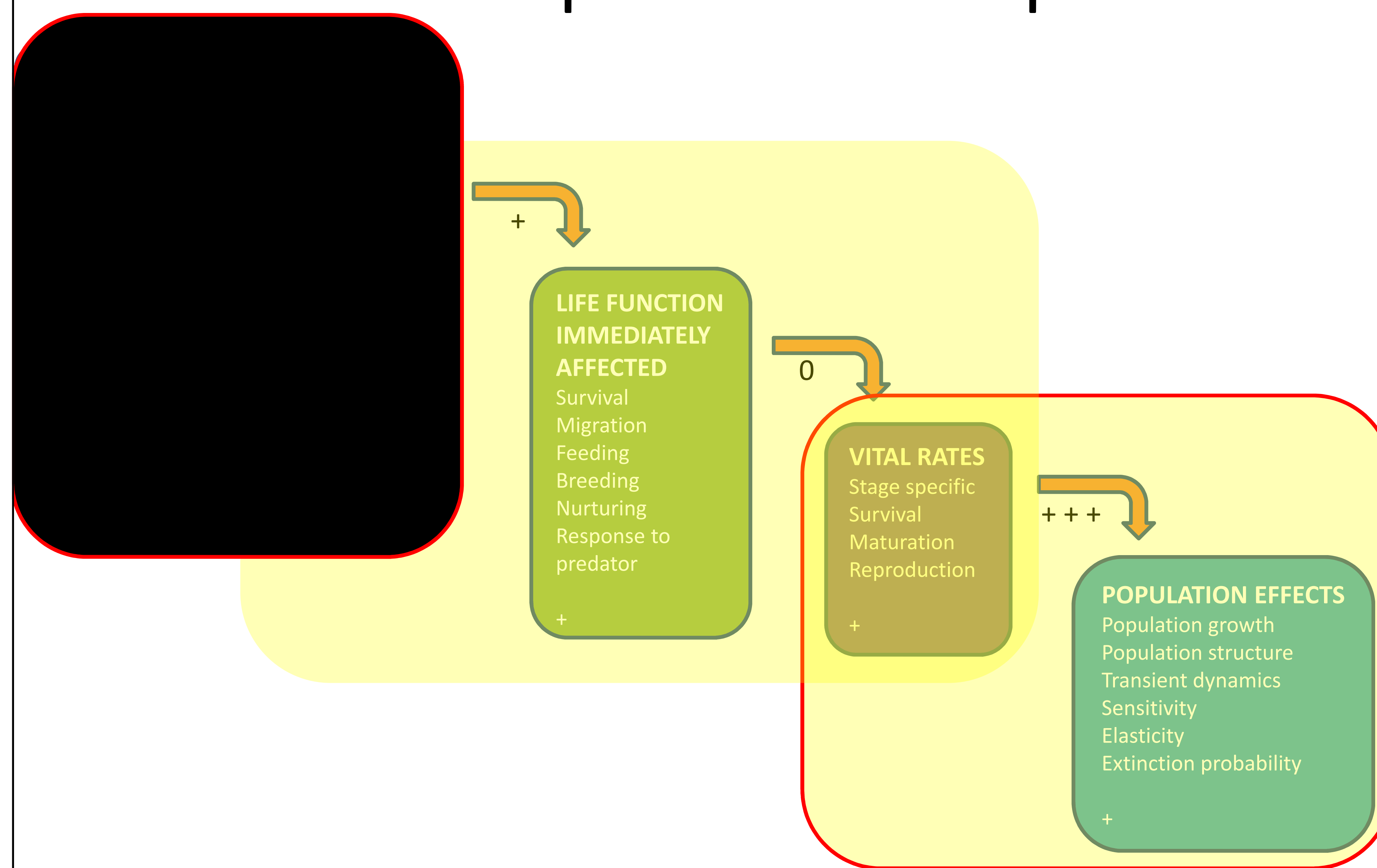
- True biological system highly complex – need to simplify while retaining some realism
- Diverse spatial and temporal scales
- Experimental and observational data that can inform model is often sparse and noisy

## Approach used

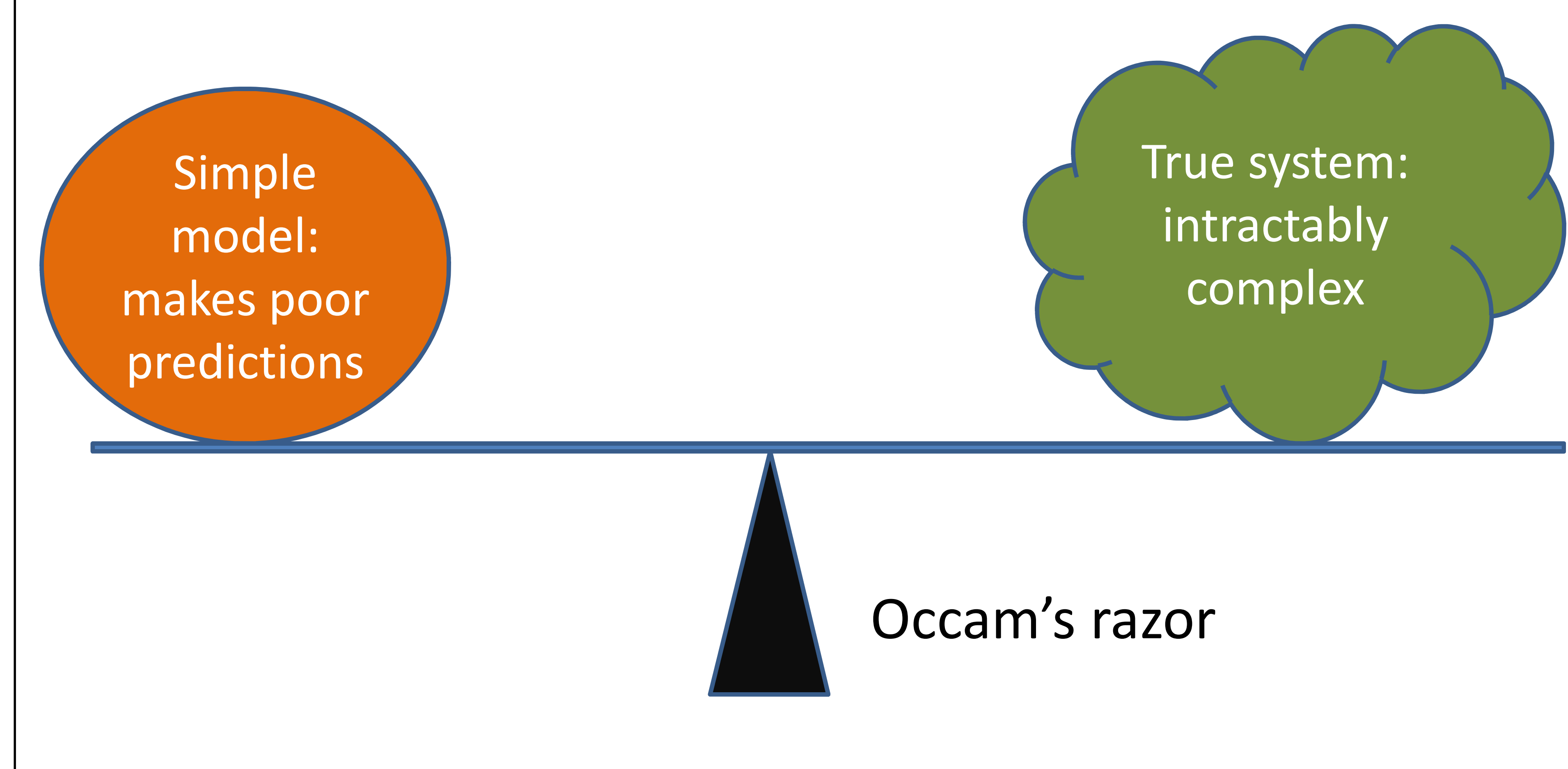
- Break the problem into parts
- For each part, construct mechanistic models with as much realism as is practical
- Fit models to data where you can, simulate with assumed inputs where you can't (or don't want to)  
(use simulated data to test if fitting works)



## Break the problem into parts



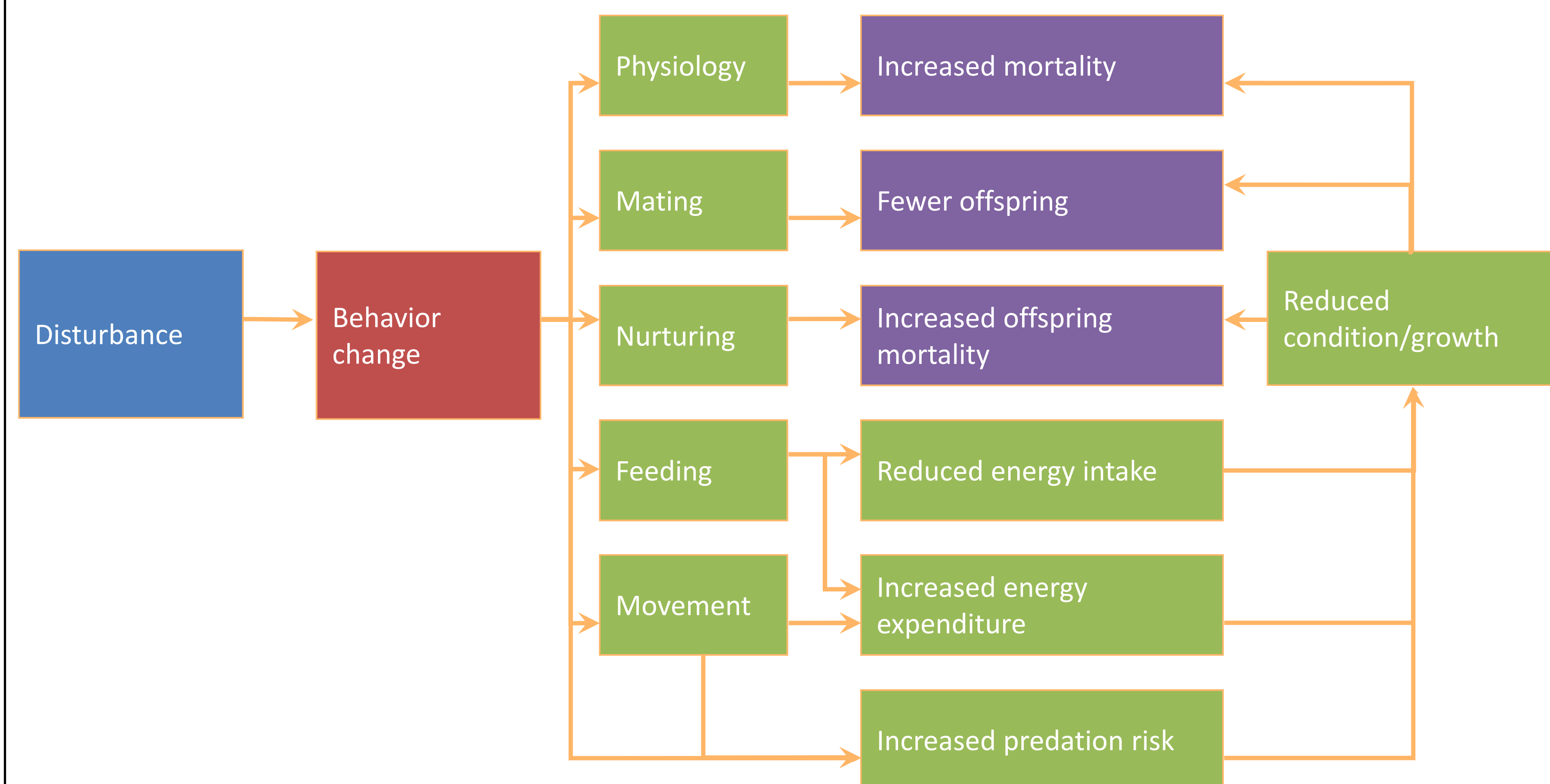
## Construct mechanistic, parsimonious models





## PCAD model

### From behavior to vital rates



## Elephant seals

Crocker, D. E., J. D. Williams, D. P. Costa, and B. J. Le Boeuf. 2001. Maternal traits and reproductive effort in northern elephant seals. *Ecology* **82**: 3541-3555.

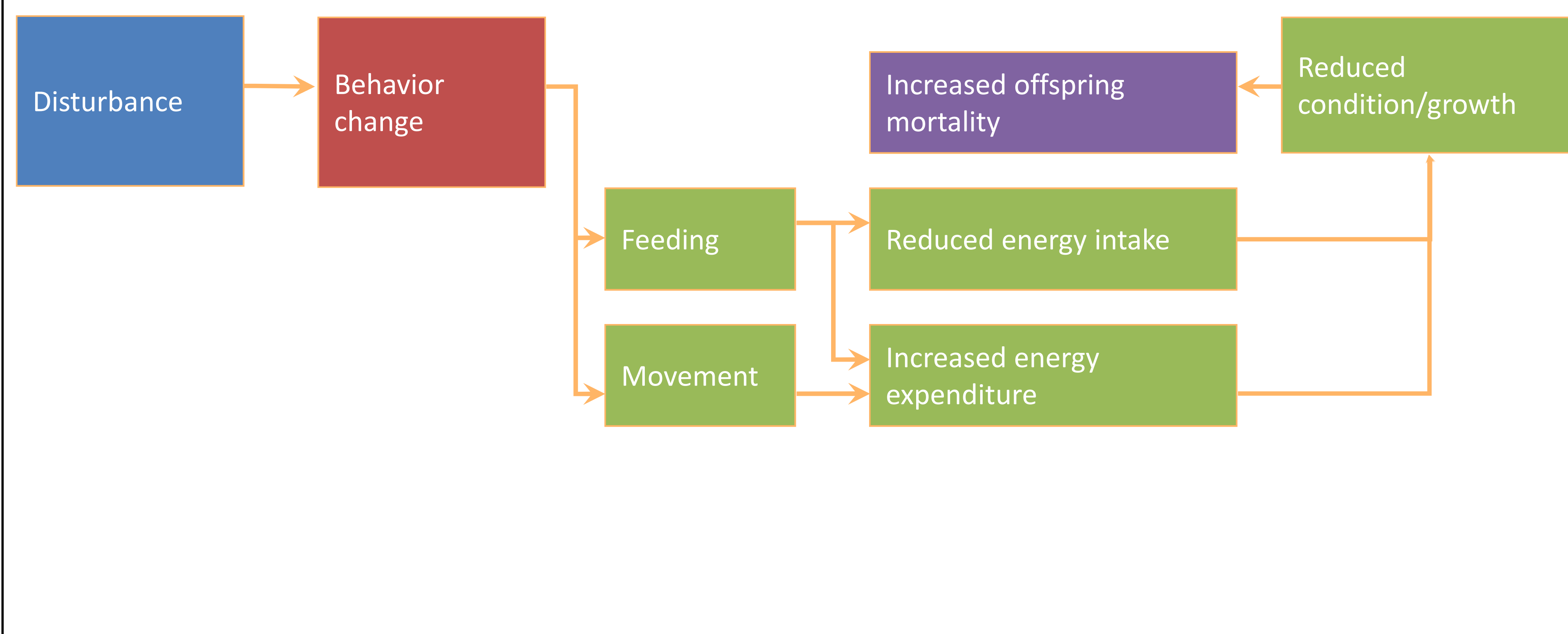
McMahon, C. R., H. R. Burton, and M. N. Bester. 2000. Weaning mass and the future survival of juvenile southern elephant seals, *Mirounga leonina*, at Macquarie Island. *Antarctic Science* **12**: 149-153.

Photos by Jason Bradley



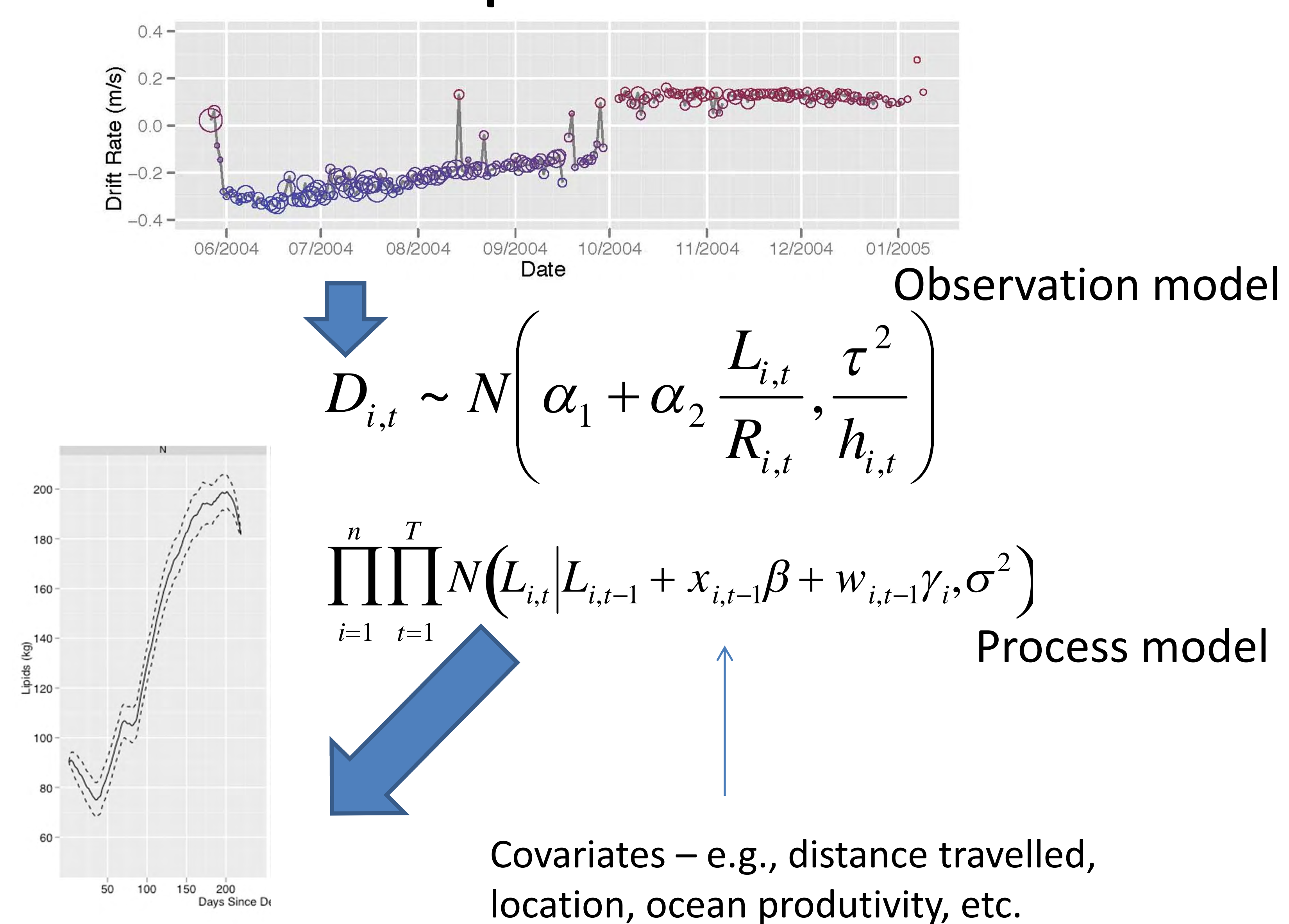
## PCAD model

### Elephant seals – pup production

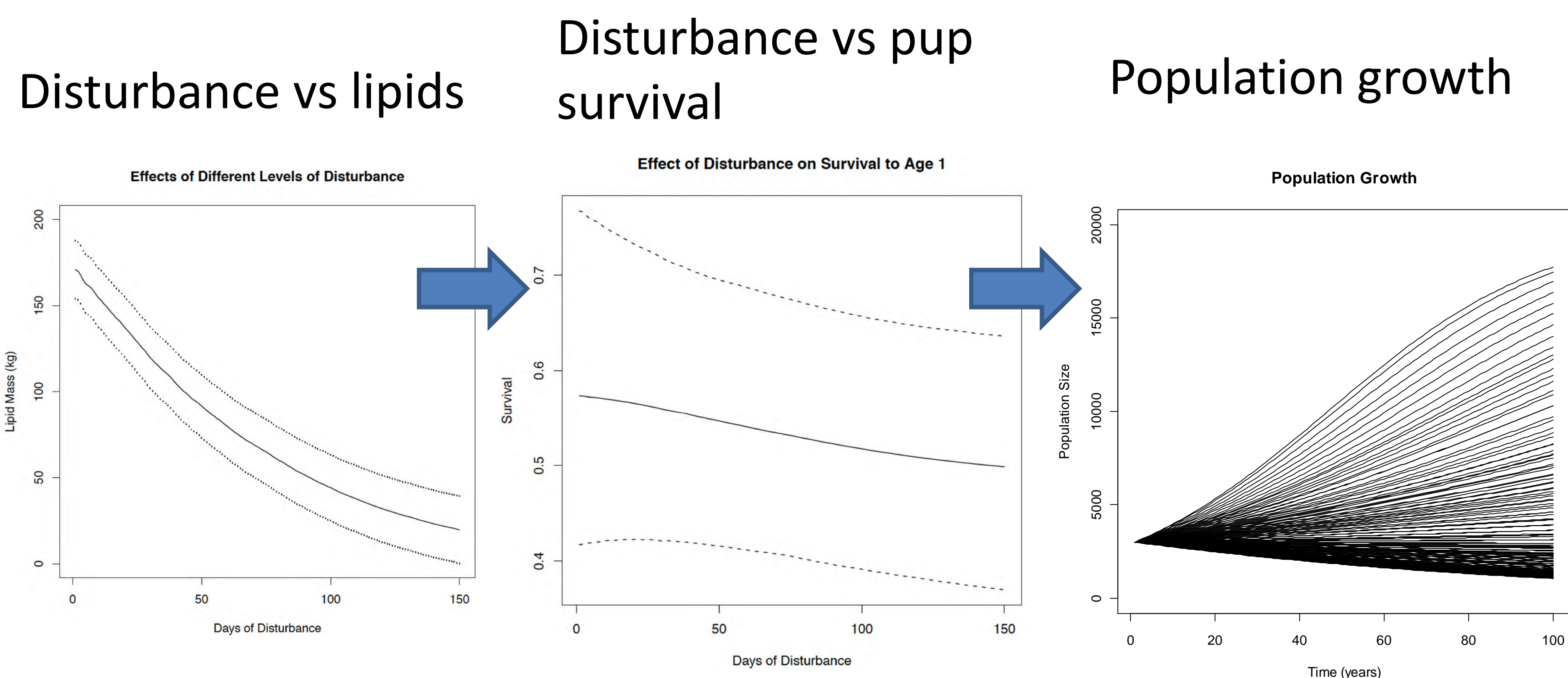


## Modeling lipid change

### State-space model

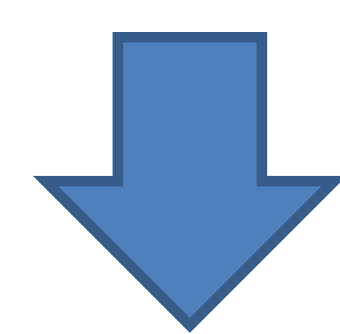


# Predicting population consequence



## Pros and Cons of Detailed Mechanistic Modeling

- + State-space models allow inferences about underlying quantities of biological interest
- + Incorporate expert opinion on mechanisms
- + Biological realism (hopefully!)
- Requires a reasonable level of knowledge about the system
- Requires a reasonable amount of pertinent data
- Model fitting can be technically challenge

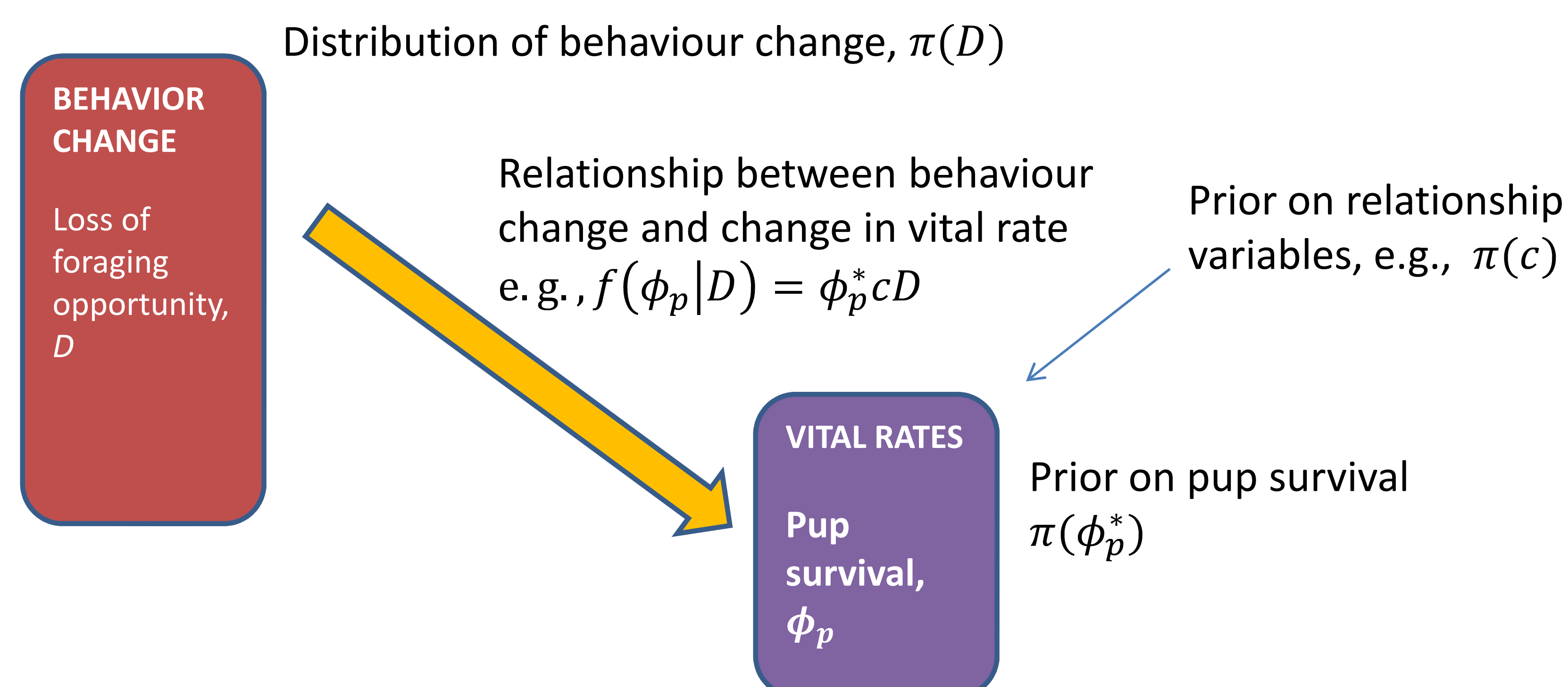


Can characterize as resource intensive but high potential gain



## A simpler alternative? Non-mechanistic models

E.g., Bayesian Belief Network



Methods exist for elucidating required relationships and distributions from expert opinion

## Conclusions

- We have focused on linking behavioural response to changes in demographic parameters
- We have constructed mechanistic conceptual models, and translated them into stochastic mathematical models
- Model details vary by case study, depending on biology and available data



## Conclusions II

- In parameterizing models, we have relied heavily on state-space modelling (particularly Bayesian)
- Where data or knowledge are not sufficient for mechanistic models, simpler methods may be available that rely on expert opinion about relationship between behavioural response and demographic change. We have not tried these yet.

