
Structure and Dynamics of Ecological Networks

CANER KAZANCI

Department of Mathematics
University of Georgia

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<http://www.math.uga.edu/~caner/09vigre>

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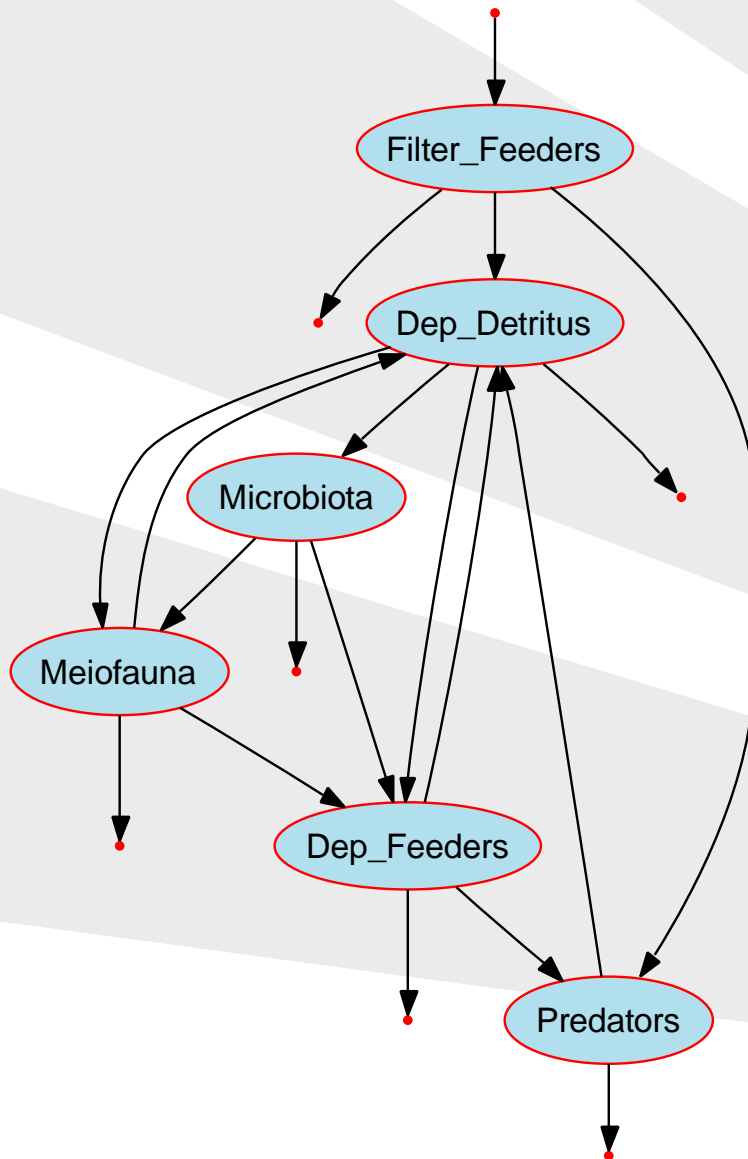
Ecosystems Models

Intertidal Oyster Reef Ecosystem Model (Energy)

by R. F. Dame and B. C. Patten

Dame, R. F., and B. C. Patten. 1981. Analysis of energy flows in an intertidal oyster reef. *Marine Ecology Progress Series* 5:115-124.

Patten, B. C. 1985. Energy cycling, length of food chains, and direct versus indirect effects in ecosystems. *Can. Bull. Fish. Aqu. Sci.* 213:119-138.

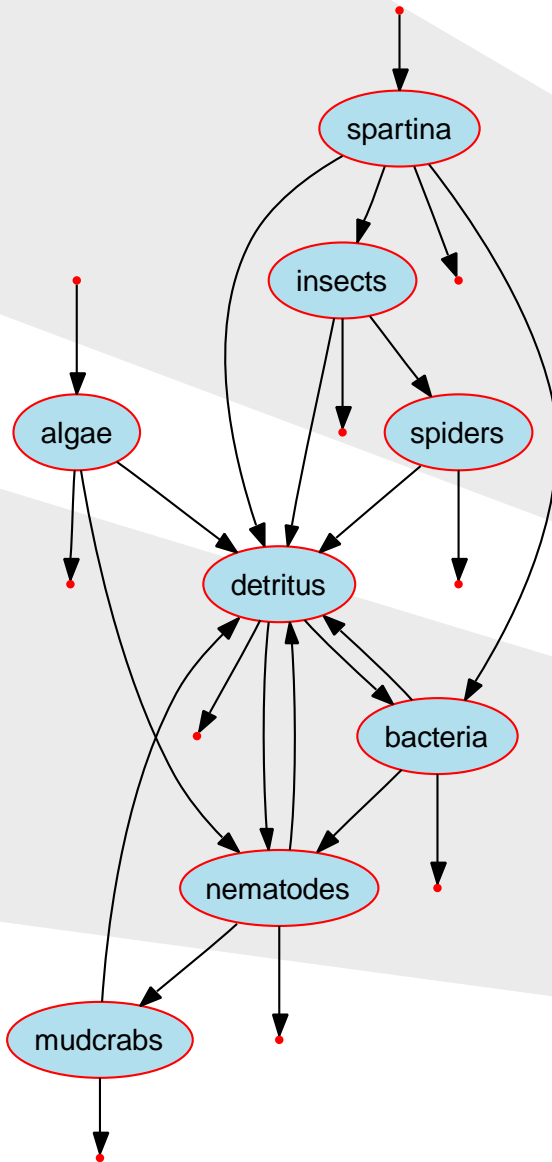


Ecosystems Models

Energy flow in the salt marsh ecosystem of Georgia

by G. Small

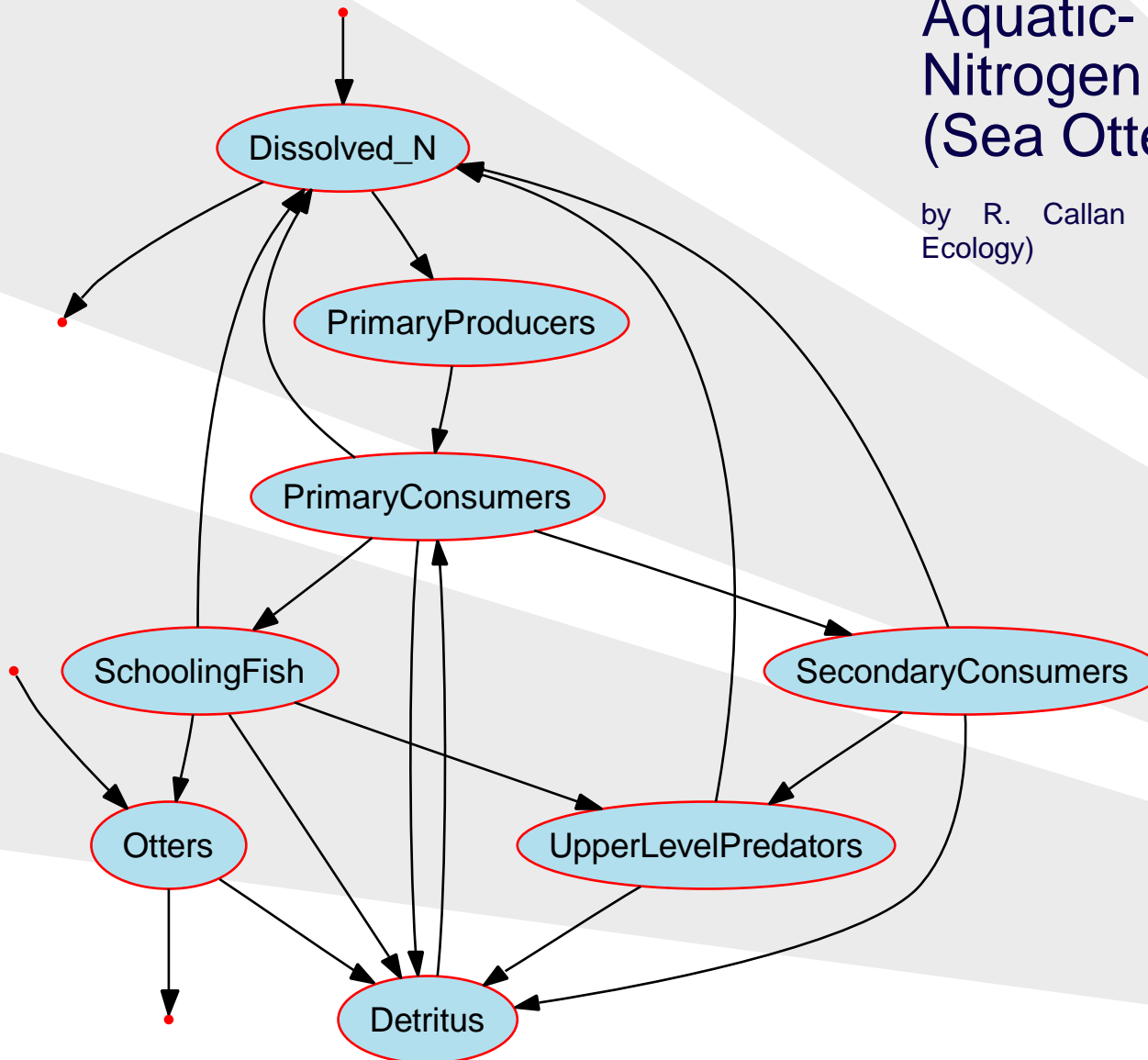
Based on model by Teal, John M. (1962)
Energy flow in the salt marsh ecosystem of
Georgia. *Ecology* 43:614-624.



Ecosystems Models

Aquatic-Terrestrial Transport of Nitrogen by *Lontra canadensis* (Sea Otter)

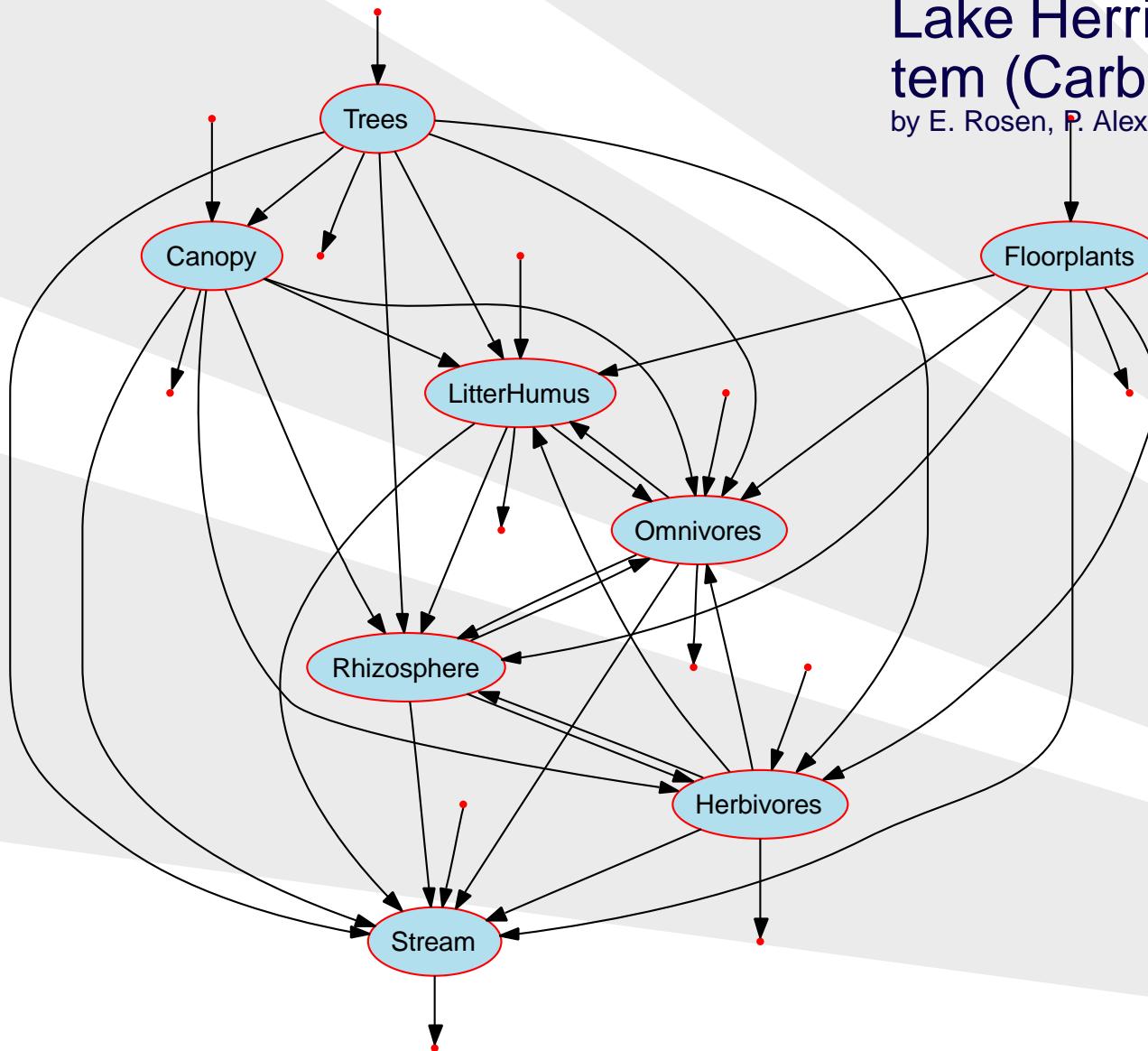
by R. Callan and M. Novak (ECOL 8580 Systems Ecology)



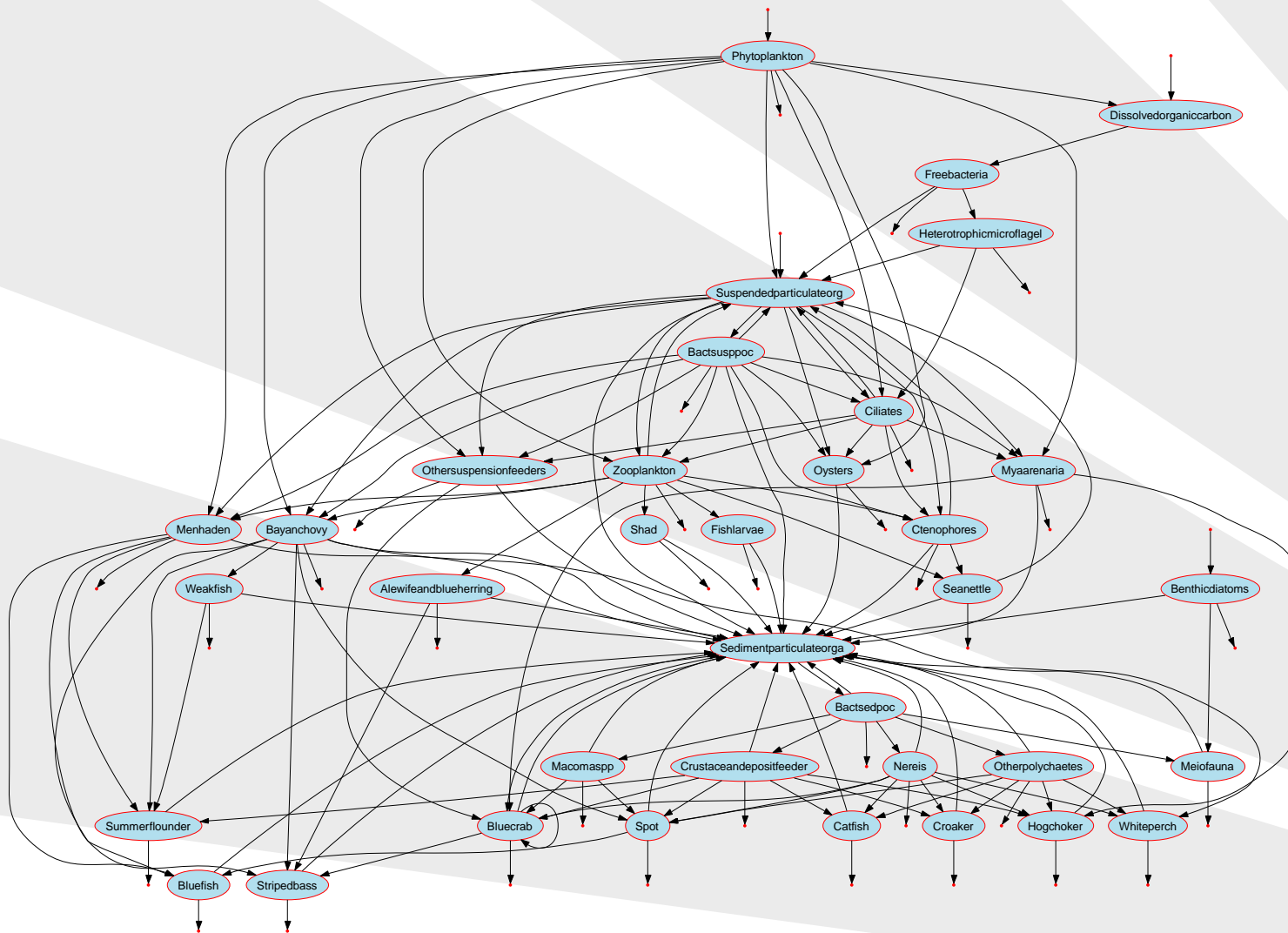
Ecosystems Models

Lake Herrick Terrestrial Ecosystem (Carbon flow)

by E. Rosen, P. Alexander and M. Knepper. (REU, 2008)



Ecosystems Models



Baird, D. and R.E. Ulanowicz. 1989. The seasonal dynamics of the Chesapeake Bay ecosystem. *Ecol. Monogr.* 59: 329-364.

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Important ecological indicators?
Ecological goal functions?
Ecosystem health?

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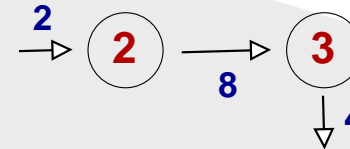
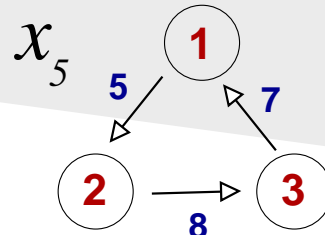
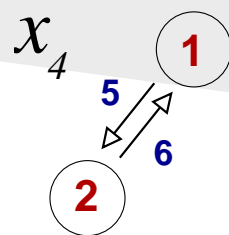
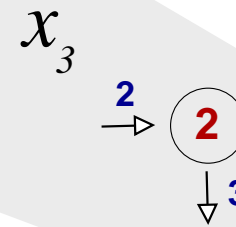
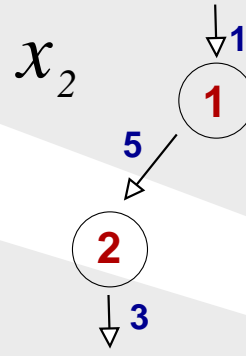
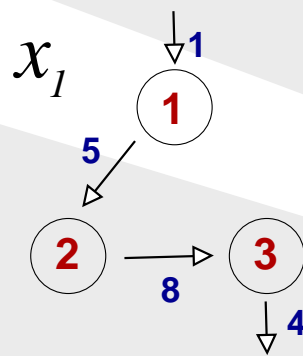
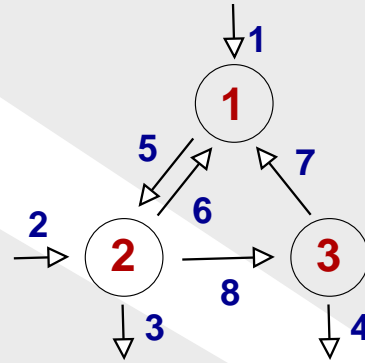
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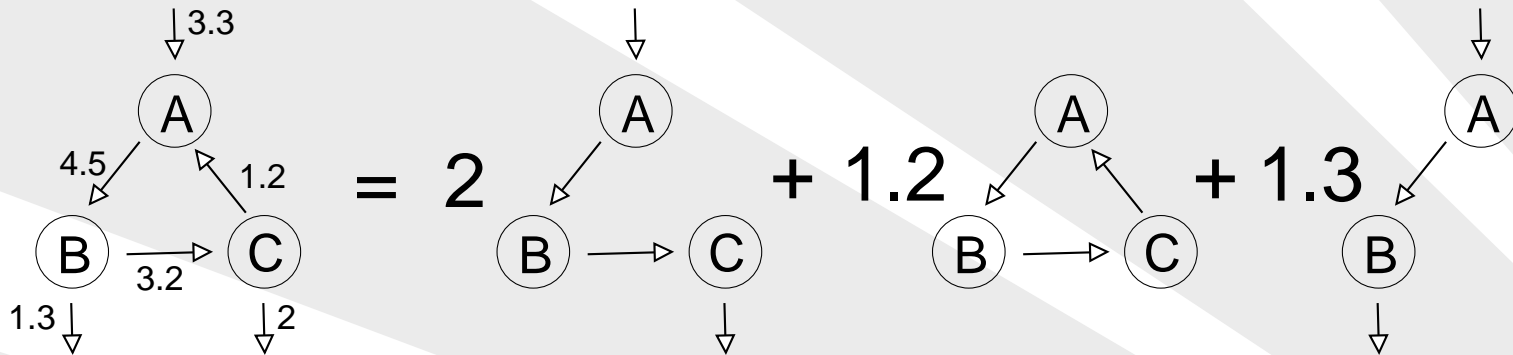
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- ◇ Exergy (Jørgensen)
- ◇ New definitions, formulations?...

Structural decomposition



Functional decomposition

Is it possible to decompose an ecosystem model while preserving its system-wide properties?



What we need?

- ◇ This is an interdisciplinary research group
- ◇ Interest, motivation, curiosity
- ◇ Differential Equations
- ◇ Linear Algebra
- ◇ Programming knowledge is a plus, but not necessary...

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Identifying relevant compartments:

- ◇ **N:** Concentration of Nitrogen available in the ocean for uptake
- ◇ **P:** Concentration of Phytoplankton
- ◇ **Z:** Concentration of Zooplankton

Constructing the model

Creating a differential equation system from observations:

- ◇ N is taken up from the ocean and incorporated into P
- ◇ N is incorporated into Z through the consumption of P
- ◇ It is recycled from P and Z to the ocean through death and excretion

$$\dot{N} = aP + bZ - cNP$$

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- ◇ **Qualitative analysis:** To determine long term behavior, we can use phase plane analysis, stability and bifurcation analysis.
- ◇ **Network analysis:** To gain further insight into how the system functions, organizes itself and optimizes, formulate system wide network properties. Eg. cycling index, indirect effects coefficients, throughflow analysis, etc. (See paper)