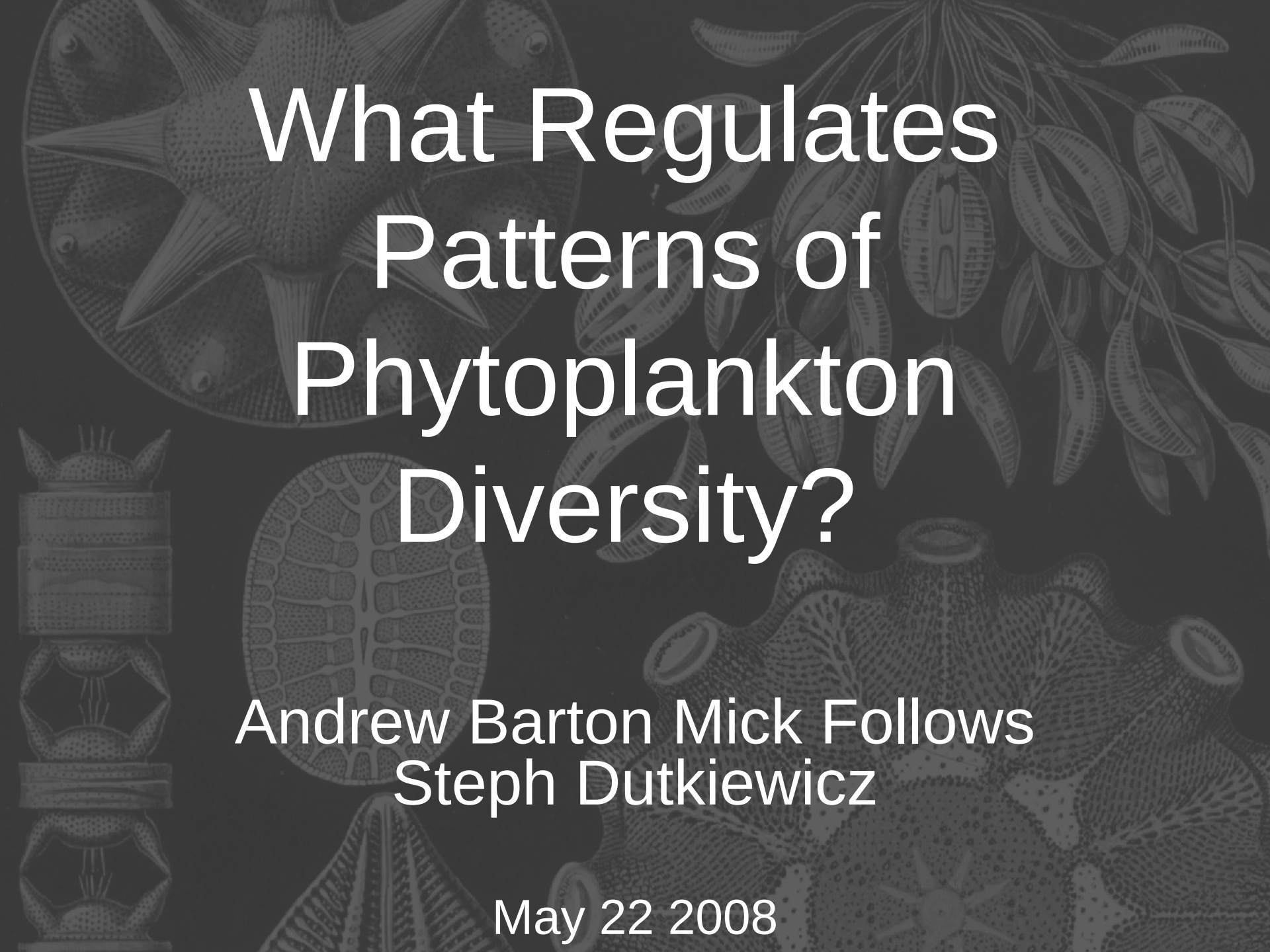
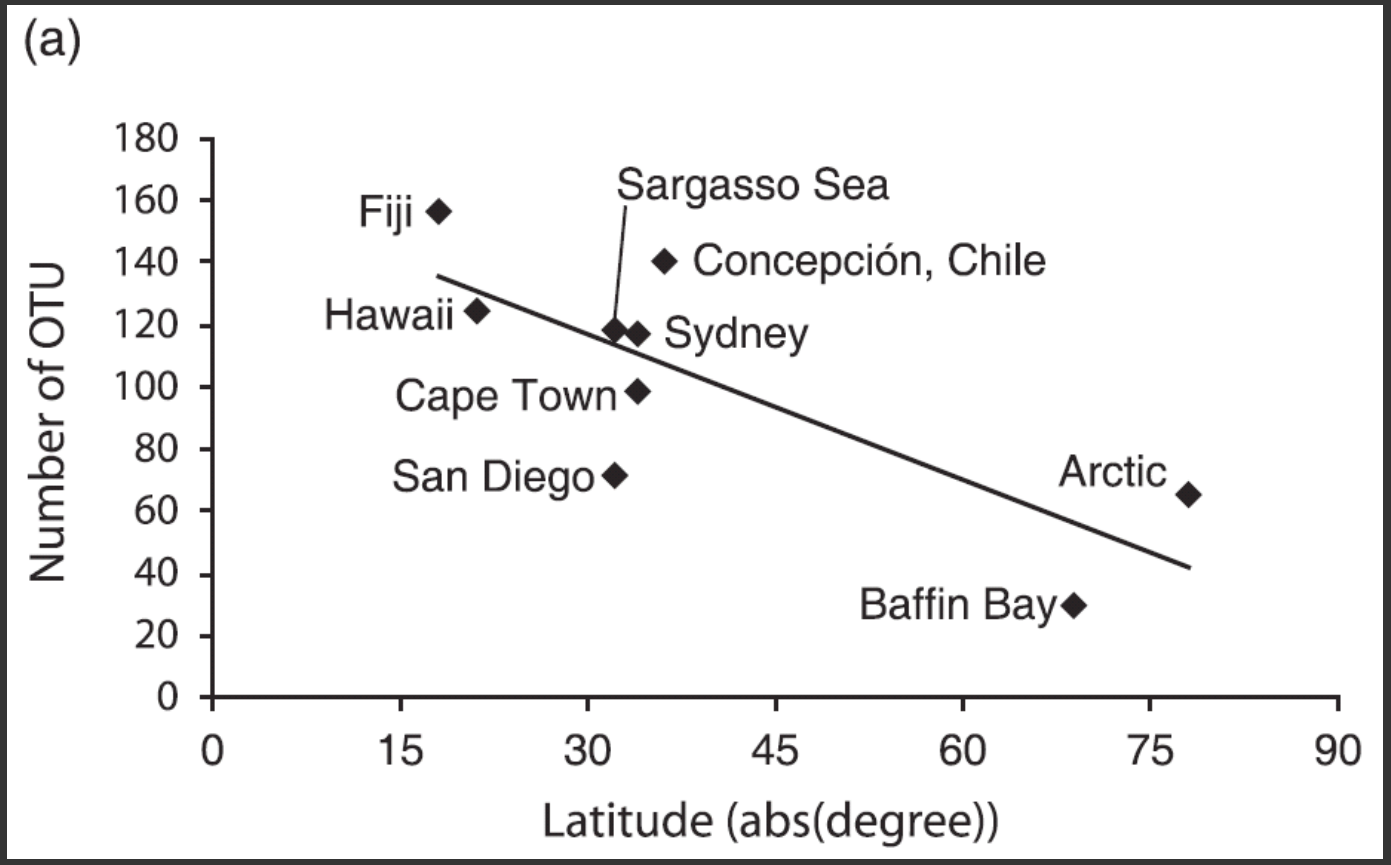


What Regulates Patterns of Phytoplankton Diversity?

Andrew Barton Mick Follows
Steph Dutkiewicz

May 22 2008

Diversity Patterns: Bacterioplankton



Number of Bacterioplankton (includes Cyanobacteria) Species Varies in Space

→ Equator-to-pole Gradients for Phytoplankton?

Pommier et al. (2007)

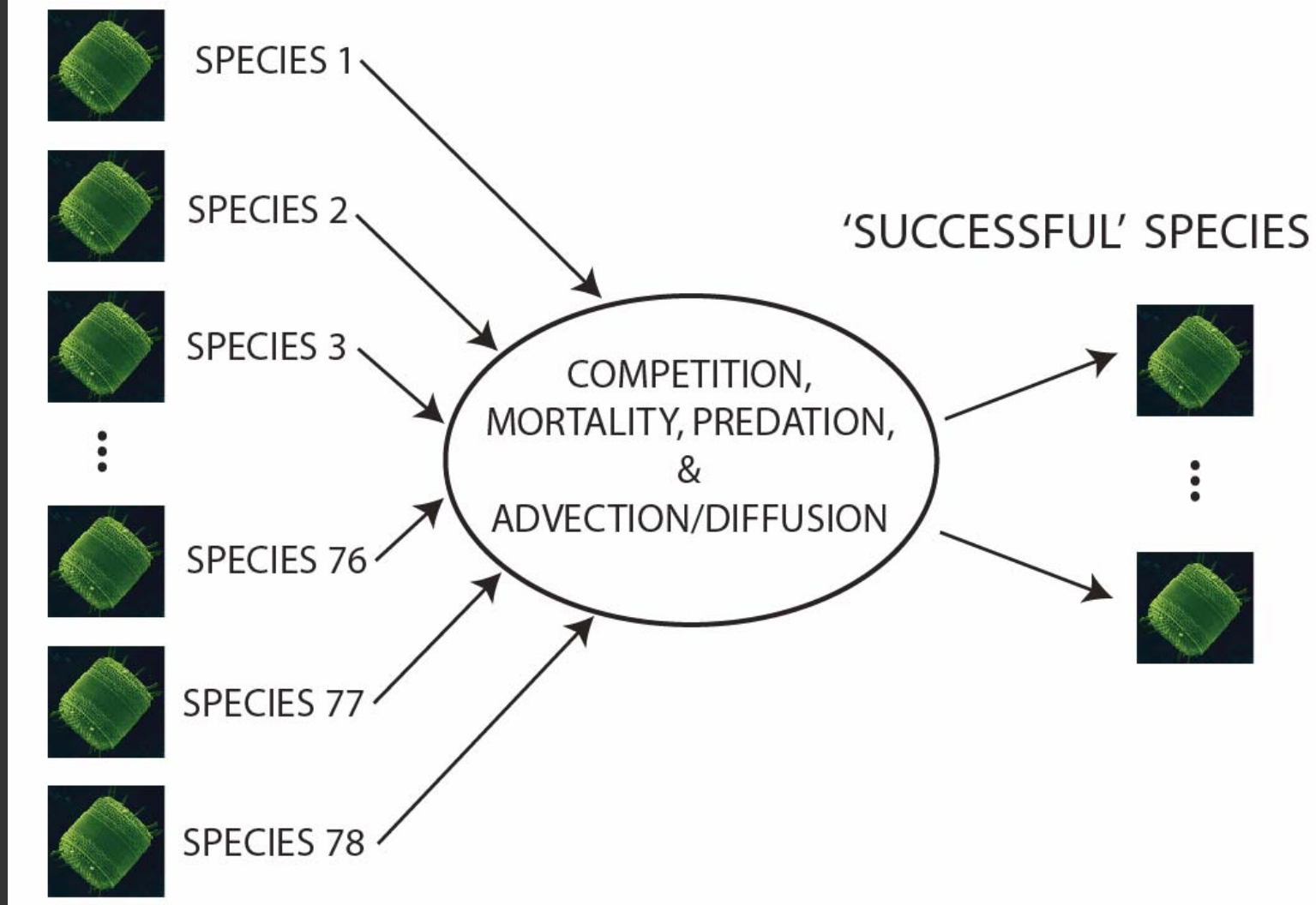
How and Why Does Phytoplankton Diversity Vary in Space?

Ecosystem Model

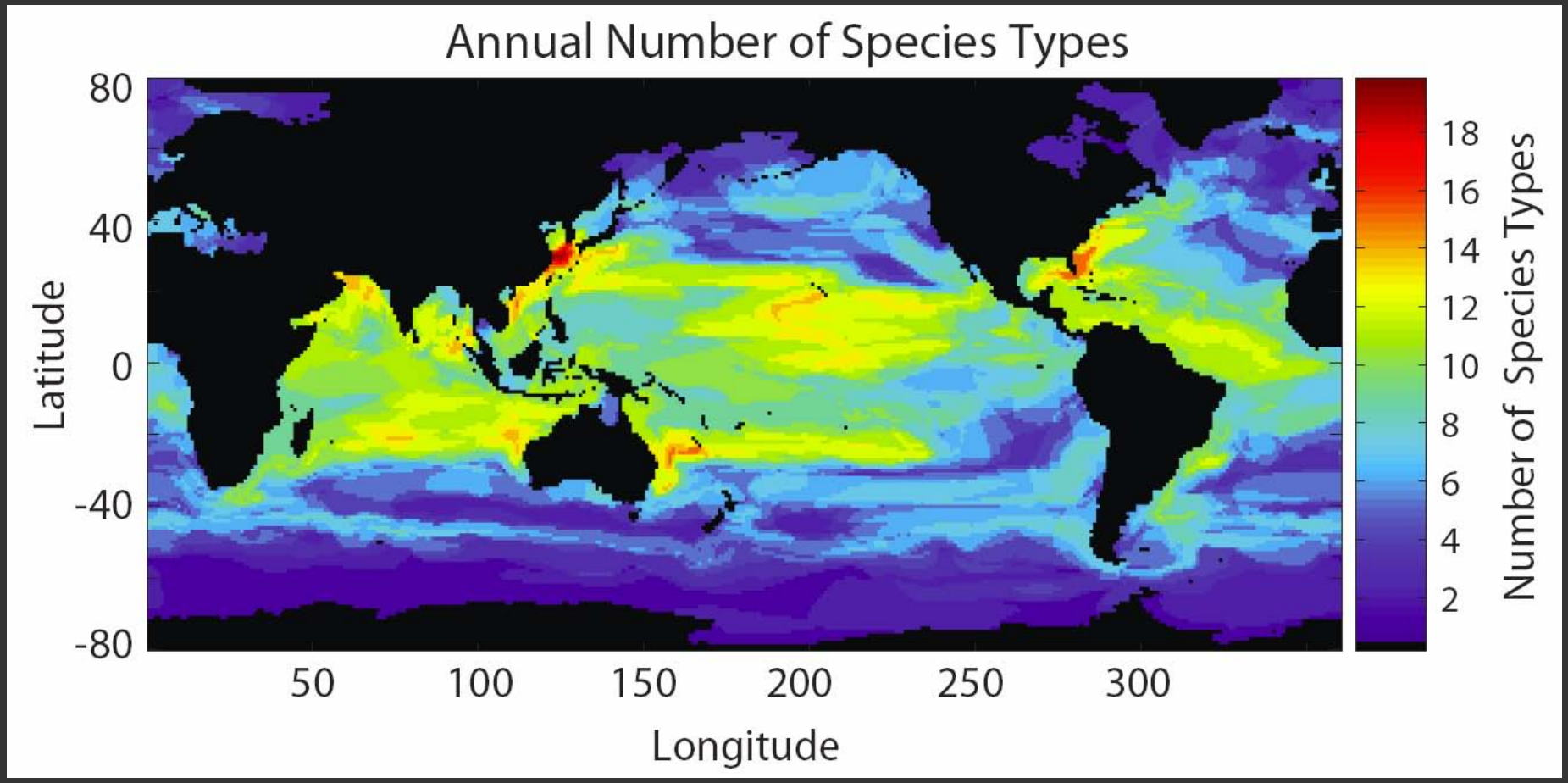
- Start with Many Species of Phytoplankton (78)
  - Traits Chosen Randomly
  - Light, Nutrients, Temp., Size, Predation
- Add Zooplankton (2)
- Track Nutrients (N,P,Fe,Si)
- Embed in Realistic 1° Global Ocean Model

Allow Ecosystem to *Self Organize*

Follows et al. (2007)

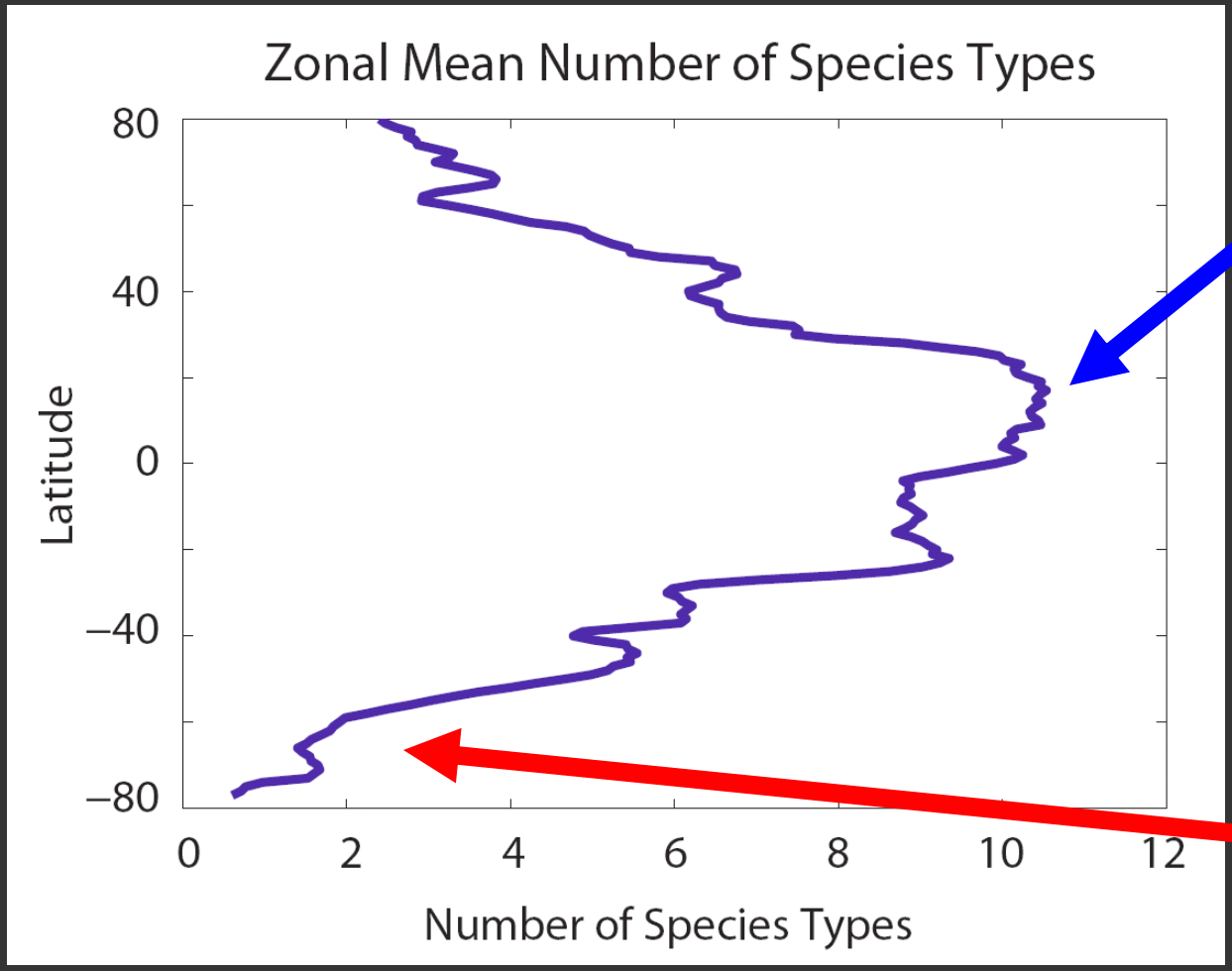

SPECIES 1
SPECIES 2
SPECIES 3
SPECIES 76
SPECIES 77
SPECIES 78
COMPETITION,
MORTALITY, PREDATION,
&
ADVECTION/DIFFUSION
'SUCCESSFUL' SPECIES

Diversity Patterns



Equator-to-Pole Decrease → WHY?

Diversity Patterns



Why More Diversity Here?

Why Less Diversity Here?

Diversity Patterns

- General Patterns
  - →Equator-to-Pole Decrease
    - w/ Local Increase in Areas of Eddies/Fronts
- Bottom-up Hypotheses?
  - →Appears Unlikely to be Temperature-Related
  - →Possibly Nutrient-Related

Resource Control

$$\frac{\partial N}{\partial t} = -\sum_j [\mu_j P_j \frac{N}{N + k_j}] + S_N(t)$$

$$\frac{\partial P_j}{\partial t} = \mu_j P_j \frac{N}{N + k_j} - m_j P_j$$

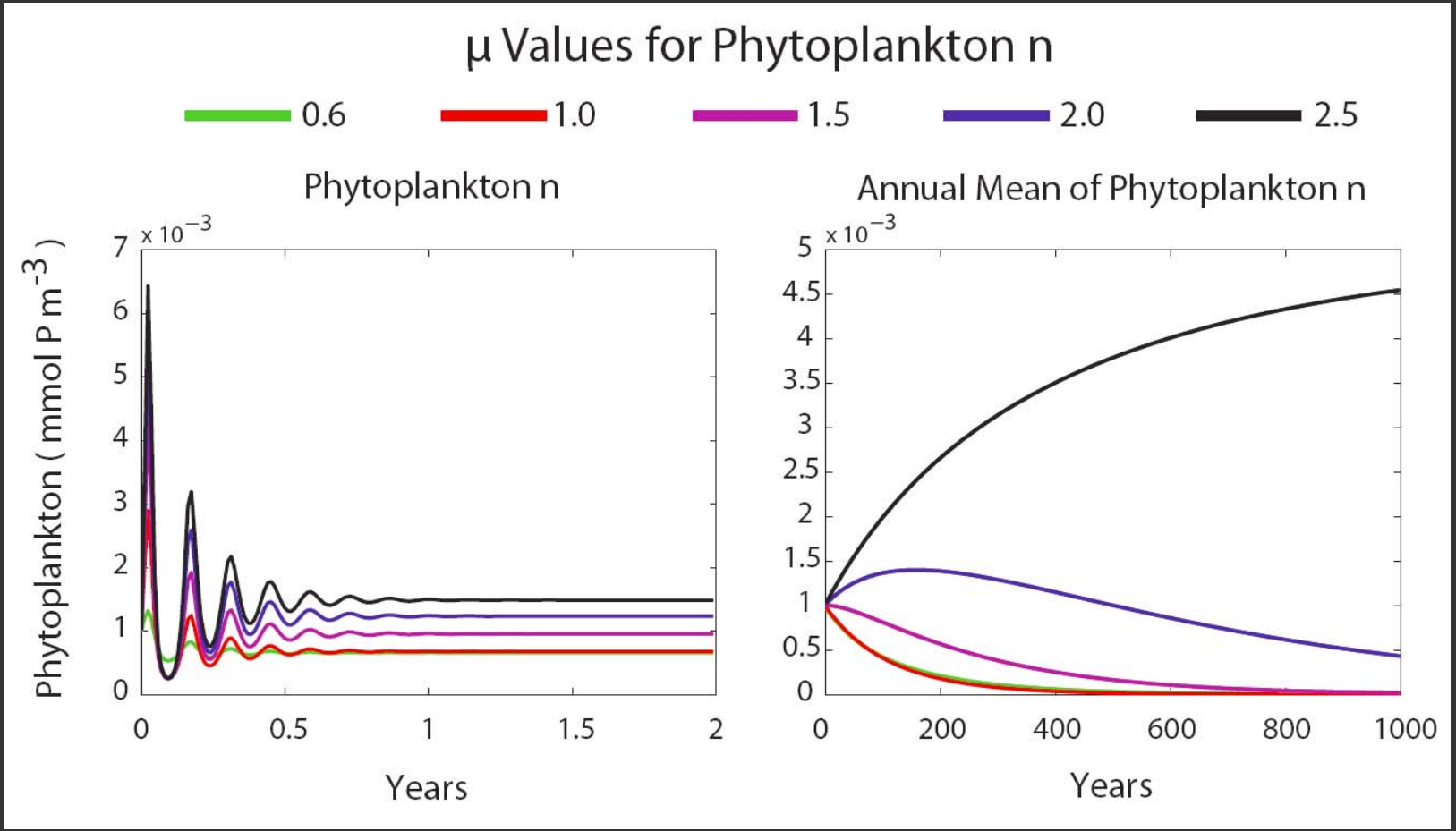
Steady State

$$R^* = \frac{m_j k_j}{\mu_j - m_j}$$

Allow n Organisms to Achieve Same R*

Nutrient Control

Coexistence

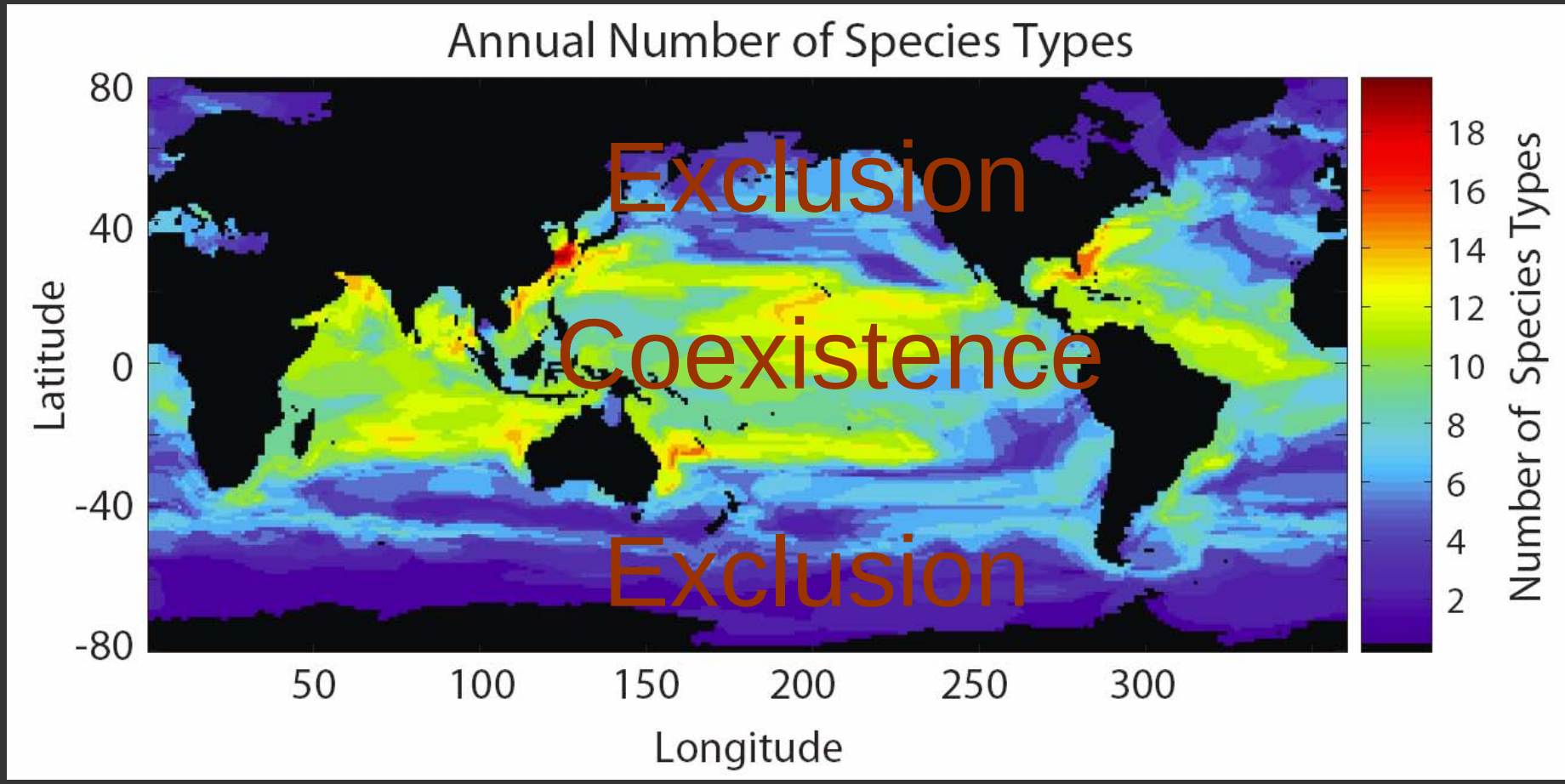


Exclusion

Steady Source

Varying Source

Resource Control



Summary

- Phytoplankton Diversity Decreases from Equator to Pole

→ Hypothesis: Controlled by Nutrient Availability

a. Constant Nutrients → Higher Diversity

b. Variable Nutrients → Lower Diversity

Possible Climate Change Connections

- A Warmer Ocean
  - →Greater Thermal Stratification
  - →Weaker Delivery of Nutrients to Surface
  - →**How do Biomes Readjust?**
- Change in Winds
  - →Westerlies Move Poleward, Intensify
  - →Nutrient Delivery/Transport Changes
  - →**How do Biomes Readjust?**

Unknown How Phytoplankton Diversity will Respond to Climate Change