

Limnology

An Introduction



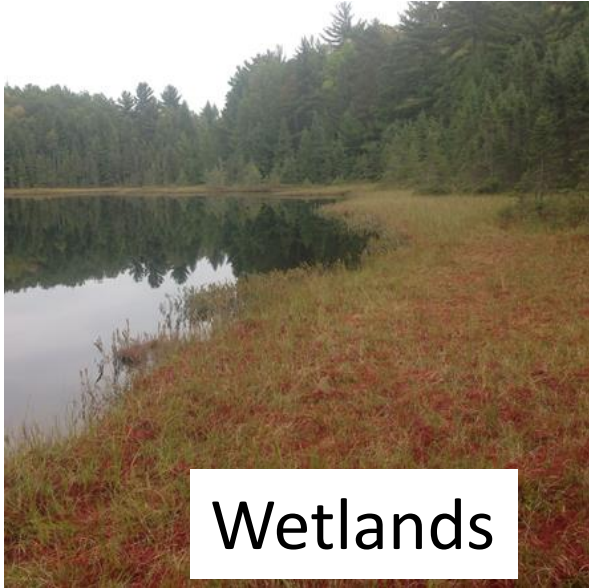
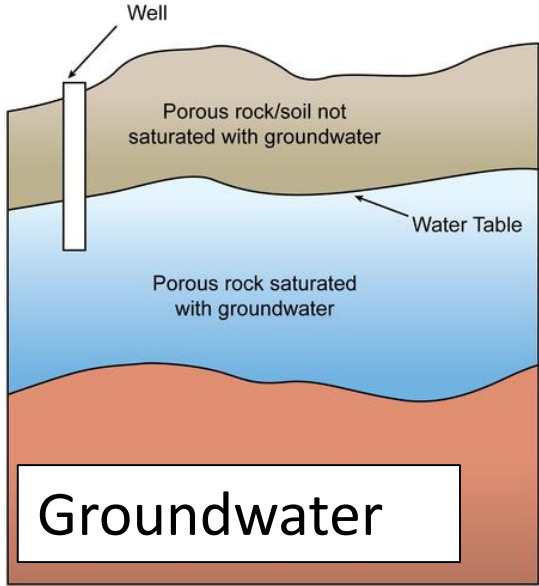
Susan Knight
April 2019



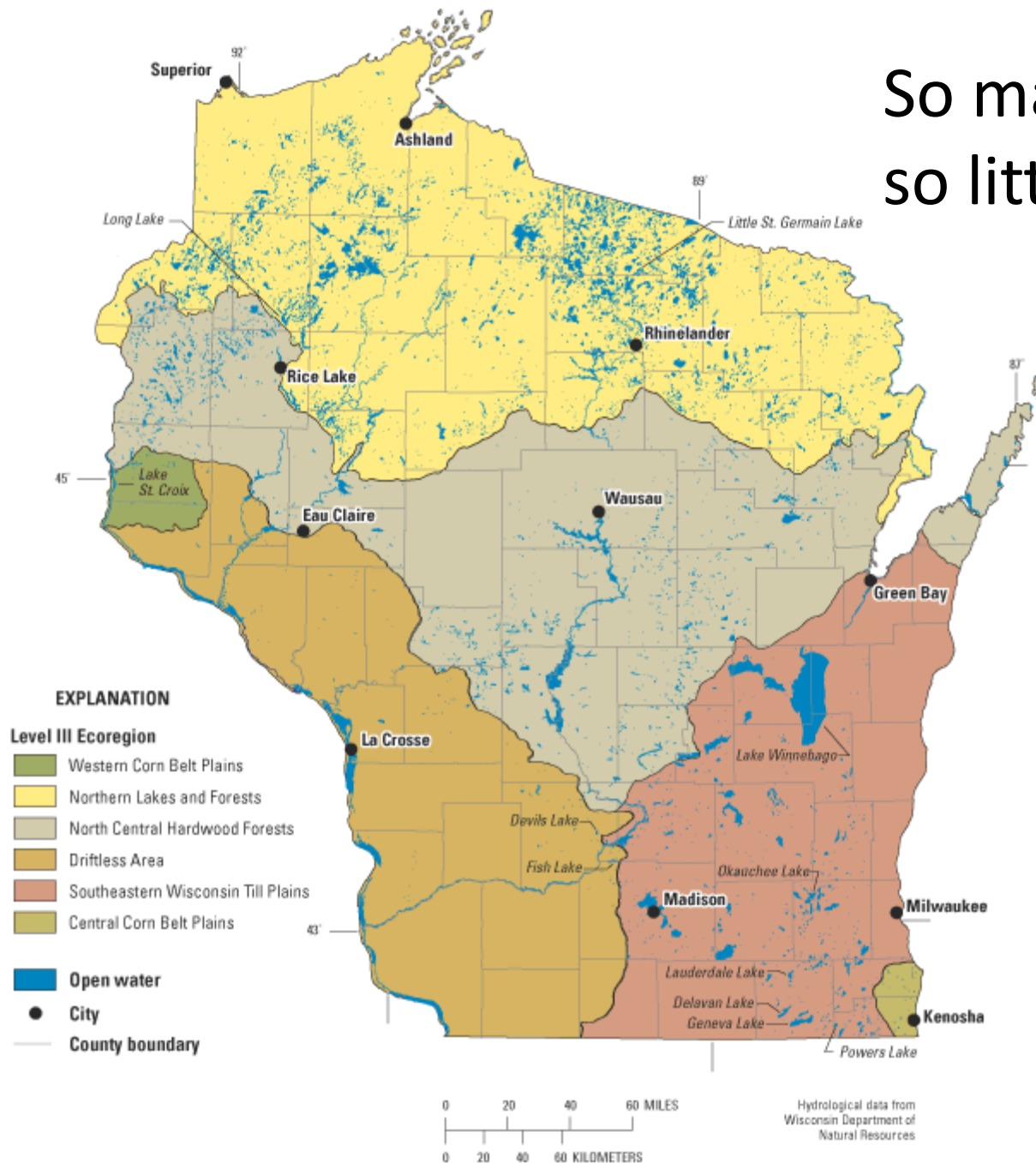
Physics

Chemistry

Biology

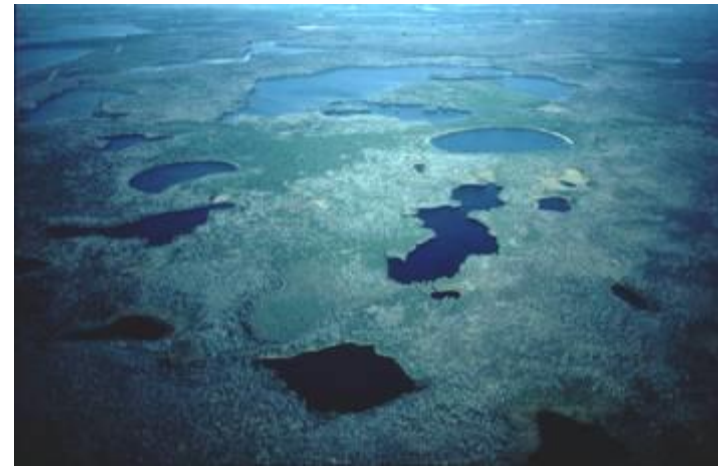


So many lakes,
so little time

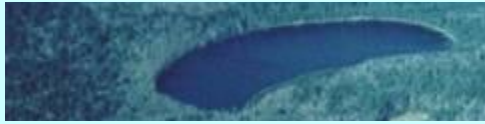


Why do Neighboring Lakes Differ?

- Lake Area: tiny to >3000 acres
- Chemistry
 - Landscape position
 - Nutrients, especially phosphorus
 - Susceptible to Acidification
- Color: Blue, Green, and Brown
- Water Clarity: Clear to Not Clear
- Boat Use: Crowded to Uncrowded
- Number of Fish Species: 0 to 37

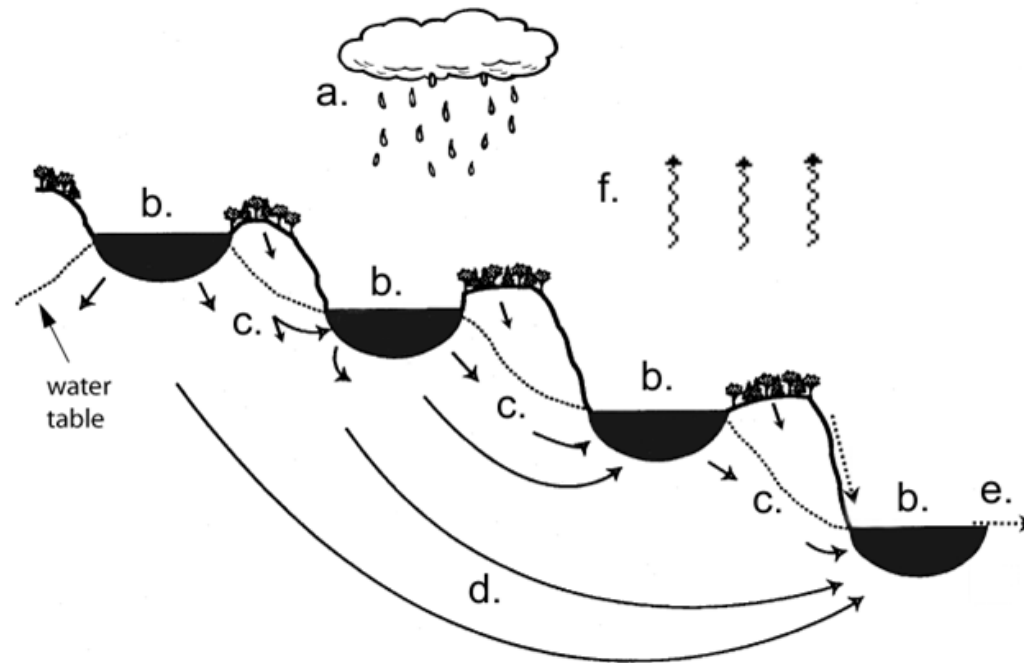
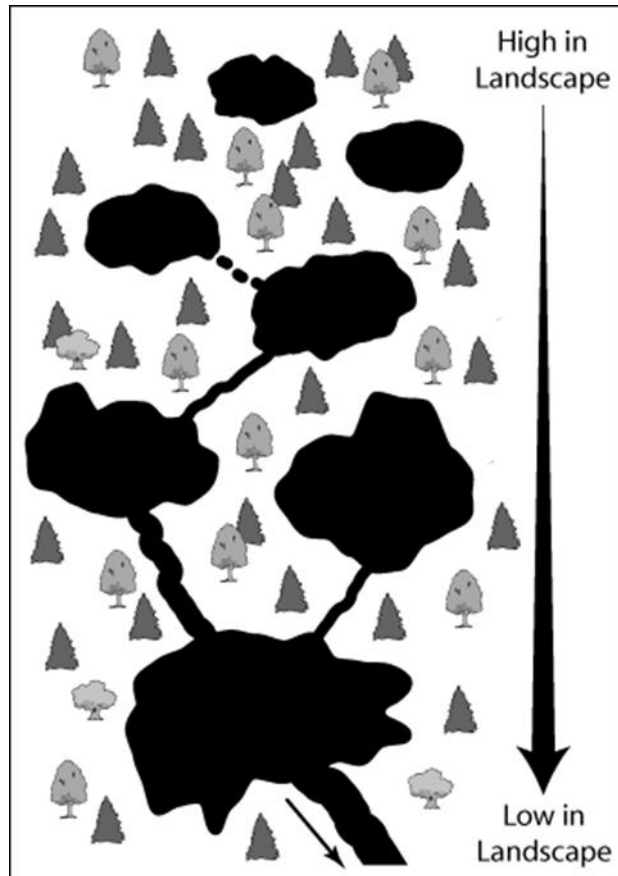


Individual Lake vs



Where does the water come from?

Balance of precipitation, groundwater and stream inputs matters to lake physics, chemistry, biology



Important elements and compounds...



- Oxygen
- Phosphorus
- Nitrogen
- Alkalinity
- Conductance
- pH (acidity)
- **Water** (especially odd)

**...are inextricably linked to
biological processes**

- Primary Productivity:
Growth of phytoplankton
and plants
- Zooplankton,
Invertebrates
- Forage Fish
- Large Fish



Nutrients in lakes

Phosphorus

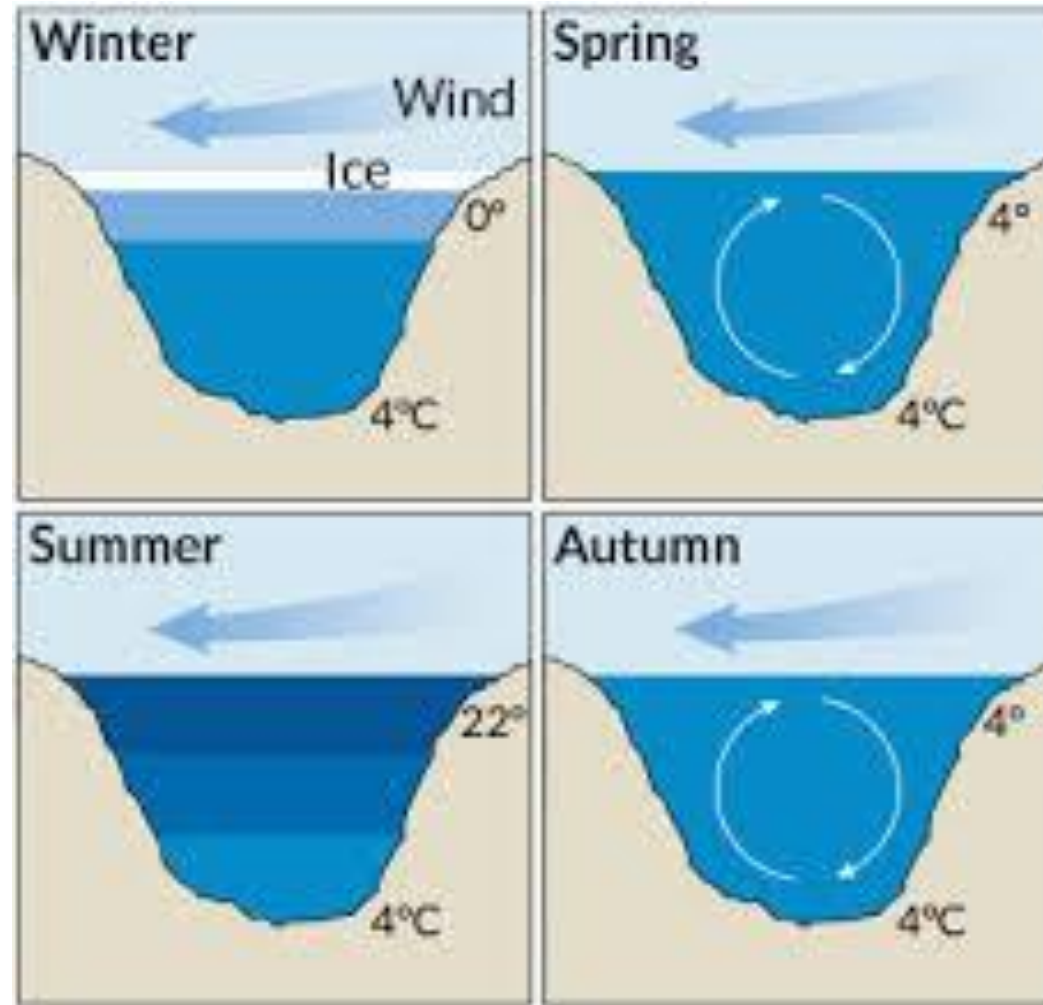
- Most often the limiting nutrient in lakes
- More P often means more algae
- More algae often means greener water
- Greener water often means impaired water

Nitrogen

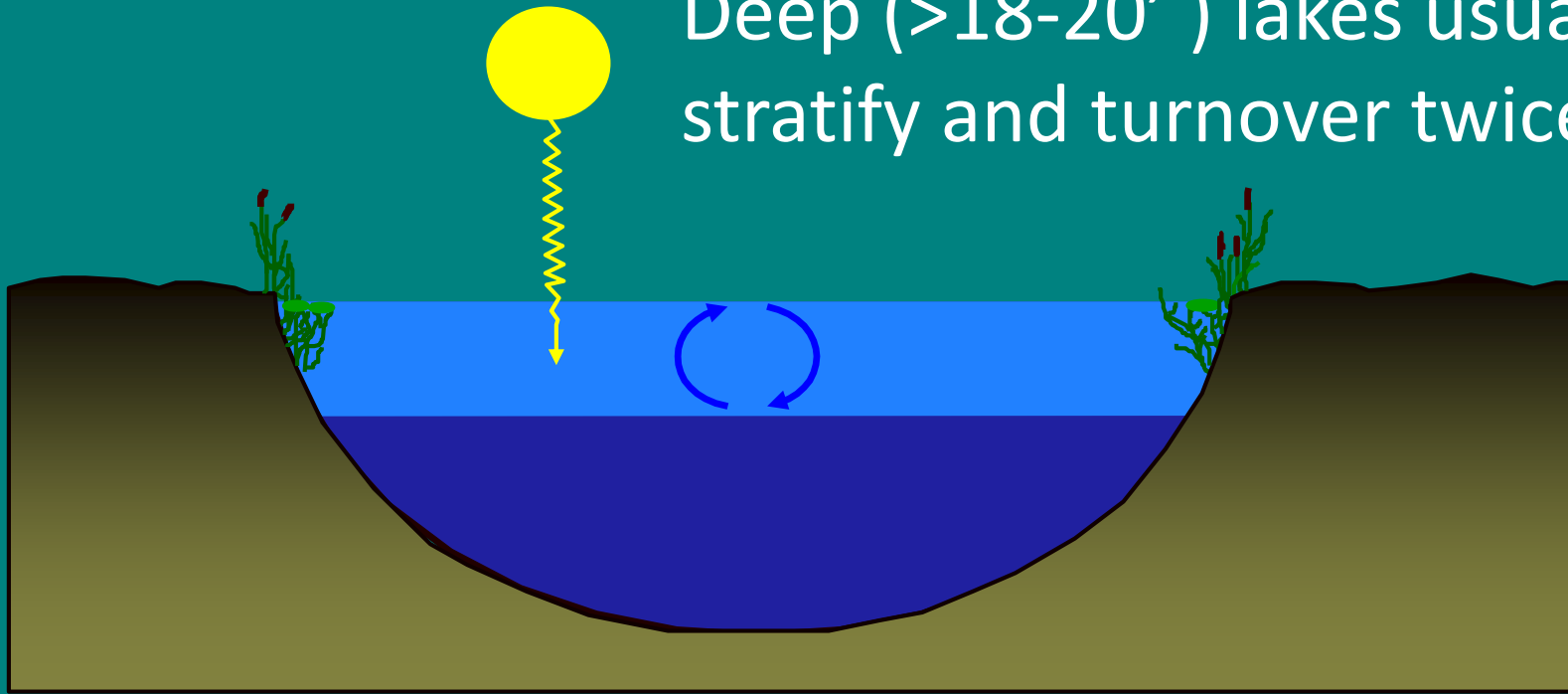
- Lakes less often N limited
- Some cyanobacteria can fix N, making it available for uptake by algae and other primary producers
- In lakes with plenty of P, may get N-fixing cyanobacteria (blue-green) blooms

Stratification

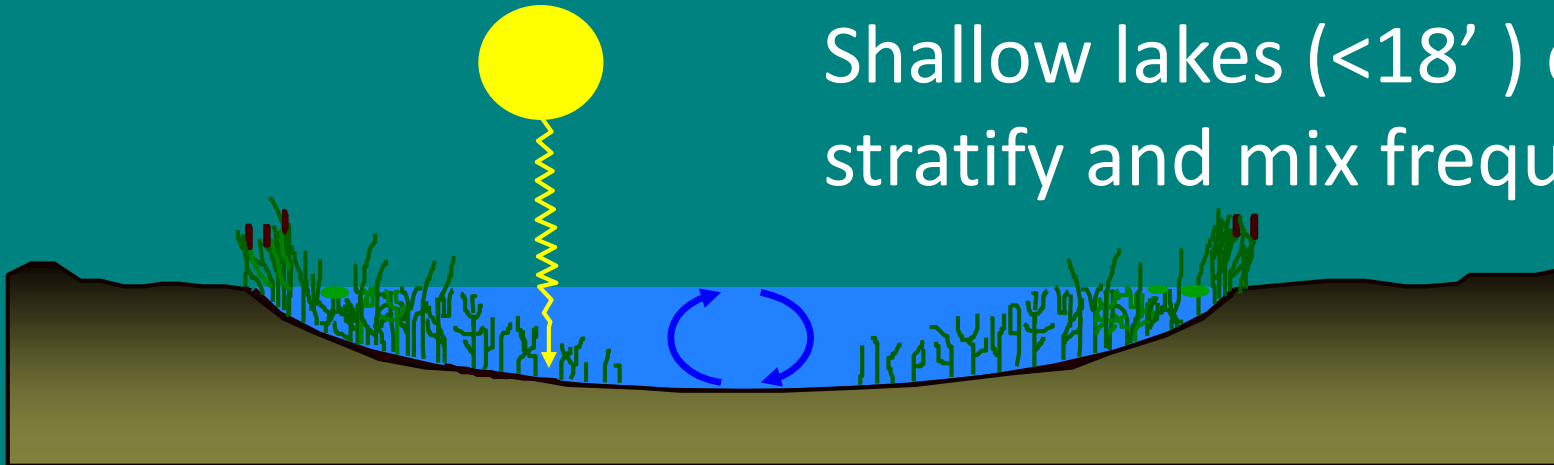
Deep lakes form layers of different temperatures, densities in summer and winter



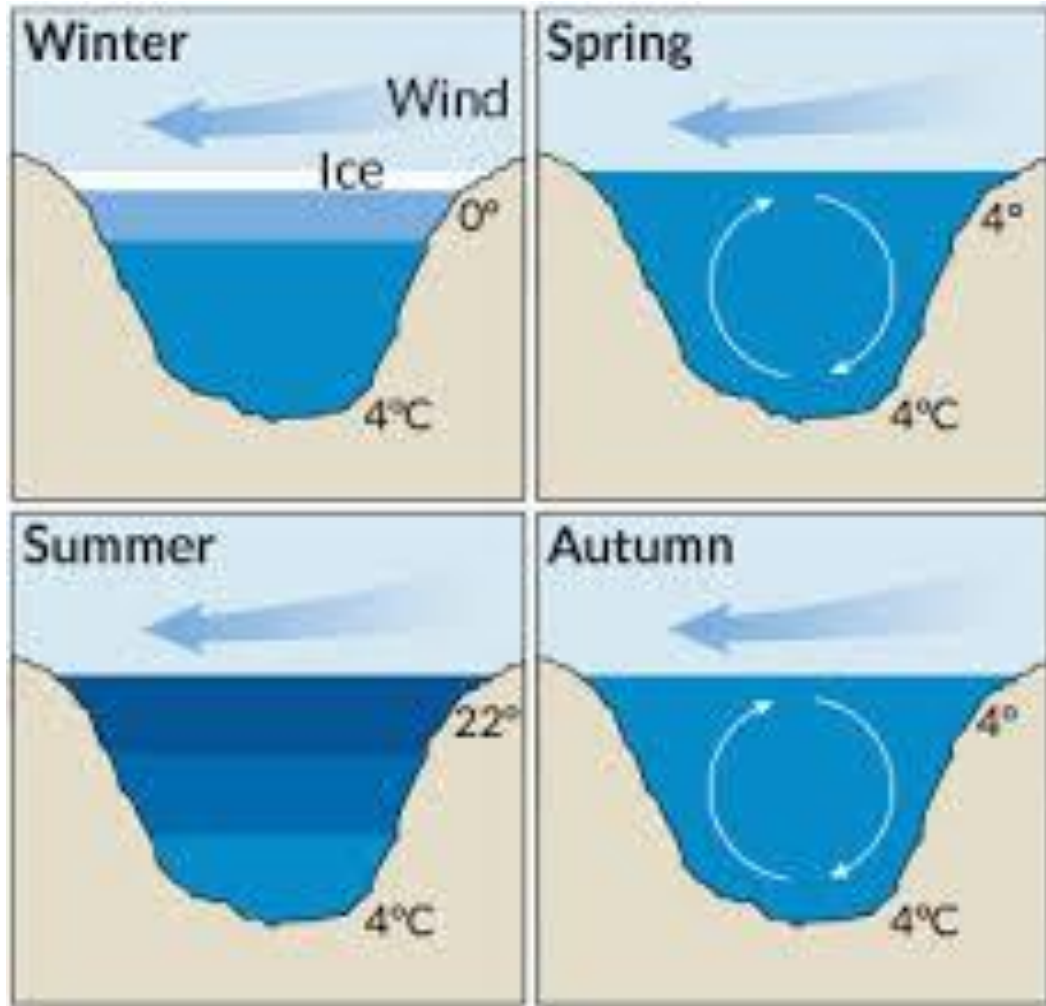
Deep (>18-20') lakes usually stratify and turnover twice a year



Shallow lakes (<18') do not stratify and mix frequently



...More on stratification and phosphorus



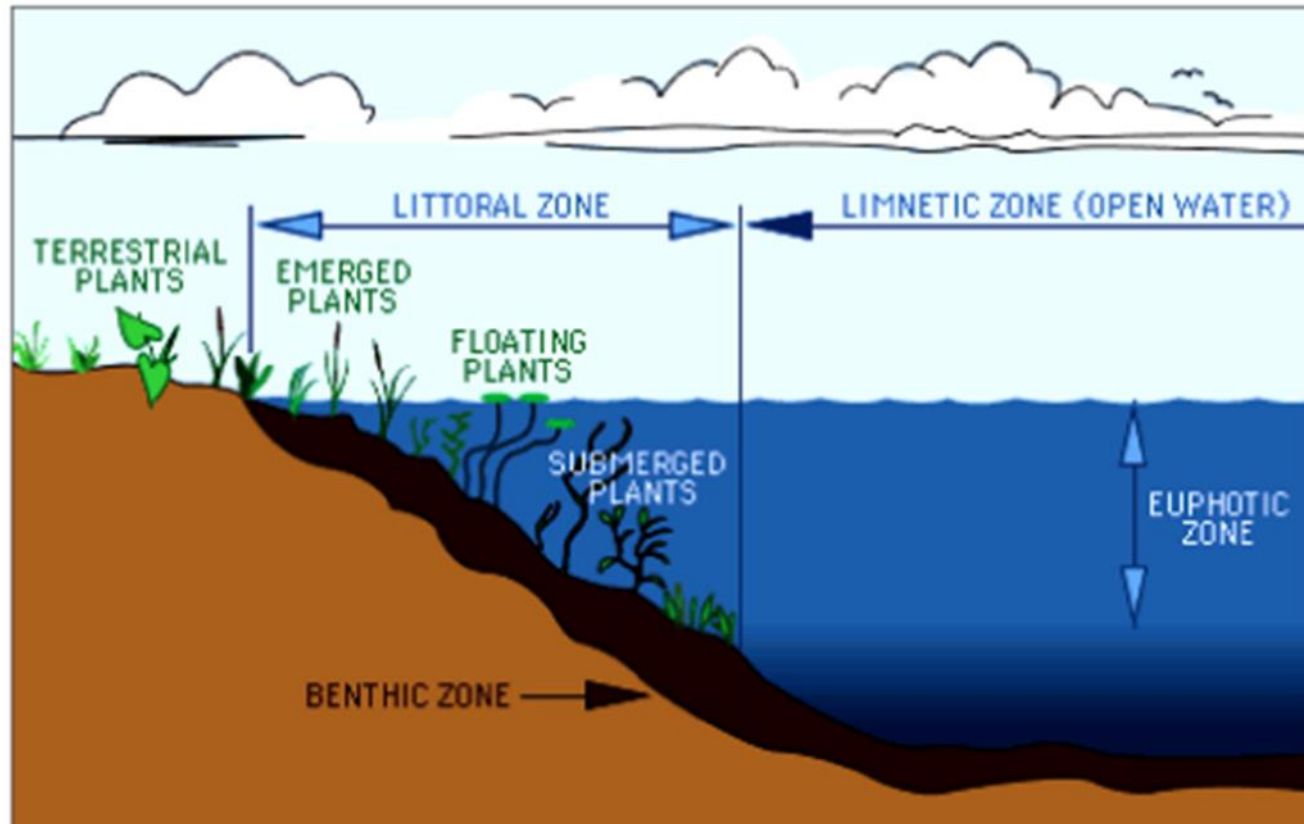
1. There may be no oxygen at the bottom of a lake in late summer.
2. When there is no oxygen, the phosphorus is not bound to iron, and the phosphorus is free for uptake.
3. When a stratified lake turns over in spring and fall, phosphorus-rich and oxygen-poor water at the bottom circulates and may cause algal blooms (**internal loading**).
4. Shallow lakes mix frequently, and have a different phosphorus dynamic than deep lakes.

Lake zones

Littoral zone – area where plants are growing, shallow water

Benthic zone – bottom

Pelagic area – deep or open water (limnetic zone)



Littoral Zone



Wood, plants, and algae in the littoral zone are very important to the lake ecosystem.

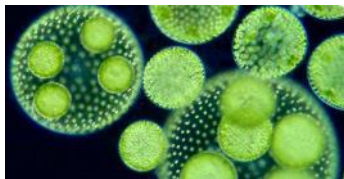


Food Webs

- Photosynthesis = 1^o production
 $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{Sugar} + \text{O}_2$
- Photosynthesis by algae, plants
- Zooplankton eat algae
- Small fish eat zooplankton
- Large fish eat smaller fish
- Larger fish eaters eat large fish

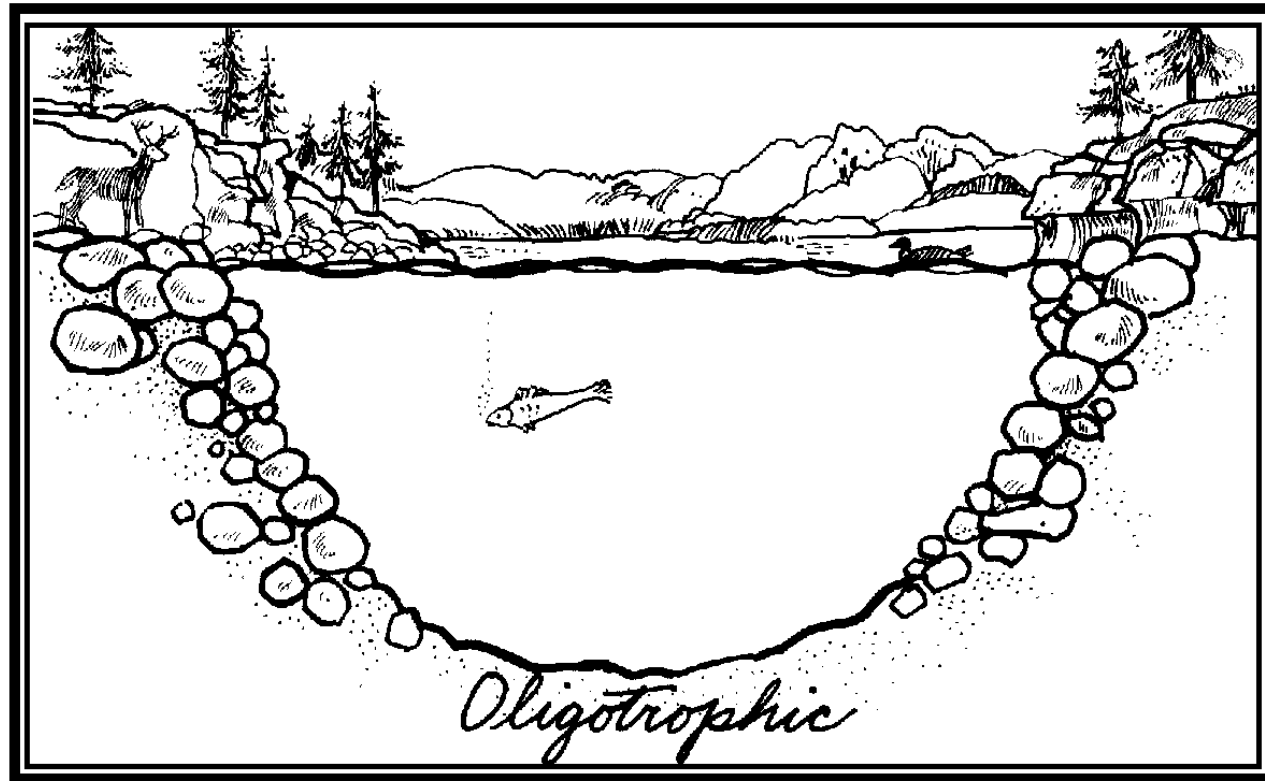


Trophic Cascade

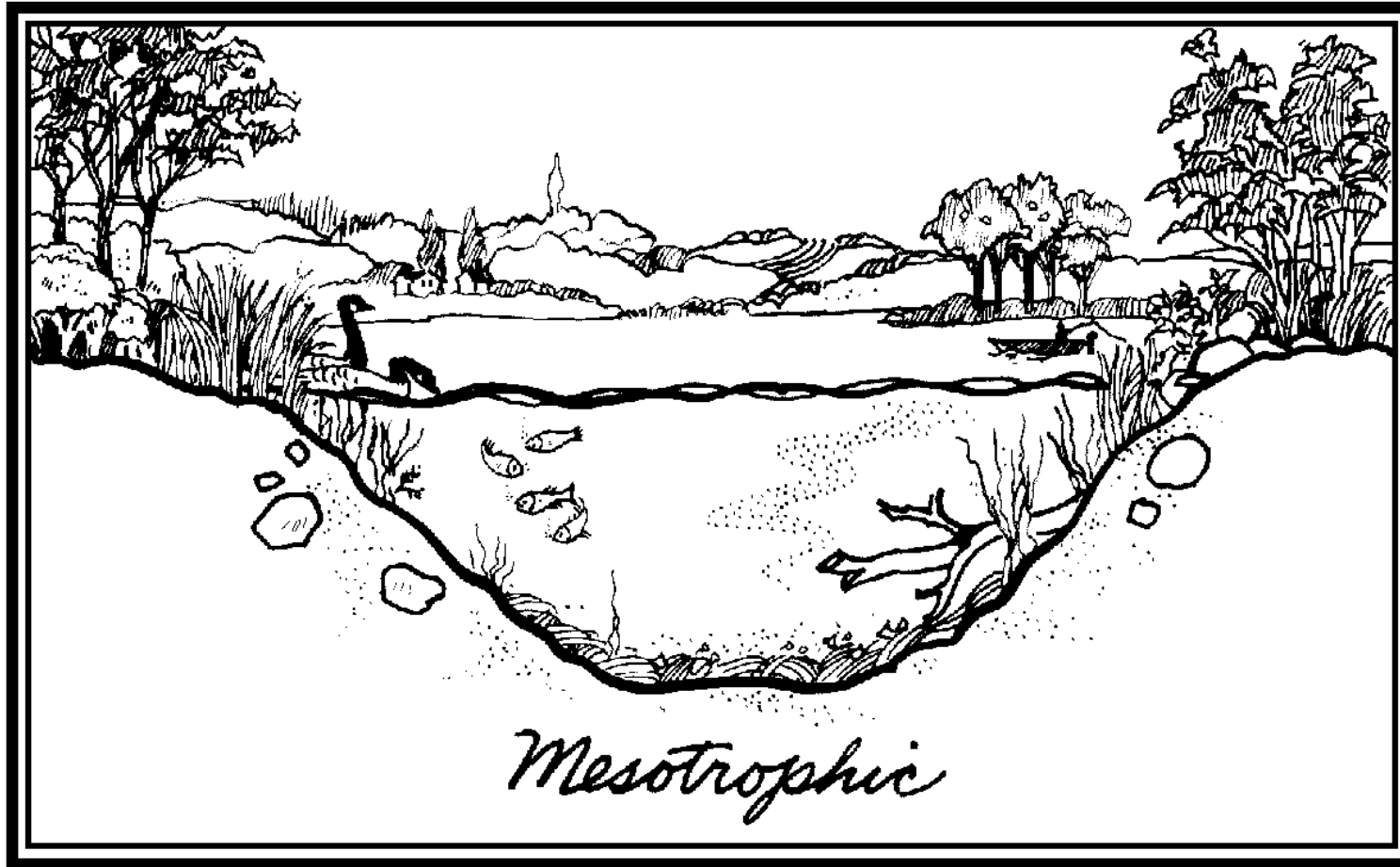


Trophic state

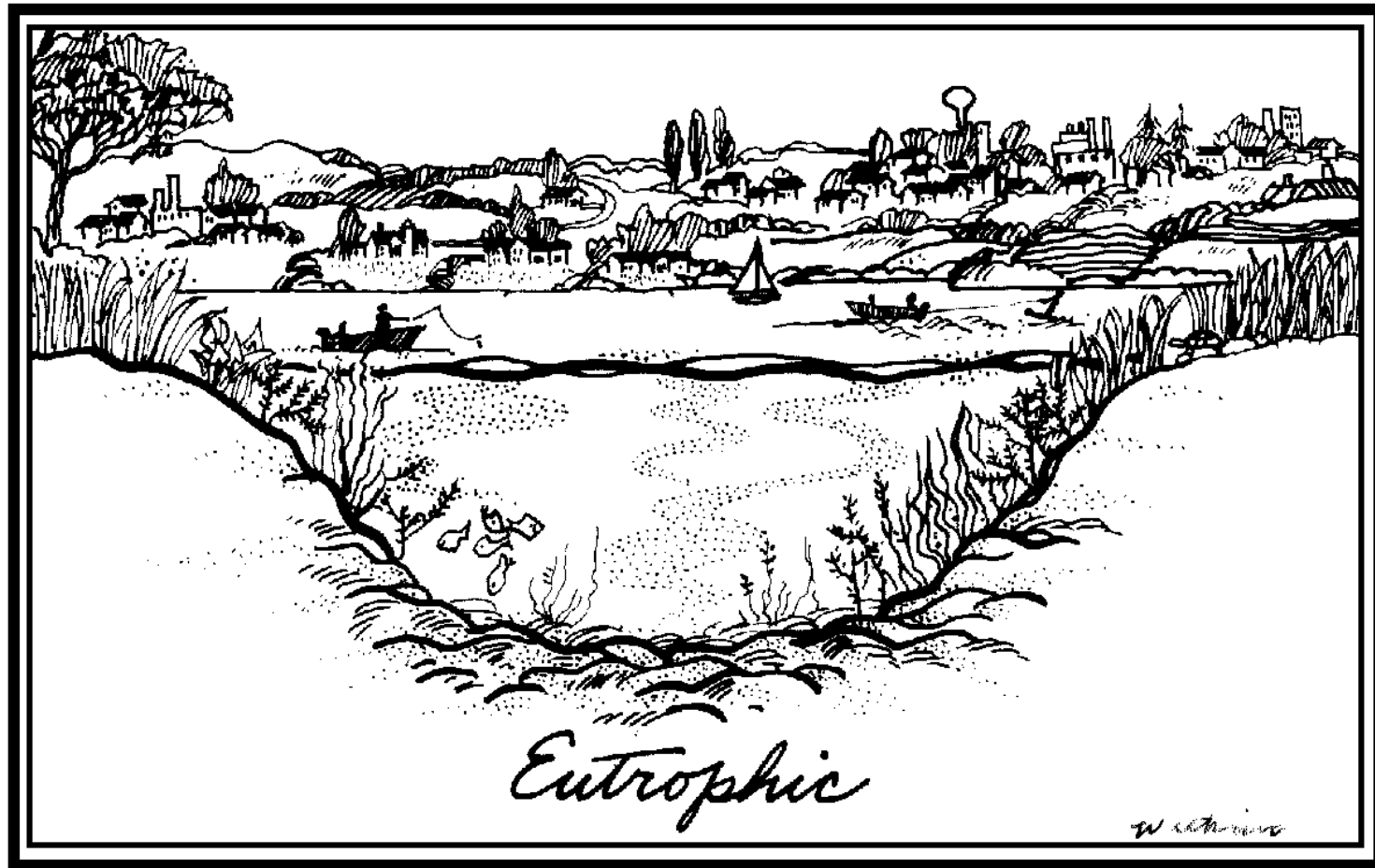
Describes productivity



Trophic state



Trophic state



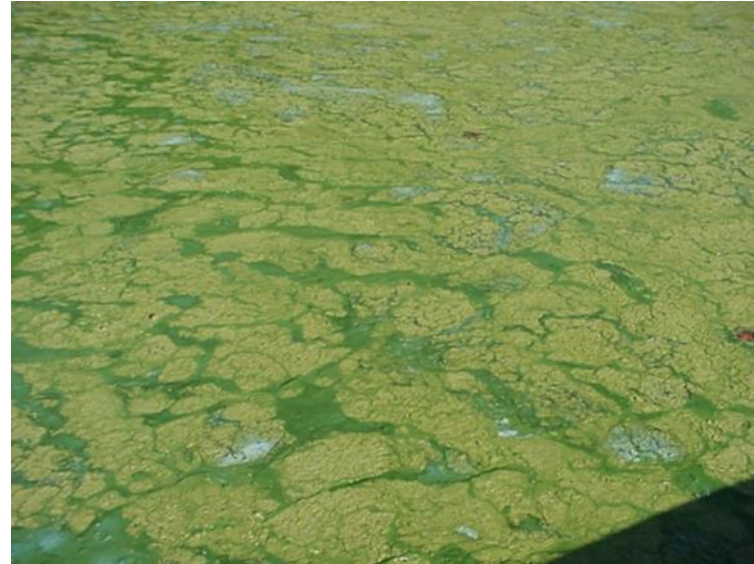
A few important lake issues

- Human-caused Eutrophication
- Invasive Species
- Climate Change
- Shoreland Destruction
- Pollution
- Lake level changes



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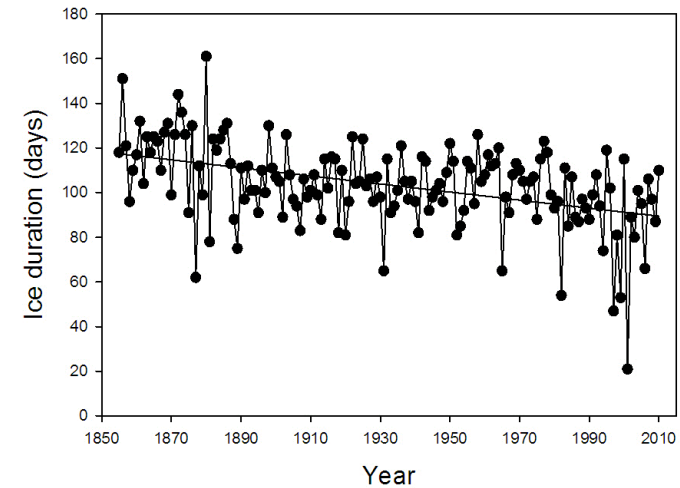
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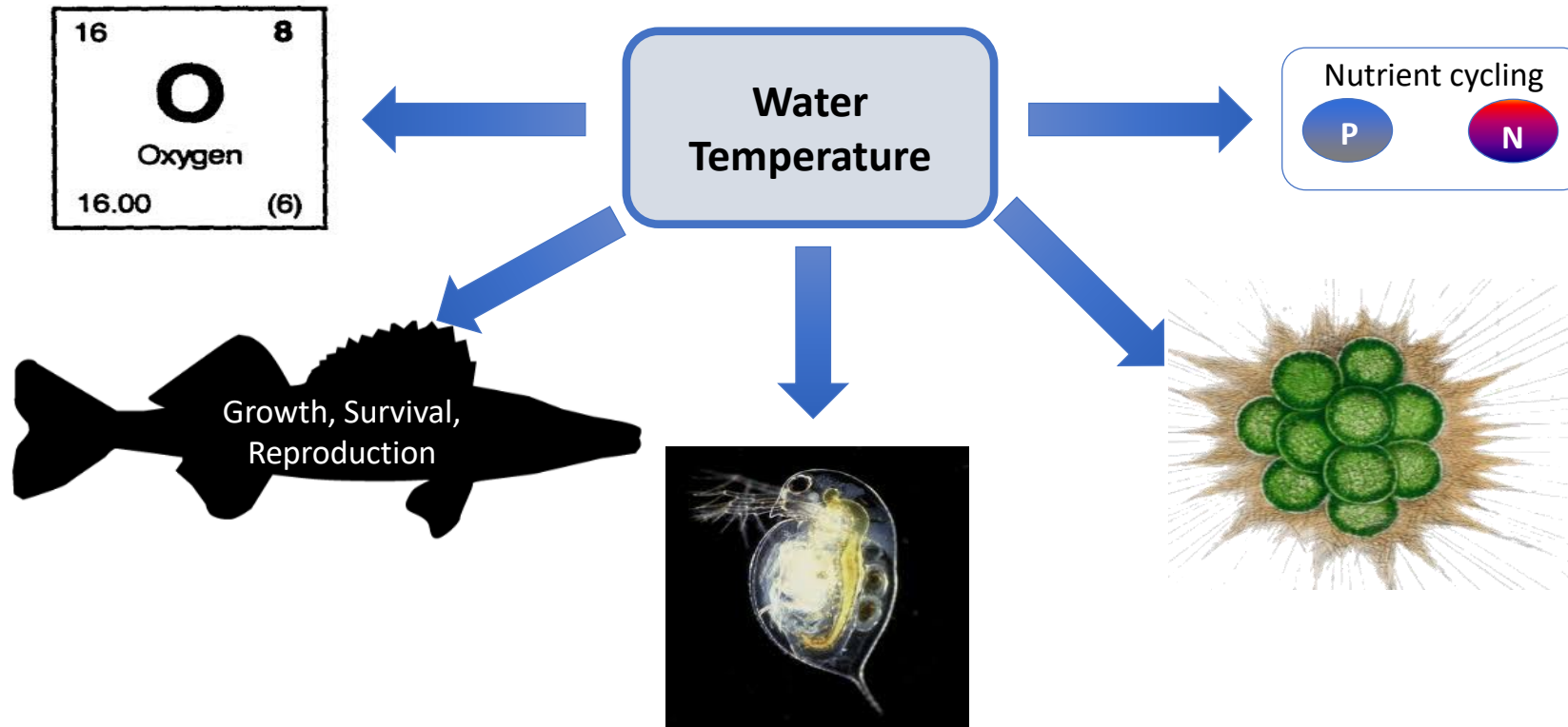
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Why is Climate Change Important in Lakes?

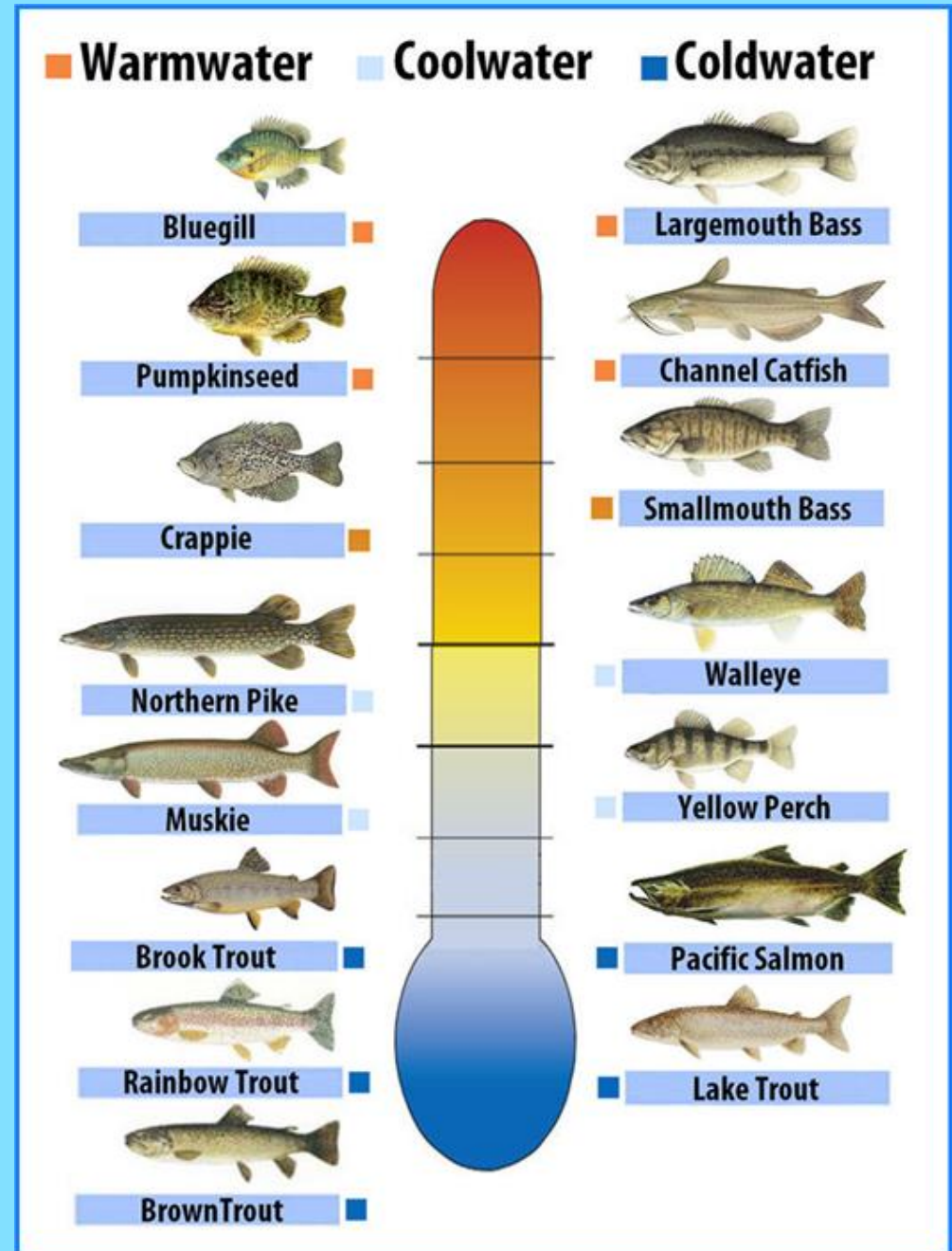
Temperature is an ecological “master factor”



Temperature is vitally important for fish

Species 'thermal niche'

Determines metabolic and other rates



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- Pollution
- **Lake level changes**
 - Natural cycles
 - Climate change causes





Questions?