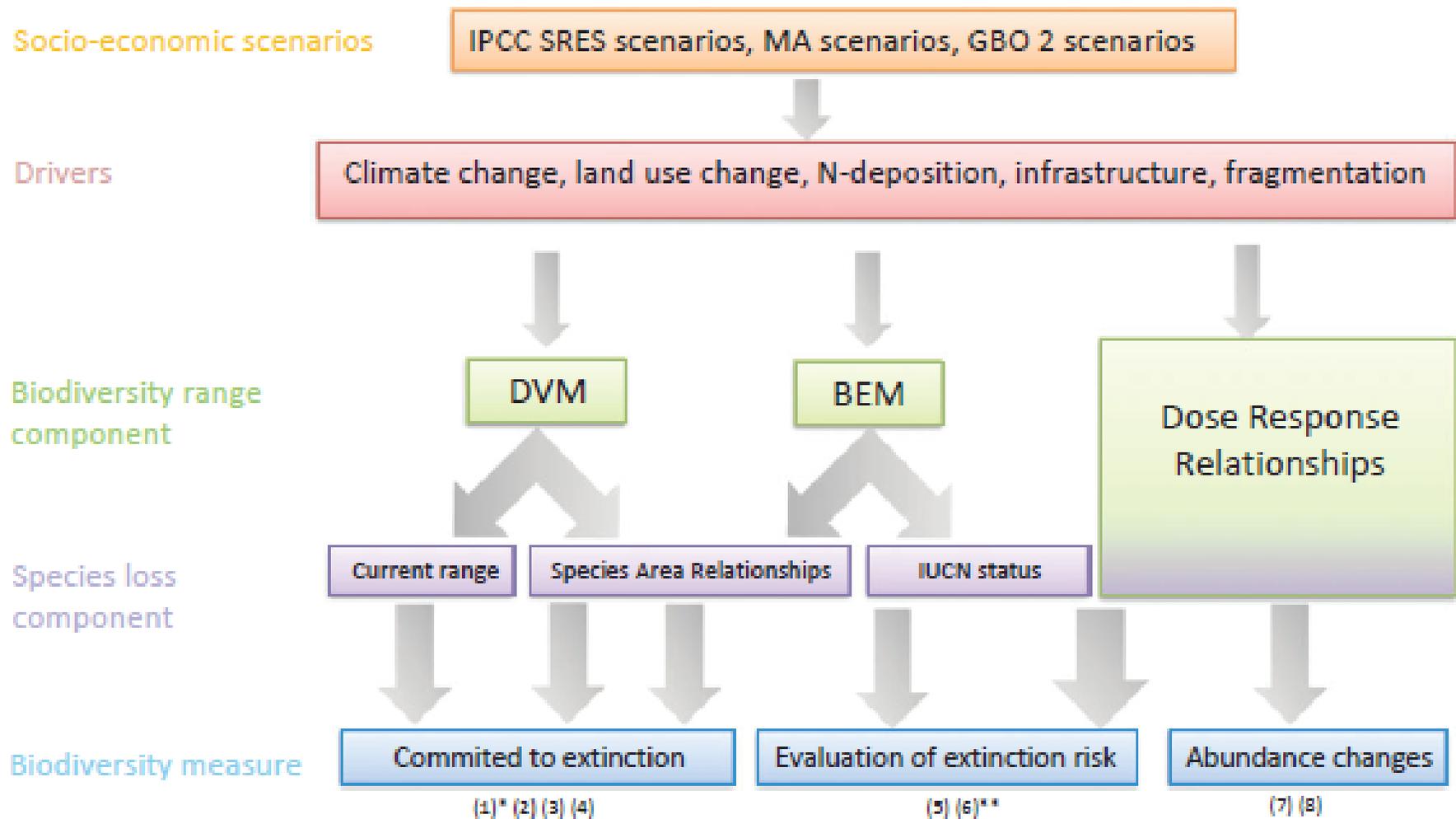


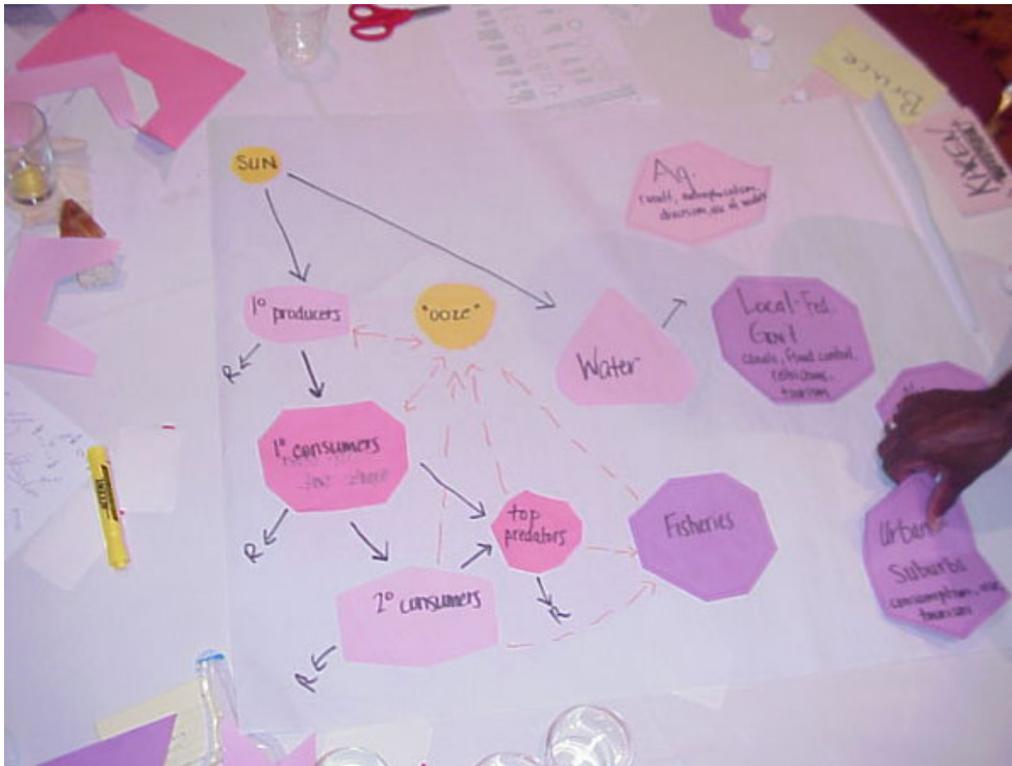
# Types of ecological response models

- Expert opinion models
- Trait-based models
- Occupancy models with habitat correlates
- Dose-response relationships
- Niche models
- Mechanistic models (physiological models)
- Dynamic vegetation models



From Bellard et al. 2012. Ecology Letters.

# Expert-opinion models



# Trait-based models

## SAVS: A System for Assessing Vulnerability of Species



### NatureServe Climate Change Vulnerability Index

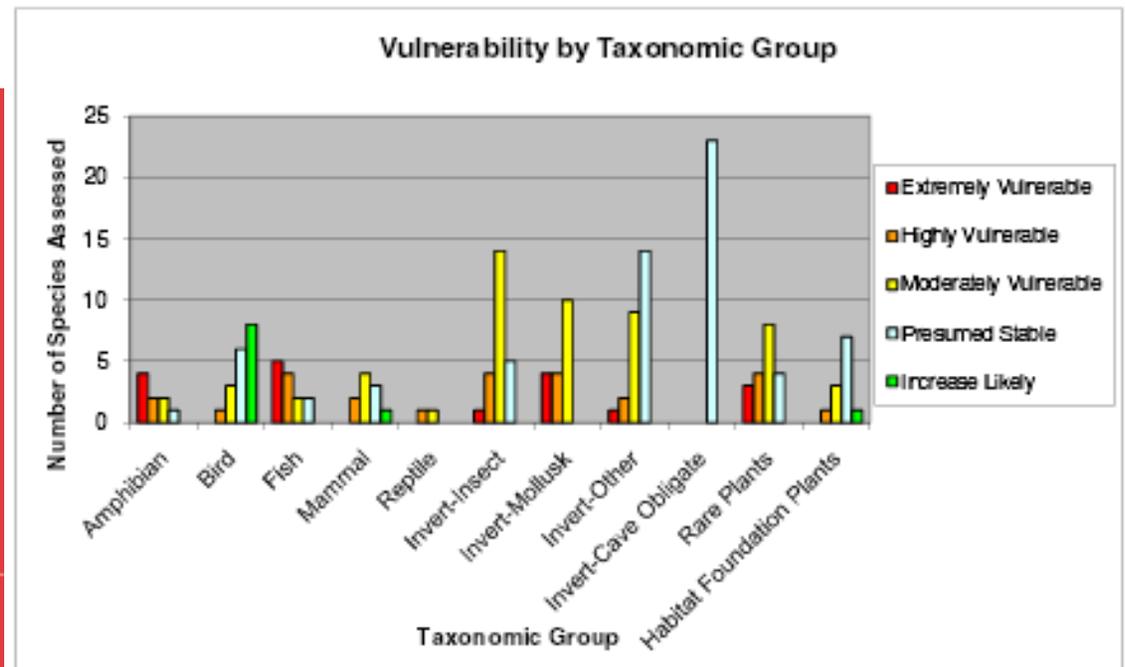
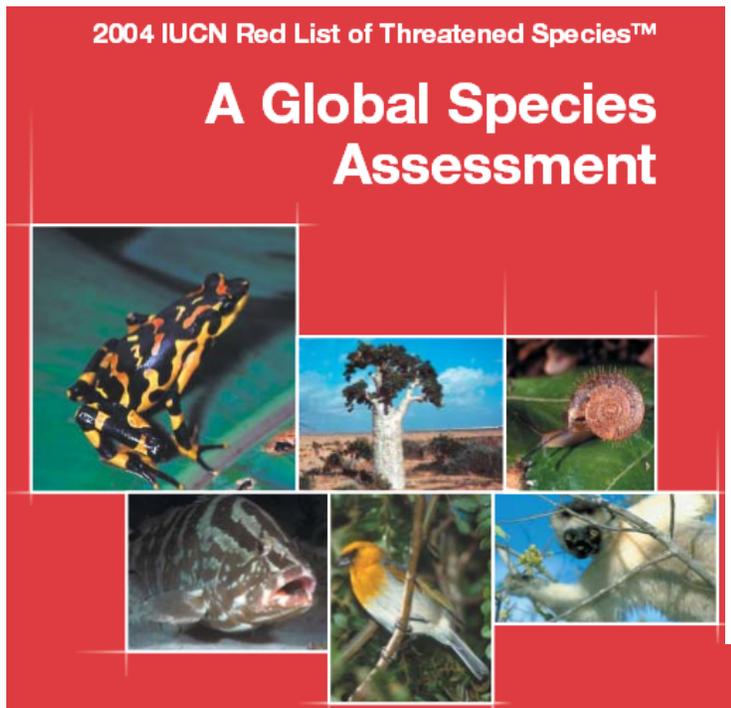
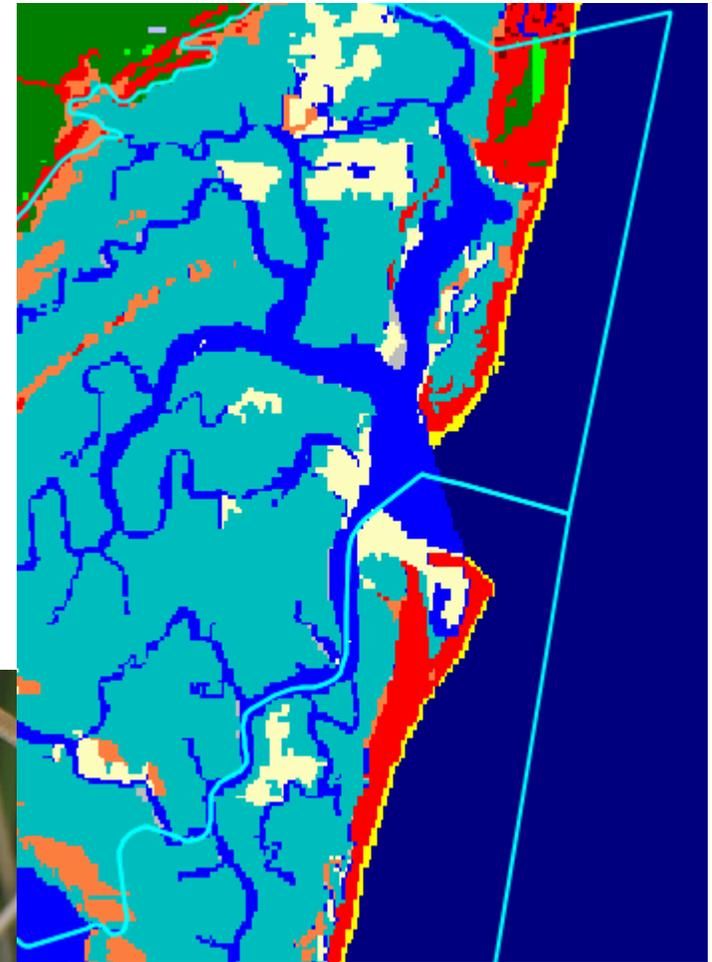


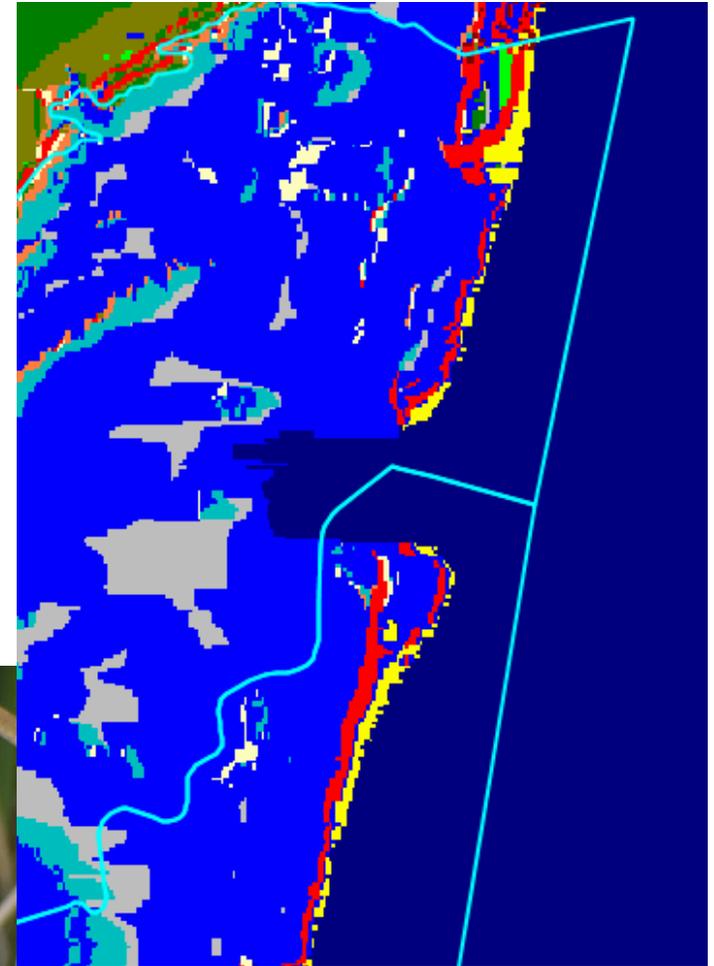
Figure 2. Vulnerability by Taxonomic Group

# Occupancy-based models with habitat correlates



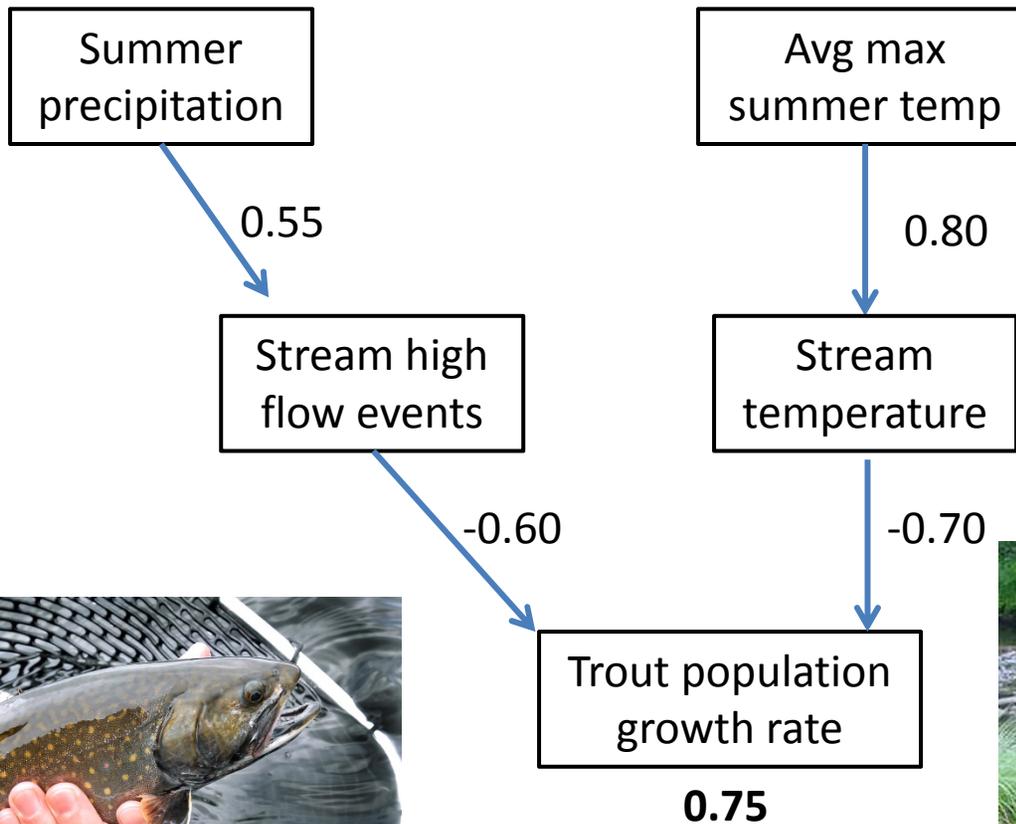
**Current land cover**

# Occupancy-based models with habitat correlates

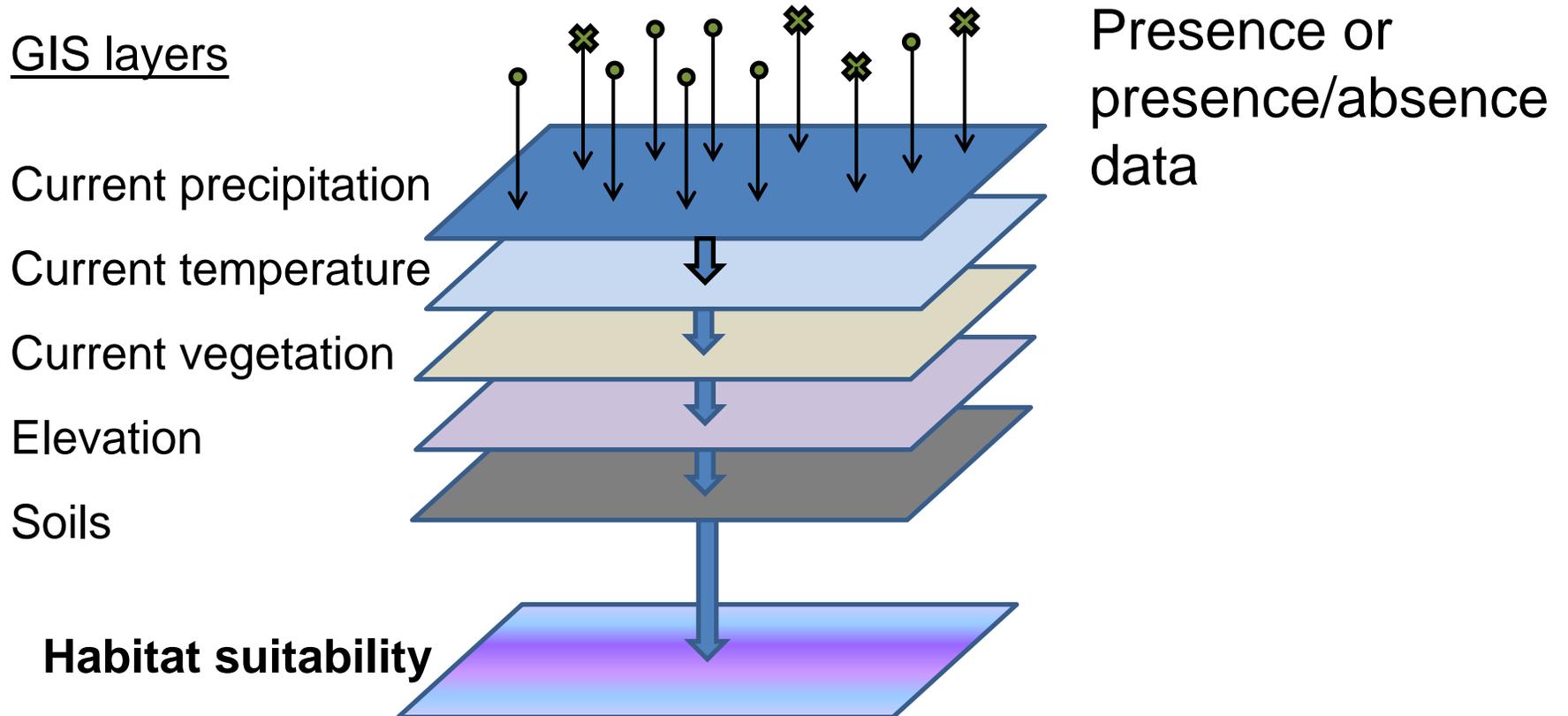


**2100 land cover**

# Dose-response models

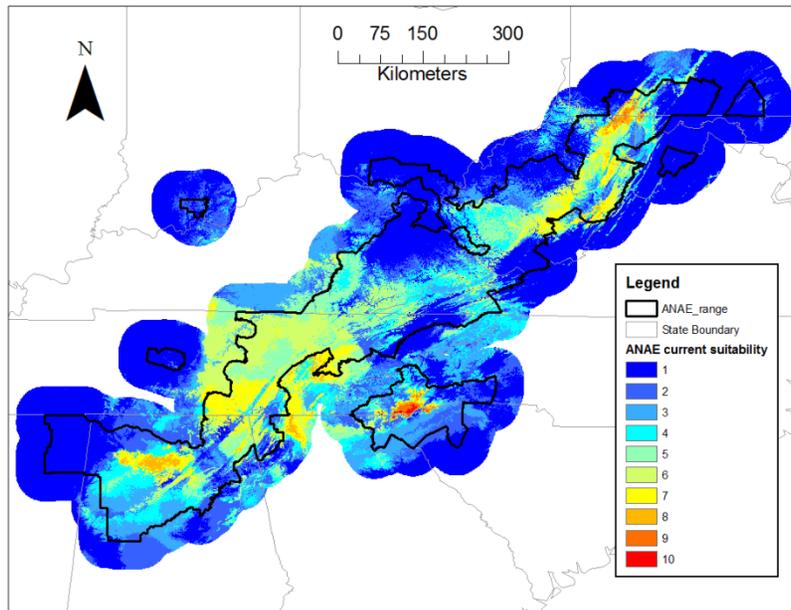


# Niche modeling

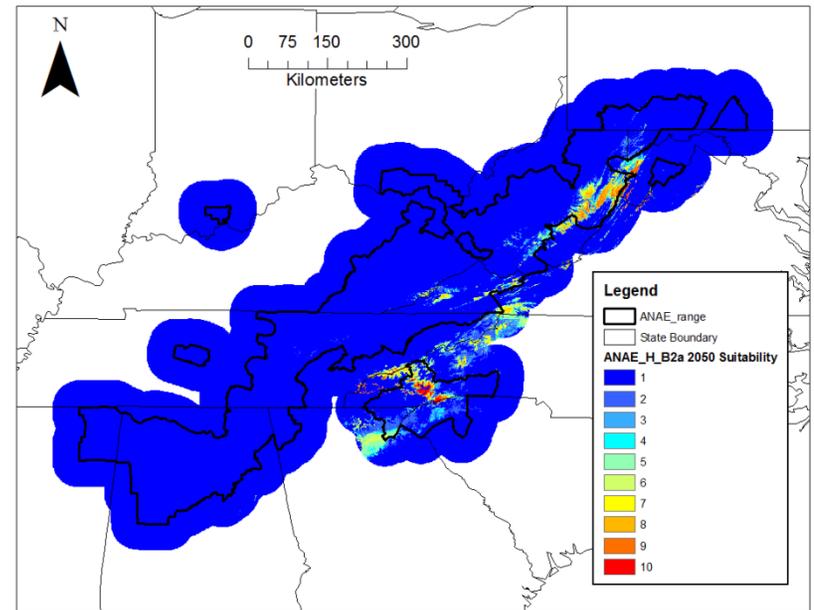


# Niche modeling

**Current suitability**



**Suitability in 2050**



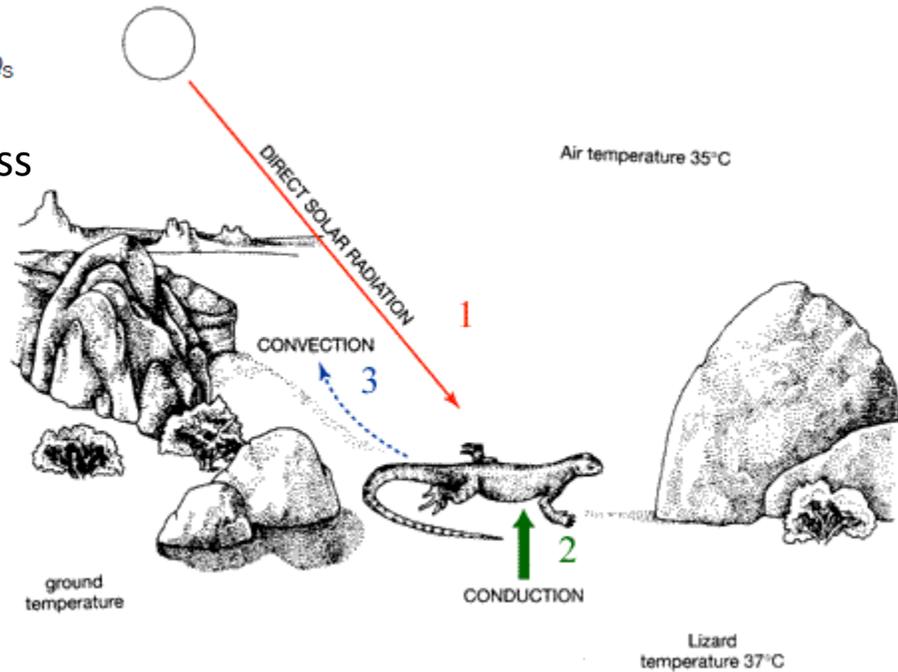
Exposure can be assessed in a quantitative and spatially explicit manner

# Mechanistic models

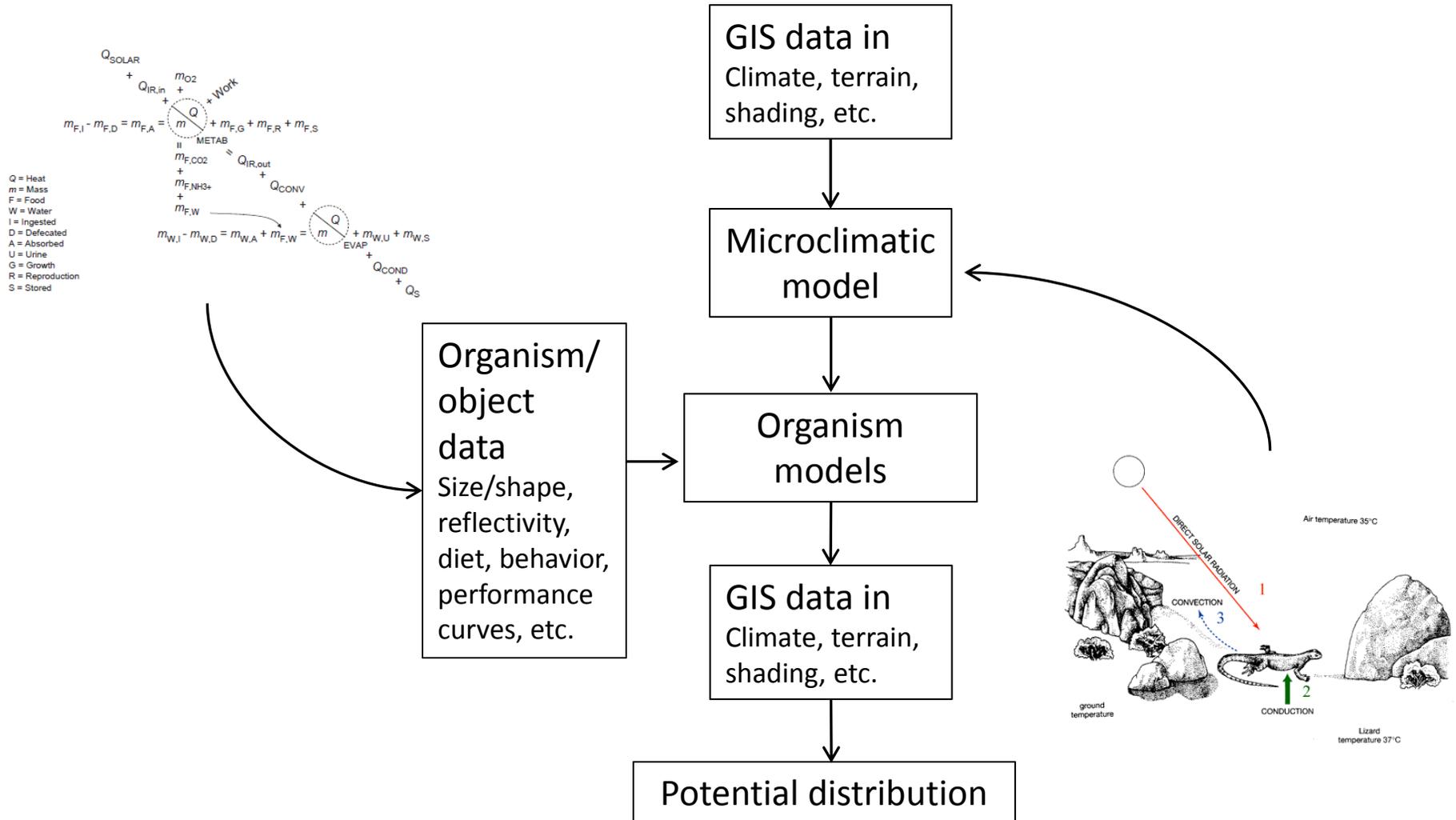
$$\begin{aligned}
 & Q_{\text{SOLAR}} + Q_{\text{IR,in}} + \frac{m_{\text{O}_2}}{m} + \text{Work} \\
 m_{\text{F,I}} - m_{\text{F,D}} = m_{\text{F,A}} &= \frac{Q}{m} + m_{\text{F,G}} + m_{\text{F,R}} + m_{\text{F,S}} \\
 & \text{METAB} \\
 & m_{\text{F,CO}_2} = Q_{\text{IR,out}} + Q_{\text{CONV}} \\
 & + m_{\text{F,NH}_3} + m_{\text{F,W}} \\
 m_{\text{W,I}} - m_{\text{W,D}} = m_{\text{W,A}} + m_{\text{F,W}} &= \frac{Q}{m} + m_{\text{W,U}} + m_{\text{W,S}} \\
 & + Q_{\text{COND}} + Q_{\text{S}}
 \end{aligned}$$

Q = Heat  
 m = Mass  
 F = Food  
 W = Water  
 I = Ingested  
 D = Defecated  
 A = Absorbed  
 U = Urine  
 G = Growth  
 R = Reproduction  
 S = Stored

Coupled energy and mass balance equation



# Mechanistic models

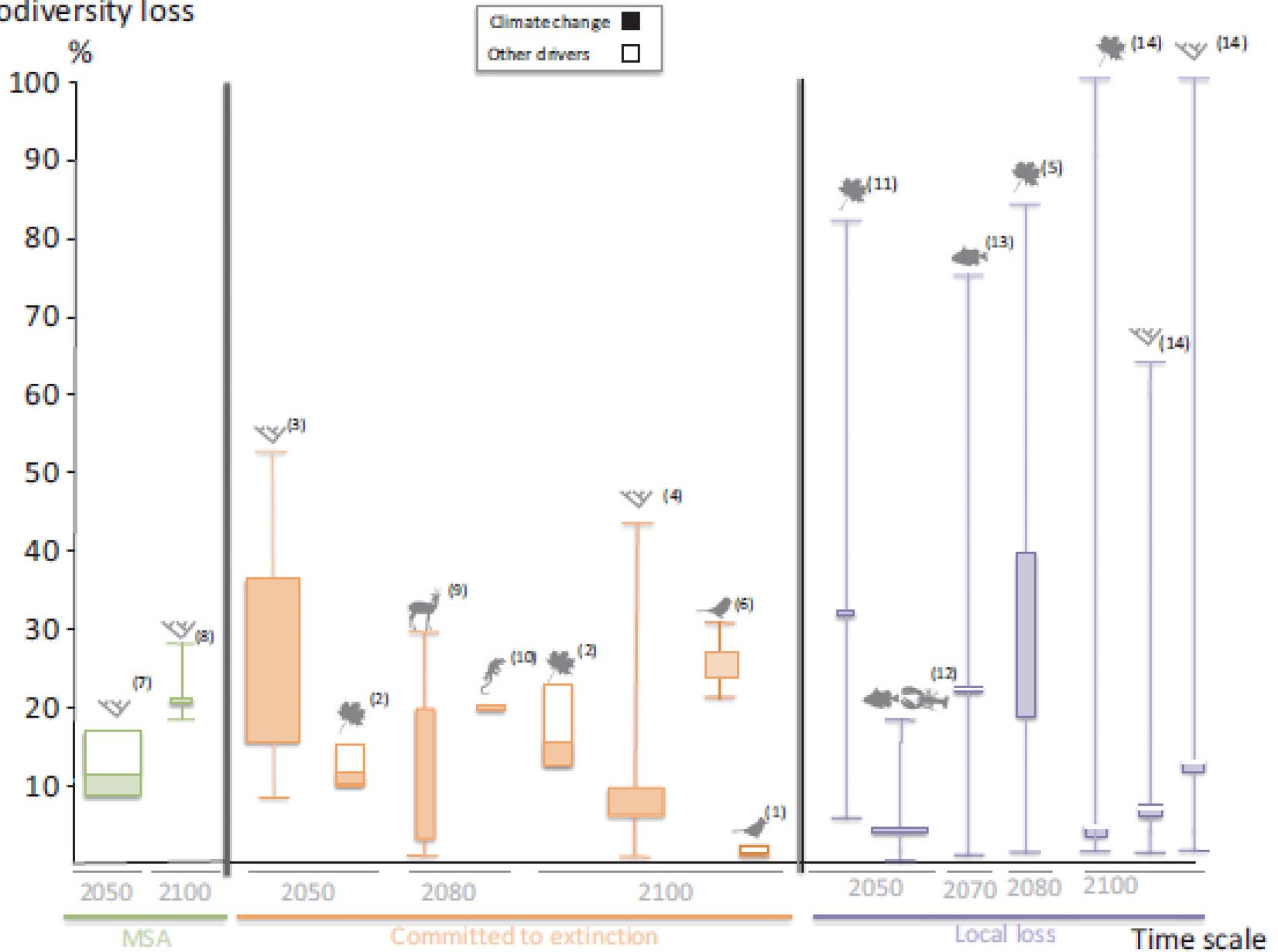


Modified from Kearney and Porter. 2009. Ecology Letters.

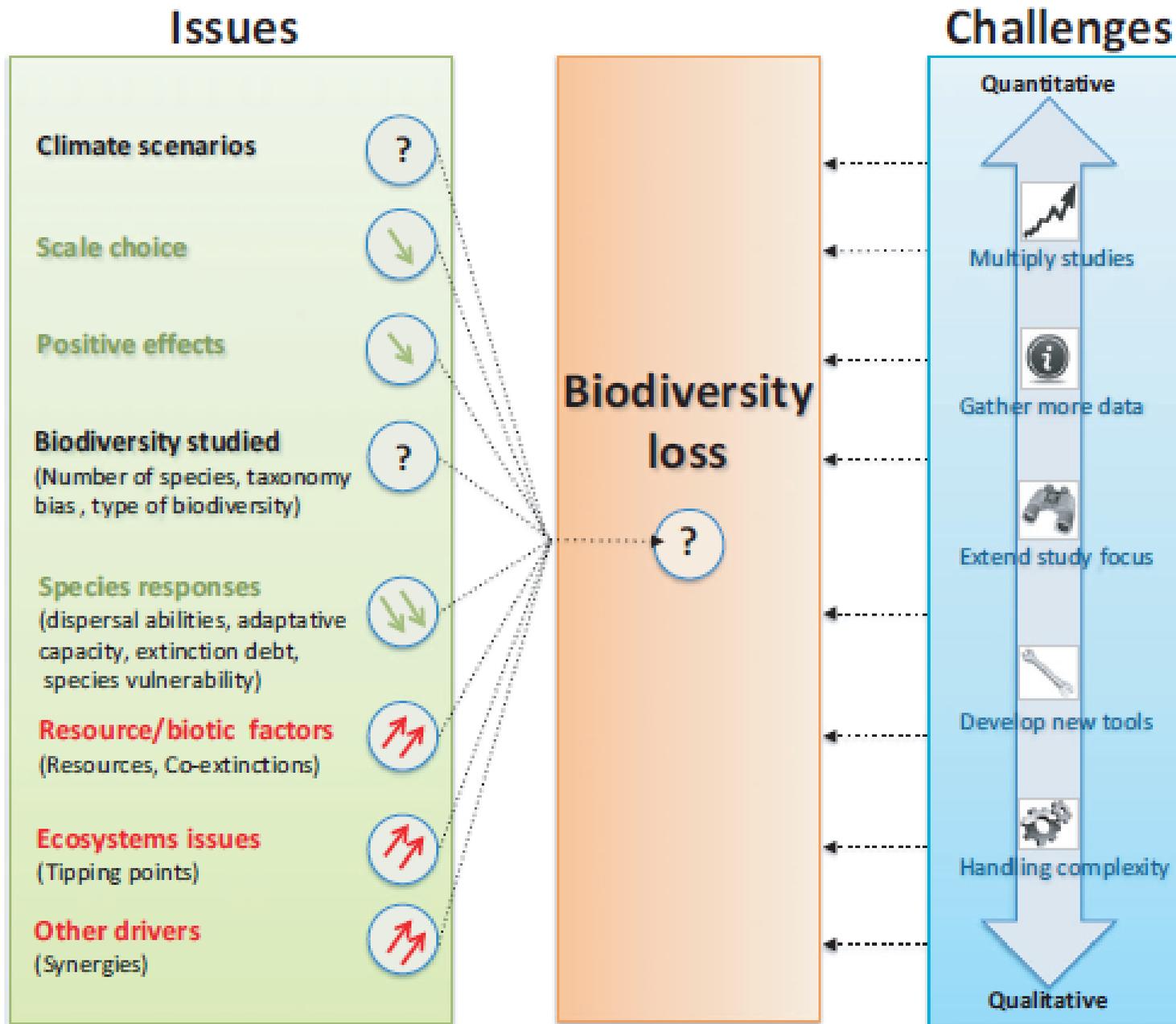
# Dynamic vegetation models

- Simulate percent cover of globally distributed plant functional types
- Use: simulate growth (NPP) and disturbance (e.g., fire), percent cover of PFT, seed dispersal
- Disadvantages: require detailed phys data, not applicable to species-scale questions

# Biodiversity loss



From Bellard et al. 2012. Ecology Letters.



From Bellard et al. 2012. Ecology Letters.

# Which model is best for my needs?

- What data are available?
- What's your timeline, expertise, and budget?
- What end data product is required to make a decision?
  - List of species (vulnerable, resistant, etc.)
  - Maps
  - Output that feeds an iterative or flow-through process