

# Water and Winter

How our seasons and the  
properties of H<sub>2</sub>O shape life in  
Michigan's lakes

Raffica La Rosa and Anne Royer

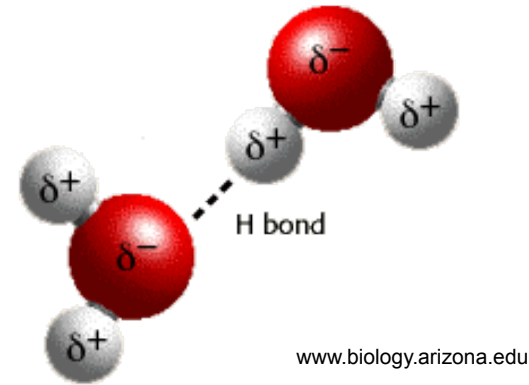
# Water is important!

- Covers 71% of the earth's surface
- Human body is ~75% H<sub>2</sub>O
- 0.6% of world's H<sub>2</sub>O is in land surface water

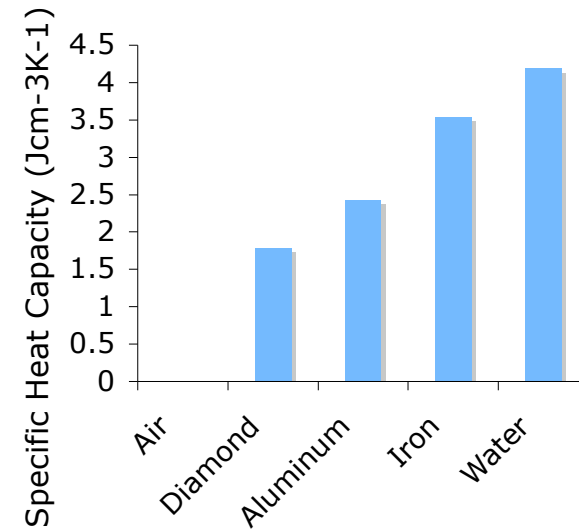


# Unique chemical properties of H<sub>2</sub>O

- Hydrogen bonding:  
high internal  
cohesion

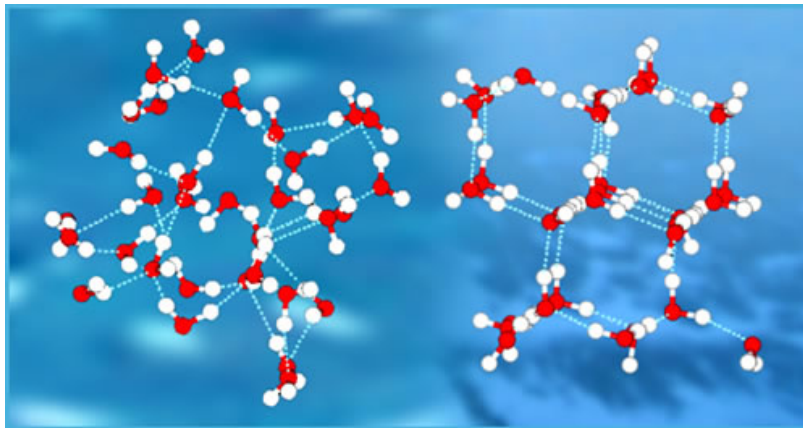


- High heat capacity:  
water acts as a  
buffer



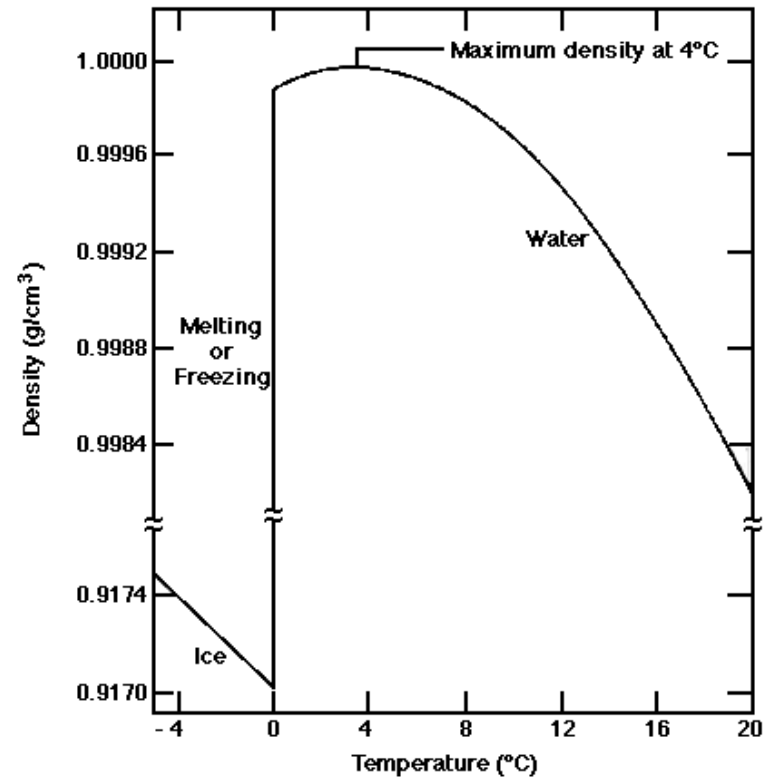
# Unique chemical properties of H<sub>2</sub>O

Density of liquid water is higher than density of ice



[www.lbl.gov](http://www.lbl.gov)

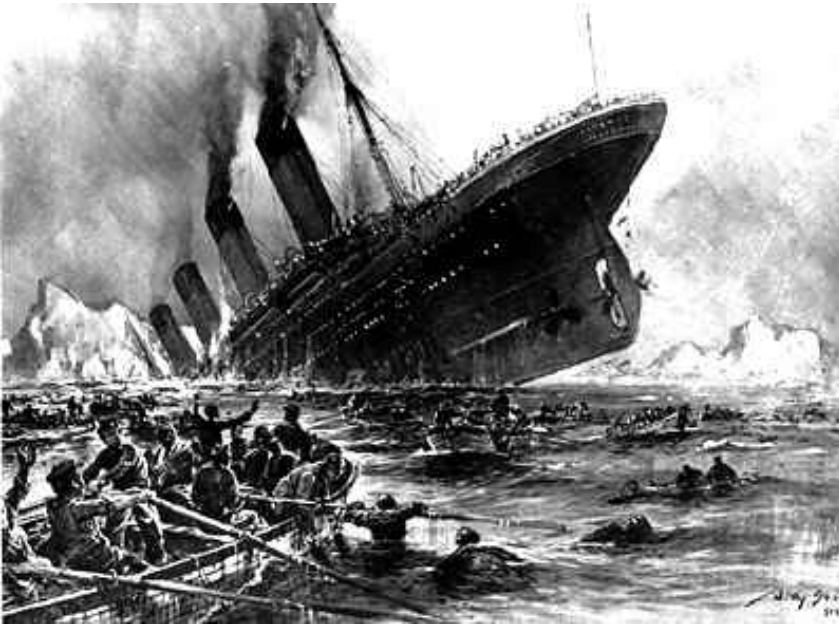
ICE FLOATS!



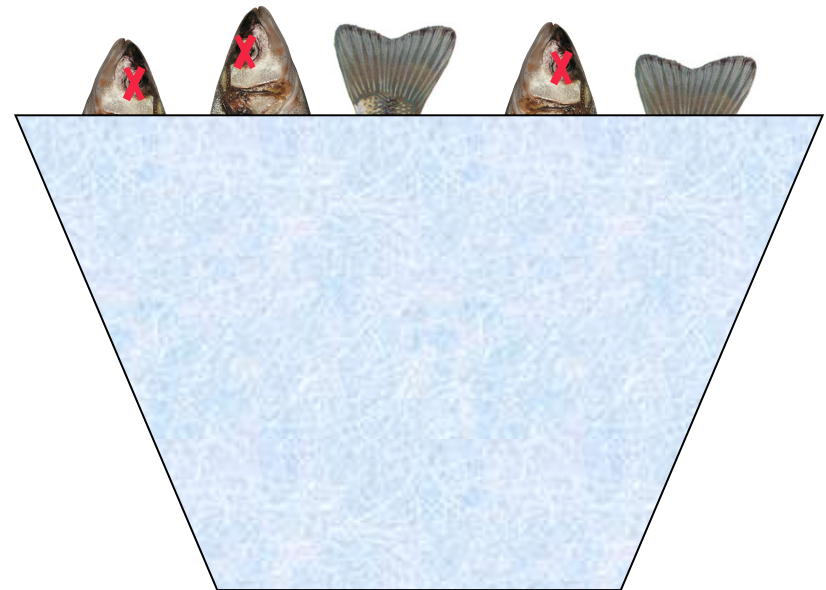
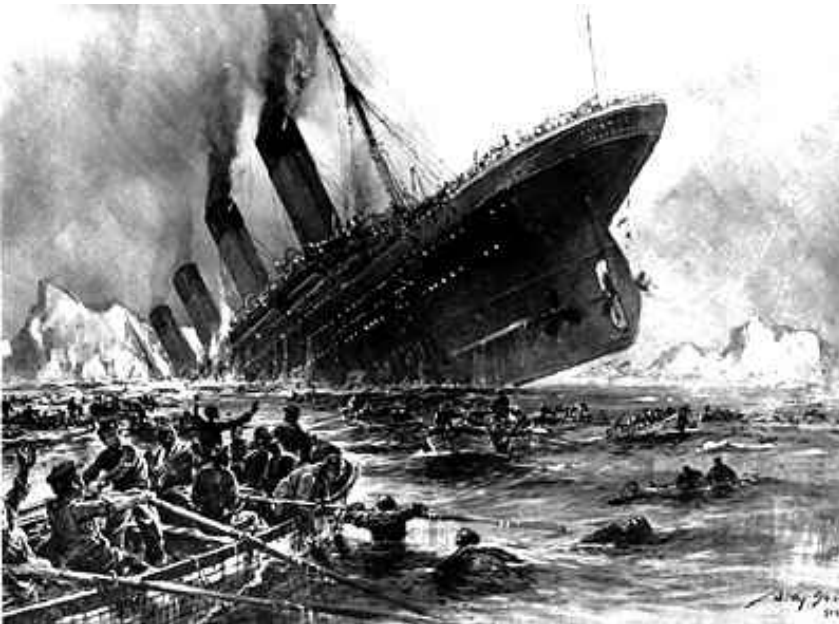
Density of water (and ice) as a function of temperature. Note maximum density of water at 4°C. (Data from Pauling 1953 and Hutchinson 1957: 204.)

What if ice was more  
dense than water?

What if ice was more dense than water?



# What if ice was more dense than water?



# Review: Ecologically significant properties of water

- High internal cohesion (H-bonds)
- Density of liquid is higher than density of solid
- Highest density at 4°C (freezing at 0°C)
- High heat capacity

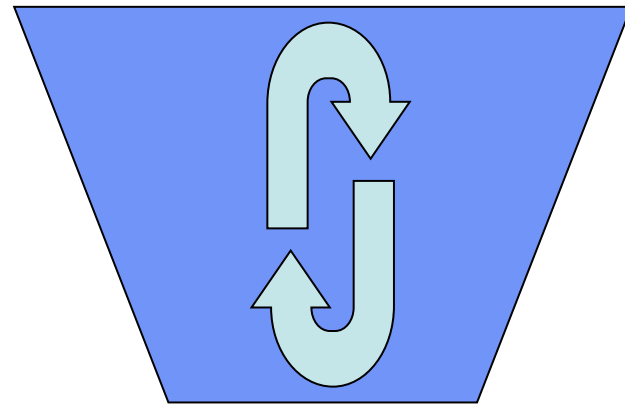


# What is turnover?

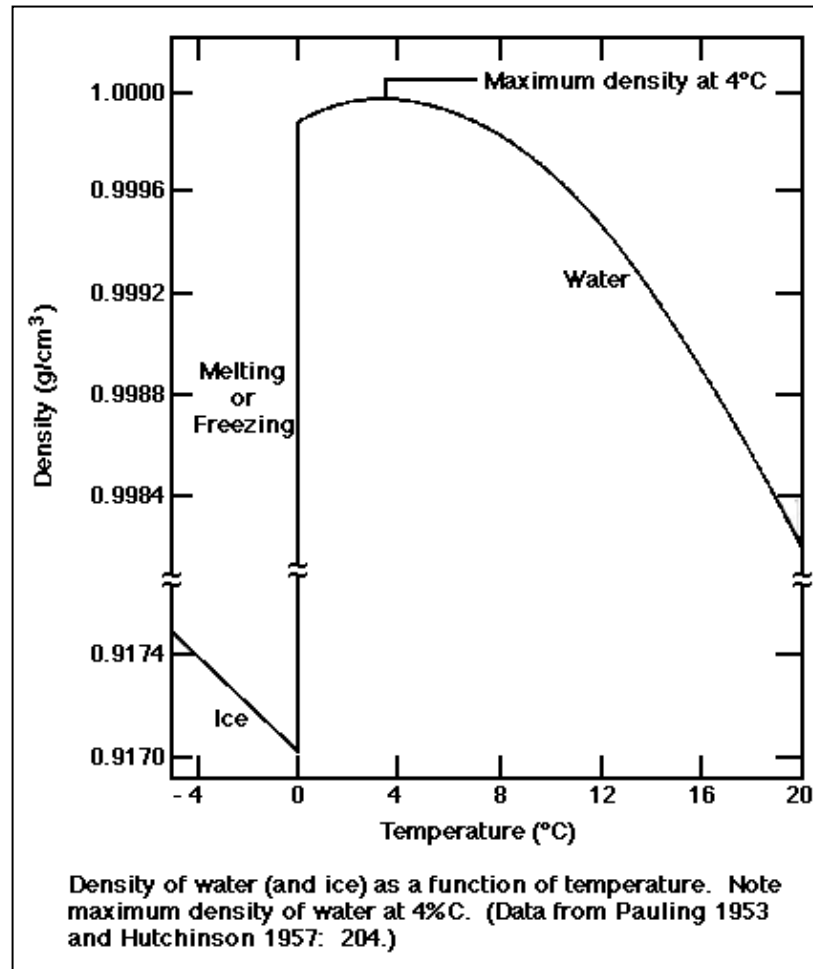
Movement of water from the top of the lake to the bottom and vice versa.

This results from:

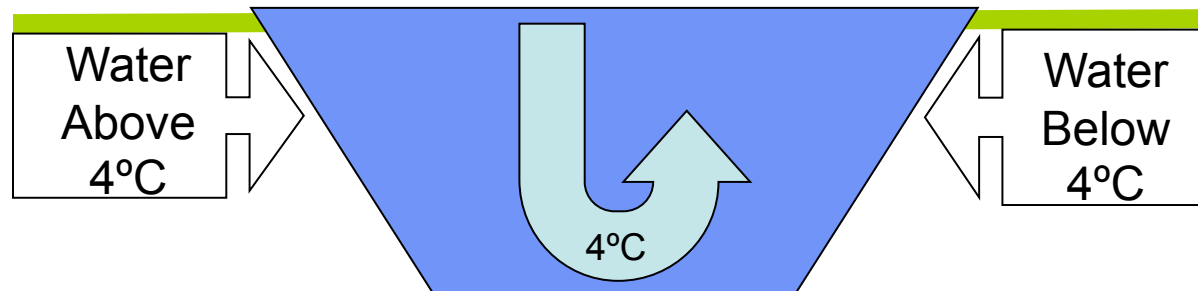
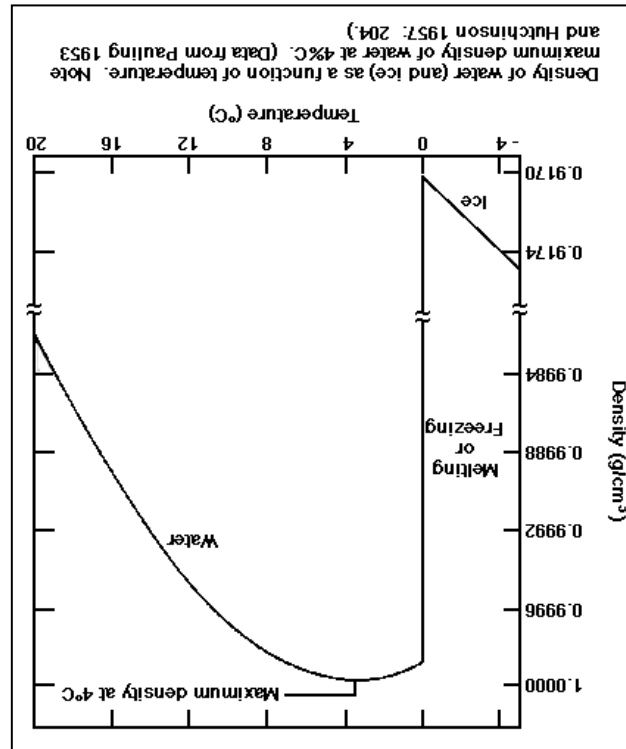
- Changing densities
- Wind



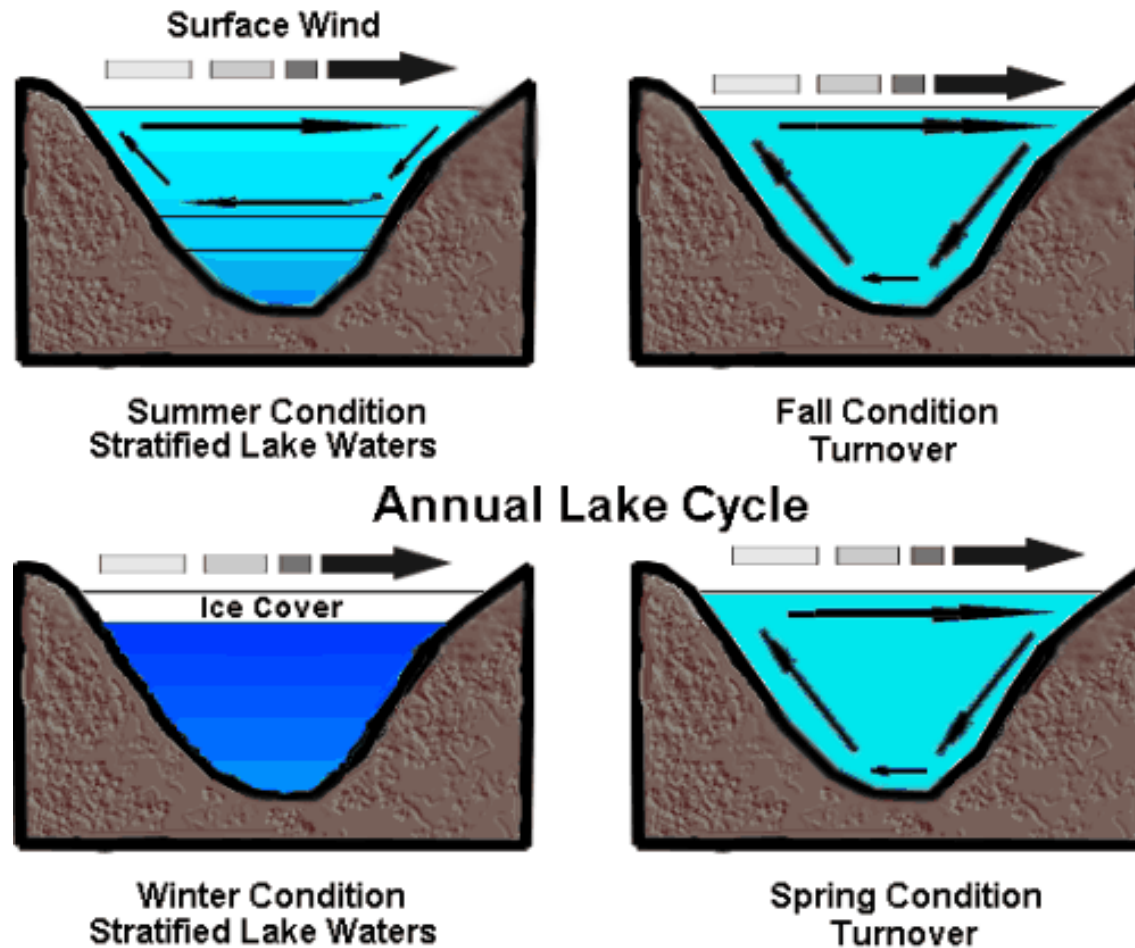
# The Density of Water



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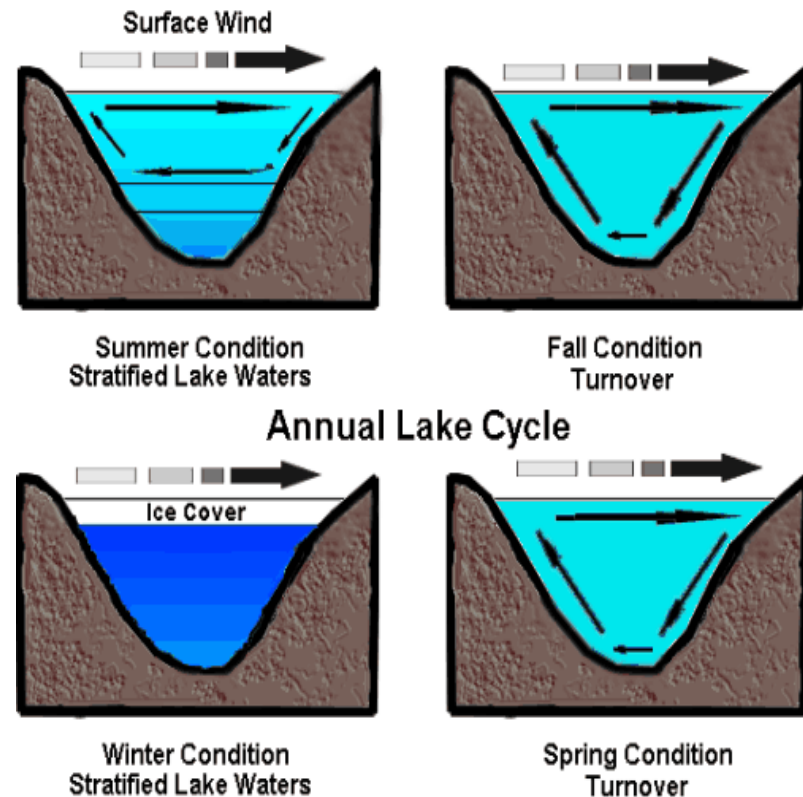


# Spring and Fall Turnover



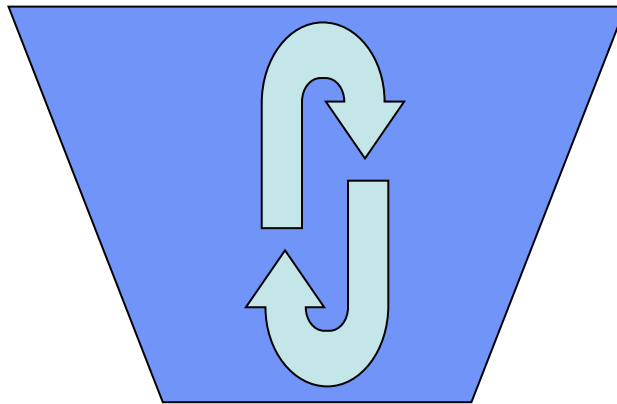
# Temperature Profile

- During spring and fall turnover, the lake becomes mixed and the temperature is uniform
- In the summer, the lake is stratified (divided into layers) with the warmest water on top
- In the winter, the lake is also stratified, but only from about  $0^{\circ}$  to  $4^{\circ}$  with the warmer water on the bottom



# What good is turnover??

- Why would mixing water from the top and bottom of the lake be good?



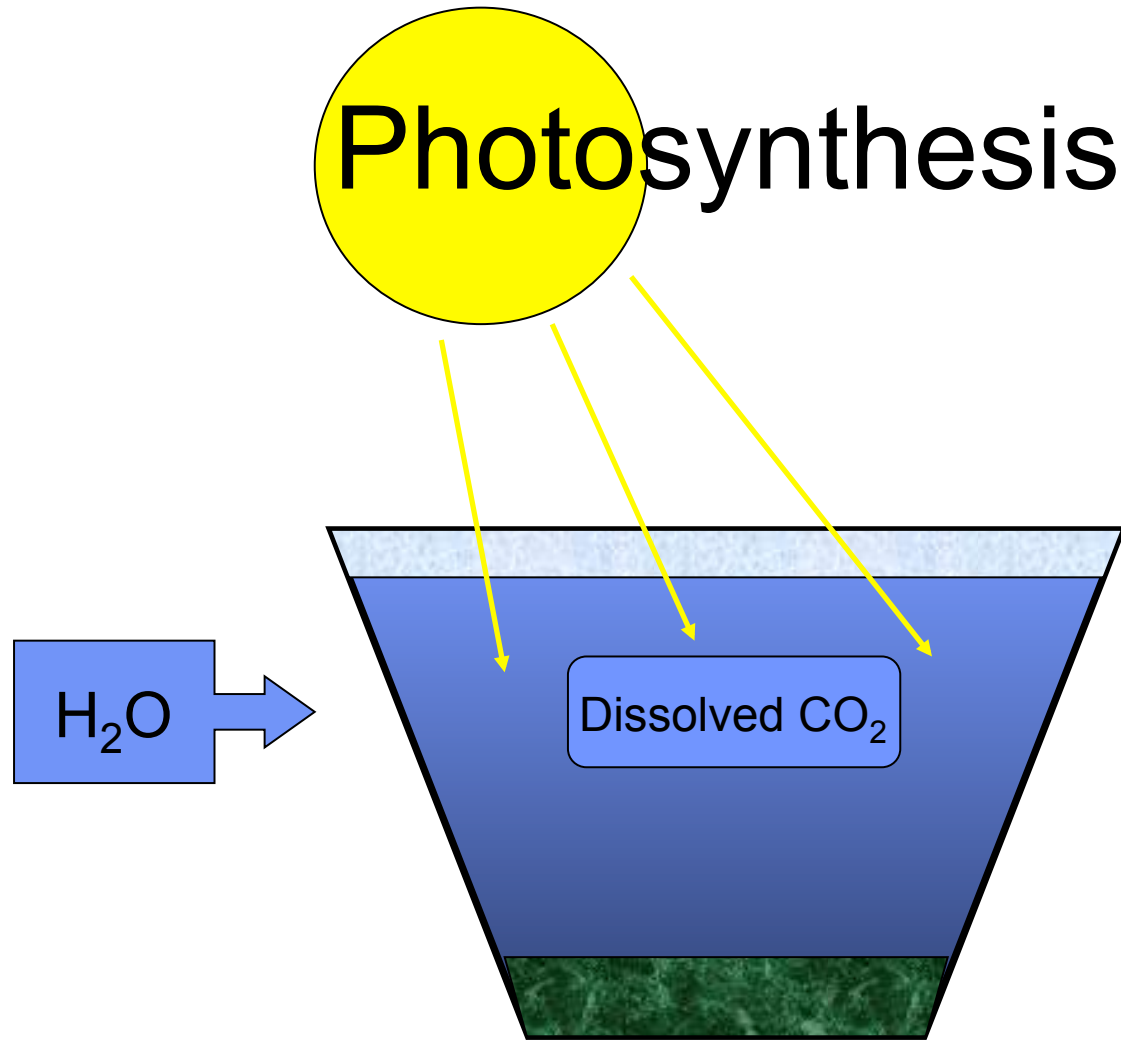
# Nutrient Cycling



Eugene Zelenko

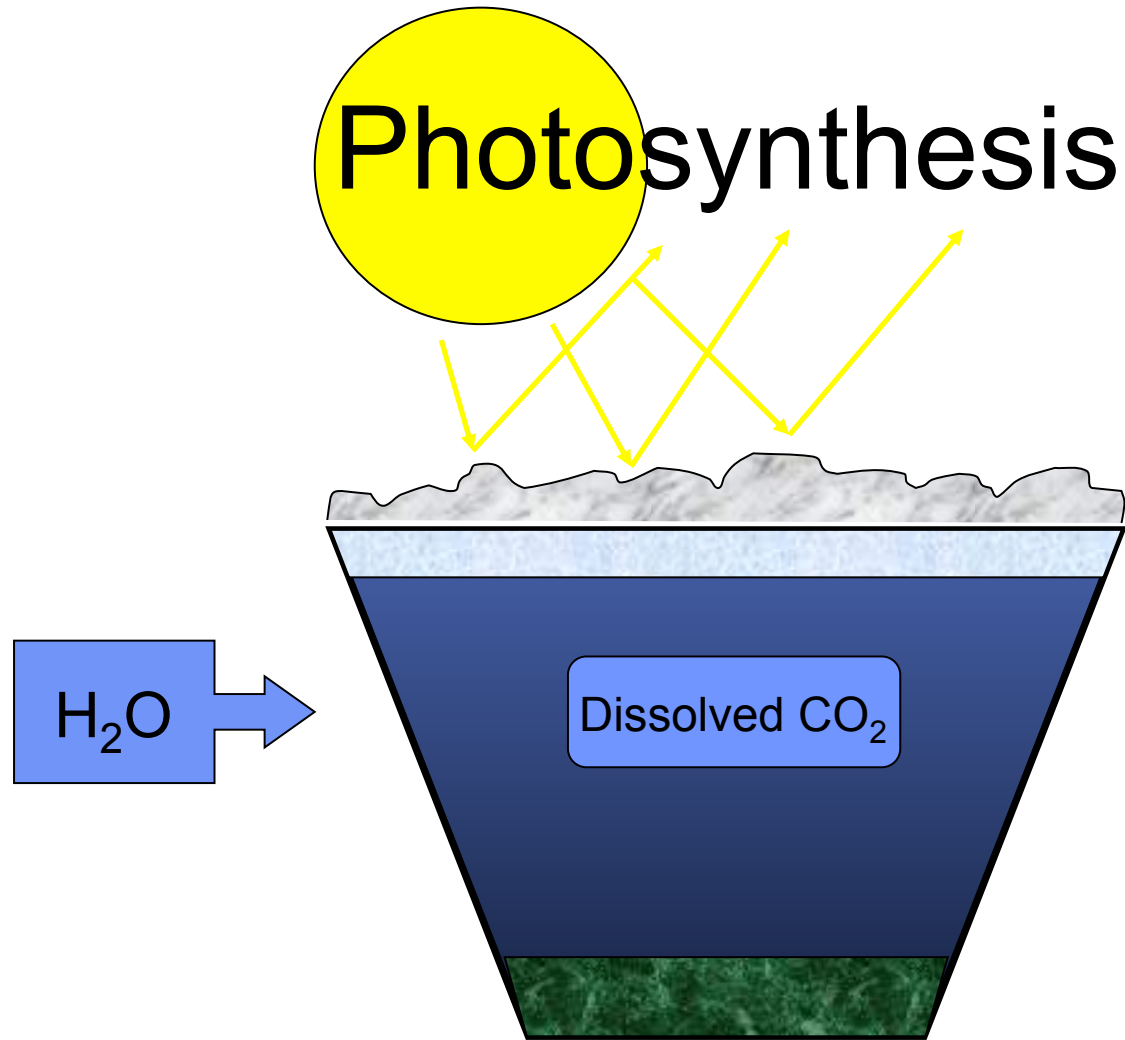
- Turnover allows nutrients that have sunk to the bottom of the lake to be brought back up to the top
- This nutrient turnover benefits phytoplankton and the rest of the food chain

Nutrients -> Algae/Phytoplankton -> Zooplankton -> Fish



What do plants need?





What do plants need?

# Without sunlight...

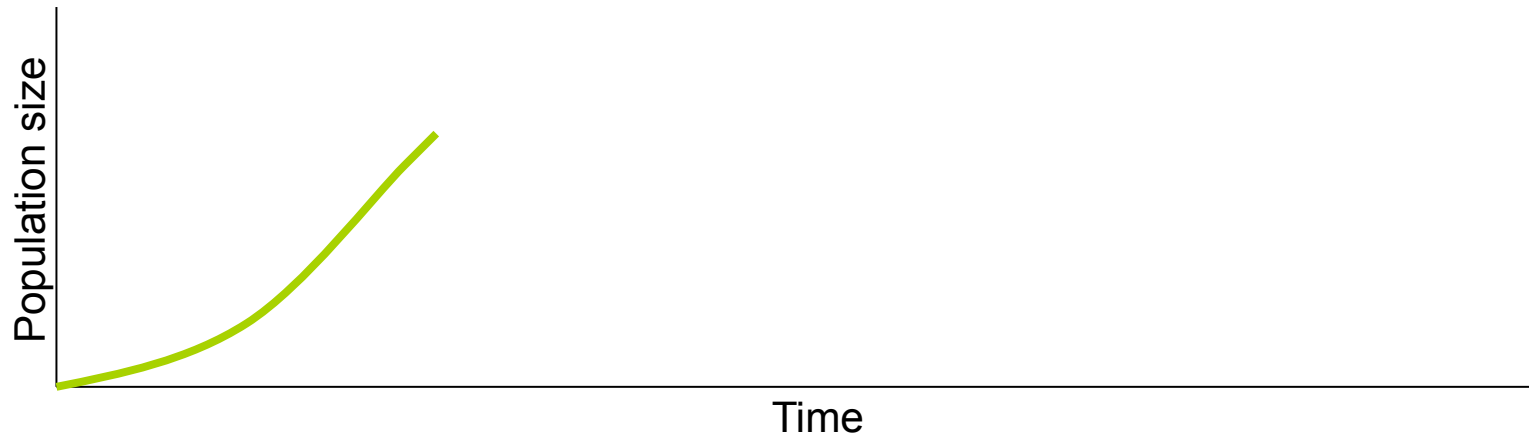
- Algae would not be able to perform photosynthesis
- Without photosynthesis, the algae begin to die and decompose, using up oxygen.
- There becomes less oxygen around for animals

Making it real...

# Additional Topics

## *Population Dynamics*

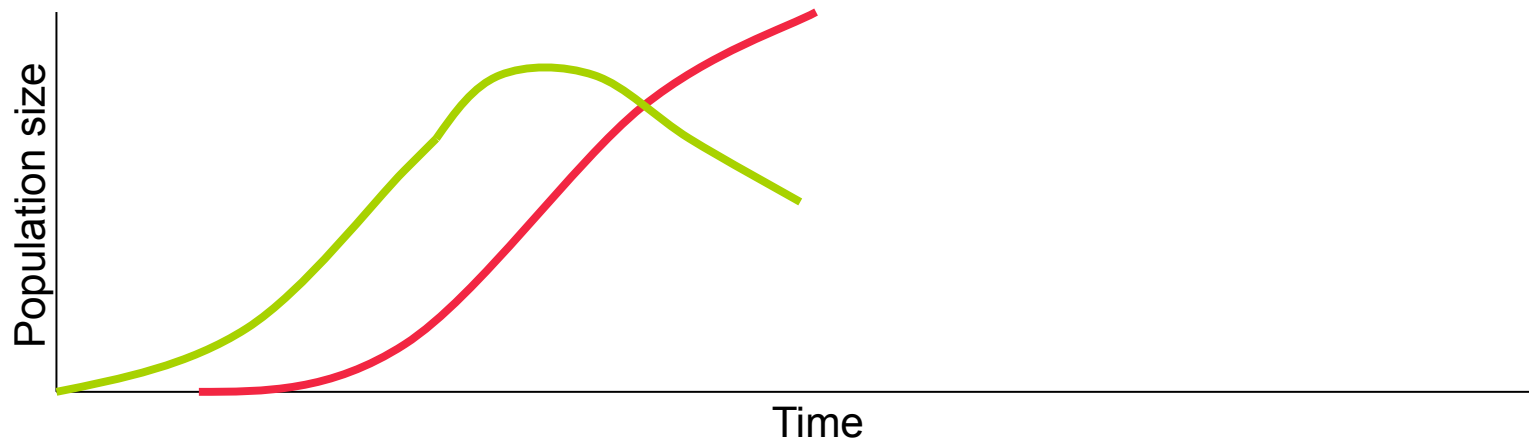
- Spring turnover produces a pulse of nutrients, stimulating phytoplankton



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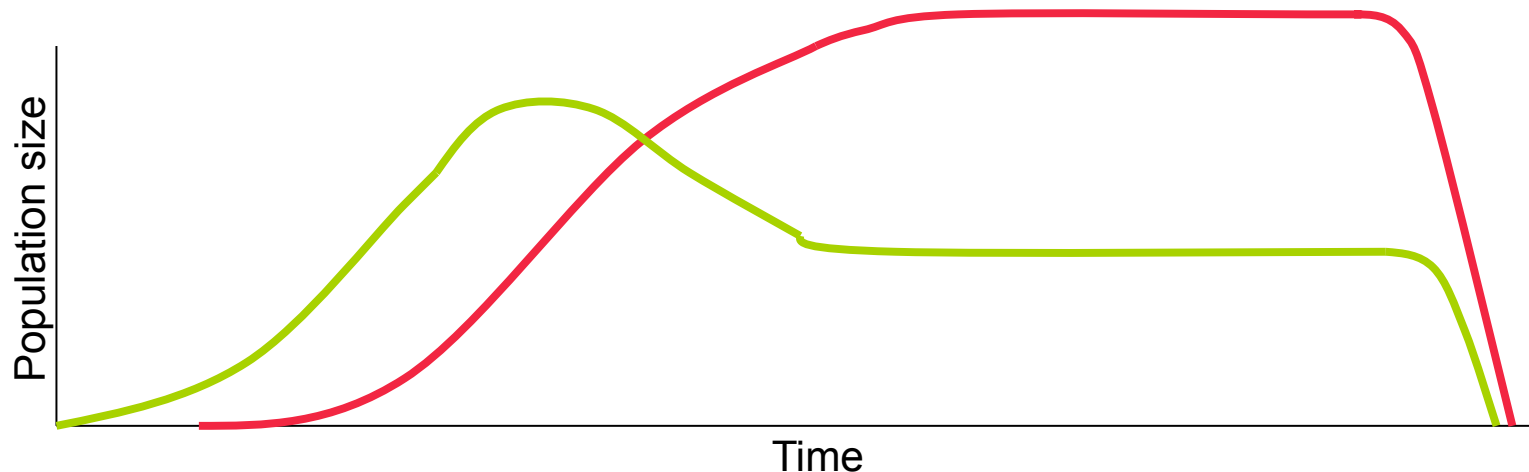
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- Zooplankton populations increase, reducing phytoplankton and producing a clear water phase



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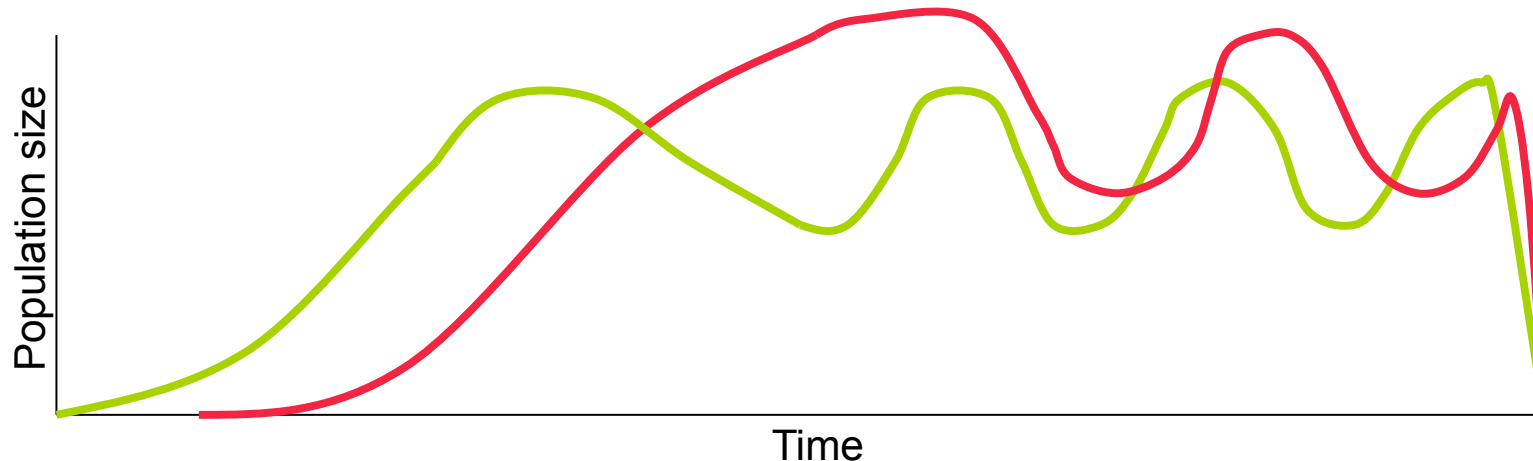
- Spring turnover produces a pulse of nutrients, stimulating phytoplankton
- Zooplankton populations increase, reducing phytoplankton and producing a clear water phase
- From this point, the clear water phase may continue until the end of the summer...



# Additional Topics

## *Population Dynamics*

- Spring turnover produces a pulse of nutrients, stimulating phytoplankton
- Zooplankton populations increase, reducing phytoplankton and producing a clear water phase
- From this point, the clear water phase may continue until the end of the summer... or the populations may continue to fluctuate



# Additional Topics

## *Tropical vs. Temperate Lakes*

How might you expect lakes in the tropics to be different?

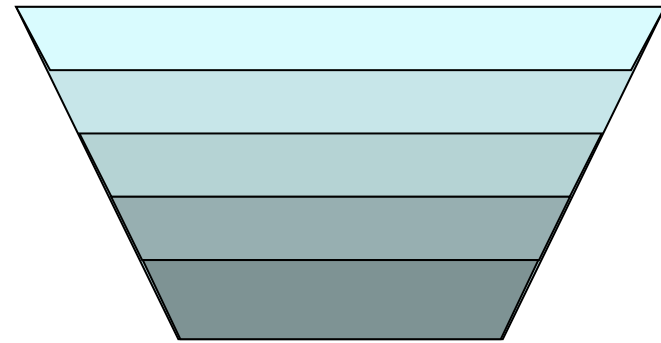
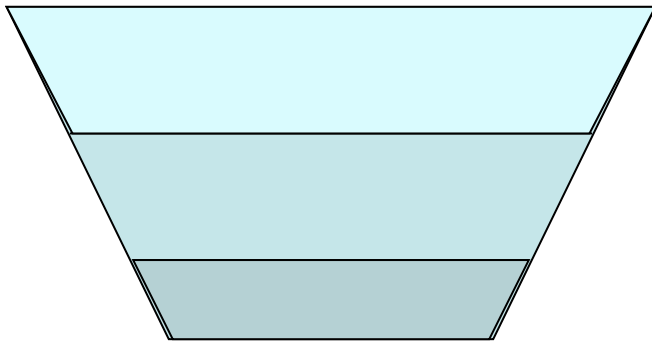




# Additional Topics

## *Tropical vs. Temperate Lakes*

- Low seasonal variation
  - Weak stratification
  - More frequent disturbance
- High seasonal temp variation
  - Strong stratification
  - Biannual disturbance



# Sampling in winter

## KBS's Klausmeier-Litchman Lab









