Ecosystem-Level Processes

- Primary Productivity (& nutrients)
- Secondary Productivity
- Decomposition
- Production: Respiration
- Production: Biomass
- Food Web Complexity (energy transfer)
- Nutrient Cycling
- Diversity
- Resistance/Resilience to disturbance

Diversity (species richness)

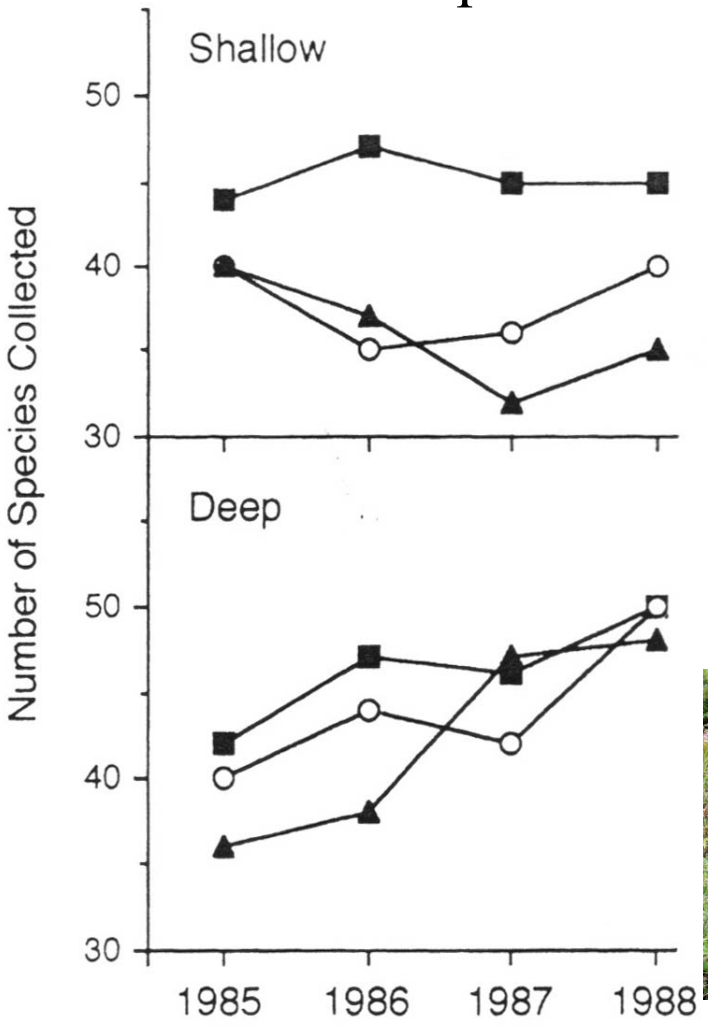
Invertebrate diversity (richness) by habitat in a small beaver pond wetland, Alabama

Invertebrate group	Open water	Floating-leaved zone	Emergent zone
Cladocera (water fleas)	4	15	5
Copepoda	4	10	2
Diptera (true flies)	25	37	56
Coleoptera (beetles)	-	11	9
Ephemeroptera (mayflies)	-	3	2
Hemiptera (true bugs)	-	3	2
Lepidoptera (moths)	-	2	6
Odonata (dragonflies, damselflies)	-	14	3
Trichoptera (caddisflies)	-	4	2
Worms	-	6	5
Other invertebrates	-	5	9
Total taxa	?	110	101

Data from Benke et al. in Batzer et al. 1999

Diversity (species richness)

Midge diversity in three vegetative habitats in two water depths



■ *Aster*

○ *Scolochloa*

▲ *Scirpus*

Diversity (species richness)

Species-area relationships
Species-sampling intensity relationships

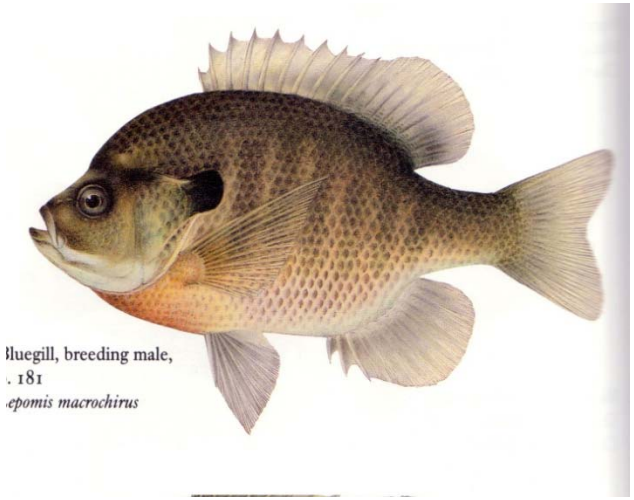
Invertebrate Diversity

Climate
Hydrologic regime
Salinity
Dissolved oxygen
pH
Nutrients
Vegetation (habitat) diversity
Disturbance
Predator presence (fish, amphibians)
Suspended sediments

Diversity (species richness)

Fish Diversity

Climate or hemisphere
Salinity
Area
Vegetation diversity
Dissolved oxygen levels
pH



Bird Diversity

Climate or hemisphere
Vegetation or habitat diversity
Structural diversity
Food abundance?

Diversity (species richness)

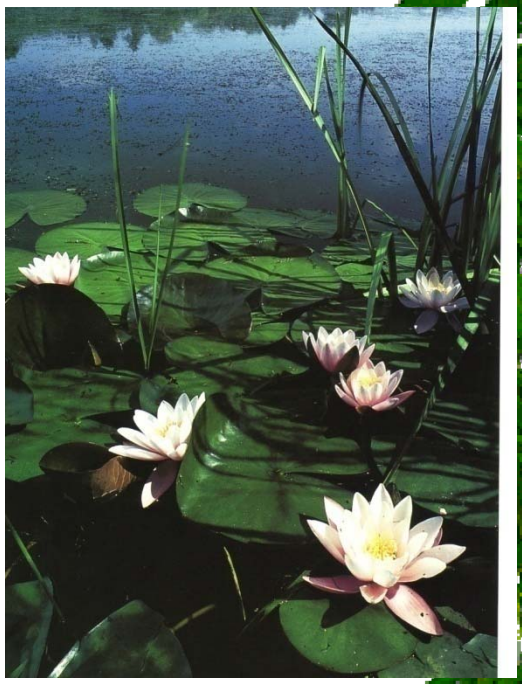
Amphibian Diversity

Hydrologic regime
Climate and hemisphere
Predators (fish)
Vegetation (habitat) diversity

Diversity (species richness)

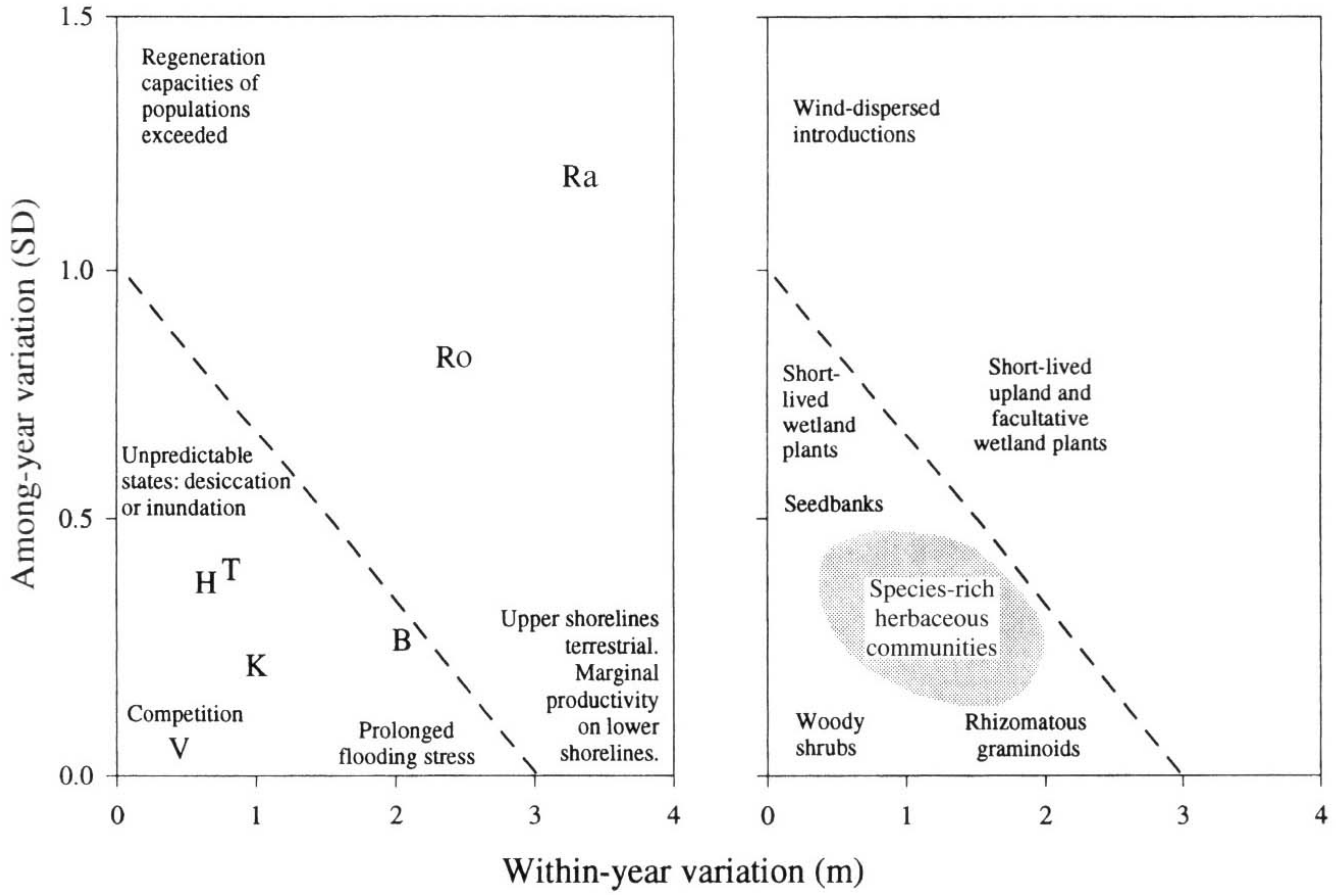
Plant Diversity

Climate and hemisphere
Hydrologic regime
Disturbance
Nutrients (food)
Biomass
pH
Salinity
Dissolved oxygen

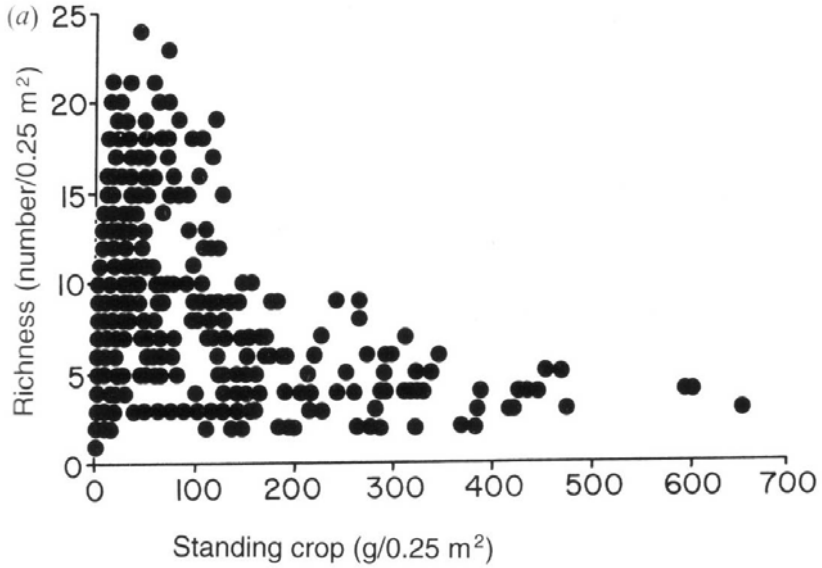


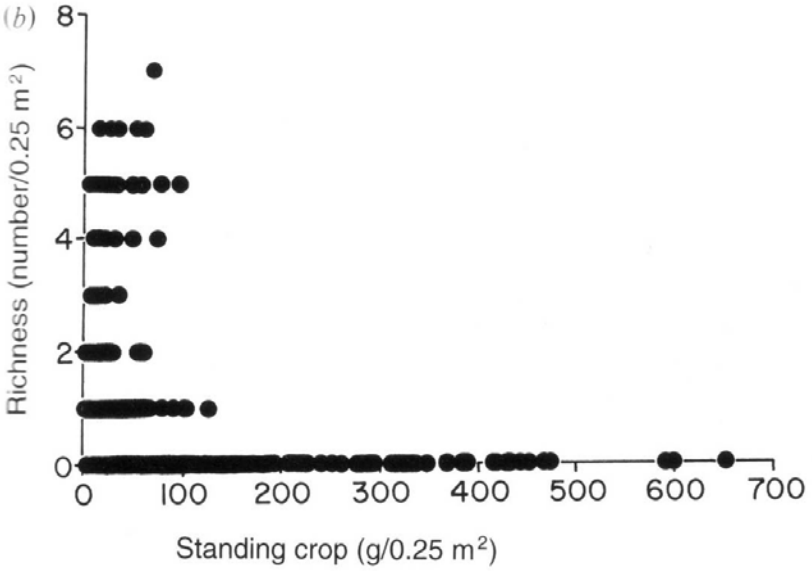
Diversity (species richness)

Intermediate Disturbance Hypothesis



Diversity (species richness)





Keddy 2000

Competition

Keddy's definition:

The negative effects that one organism has upon another by consuming, or controlling access to, a resource that is limited in availability.

Elemental requirements of organisms (CHNOPS)

Elements	Function
C	Structure; energy storage
H	Structure; energy storage
N	Structure of proteins
O	Structure; aerobic respiration
P	Structure of nucleic acids, skeletons, energy transfer
S	Structure of proteins

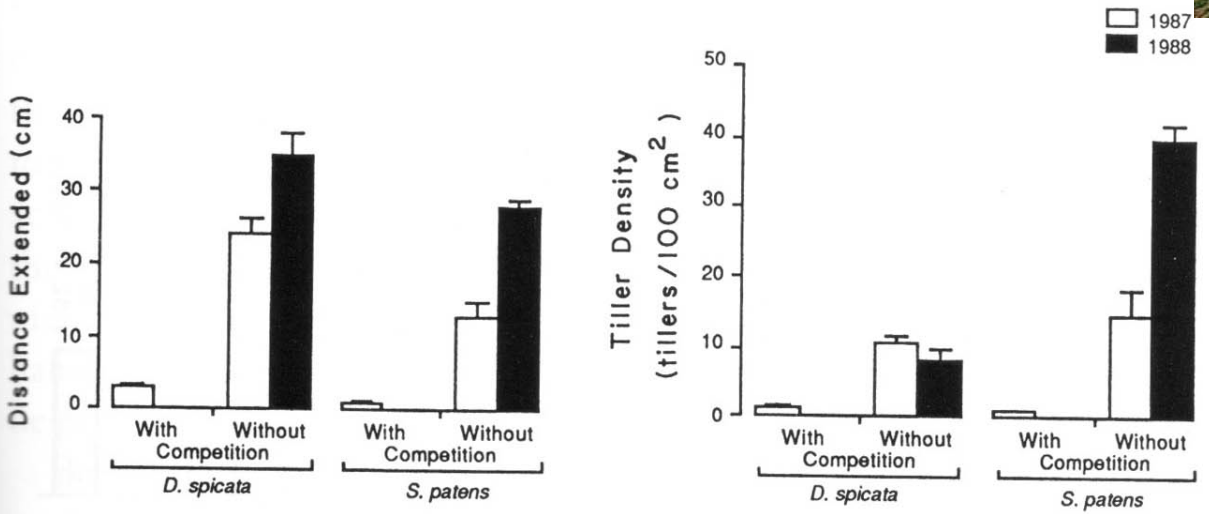
Competition

Types of experiments:

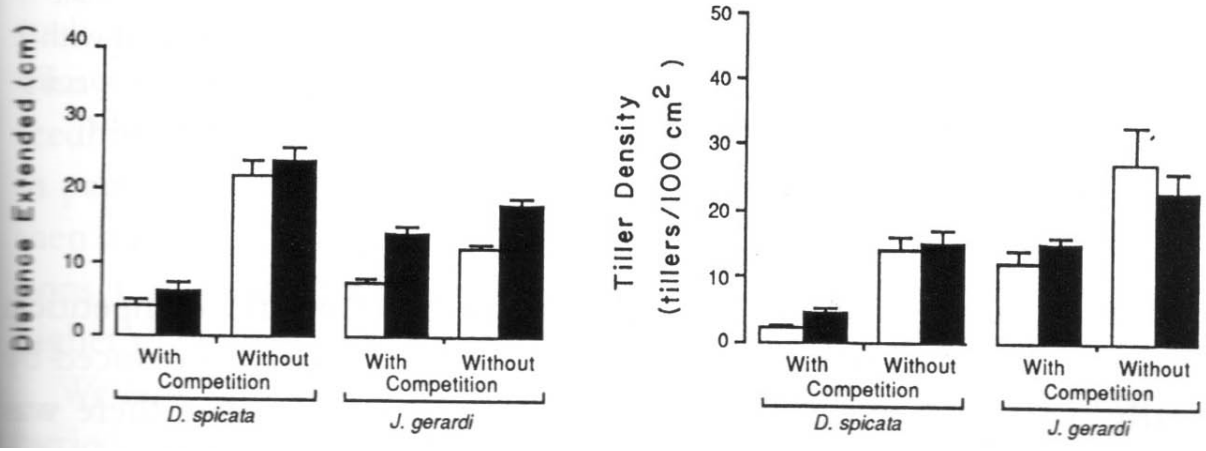
- Species removal (animals and plants)
- Transplants with and without neighbors (mostly plants)
- Increasing and decreasing the abundance of a suspected competitive dominant (animals and plants)
- Artificial associations (animals and plants)

Transplant experiment for competition

Juncus zone

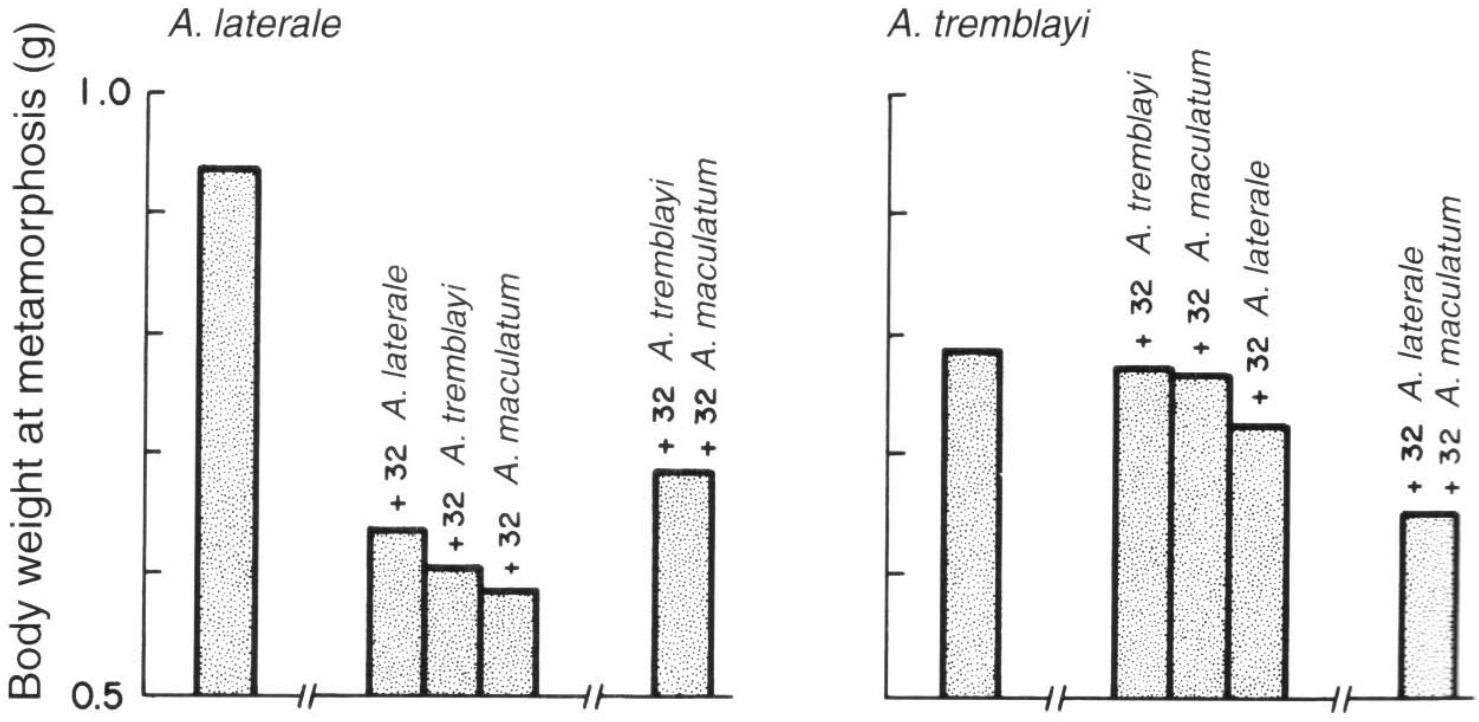


Spartina zone



Bertness 1991

Creating artificial associations to test for competition



Wilber 1972

Creating artificial associations to test for competition

Closely related species of sunfish

(all in same genus & with overlapping occurrence in lakes & wetlands)

Data are percent of prey types eaten

	Bluegill		Pumpkinseed		Green	
Prey type	**A**	**T**	**A**	**T**	**A**	**T**
Veg fauna	61	15	41	5	43	40
Benthic fauna	10	15	12	34	23	12
Open water zooplankton	8	33	1	6	1	4
Other	21	37	47	55	33	44

A = alone as a species

T = together with the other species

Werner & Hall 1976

Competition & species distributions

Zonation patterns:

Deeper water

Less fertile habitats

Above & belowground competition

Competition
Mechanisms and escape

Exploitive vs interference competition

Competition type	Number of aquatic examples in 1983
Interference	7
Exploitive	37

Schoener 1983

Escape from competition:

- Marginal habitats (centrifugal organization)
- Founder control
- Spatial escape
- Biotic control (keystone species)

Competition
Spatial escape

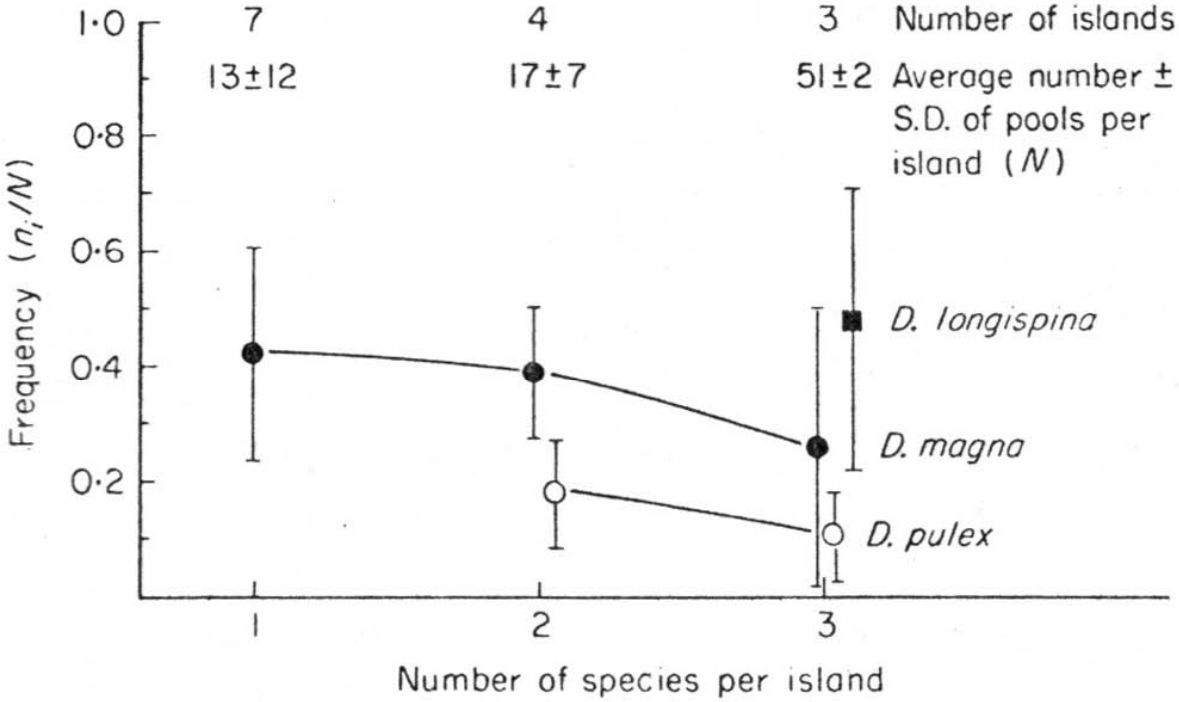


FIG. 2. The fraction (mean ± S.D.) of pools inhabited by the three species of *Daphnia* (n_i/N) on the islands with one, two, and three species. The number of islands is given in the upper part of the figure with the average number (± standard deviation) of pools (N) suitable for daphnids.

Colonization: D. magna > D. pulex > D. longispina

Competition: D. longispina > D. pulex ~= D. magna

Hanski & Ranta 1983

Competition: Biotic Control

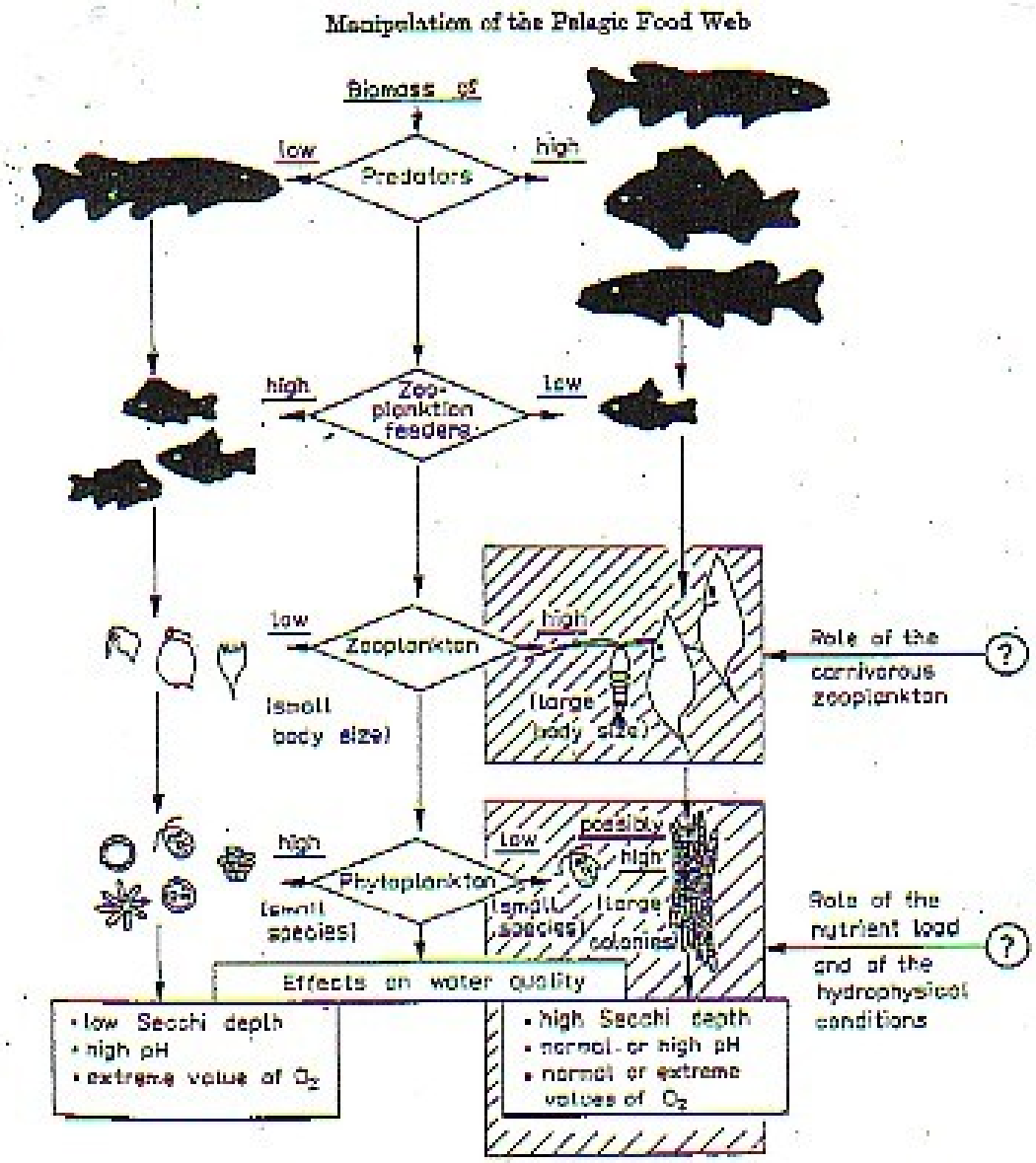


Figure 1. Hypothetical scheme showing the connections involved in biomanipulation; shaded area = connections as yet unsure (modified after Kozarr (1982)).

Cooperation or commensalism

Abundance (per m^2) of selected invertebrates pre and post zebra mussel colonization in Lake Ontario

Invertebrate	Pre zebra mussel	Post zebra mussel
Zebra mussels	0	5192**
Oligochaete worms	41	571**
Physid snails	1	41**
Valvatid snails	0	10**
Hydrobiid snails	0	221**
Pleurocerid snails	71	253**

** = difference significant at $p < 0.001$

Data from Haynes et al. 1999