Species interactions in lakes

Limnology

Lecture 10

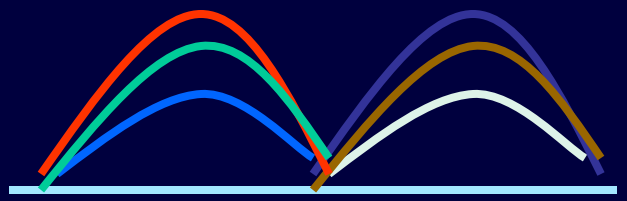
Ecological community

Assemblage – a set of species that co-occur in space and time

Community – a set of interacting species that co-occur in space and time

Guild – a set of species that co-occur in space and time and exploit the same class of resources in a similar way

Community concepts

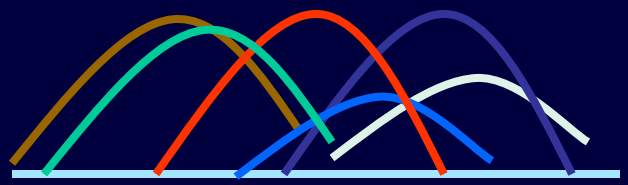


Super-organism (Clements)

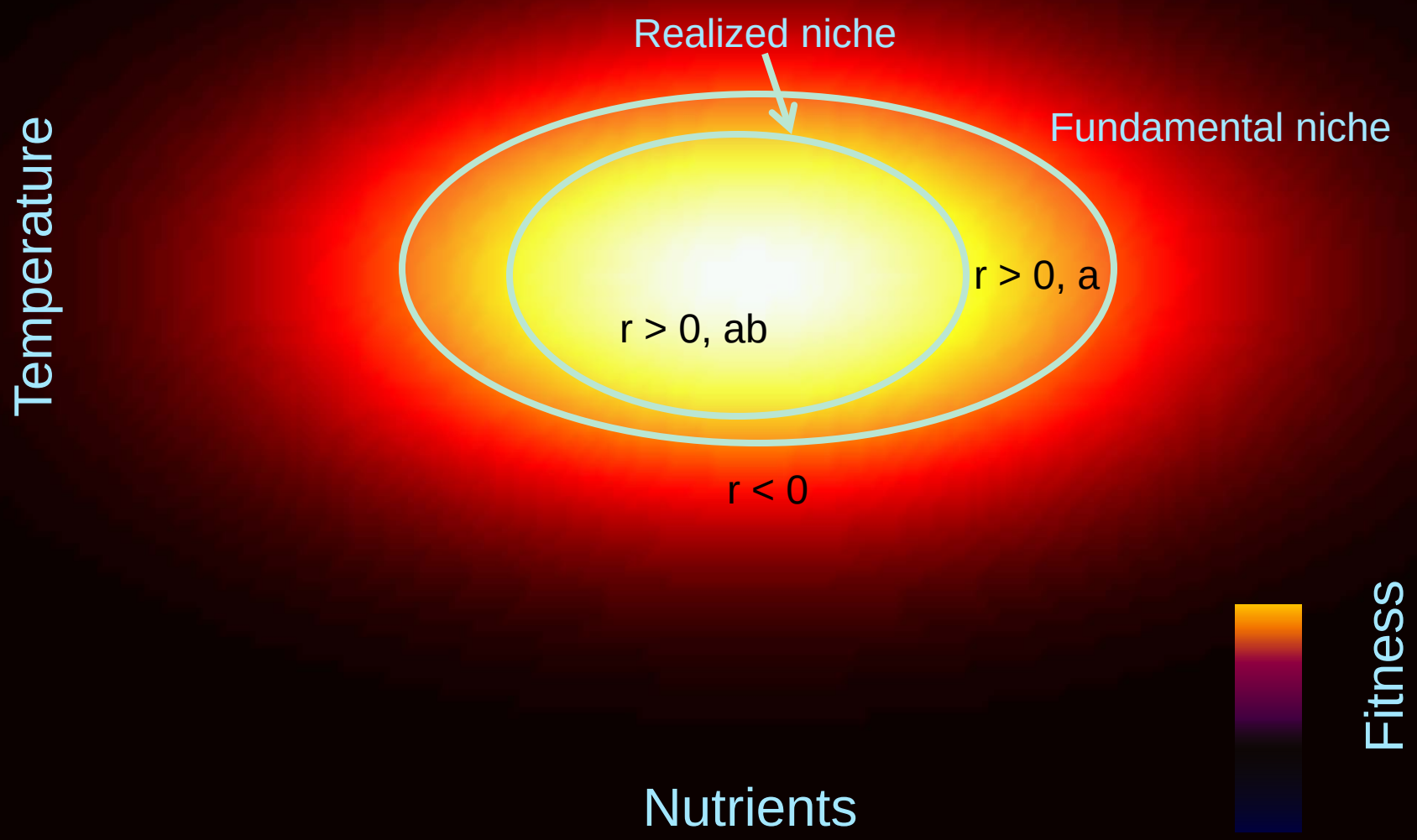
- Integrated, self-regulating system
- Emergent properties ~ Gaia hypothesis
- Communities → distinct units across gradients

Individualistic (Gleason)

- Independent responses to environment
- Environment as filter
- Communities → assemblages of independently determined species distributions



Niche – n-dimensional hypervolume of environmental conditions in which a population has positive population growth



Niche partitioning

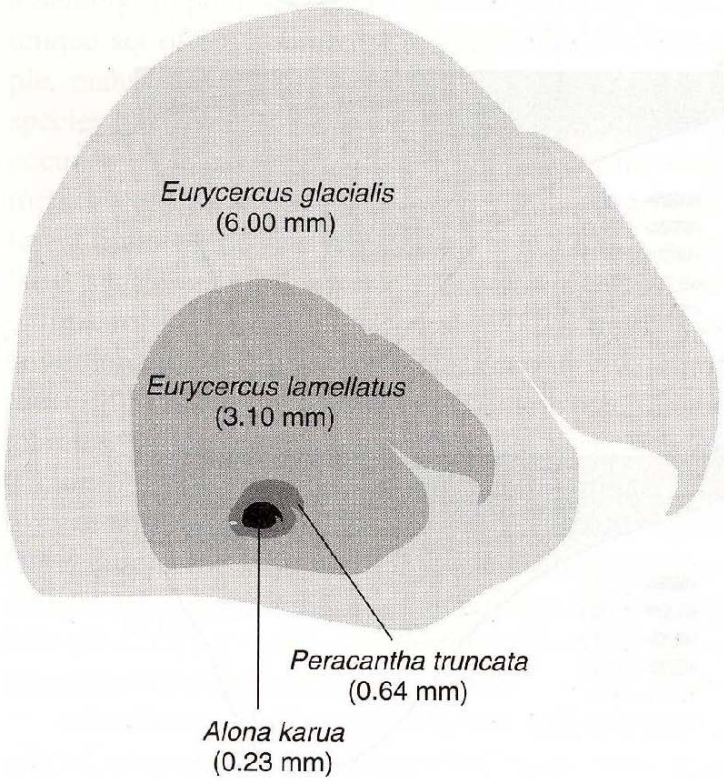


FIGURE 7.4 Range of morphological and size variation in species of chydorid water fleas. The ratio of length of the largest to the smallest is about 24; the ratio of volumes is about 24^3, or 15,625.

Niche vs. neutral

Niche dynamics

Species patterns driven by match between species traits and environment

Species niches determine dynamics

Deterministic

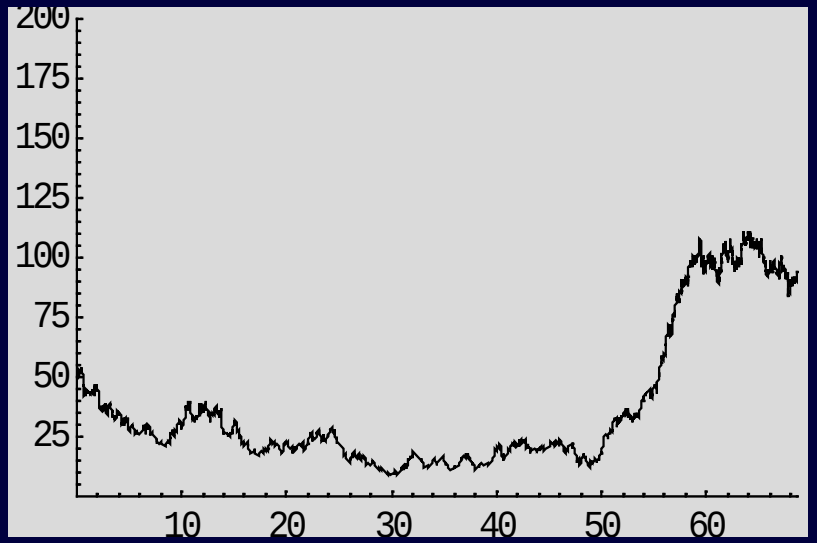
Neutral dynamics

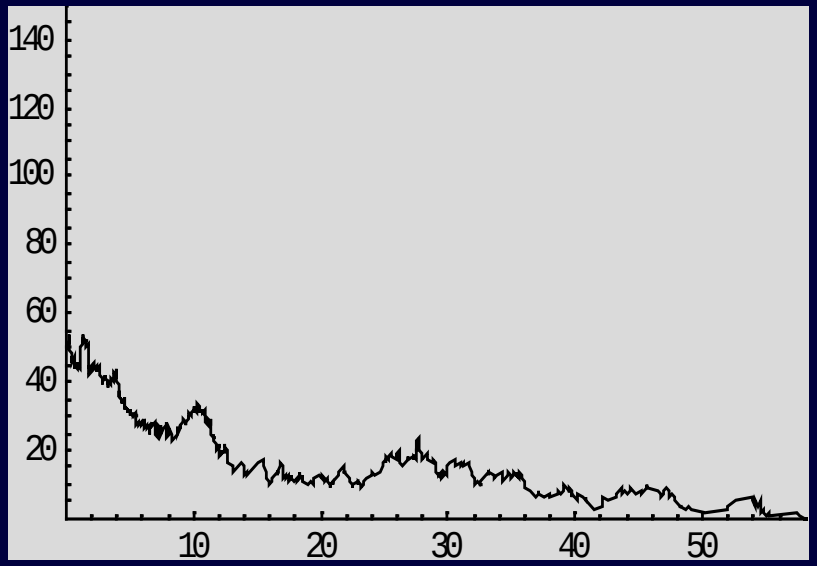
Species patterns driven by random events

Species equivalent in all ways

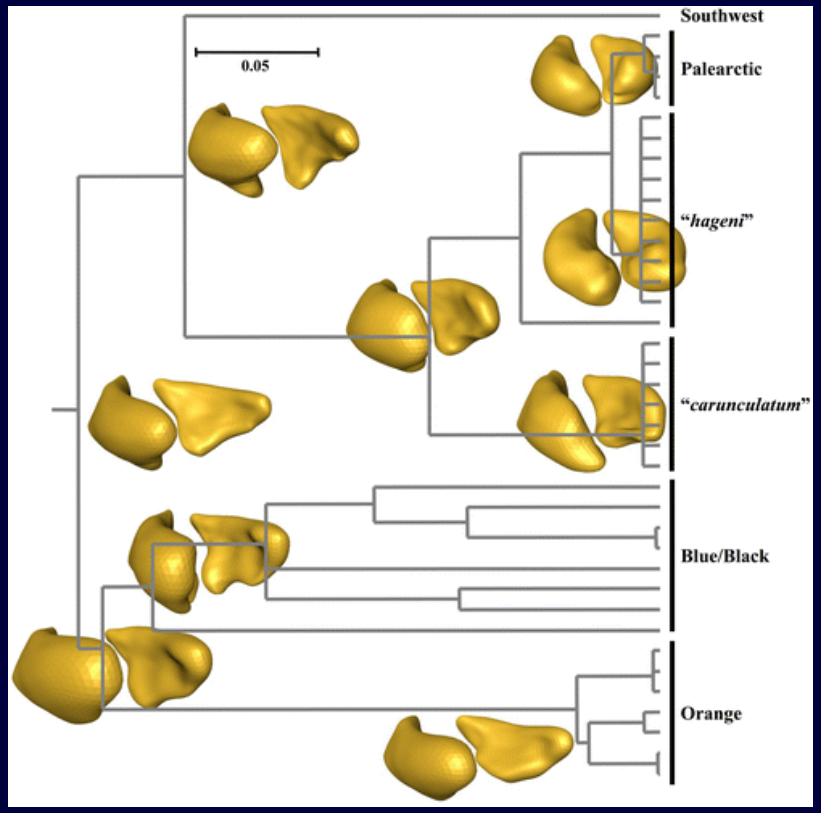
Stochastic

Neutral species and “random walks”





Example of neutral species



Enallagma damselflies

Humans and damselflies use small shape variations in reproductive organisms to tell species apart

Ecologically pretty much the same

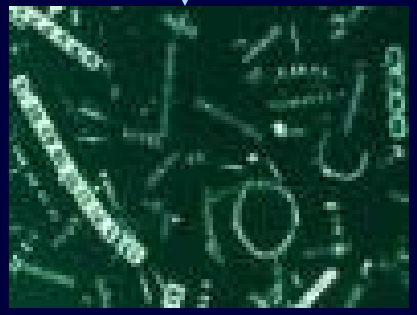
Food chain

Tertiary consumer

Secondary consumer

Primary consumer

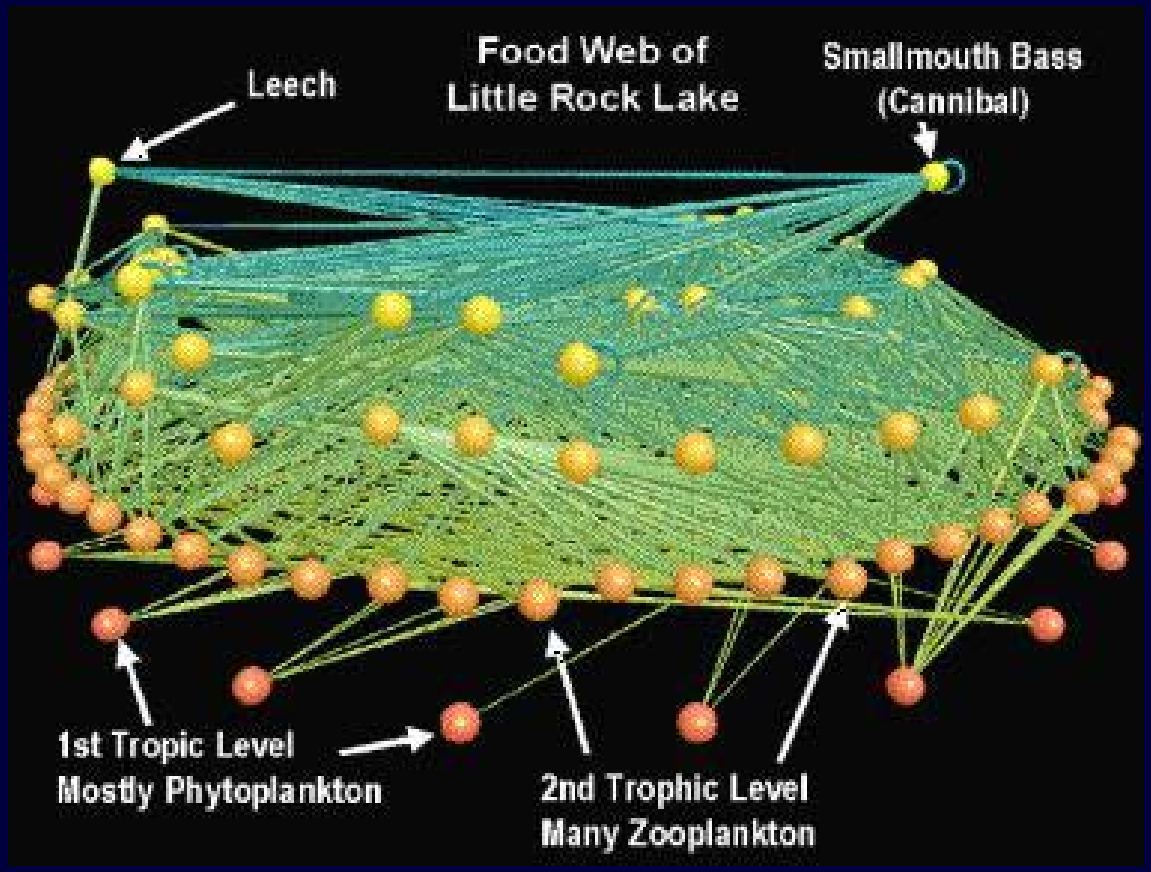
Producer



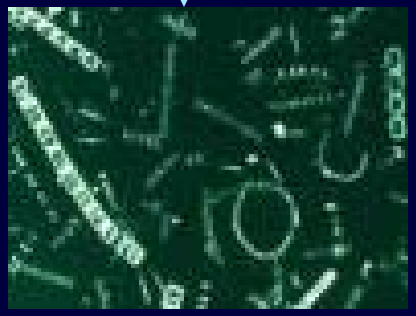
Food web

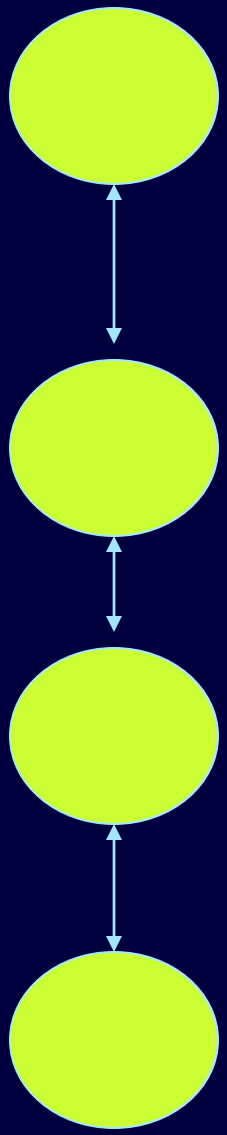
A pelagic food web

Complex food webs



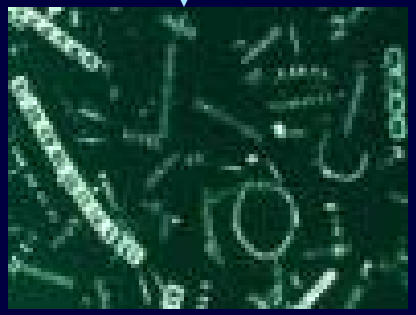
Indirect effects

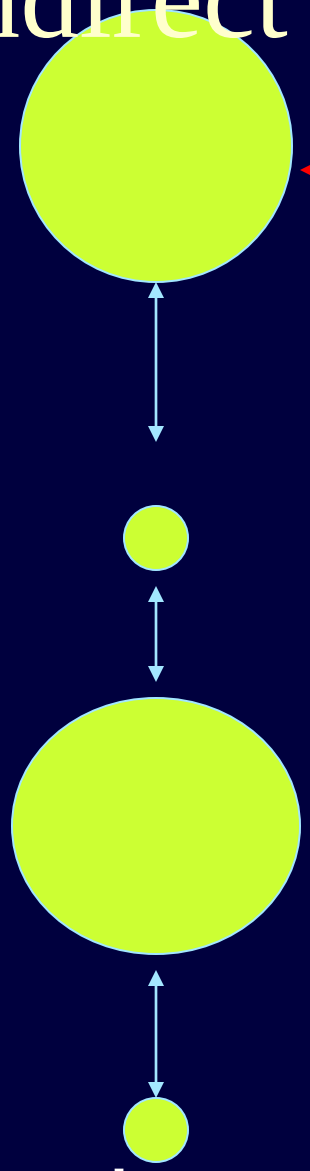




Top-down:
predator-controlled

Indirect effects





Top-down:
predator-controlled

Trophic cascade

The enemy of my enemy is my friend

Indirect effects in lakes

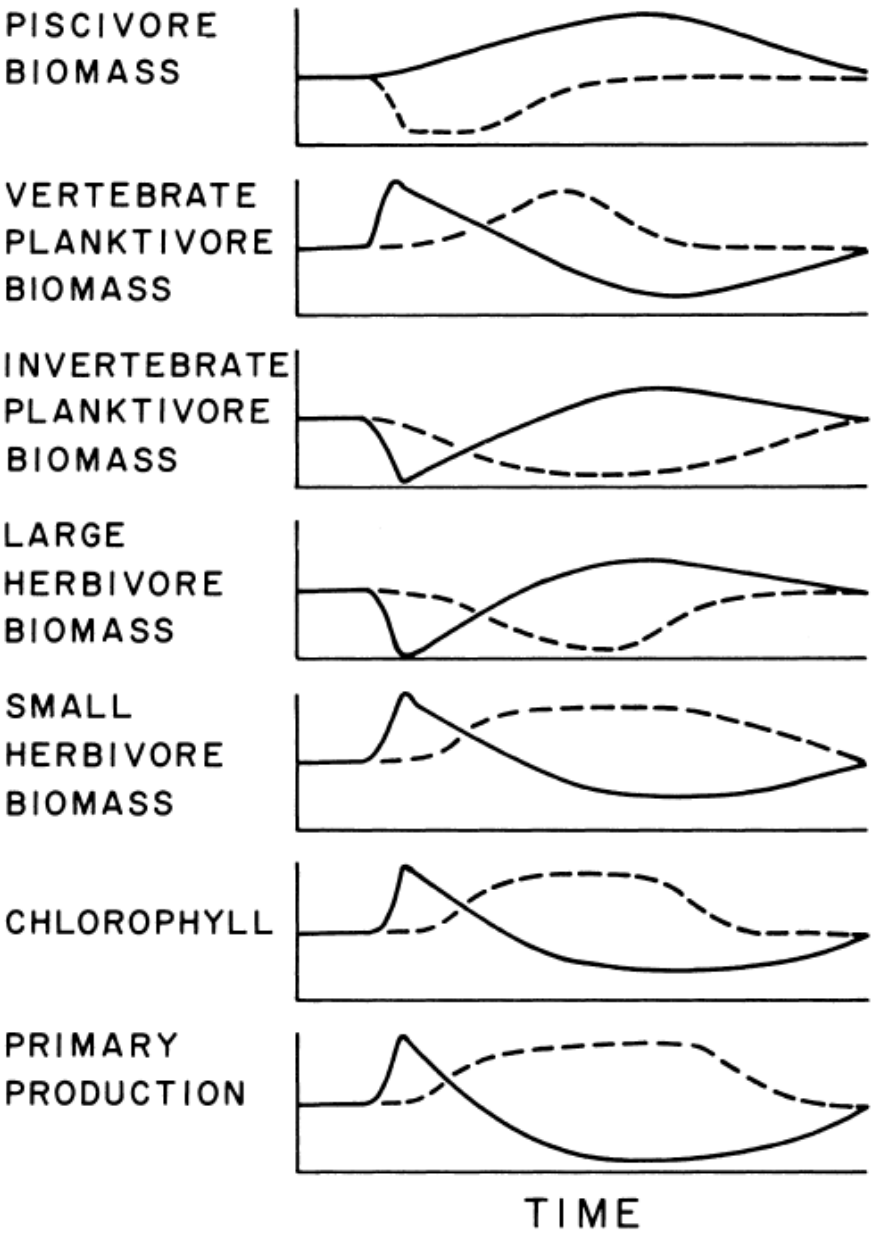
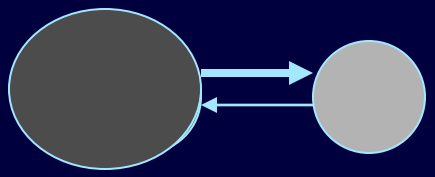


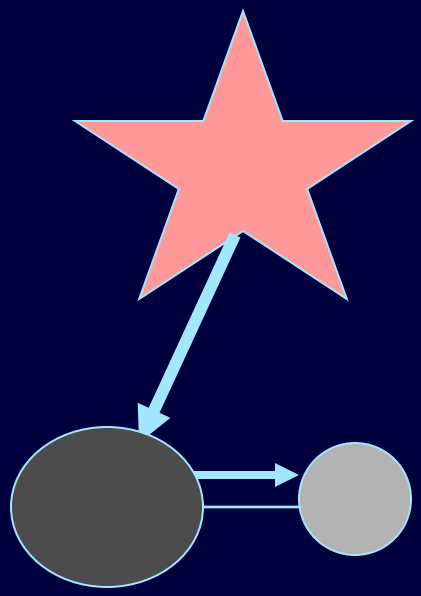
Figure 3. Time course of ecosystem response to a strong piscivore year class (solid line) and a partial winter kill of piscivores (dashed line).

Carpenter et al. 1985

Keystone predation



Keystone predation



1. Asymmetric competition
2. Selective predation on superior competitor

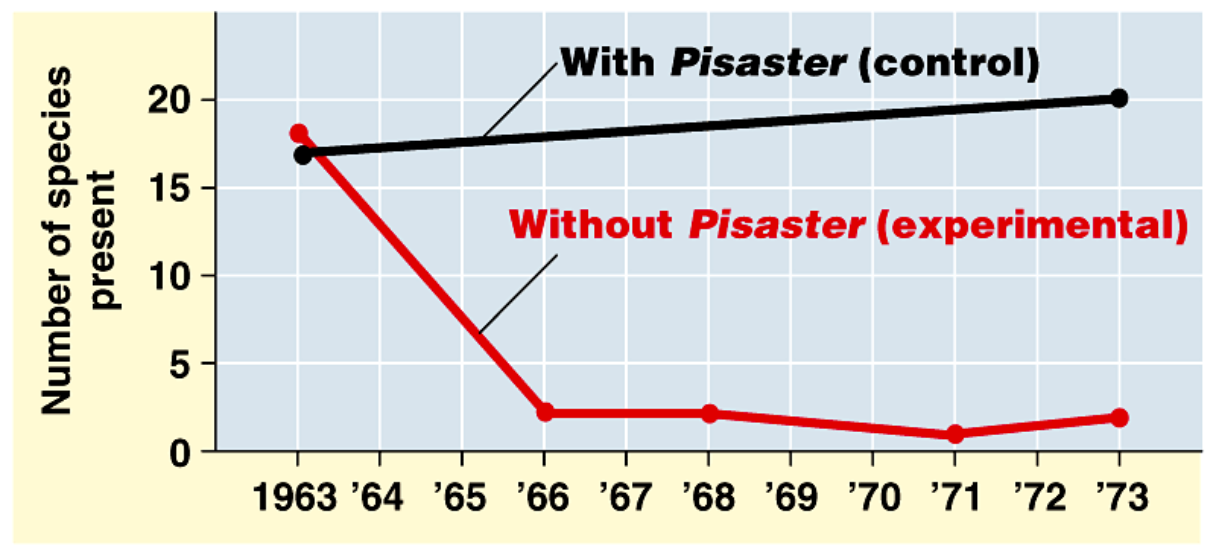
Keystone predation

Predator-

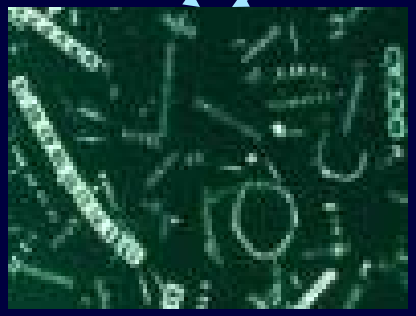
Mediated

Asymmetric

Competition

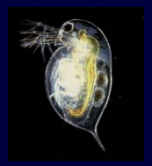


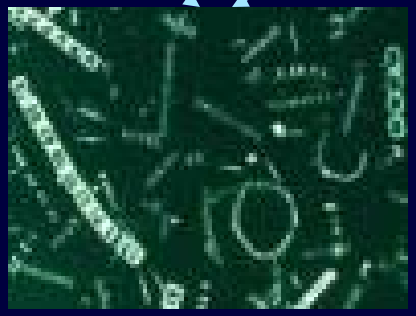
Keystone predation in lakes



Keystone predation in lakes

Keystone predation in lakes

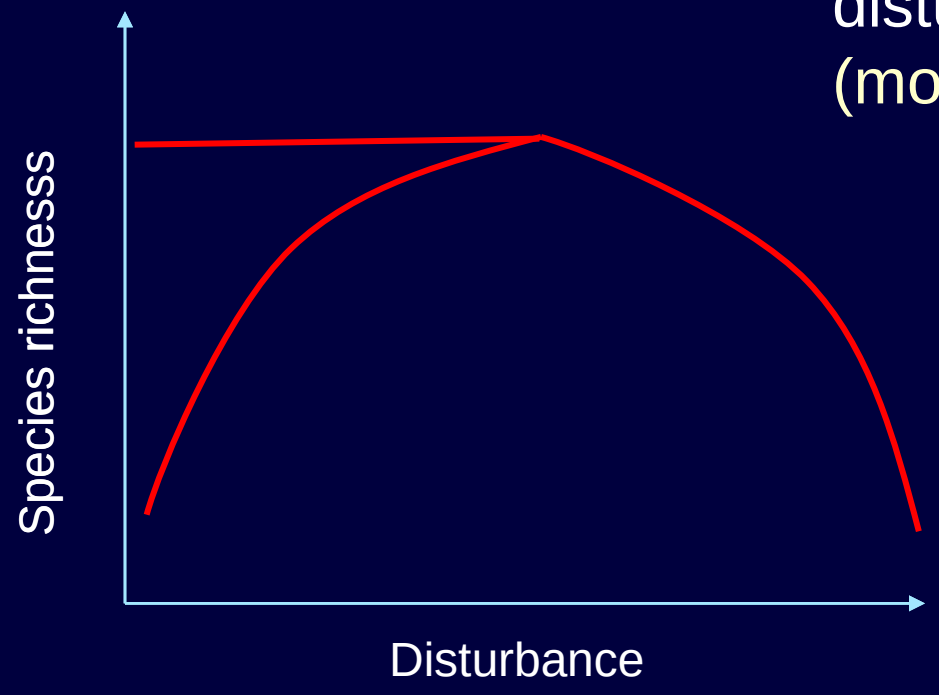




Intermediate disturbance hypothesis

Biological processes (less support)

Fewer species can survive disturbance (more support)



Intermediate disturbance hypothesis

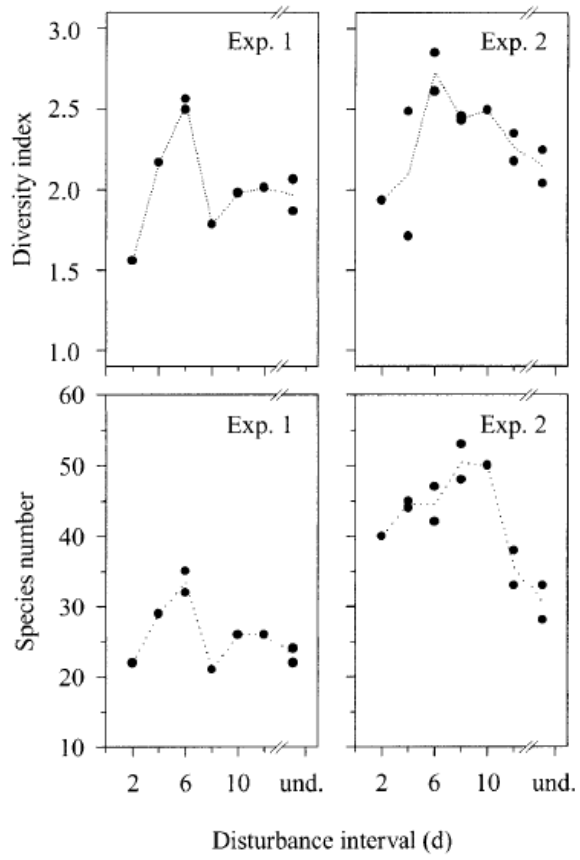
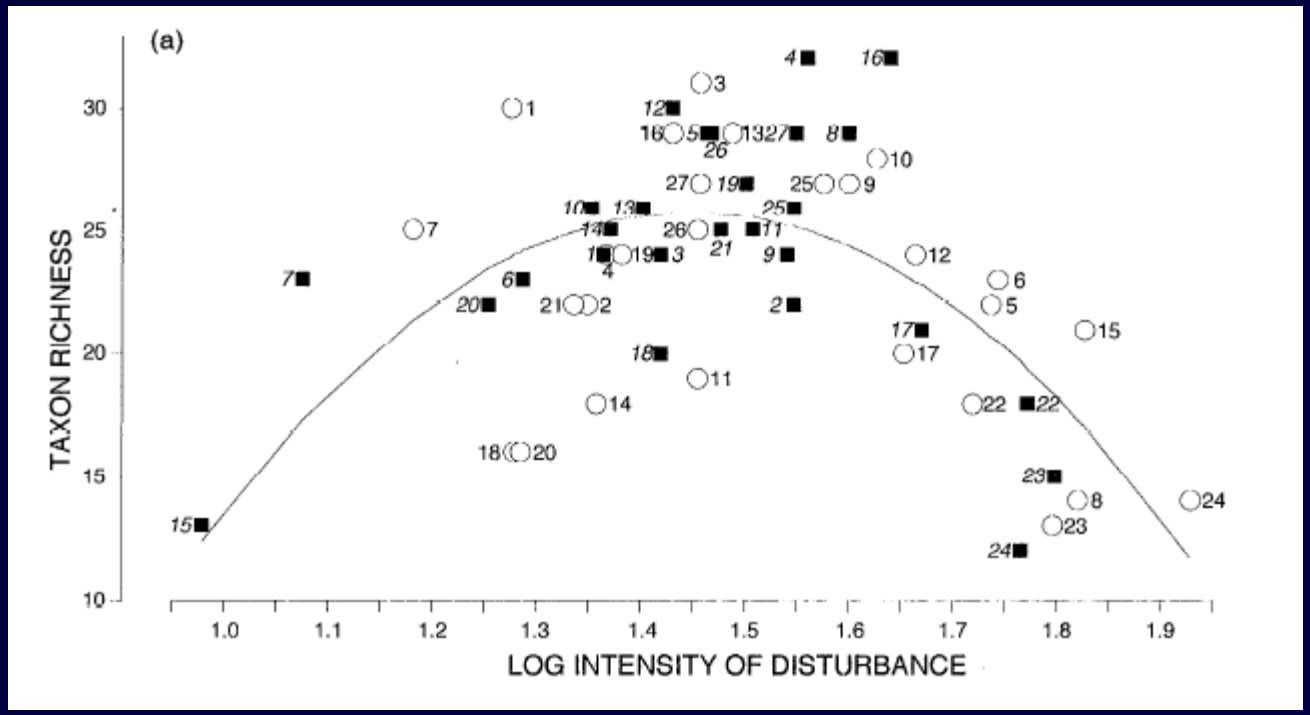


Fig. 4. Diversity index (H′) and species number at the end of the experiments. 2–12 d: length of the disturbance interval in days; und.: undisturbed treatment. The dashed lines serve to provide orientation only. The higher value of H′ and species number corresponds to the replicate ×.1 of the former figures. Experiment 1: 225% increase of the natural mixing depth (4 m); experiment 2: 150% increase of the natural mixing depth.

Floder & Sommer 1999

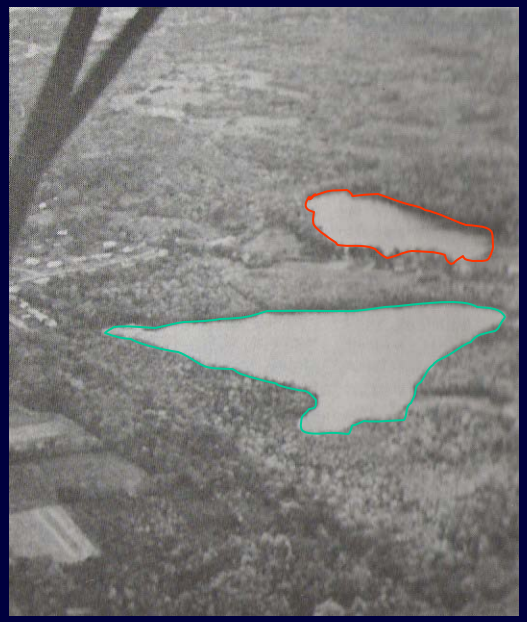
Intermediate disturbance hypothesis in rivers



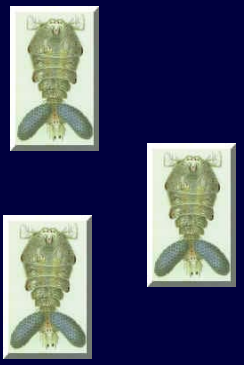
Townsend & Scarsbrook 1997

Size efficiency hypothesis

Observations → Theory → Experimental manipulation



Small zooplankton
+ alewife



Large zooplankton
- alewife

Observation: planktivorous fish → size and species composition of zooplankton communities

Brooks and Dodson (1965)

Size efficiency hypothesis

Observations → Theory → Experimental manipulation

Hypothesis: Predator size-selectivity changes zooplankton size/composition

1. Filter-feeding zoop compete for small food particles
2. Large zoop filter more efficiently (filter area ~ body length$^{2)}$ and can exploit large resources
3. Large zoop are competitively superior (w/o predation)
4. Planktivorous fish selectively remove large zoop

Prediction: Large zoop dominate in lakes without alewife

Size efficiency hypothesis

Observations → Theory → Experimental manipulation

1. Planktivorous fish absent until accidental introduction of *Alosa* sp. in Crystal Lake

2. After introduction, size distribution and species composition changed in line with predictions

SE hypothesis has mixed but generally positive support; competitive mechanism less supported