Ecosystem Modeling With an Emphasis on Phytoplankton

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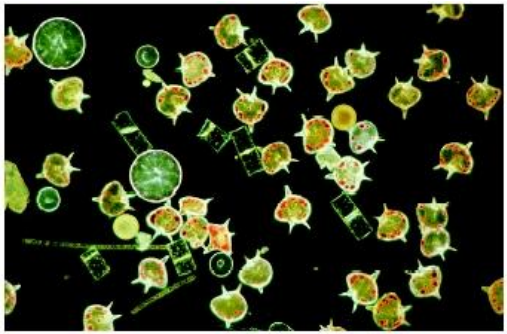
Introduction

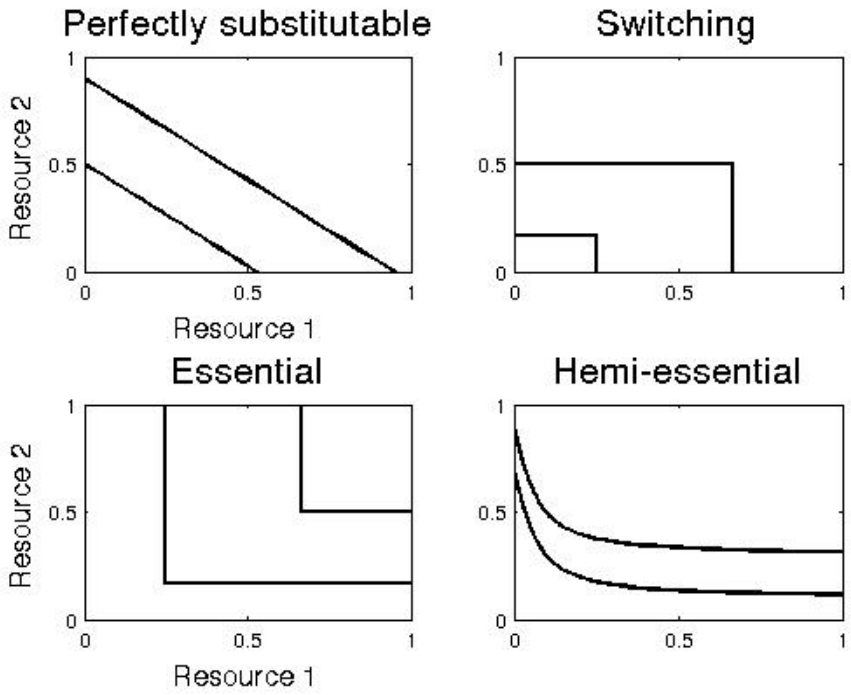
- What are phytoplankton?
  - Small phytosynthetic microorganisms
  - Motile but dependent on current
- Project focused on the growth rate of phytoplankton communities
- How do we get multiple species using the same nutrient without a clear "winner"?



Importance

- We want to understand how ecosystems work.
  - Why do we have multiple "winners" in some ecosystems but a clear "winner" in others?
  - If we understand more about how the species interact we may be able to intervene without catastrophe.

Resource Models



Equations

- Population

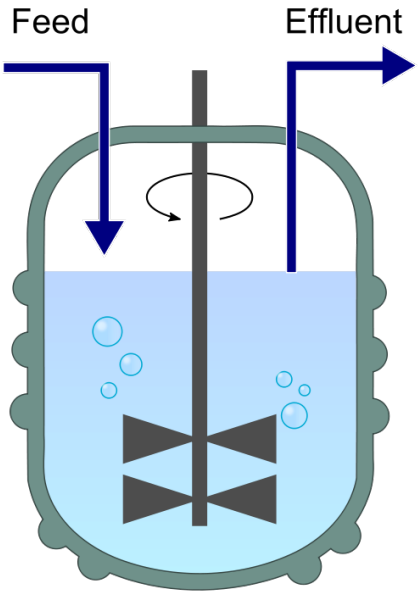
$$\frac{dN_i}{dt} = \mu N_i - \nu N_i$$

- Substrate or Nutrient

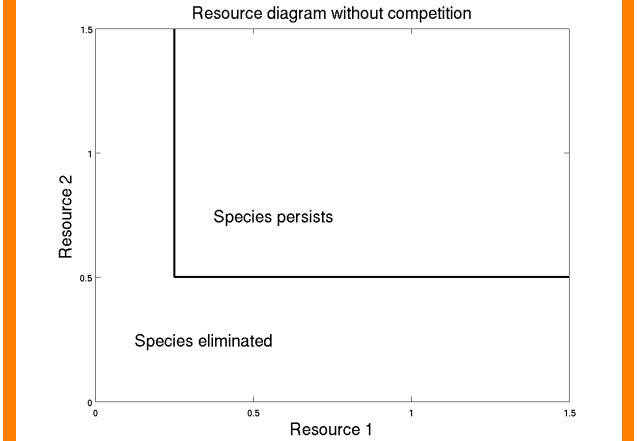
$$\frac{dS}{dt} = \nu\left(S_{in} - S_j\right) - \sum_{i=1}^{n} Q_{ij}\mu_i N_i$$

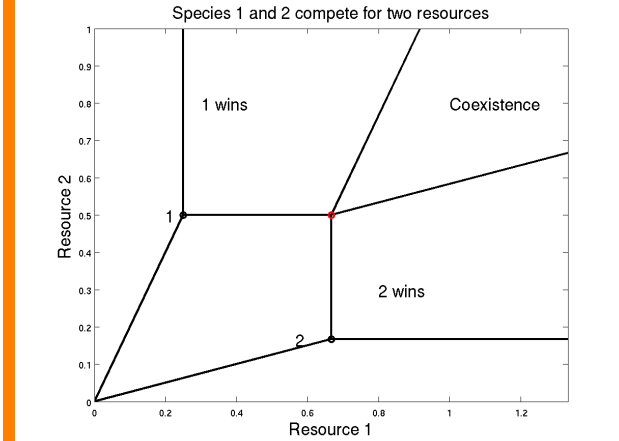
- Resource Dependent Growth Equation

$$\mu_i = \tilde{\mu}_i min_j\left(\frac{S_j}{S_j + k_{ij}}\right)$$



Resource Diagrams

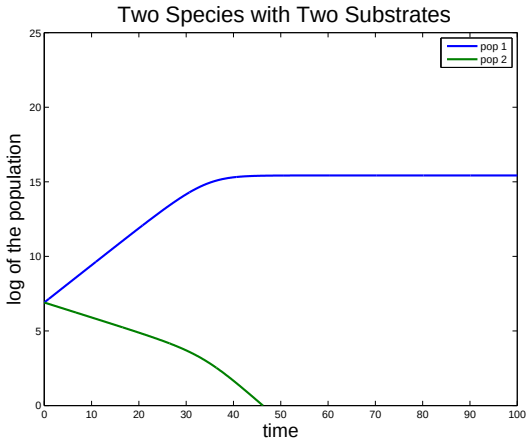


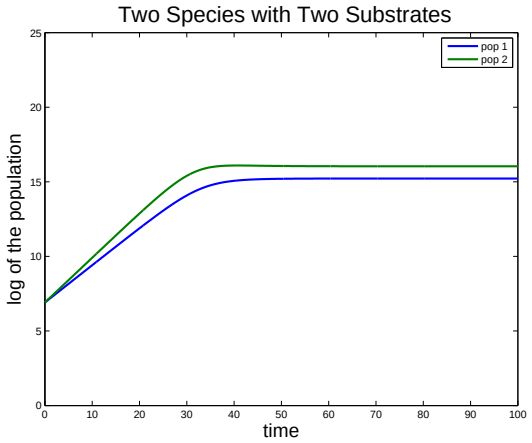


- $\frac{dN_i}{dt} = 0$ equilibrium
- $\frac{dN_i}{dt} = \mu_i N_i - \nu N_i$ where $\mu_i = \nu$
- Plug ν into $\mu_i = \tilde{\mu_i}(\frac{S_j}{S_j + k_{ij}})$ if nutrient j is limiting
- $\nu = \tilde{\mu_i}(\frac{R^*_{ij}}{R^*_{ij} + k_{ij}})$
- $R^*_{ij} = \frac{k_{ij}\nu}{\tilde{\mu_i} - \nu}$

- In the following models all the parameters had the same values except the amount of nutrient entering the system (S_{in}).

$$S_{in} = \begin{bmatrix} 10 \\ 7.5 \end{bmatrix} \qquad S_{in} = \begin{bmatrix} 10 \\ 4.5 \end{bmatrix}$$





Credits

- Nutrient limitation models are from David Tilman's book *Resource Competition and Community Structure*. Princeton University Press, Princeton, NJ. 1982.
- Pictures of phytoplankton provided by http://www.cof.orst.edu/project/plankton/truittr.html and http://www.biologyreference.com/Ph-Po/Plankton.html