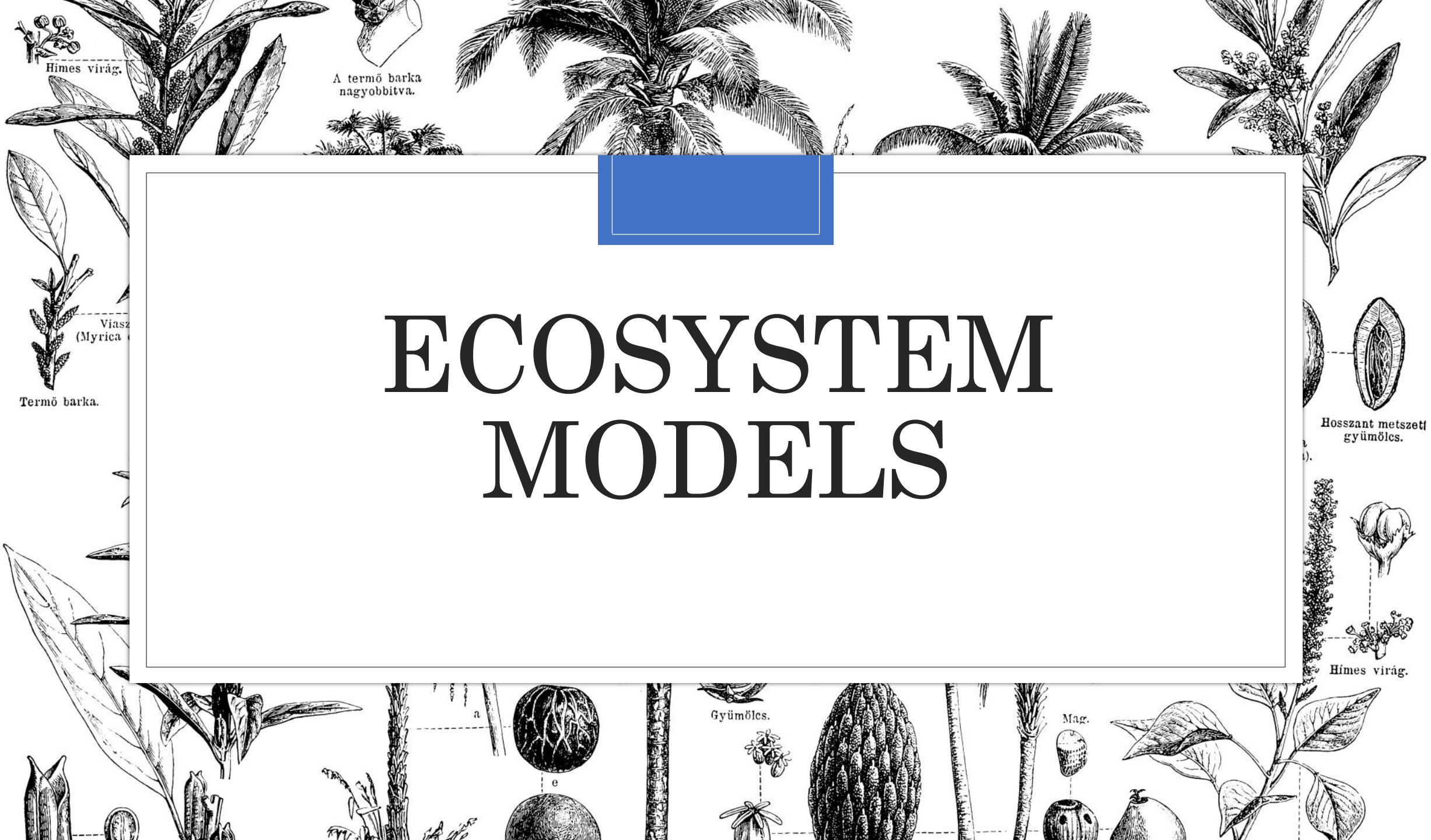


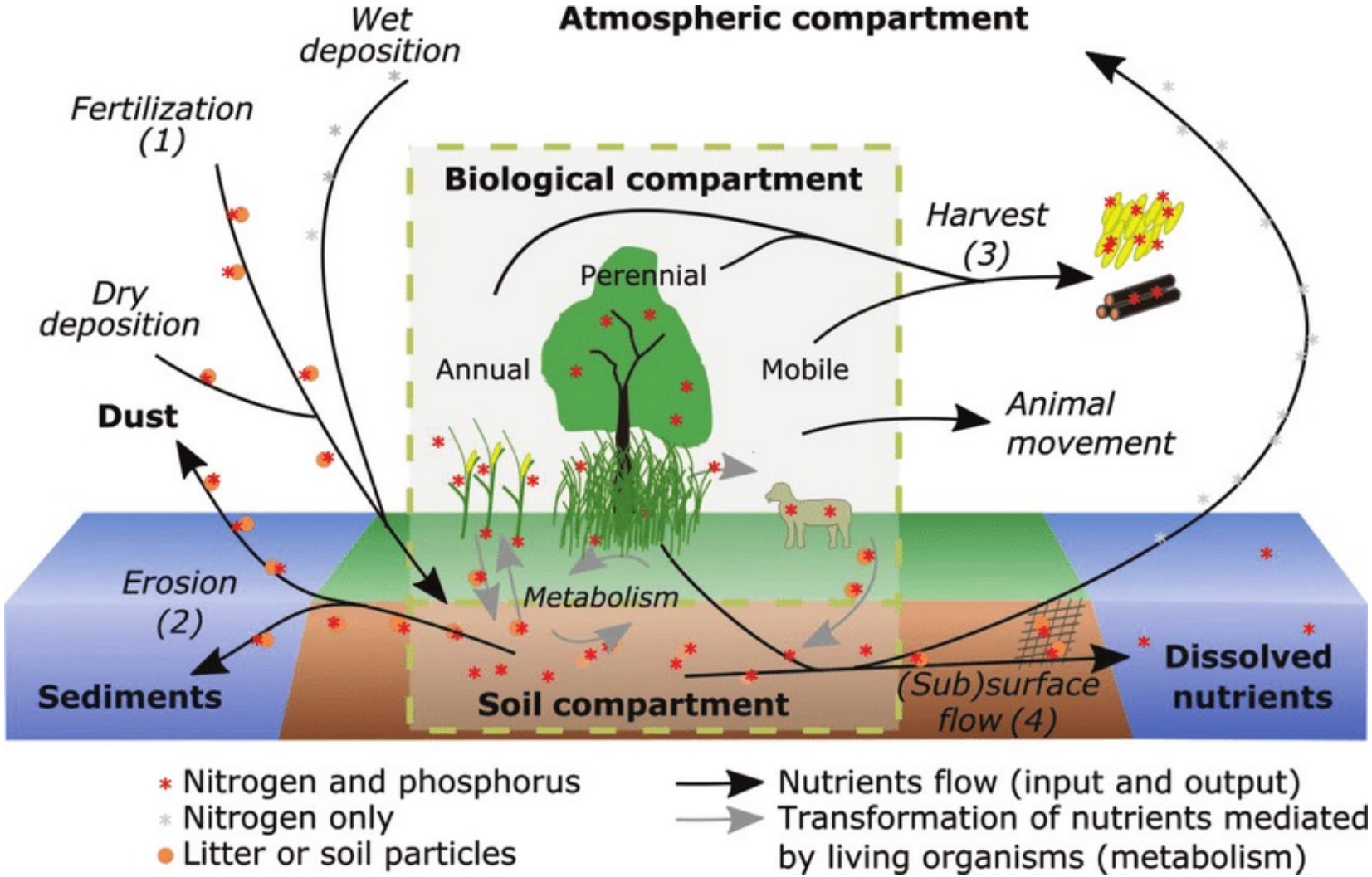
ECOSYSTEM MODELS

But first…data!

- Pacific halibut (*Hippoglossus stenolepis*)
  - Size-at-age
  - Abundance index time series
- Chimney swift (*Chaetura pelagica*)
  - Breeding bird survey (BBS) counts time series
- Tree seedlings (< 1” diameter at breast height; 6” conifers, 12” hardwood)
  - USDA Forest inventory and analysis
  - Not species-specific
- What else?

How do we model ecosystems?

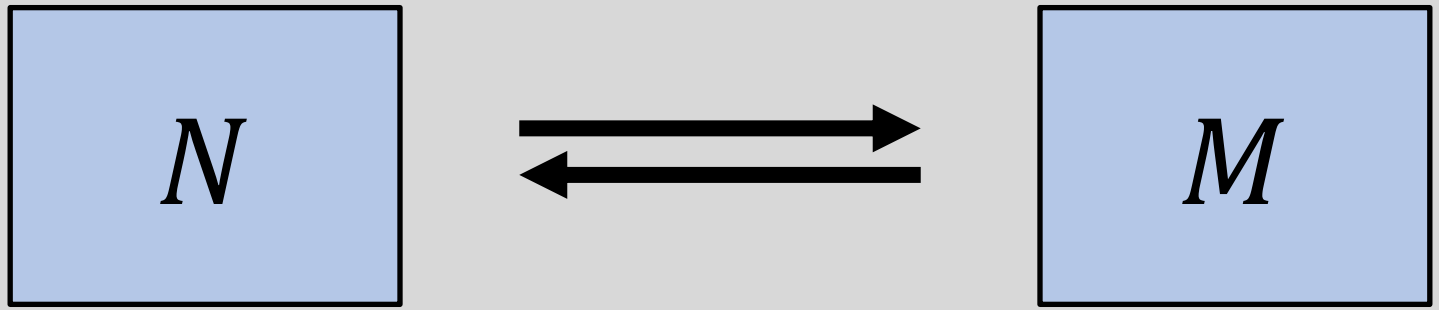
- Mass balance
  - Law of Conservation of Mass
  - Flow of energy/mass/stuff between compartments



Carlos Alberto Arnillas, Cindy Yang, Sophia A. Zamaria, Alex Neumann, Aisha Javed, Yuko Shimoda, Natalie Feisthauer, Anna Crolla, Feifei Dong, Agnes Blukacz-Richards, Yerubandi R. Rao, Diana Paredes, and George B. Arhonditsis. 2020. Integrating watershed and ecosystem service models to assess best management practice efficiency: guidelines for Lake Erie managers and watershed modellers. *Environmental Reviews*. **29**(1): 31-63. https://doi.org/10.1139/er-2020-0071

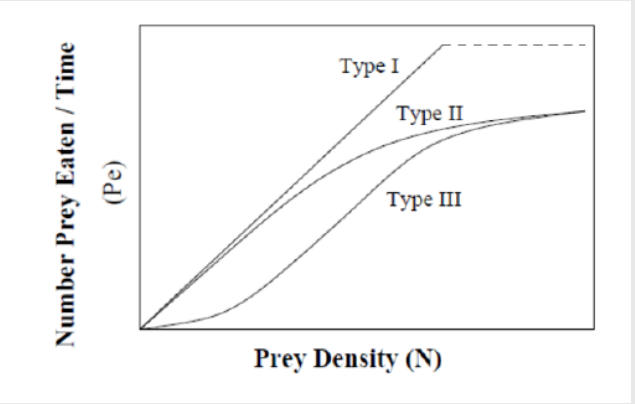
$$\frac{dN}{dt} = aM - bN$$

$$\frac{dM}{dt} = bN - aM$$



Ecopath with Ecosim

- Determines un-observed ”compartments” with observed, often single-species data + some assumptions regarding rates and efficiency of energy transfer
  - Growth
  - Reproduction
  - Mortality
- Models include several components
  - Functional responses between predators and prey
  - Removal by humans (“fishing”)
  - Compartments for each ecosystem component
  - Age-specific stages (stanzas)



Rpath

- A new implementation of EwE within R
- What do you need?
  - Model: parameters, including biomass, production, consumption, etc.
  - Diet: proportion of diet arising from other compartments in the model
  - Stanzas: age classes
  - Pedigree: data origin and reliability