Lake Ecosystems

Limnology

Lecture 12

Raymond Lindeman
& Cedar Creek Bog

Upon
cycle,
rgan-
nity''
nutri-
nent''
The

Ecosystem defined

Biotic + abiotic components

Energy and chemical flows between living and non-living elements

Mass-balance

Box/arrow diagrams

Types of Questions

Biogeochemistry –

fluxes, transformations, and interactions of carbon, nutrients, and energy
~ black box organisms (ooze)

Ecosystem ecology –

how energy and nutrient fluxes affect biota
~ named organisms

Types of Questions

In lakes

Sources and fate of primary production

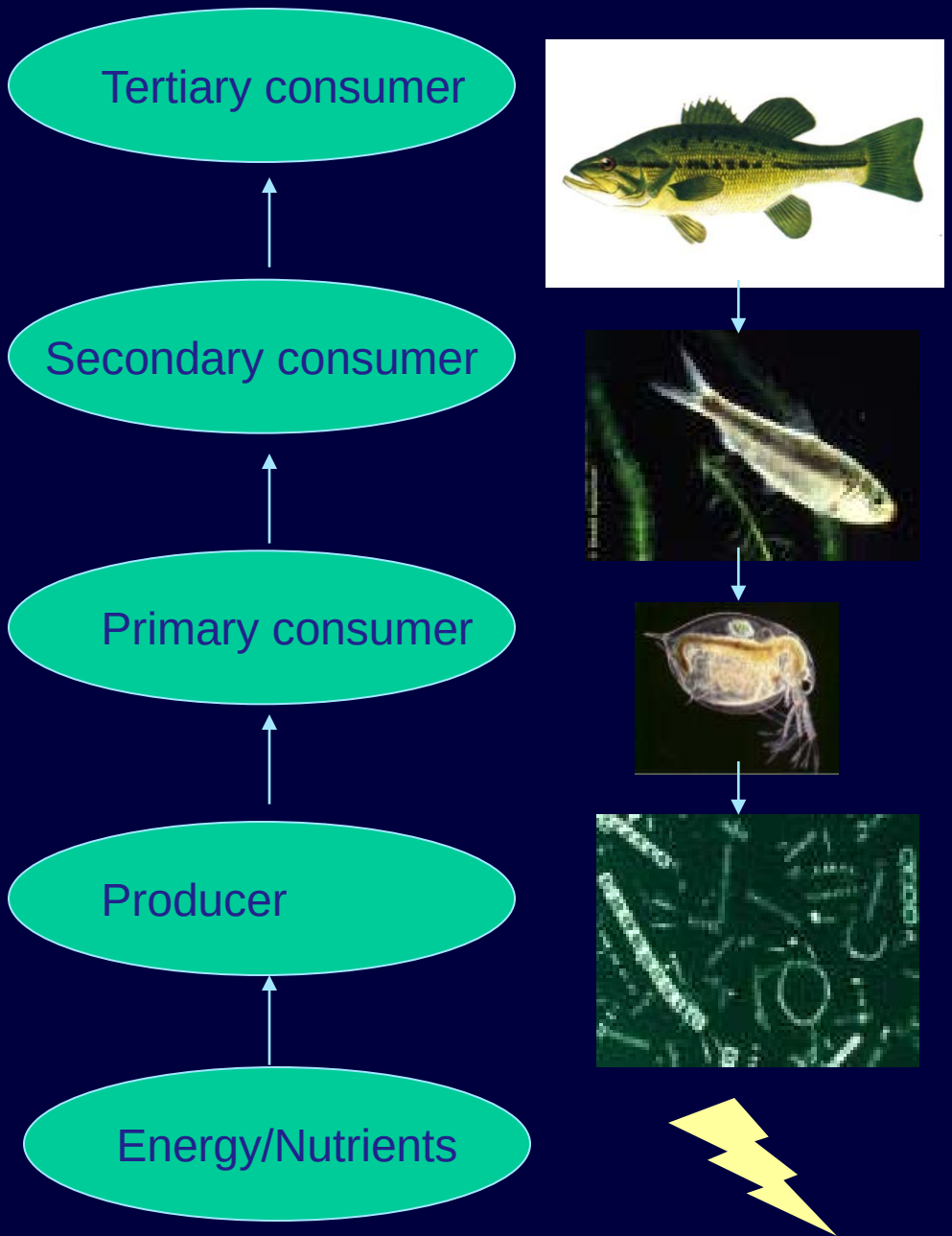
- Autocthonous (from within)
- Allocthonous (from outside)

Energy transfers

Nutrient stoichiometry

Manipulations of entire systems

~~Food chain~~ Trophic structure



Omnivory

Complicates things?

Is omnivory important in aquatic systems?

Omnivory

Feeding depends on “ontogeny” = development of organisms through time

Copepod immature→ herbivores
Copepod adults → carnivores

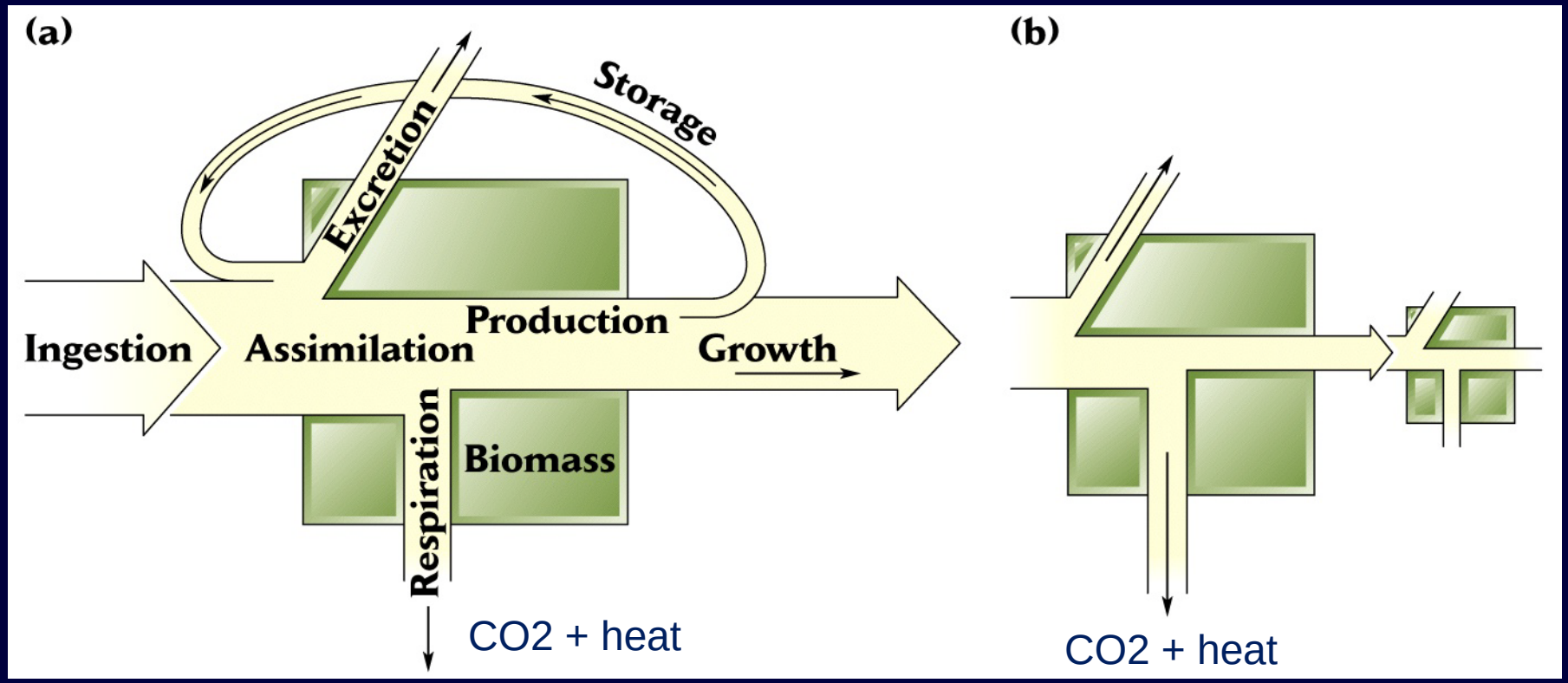
Trout fingerlings → planktivores
Trout adults → piscivores

Small green frog tadpoles→ grazers
Large green frog tadpoles → omnivores

1st Law of thermodynamics:
energy is neither created nor destroyed, only transformed

2nd Law of thermodynamics:
internal losses during energy transfer (waste heat)

Energy pyramid



Tertiary consumer

10%

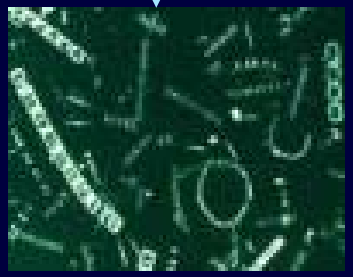
Secondary consumer

10%

Primary consumer

10%

Producer



Microbial loop

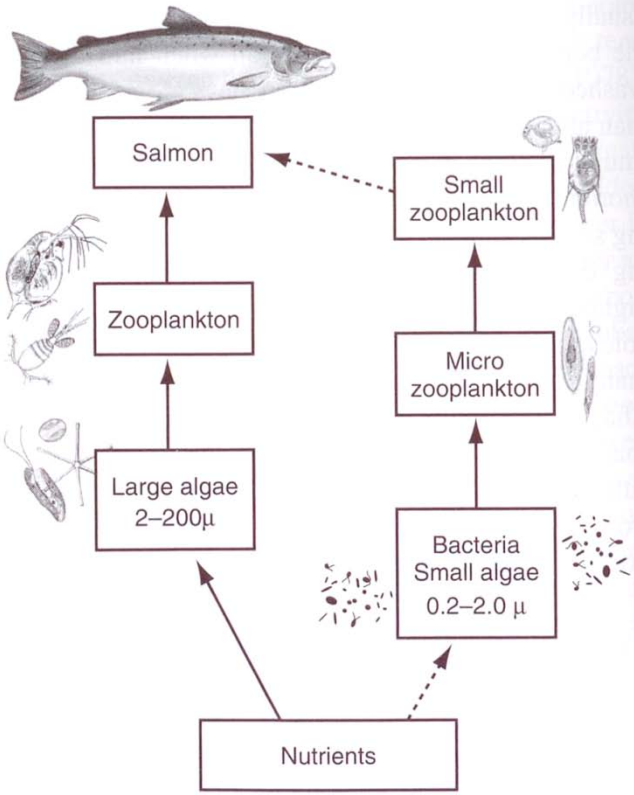


FIGURE 9.6 The microbial loop model. Compared to a standard model (see figure 9.1), this trophic structure has an extra level at the microbial level, resulting in less energy being available for the top trophic level.

Fish production

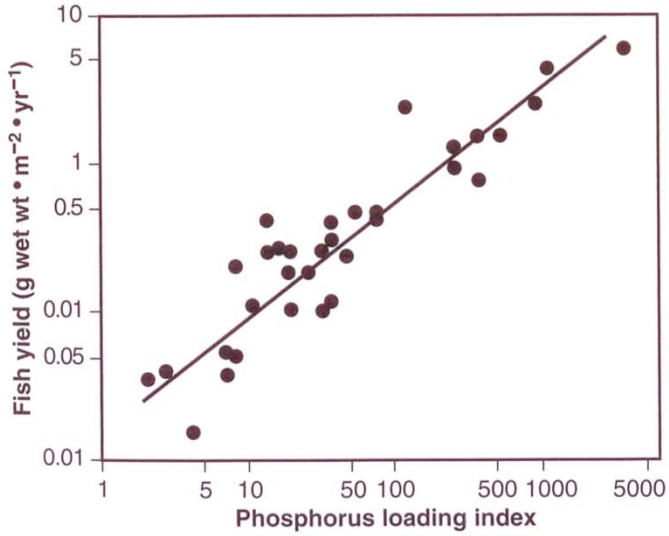
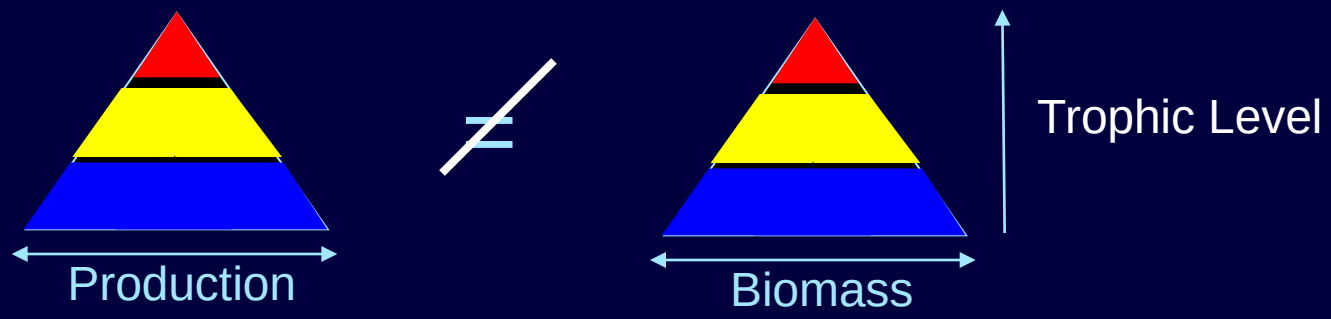


FIGURE 9.5 The relationship between annual fish production and the input of phosphorus to a lake (phosphorus loading). This graph has logarithmic scales. **Source:** Data from Jones & Lee, 1991.

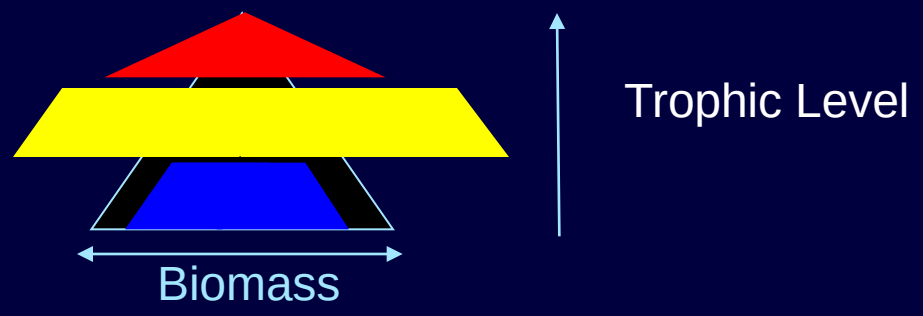
Demonstration of top-down or bottom-up?
Change in composition → lack of O_2

Not necessarily biomass pyramid



Aquatic systems:

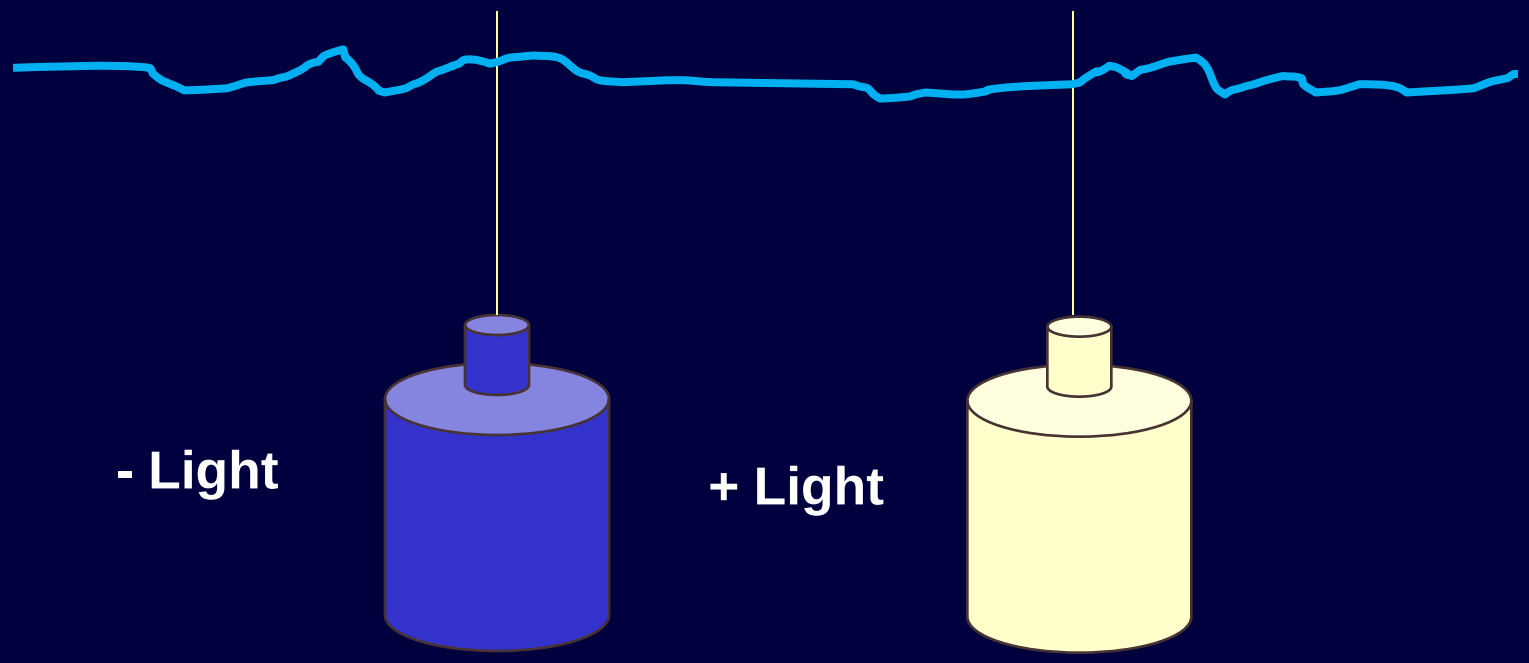
Inverted Pyramid



Autotrophs primarily unicellular
Rapid growth

Measuring net primary productivity

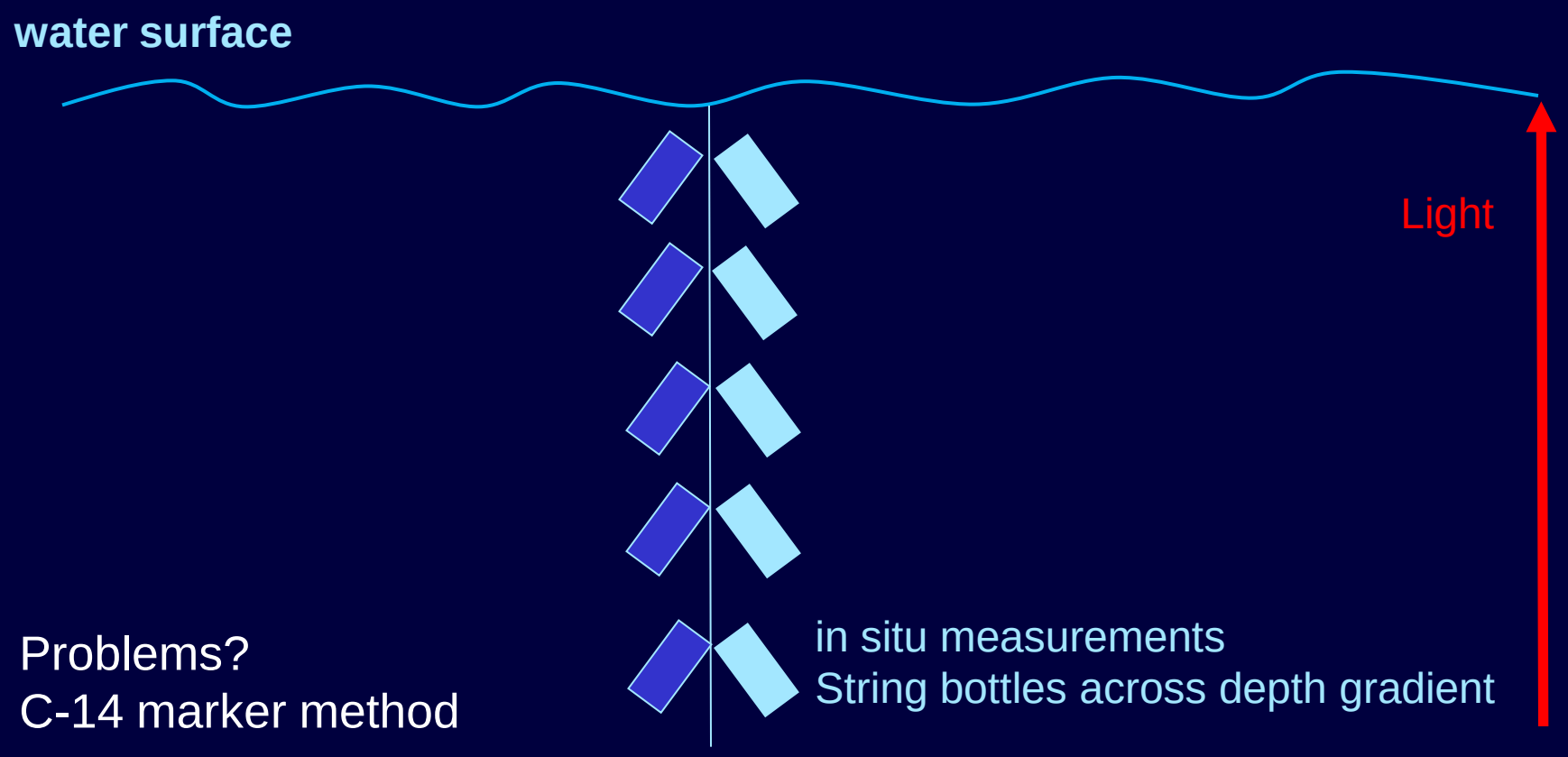
Net PP = Gross PP - Respiration



Dark Bottle
Respiration

Light Bottle
Gross PP

Measuring net primary productivity



Problems?
C-14 marker method

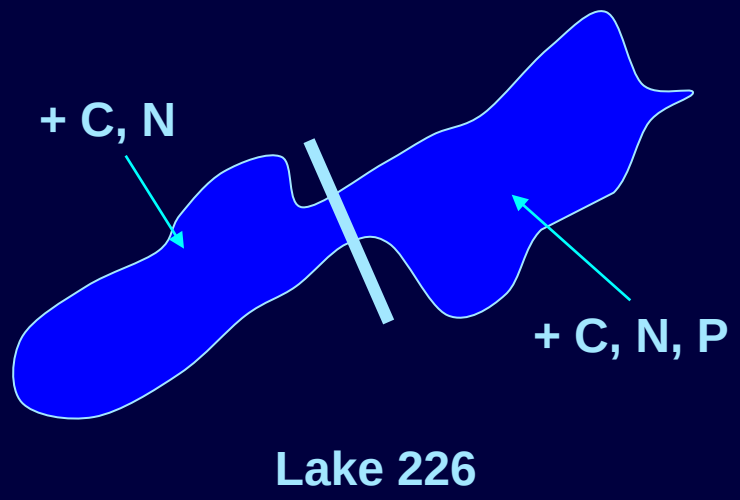
Experimental ecosystem ecology

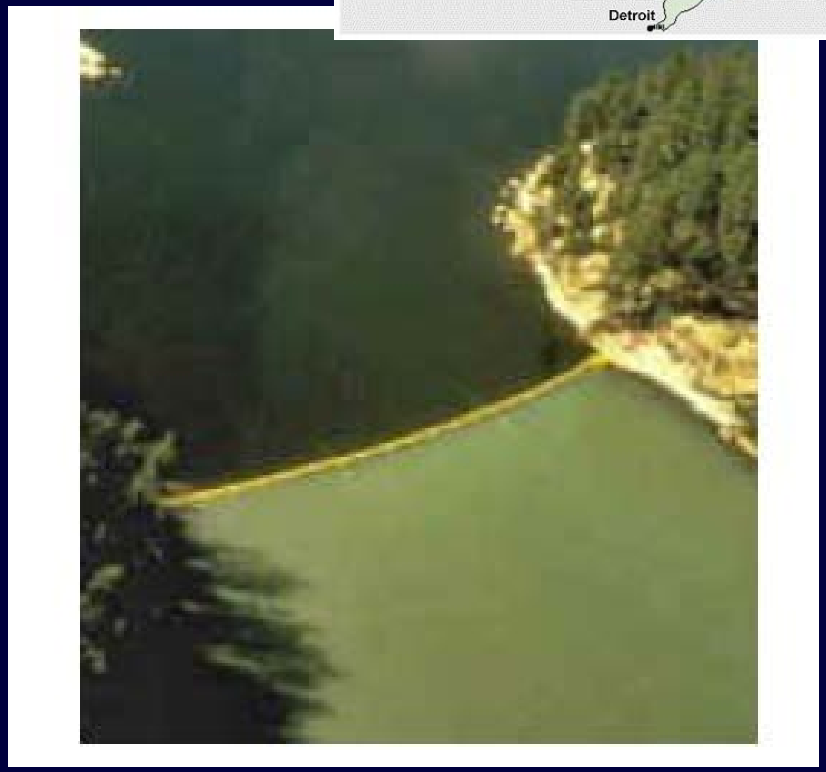
Manipulate entire ecosystem

Control and treatment

Large-Scale Experiment Resolves Debate about P

Experimental Lakes Area, Ontario Canada





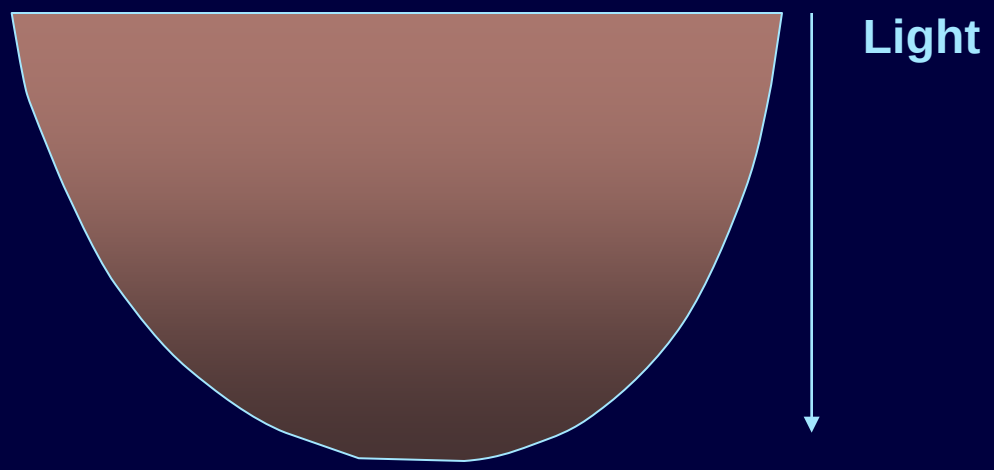
David Schindler and Colleagues

Arthur Hasler: Lakes are too complex to study in the lab

Arthur Hasler's Hypothesis:
Lake productivity in humic lakes is limited by low light

Add lime:

increase pH,
precipitate brown humic colloids
increase transparency
increase primary production



Arthur Hasler's Hypothesis:
Lake productivity in dark-stained lakes is limited by low light

Permanent Dike

Biotic changes

Water clear

Large, easily seen pulex replaced by cryptic rosea

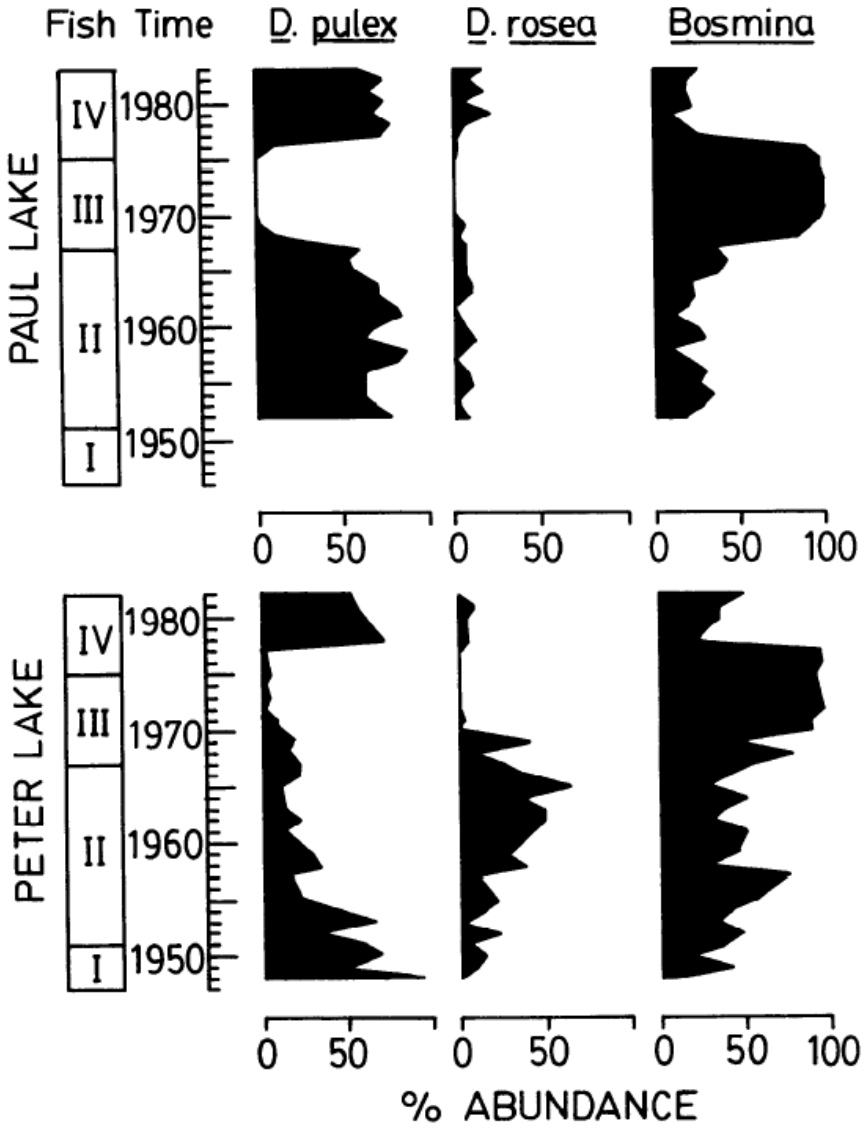


Fig. 4. Relative abundance of pelagic zooplankton microfossils. Fish zones as in Fig. 3.

Leavitt et al. 1989

Experimental ecosystem ecology

Manipulate entire ecosystem

Pros?

Cons?