Great Lakes Fisheries Leadership Institute

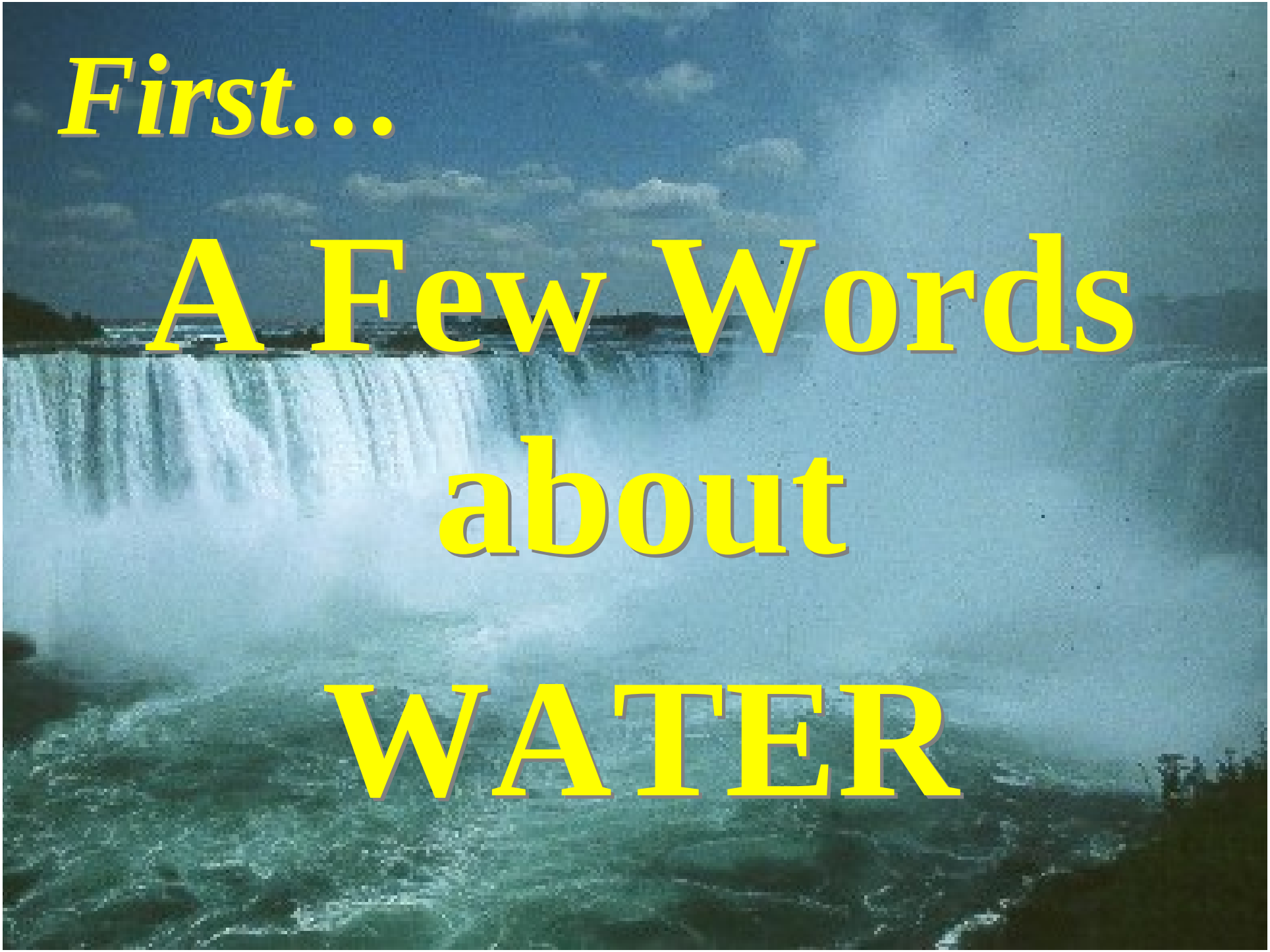
Sea Grant
Great Lakes Network

AQUATIC BIOLOGY

Produced by

Fred L. Snyder

Ohio Sea Grant College Program


First…
A Few Words about WATER

WATER

Water is densest at 4ºc (39º) – that's why ice floats and the warmest water is at the bottoms of frozen lakes.

WATER

***TEMPERATURE**

- controls reaction rates

***DISSOLVED OXYGEN**

(D.O.)

- most fish require 3-5 ppm minimum

WATER

***pH - measures water's acid-base condition**

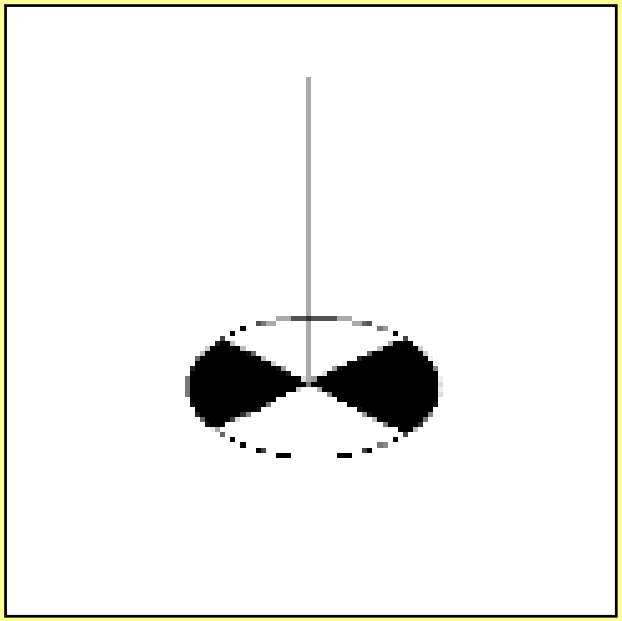
- logarithmic scale, 7.0 = neutral

- most aquatic life lives in range of 5.5 – 9.0

WATER

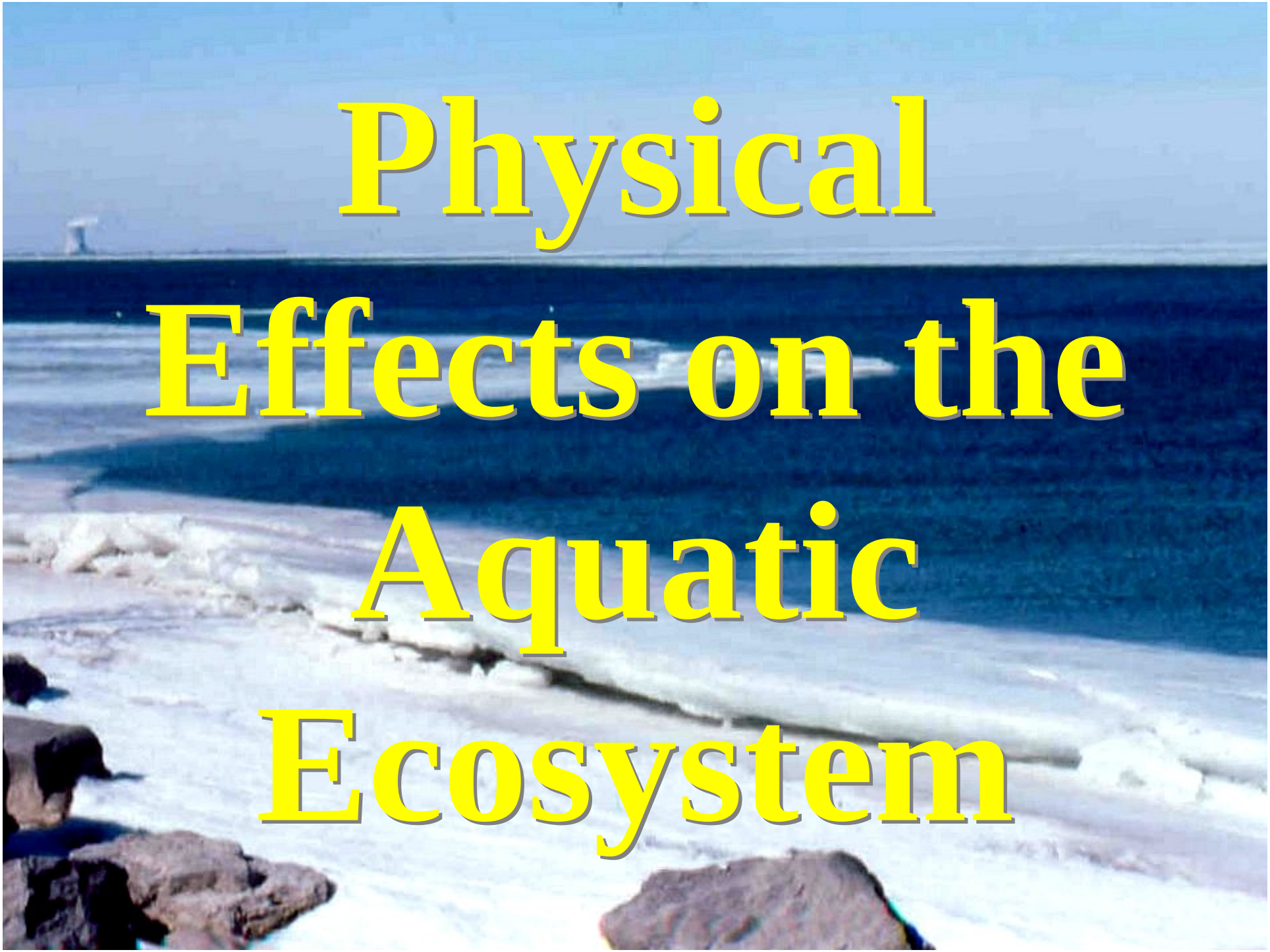
*TRANSPARENCY-

measured by Secchi disk



WATER

LAKE EFFECT –
The ability of a large water body to affect weather conditions over adjacent land areas


Physical
Effects on the
Aquatic
Ecosystem

Nutrients

A lake's productivity is limited by the nutrient in shortest supply. In fresh water, this usually is phosphorus

Nutrients

Low-nutrient lakes, with low productivity and clear water are termed

Oligotrophic

Example: Lake Superior

Nutrients

Lakes with moderate nutrient levels and productivity are called

Mesotrophic

Nutrients

Human activities have raised phosphorus levels in many waters, from:

Agricultural runoff…

Nutrients

…and sewage effluents

Nutrients

Lakes with high nutrient levels and high productivity are called

Eutrophic

Example: Western Lake Erie

Nutrients

While productivity increases, waters become turbid, often with excessive algae blooms

Nutrients

Phosphorus is being controlled by sewage treatment improvements, conservation tillage and filter strips on streams, but some areas are still troubled by nutrient enrichment

Temperature

Van t'Hoff's Law:

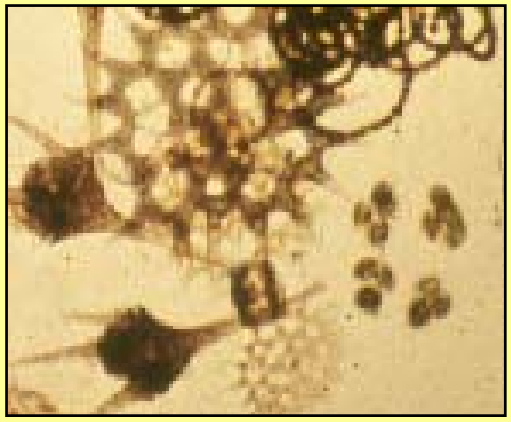
For every 10° C increase in temperature, the speed of a chemical reaction doubles…

Temperature

…and for each 10° C decrease in temperature, the reaction rate is reduced by half

Temperature

This governs the metabolic rates of all cold-blooded organisms



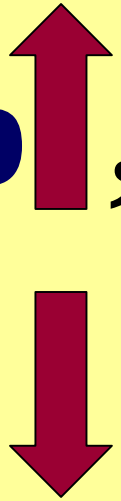
Temperature

The oxygen dilemma:

The ability of water to hold dissolved oxygen increases as the temperature goes down

Temperature

…conversely, as the temperature of water goes up, it holds less oxygen



Temperature

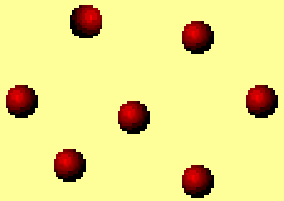
But, higher temperatures increase organisms' oxygen needs while the actual supply of dissolved oxygen is decreasing

Temperature

Water molecules move apart at high temperatures and move together at low temperatures

cold

warm

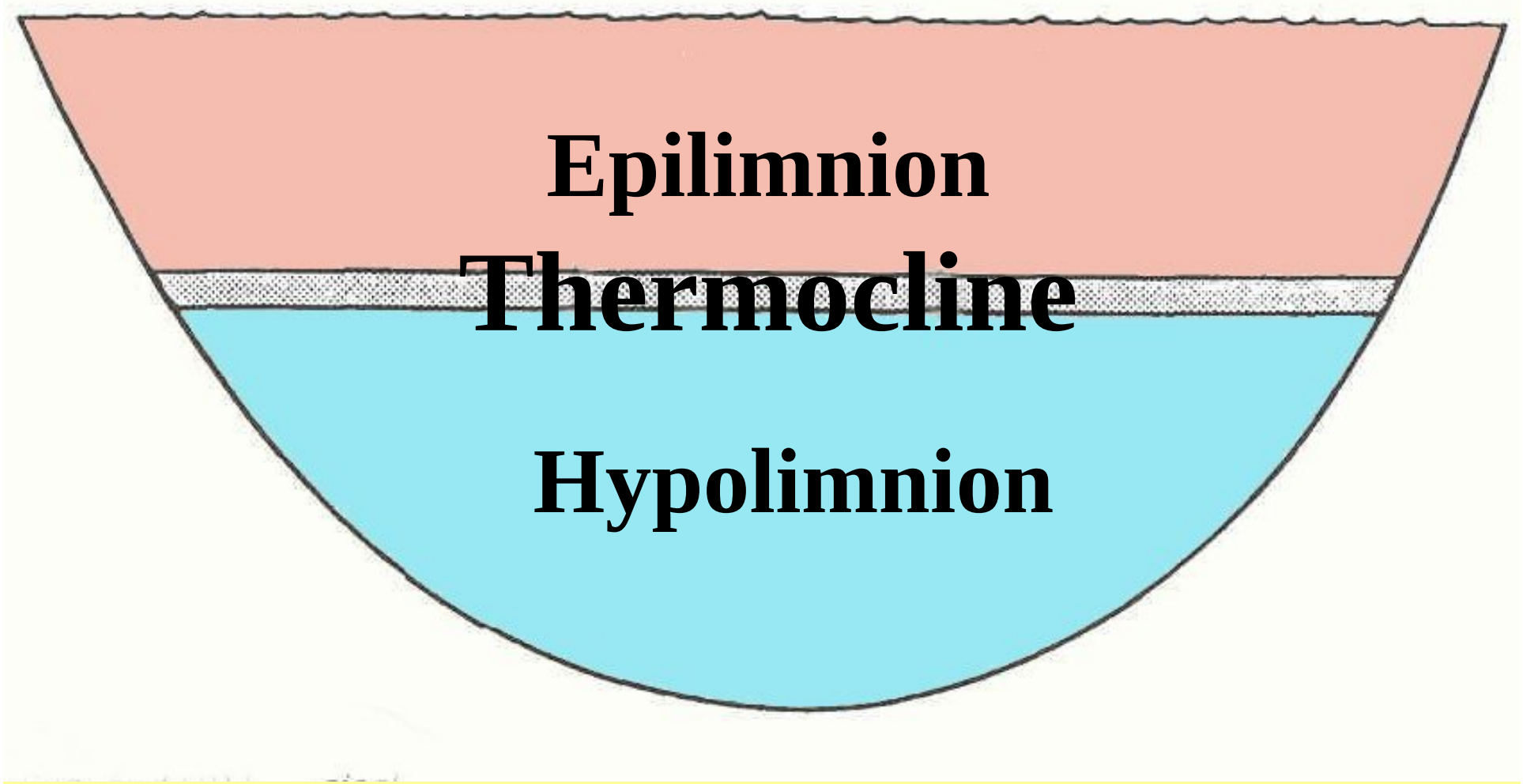


So, a cup of cold water is heavier than a cup of warm water – it contains more molecules

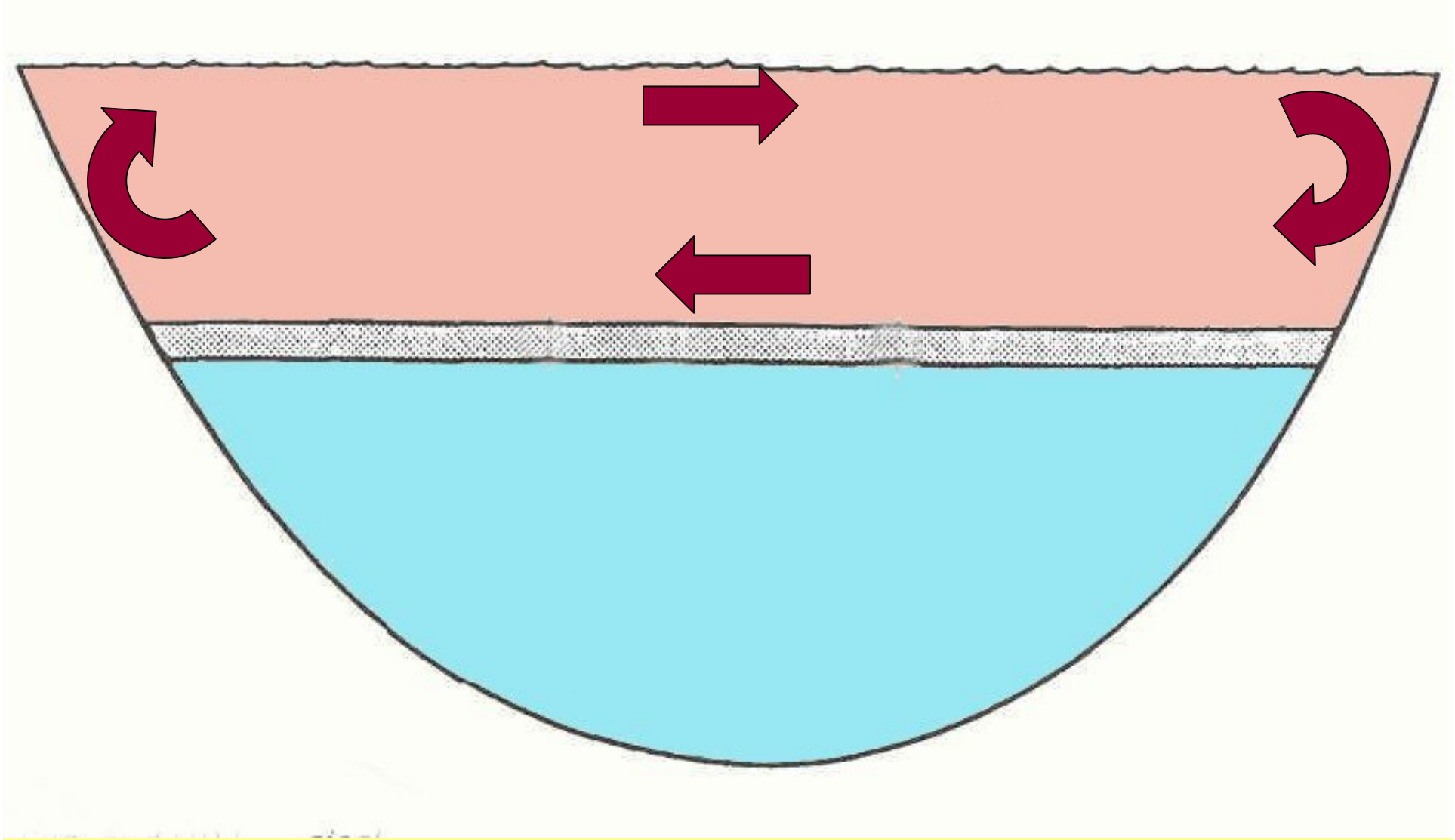
Temperature

In summer, bright sun warms the upper portion of the water, making it lighter than the colder, heavier water below. A warm layer sits atop a cold layer

Temperature



Temperature

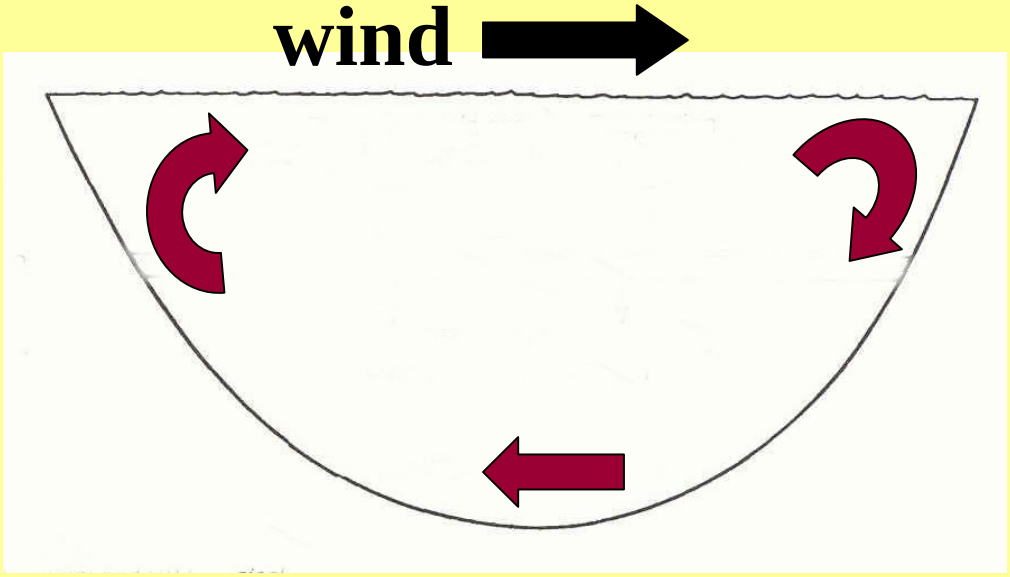


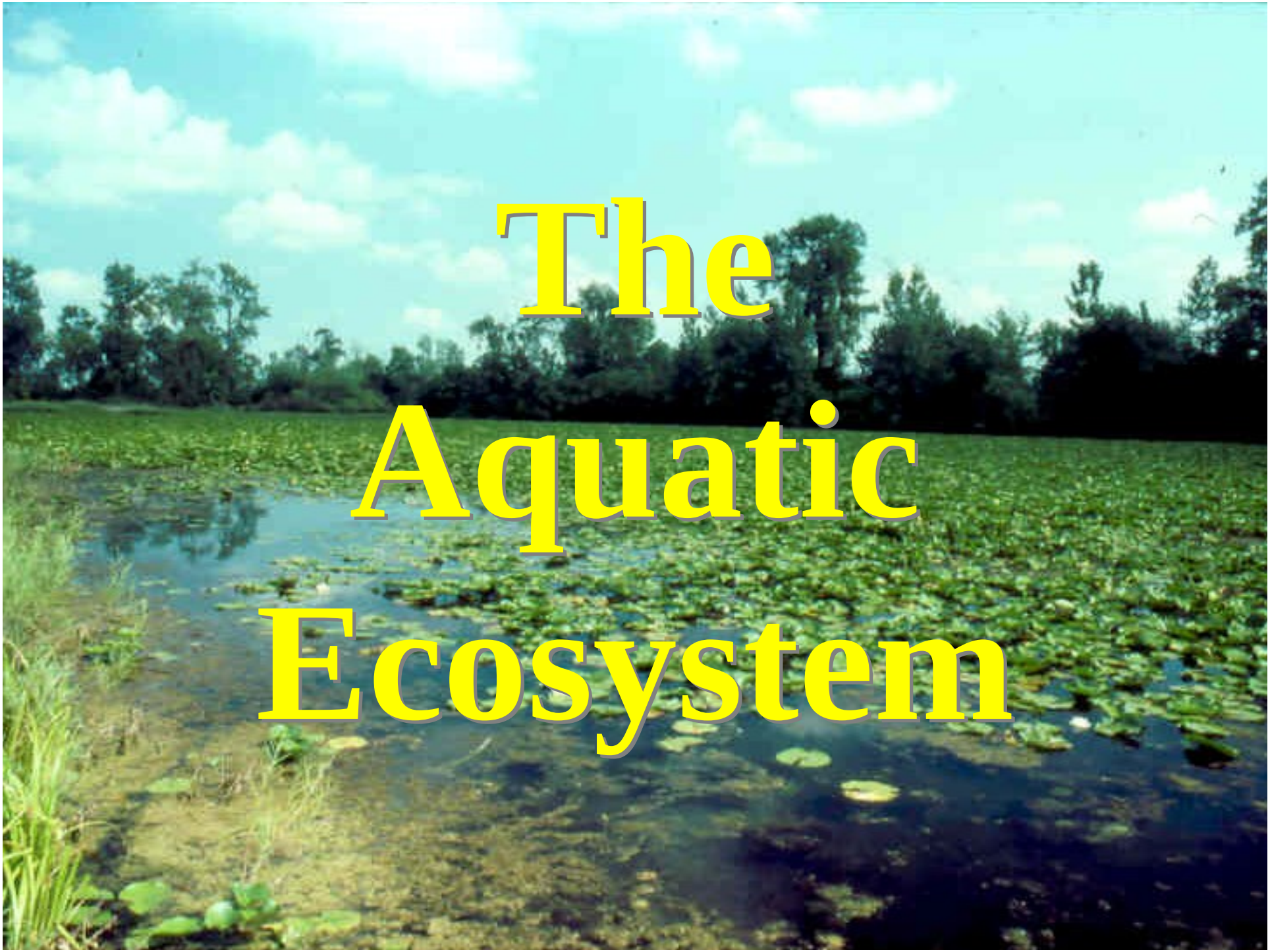
Temperature

The hypolimnion does not circulate back to the surface until fall turnover, when the lake reaches a uniform temperature

Temperature

…allowing autumn winds to circulate water from top to bottom




The
Aquatic
Ecosystem

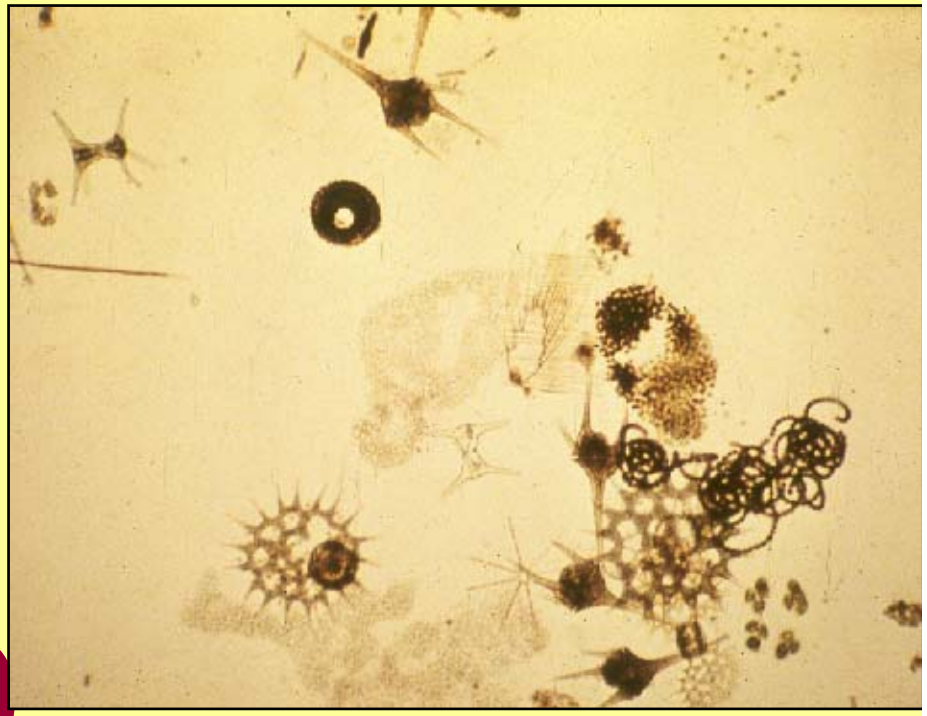
Ecosystem:

The community of living organisms and their non-living environment

Meet some of the players…

Algae –

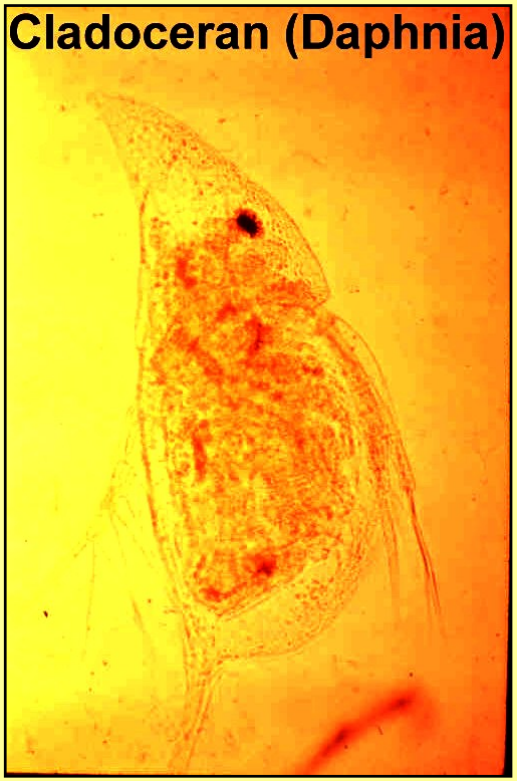
Can be free-floating (phytoplankton)

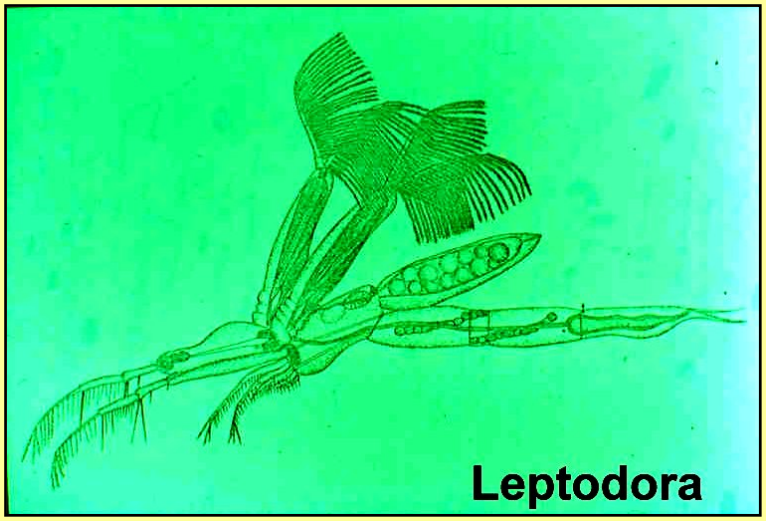


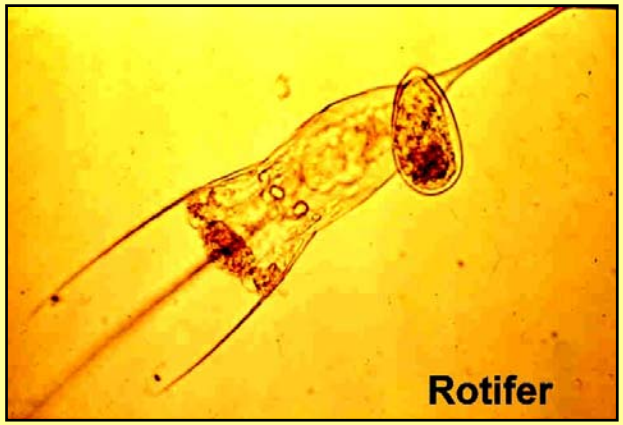
Or attached

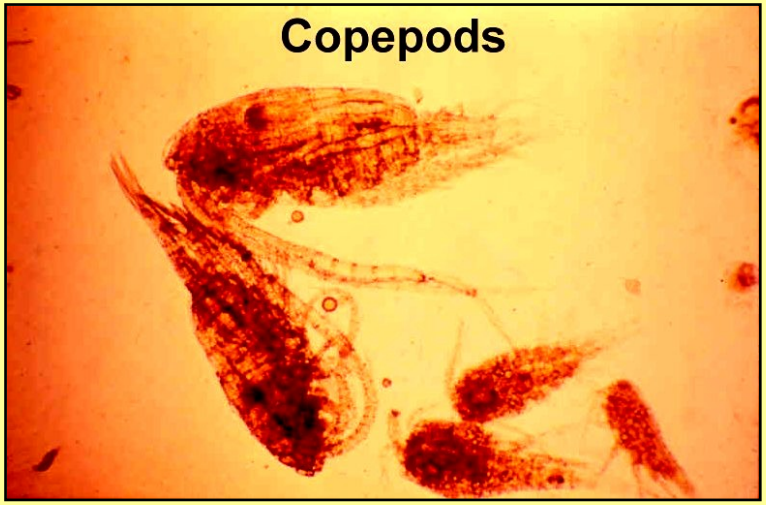
Macrophytes (rooted plants)

Zooplankton







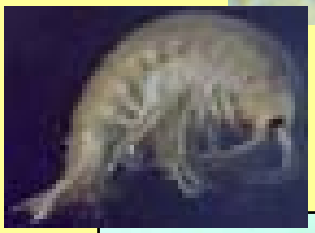


Macroinvertebrates

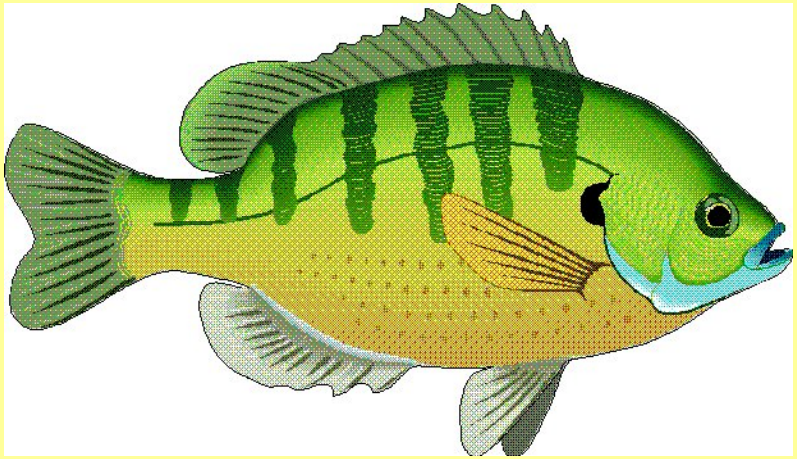
- Insects
- Leeches
- Clams & mussels
- Crayfish
- Sponges
- Bryozoans…and many more

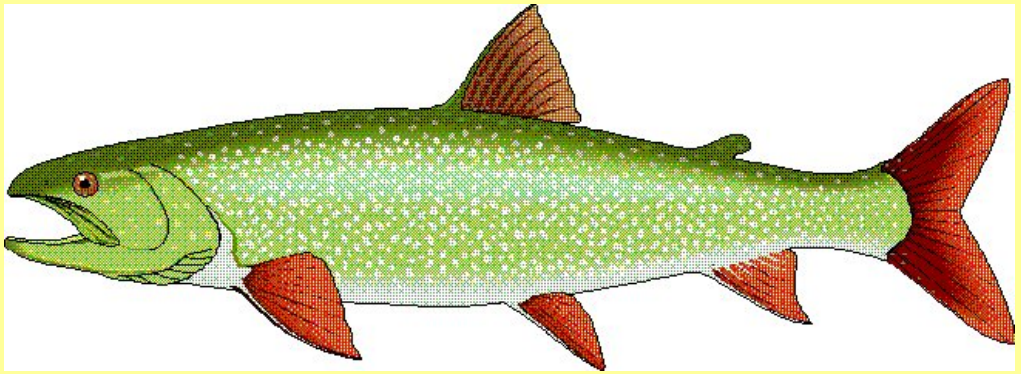


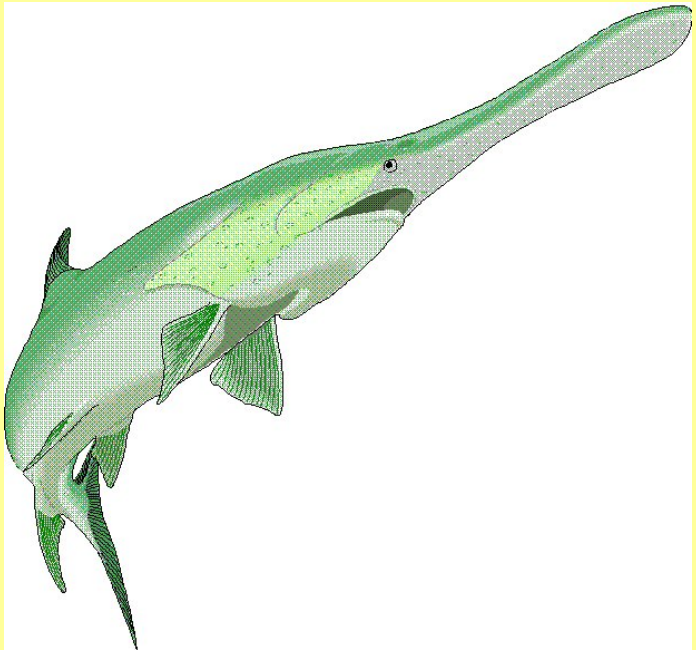


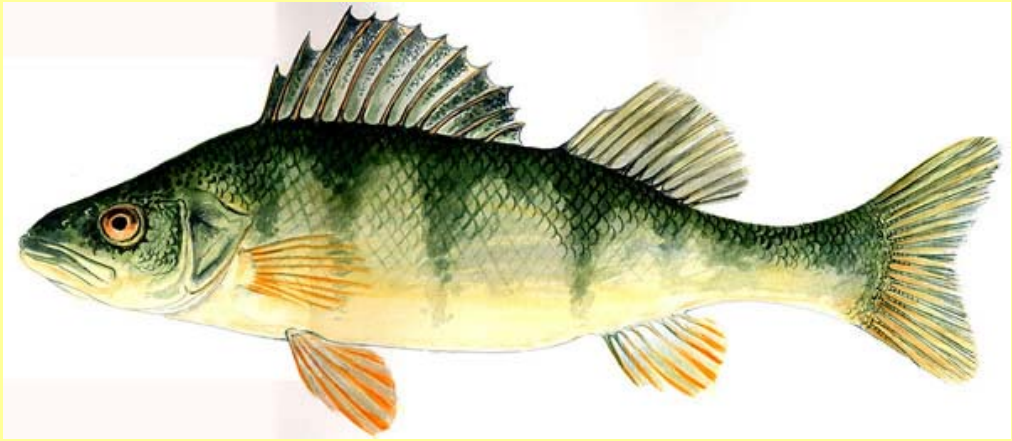


Fish…



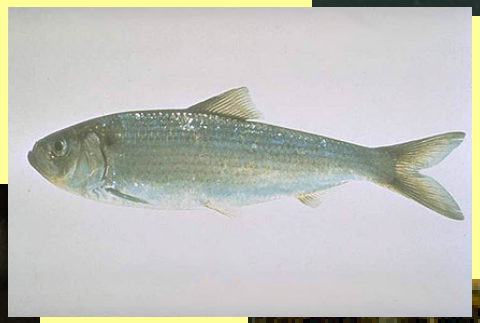


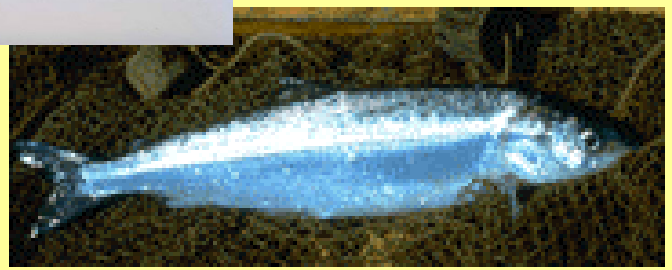




FORAGE FISH:

Any fish species that can be preyed upon by other fishes…





…LITTLE FISH!

BIG FISH!

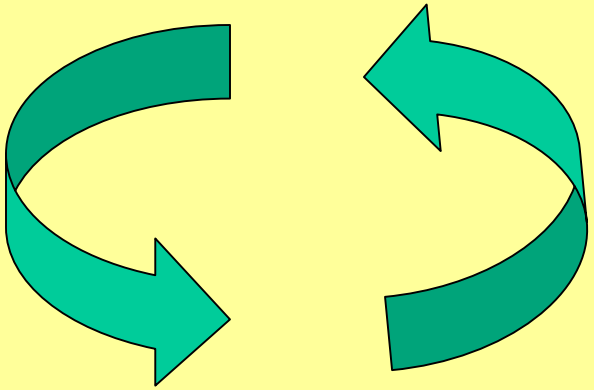
- Larger Predatory Species, such as:
  - Salmon or Trout
  - Bass or Pike
  - Perch or Walleye
  - and others

(Commonly thought of game species)

…and the non-living parts -

- Water
- Minerals/nutrients
- Sunlight

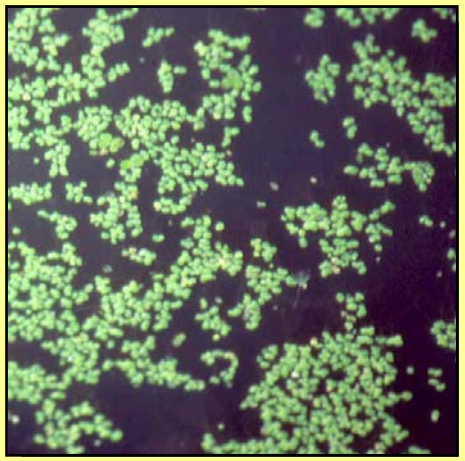
BIOTIC



ABIOTIC

Energy and matter cycle between the living and non-living parts

The nonliving parts enter the biological chain through primary production, as plants combine water, light and nutrients into living cells



Living in the Aquatic Ecosystem

Carol Stepien

PLANKTON:

Mostly microscopic plants and animals, dependent upon water currents for movement, including algae, diatoms, etc.

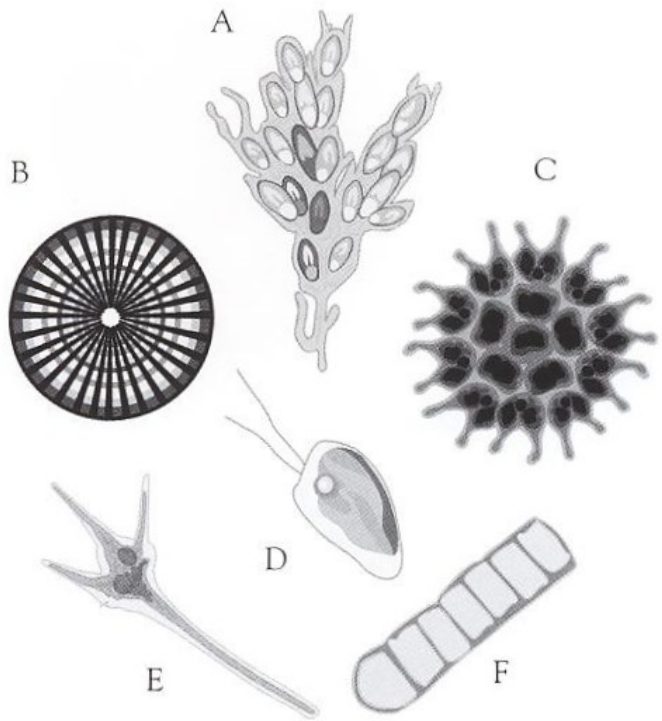


Fig. 1

(Note: Not drawn to scale. Scales range from 10,000 - 20,000 times life size.)

Phytoplankton Key

A – *Dinobryon spp.* (a chrysophyte)

B – *Stephanodiscus spp.* (a diatom)

C – *Pediastrum spp.* (a green alga)

D – *Rhodomonas spp.* (a cryptophyte)

E – *Ceratium spp.* (a dinoflagellate)

F – *Melosira spp.* (a diatom)

Plankton

- **Among the many zooplankton groups, a few are especially important…**

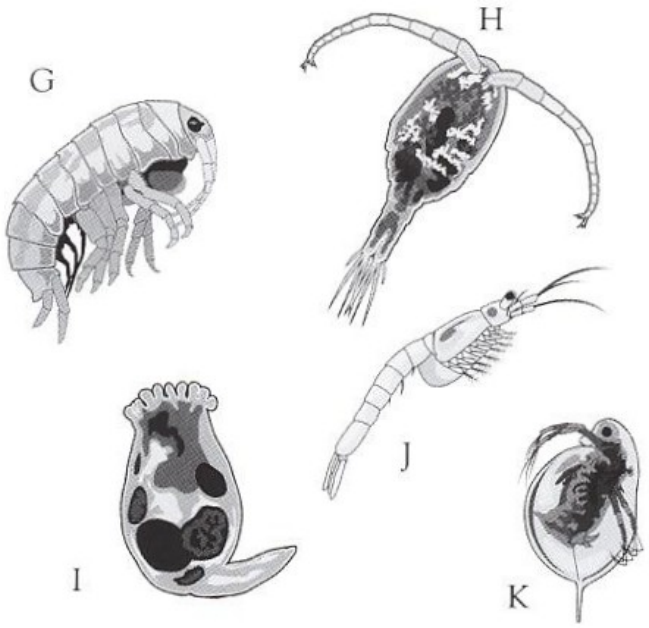


Fig. 2

(Note: Not drawn to scale. Scales range from 5 - 1,000 times life size.)

Zooplankton Key

G – *Diporeia spp.* (a crustacean)

H – *Diaptomus spp.* (a copepod)

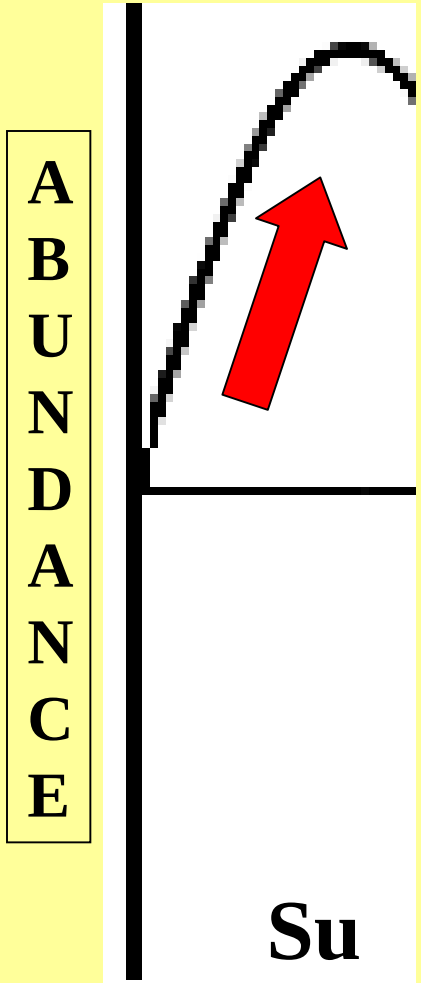
I – *Philodina spp.* (a rotifer)

J – *Mysis relicta* (a malacostran)

K – *Daphnia spp.* (a water flea)

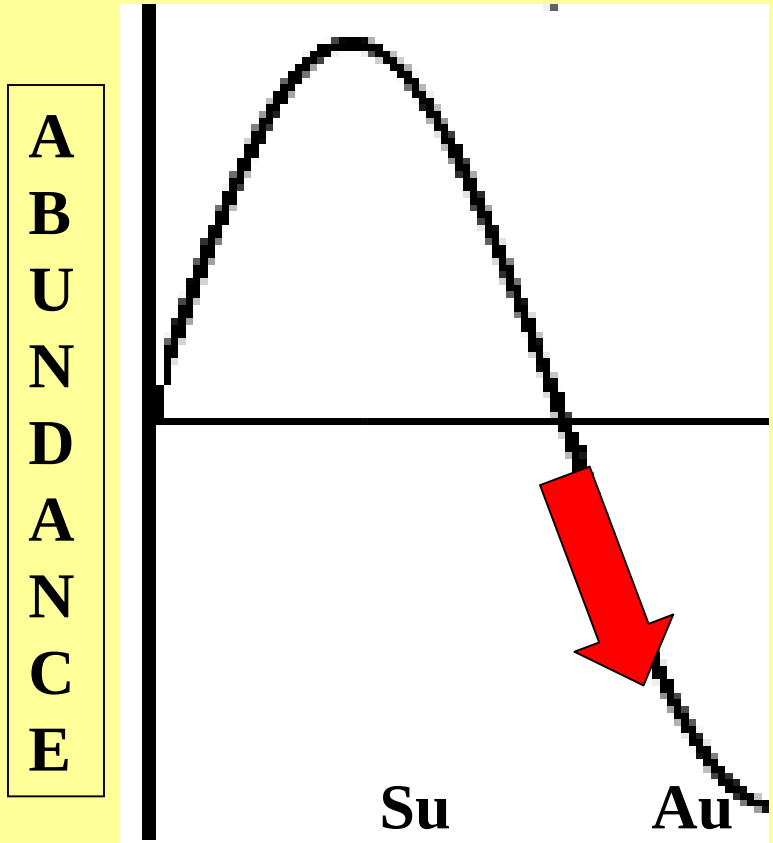
Plankton

In early summer, rising temperatures, lengthening days and nutrient inflow bring plankton levels up



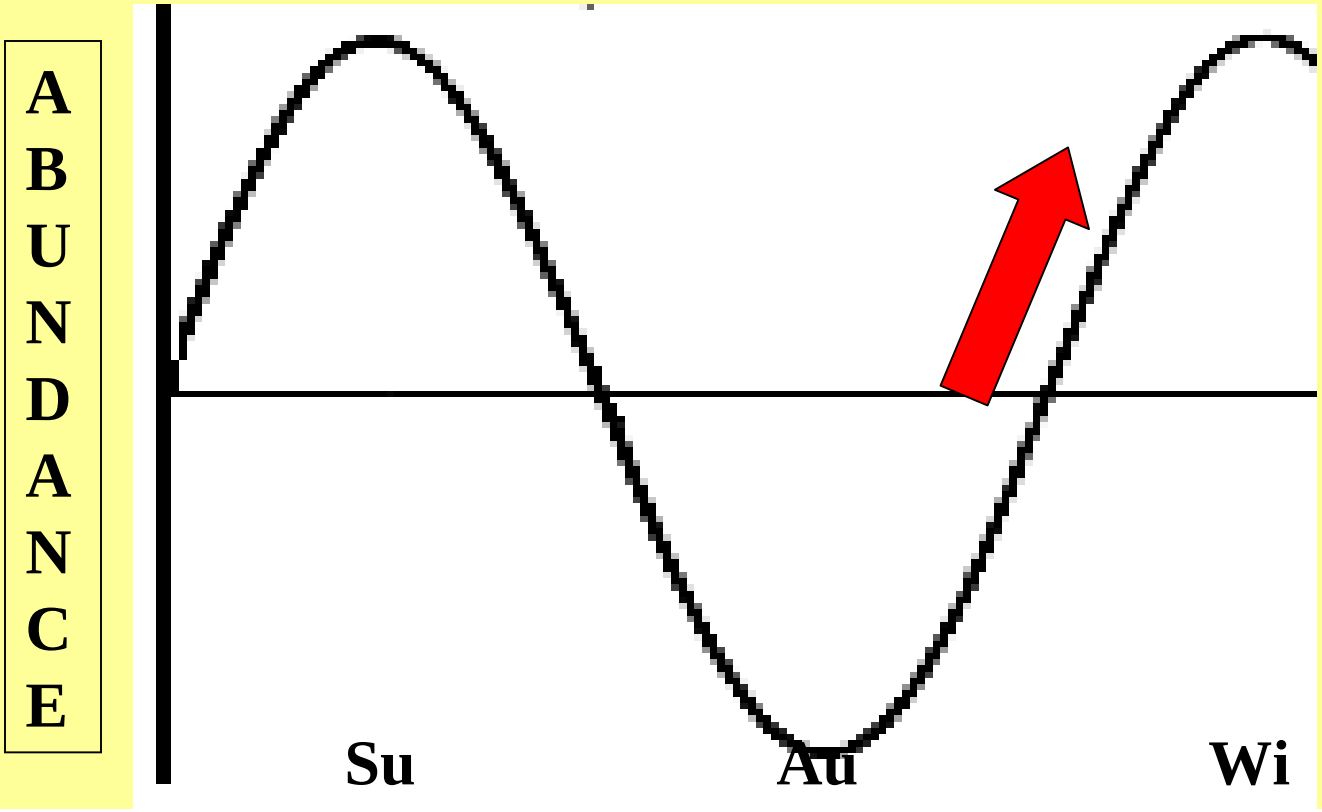
Plankton

By autumn, grazing by zooplankton, nutrient depletion, falling temperatures and shorter days bring plankton levels down



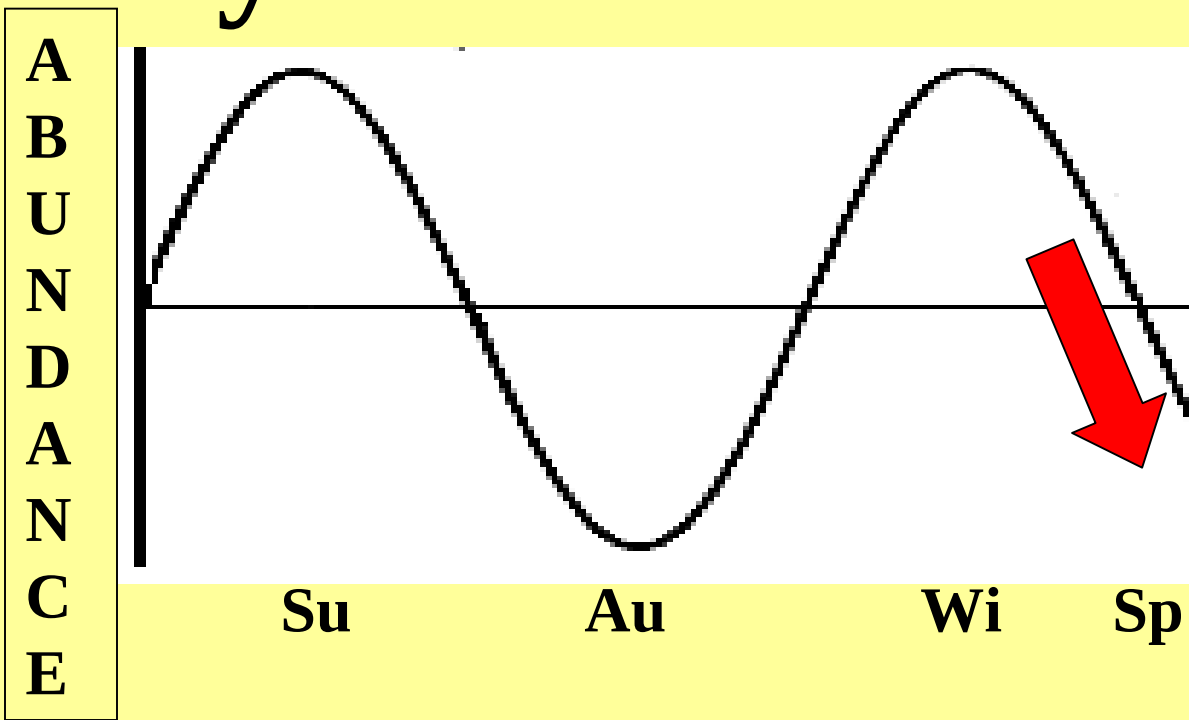
Plankton

Winter brings another peak as diatoms bloom



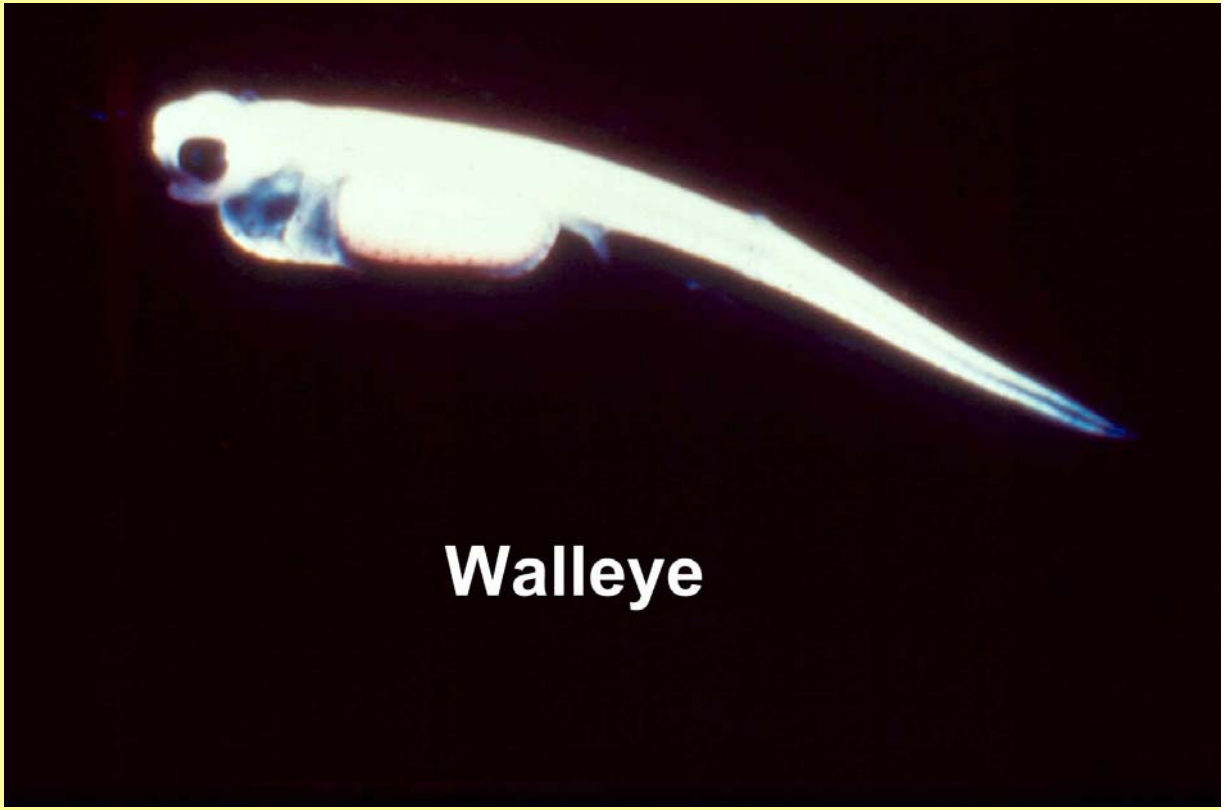
Plankton

As the winter plankton community wanes, spring recharges the cycle with nutrients and sunlight



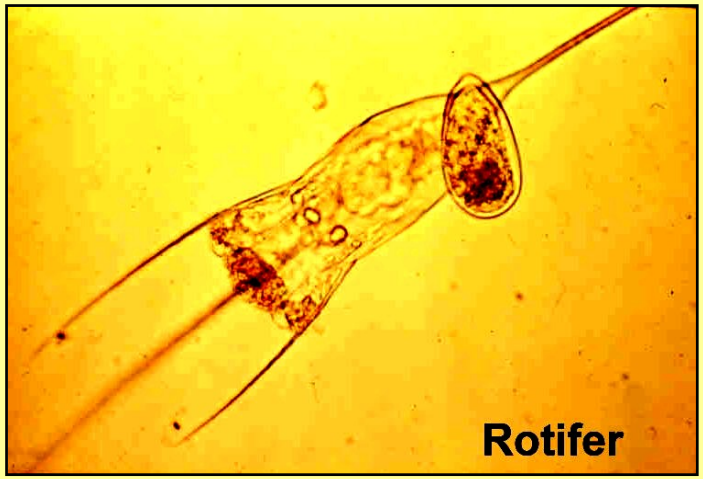
Plankton

All young fish depend upon plankton as their first food after hatching.



Plankton

Tiny zooplankton like rotifers are critical – they must bloom in abundance as larval fish exhaust their yolk sacs and begin to feed



Plankton

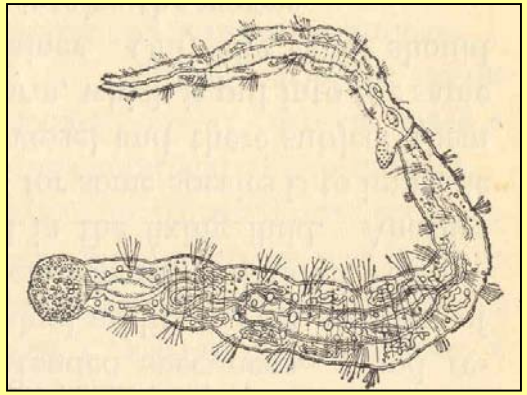
If small zooplankton doesn’t appear in time for the feeding transition a year class of young fish can be lost

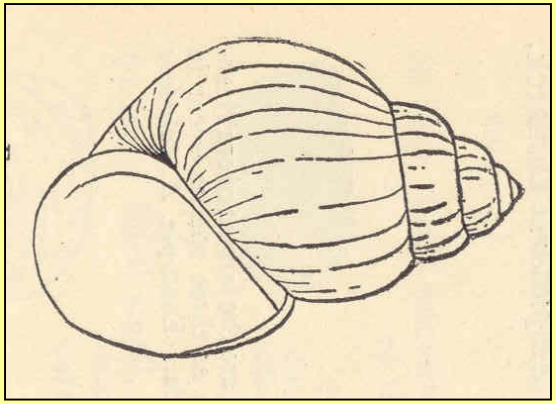
Plankton

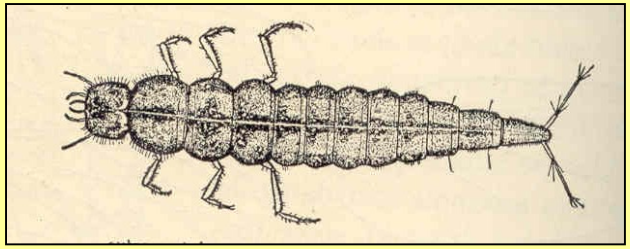
Plankton also supports the forage fish upon which predators feed in later life.

BENTHOS **–**

All the organisms living on the bottom of a lake or stream







Benthos

Benthic organisms are diverse and widely distributed, due to a variety of:

***Feeding requirements**

***Body/behavior adaptations**

***Reproductive modes**

Benthos

Benthos are more affected by environmental changes than plankton and fish because they are less mobile

Benthos

Important groups of benthos include:

***Insect nymphs and larvae**

Mayfly

Benthos

***Scuds (small crustaceans)**

Diporeia

Echinogammarus

Benthos

*Clams and mussels

Forage fish

Most large sport and commercial fish species feed on forage fish

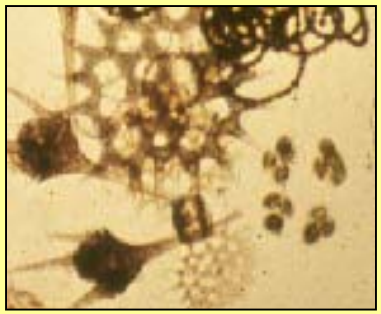
***Concentrated source of protein and fats**

Forage fish

Many predatory fish feed on plankton and benthos in first weeks of life, then switch to forage fish

Forage fish

Forage fish transfer energy and nutrients from plankton to larger species

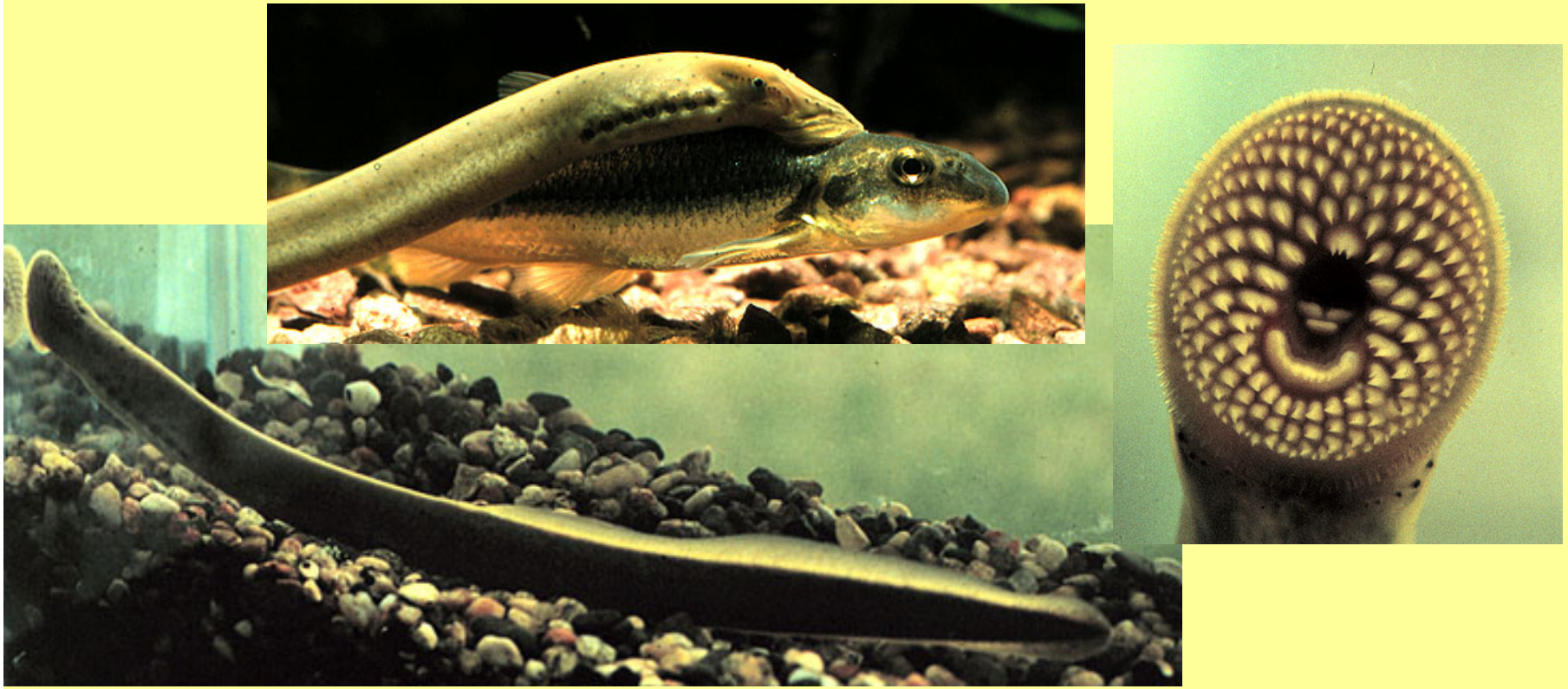


A few more terms…

What's a "species?"

A group of organisms that actually interbreed with each other – but do not interbreed with other such groups

Yellow perch and walleye are different species



Chestnut Lamprey

Ichthyomyzon castaneus

- 1 slightly notched dorsal fin
- Expanded oral disk as wide or wider than head
- Disc teeth large and sharp
- 51-56 trunk myomeres
- Black lateral line organs
- 2-2-2-2 or 2-2-2-2-2 lateral circumoral teeth

Photos courtesy of Konrad Schmidt

Suckermouth Minnow

Phenacobius mirabilis

- Large, fleshy lips on subterminal mouth
- Intense black spot on caudal fin base
- Thin dark stripe along side of body
- Thin dark stripe along back
- Small eyes

Brook Stickleback

Culaea inconstans

- 4-6 short dorsal spines
- Deep, compressed body
- No keel on short caudal peduncle
- Gill membranse joined but free of isthmus

Smallmouth Bass

Micropterus dolomieu

- Bronze specks, often as 8-16 bars on side
- Large mouth with jaw extending under eye
- 69-77 lateral scales
- 13-14 dorsal rays
- 11 anal rays
- Usually no patch of teeth on tongue

POPULATIONS

Groups of the same kind of organisms (species), isolated from the same species in other lakes.

Within a certain fish population, some groups may spawn together and stay somewhat distinct within the lake

These are called individual stocks. Examples:

***Maumee River walleye stock**

*** Bay of Quinte lake trout stock**

A Great Lake will have a:

- **Walleye population**
- **Black crappie population**
- **Alewife population**
- **But not a**

  “fish population”

COMMUNITY

(sometimes called the biotic community):

All the populations occupying a common habitat and interacting with each other

All of the fish populations, plant populations, plankton populations, etc. make up a lake or stream's COMMUNITY

We sometimes speak of individual communities – a lake's

- **Fish community**
- **Plant community**
- **Invertebrate community, etc.**

All of these combine into the lake's

Aquatic community

Great Lakes Fisheries Leadership Institute

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“Take a Kid Fishing”

Aquatic biology curriculum produced by Fred L. Snyder, Ohio Sea Grant College Program