

A scenic view of a river with autumn foliage on the banks and a duck in the water. The water is calm, reflecting the surrounding trees and rocks. The banks are lined with large, smooth rocks and dense vegetation with yellow and orange leaves. A single duck is visible in the water, swimming near the rocky shore.

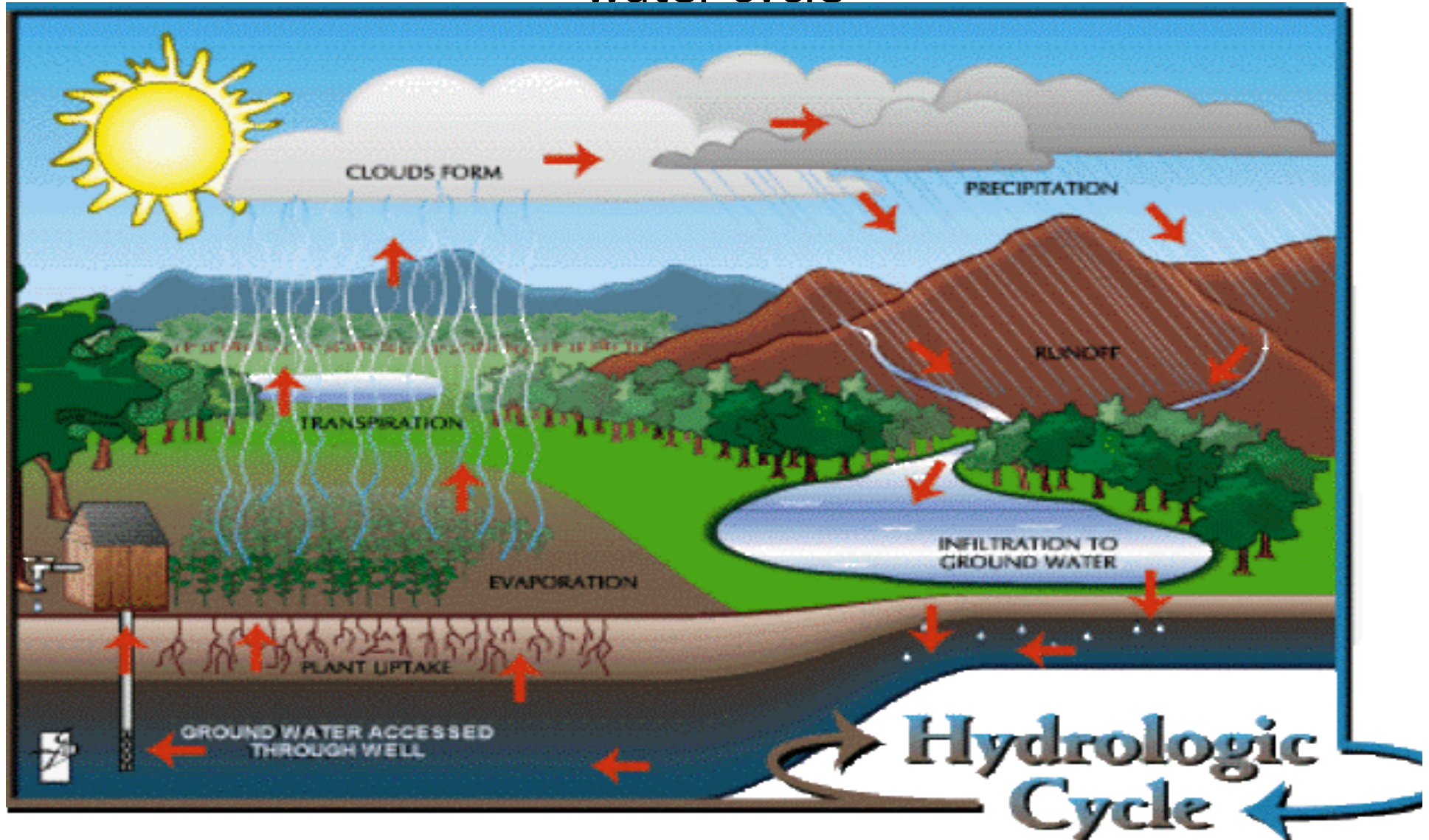
Envirothon 2009

Aquatic Ecology

What should I study?

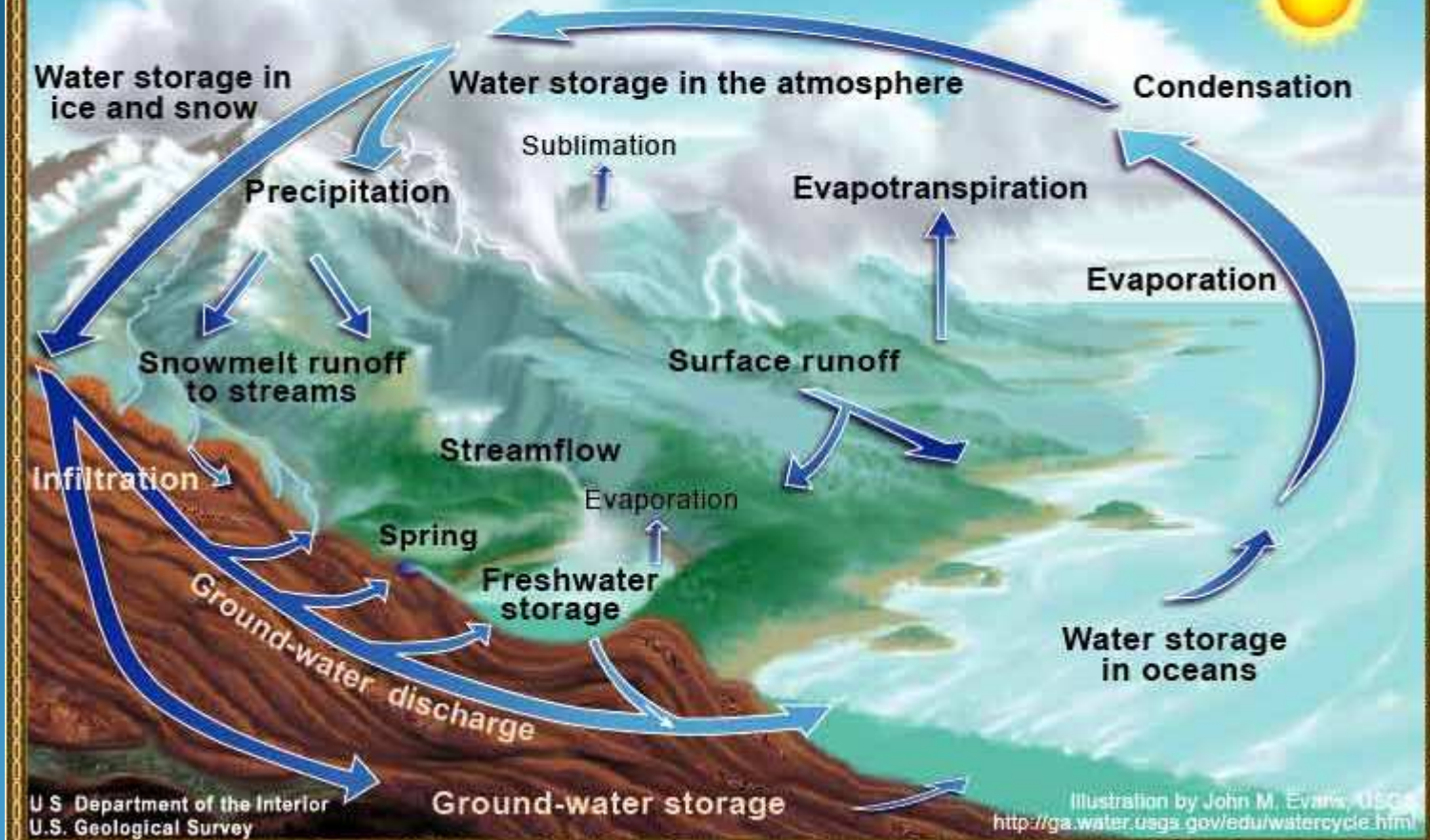
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Identify the process and phases for each part of the water cycle





The Water Cycle



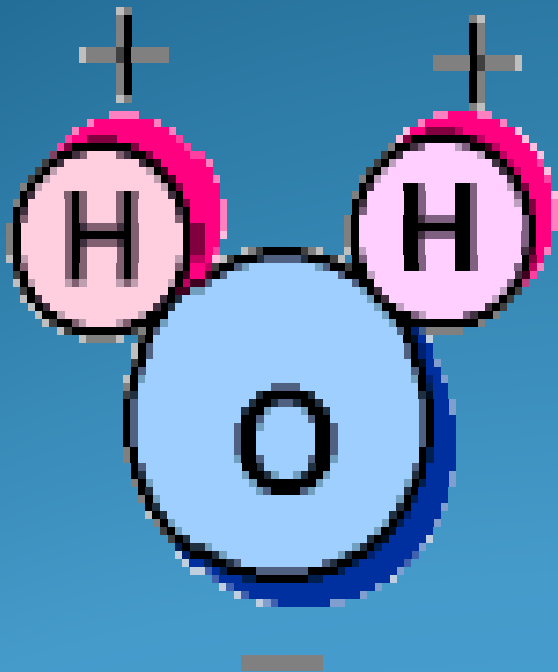
U.S. Department of the Interior
U.S. Geological Survey

Illustration by John M. Evans, USGS
<http://ga.water.usgs.gov/edu/watercycle.html>

Water Cycle terms

- Condensation
- Evapotranspiration
- Ground-water discharge
- Infiltration
- Snowmelt runoff to streams
- Stream flow
- Surface runoff
- Water storage in ice and snow
- Evaporation
- Freshwater storage
- Ground-water storage
- Precipitation
- Spring
- Sublimation
- Water storage in the atmosphere
- Water storage in oceans

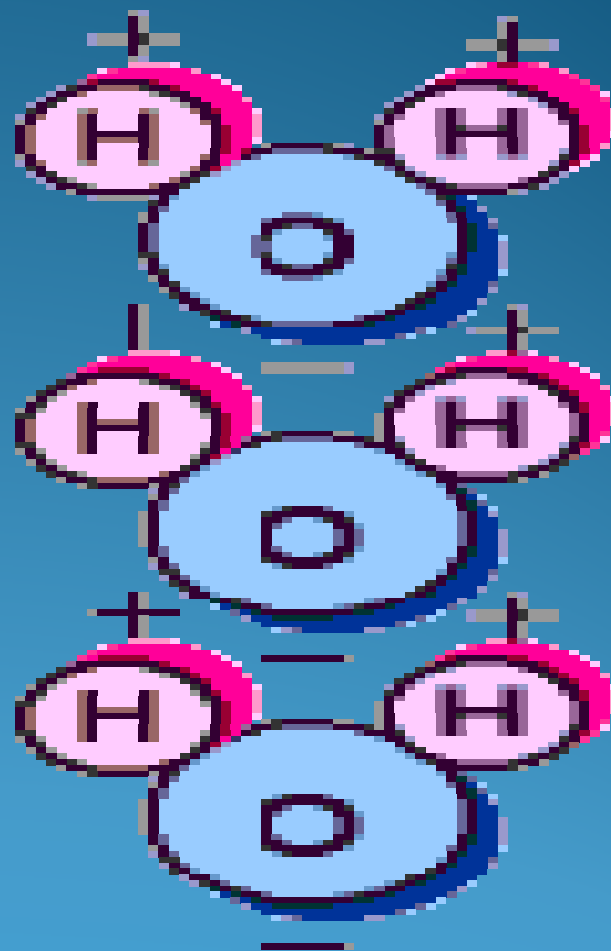
Properties of water - chemical properties



A water molecule contains one atom of oxygen bound to two atoms of hydrogen. The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." (If the water molecule here looks familiar, remember that everyone's favorite mouse is mostly water, too).

Properties of water - chemical properties

As the right-side diagram shows, the side with the hydrogen atoms (positive charge) attracts the oxygen side (negative charge) of a different water molecule. All these water molecules attracting each other mean they tend to clump together. This is why water drops are, in fact, drops!



Properties of water - physical properties

Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) -- at the temperatures normally found on Earth.



Properties of water - physical properties

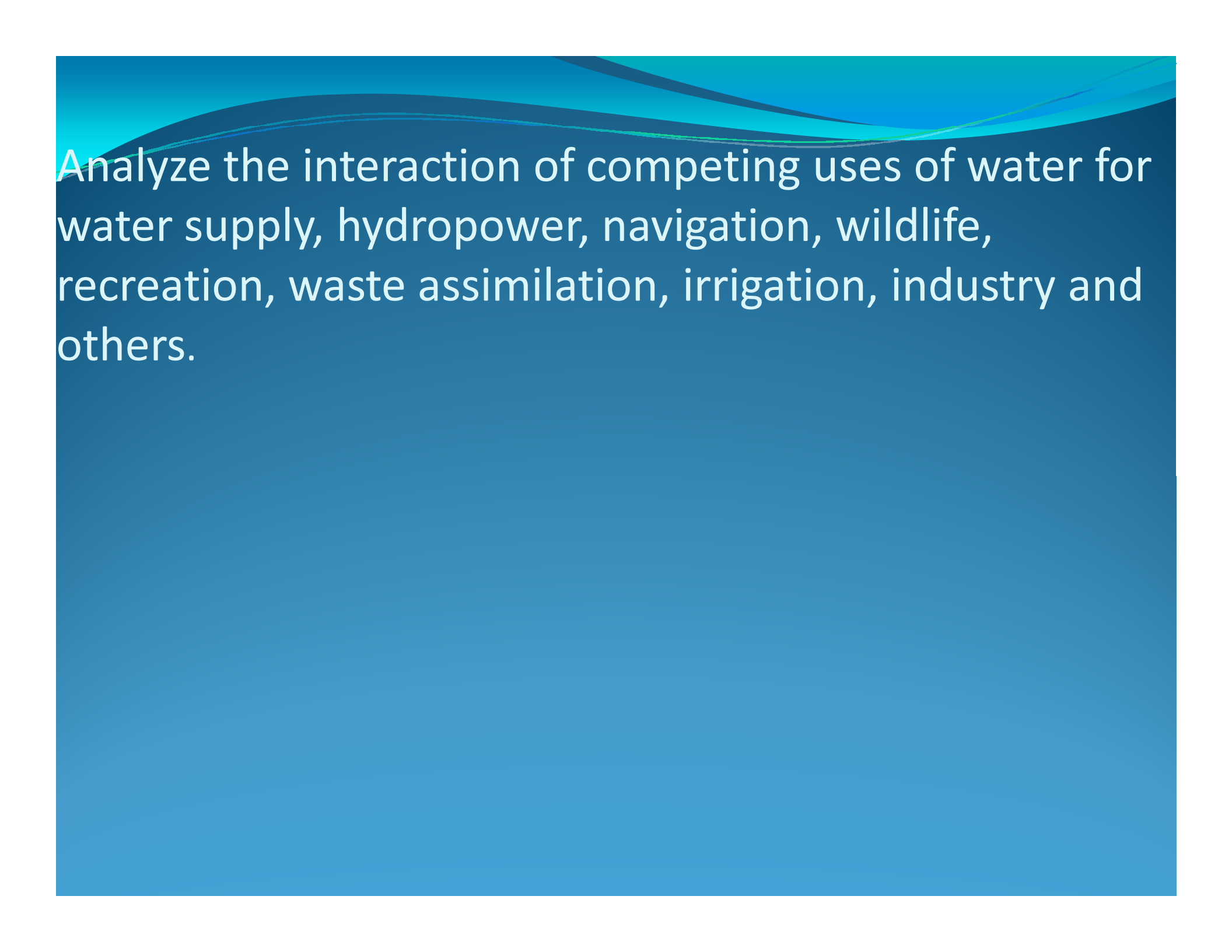
- Water freezes at 32 Fahrenheit (F) and boils at 212 F. water's freezing and boiling points are the baseline with which temperature is measured: 0 on the Celsius scale is water's freezing point, and 100 is water's boiling point.
- Water is at its most dense at 4°C
- Weight: 62.416 pounds per cubic foot at 0°C
- Weight: 61.998 pounds per cubic foot at 100°C

Fresh water ecosystems – important properties of water

- Ice is water in its solid form. Unlike most substances, which are densest in their solid state, ice is less dense than water and thus floats. If this were not the case, Fresh water lakes and rivers would freeze from the bottom up. Fish could not survive, and it is unlikely that rivers and lakes in northern countries would ever completely thaw.

Saltwater ecosystems – important properties of water

- The oceans have a profound influence on climate. They are the world's great heat reservoirs and heat exchangers. Water has a high specific heat index. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.



Analyze the interaction of competing uses of water for water supply, hydropower, navigation, wildlife, recreation, waste assimilation, irrigation, industry and others.



- United States Geological Service (USGS) surveys nation wide water use every 5 years. The chart to the right is based on the 2000 survey.

Withdrawals totaled 408 billion gallons per day in 2000

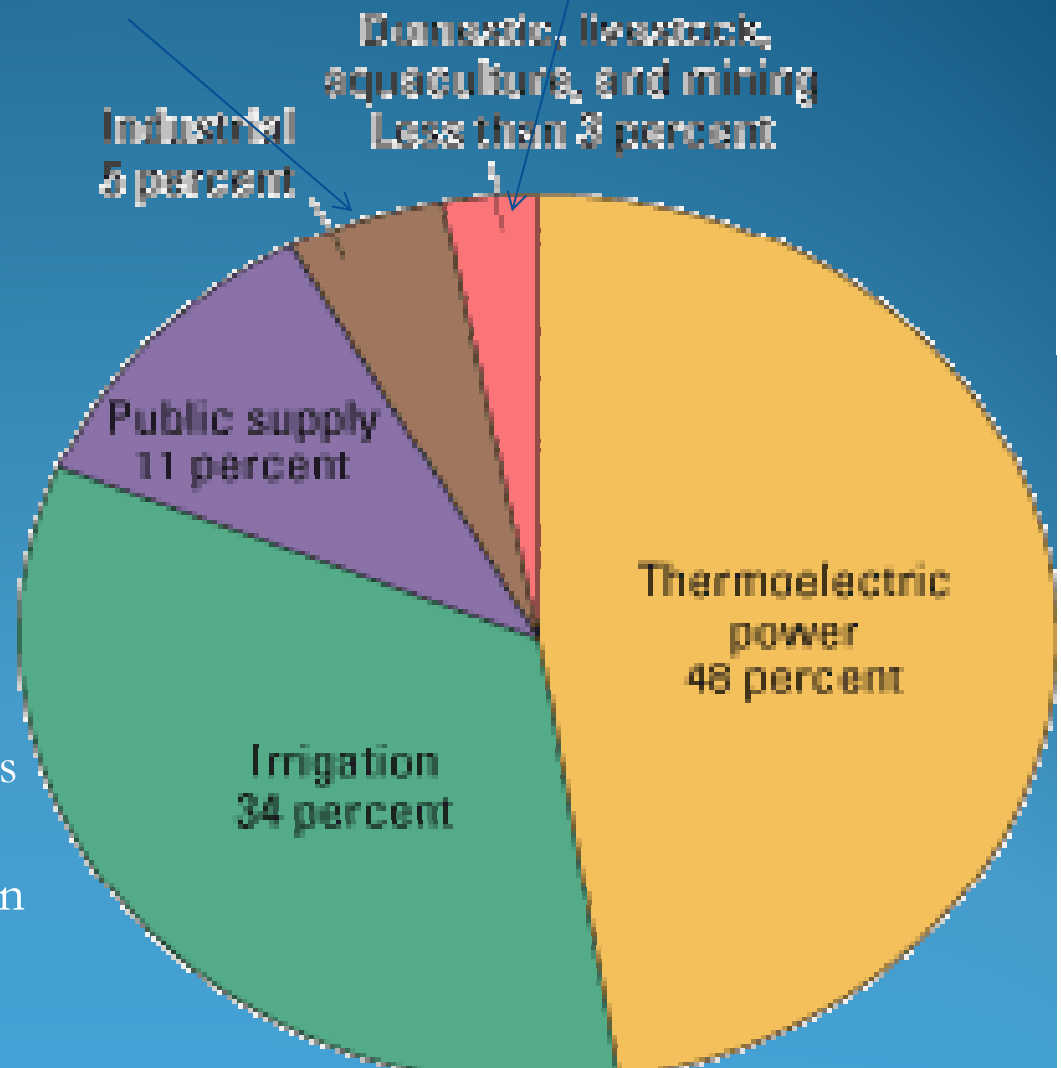
Freshwater withdrawals were 85 percent of the total

Seventy-nine percent of total withdrawals were from surface water

Thermoelectric-power plants withdrew an estimated 195 billion gallons per day

Industrial 5%

Domestic, livestock, aquaculture, mining <3%



Look into methods of conserving water and reducing point and non-point source pollution

History of the NYC Water System

Tips to conserve water

http://www.nyc.gov/html/dep/html/ways_to_save_water/hcisw.shtml



Safe Drinking Water Act - Protecting America's Public Health



MULTIPLE RISKS REQUIRE MULTIPLE BARRIERS

Drinking water is essential to the health of American citizens and the economic vitality of our communities. However, drinking water is vulnerable to contamination from many potential threats. There are programs and activities that when operated properly form a protective web of multiple barriers to ensure the safety of our drinking water. The success of these barriers relies on the involvement and vigilance of state and federal officials, the private sector, public interest groups and all citizens.

The Act identifies examples of surface and groundwater sources of drinking water (in blue), potential threats to those drinking water sources (in red), and multiple barriers that together protect our nation's public health (in green).

Examples of barriers include:

- Prevention Barrier
- Management Barrier
- Monitoring and Compliance Barrier
- Enforcement and Remedial Action Barrier

Clean Water Act **Safe Drinking Water Act**

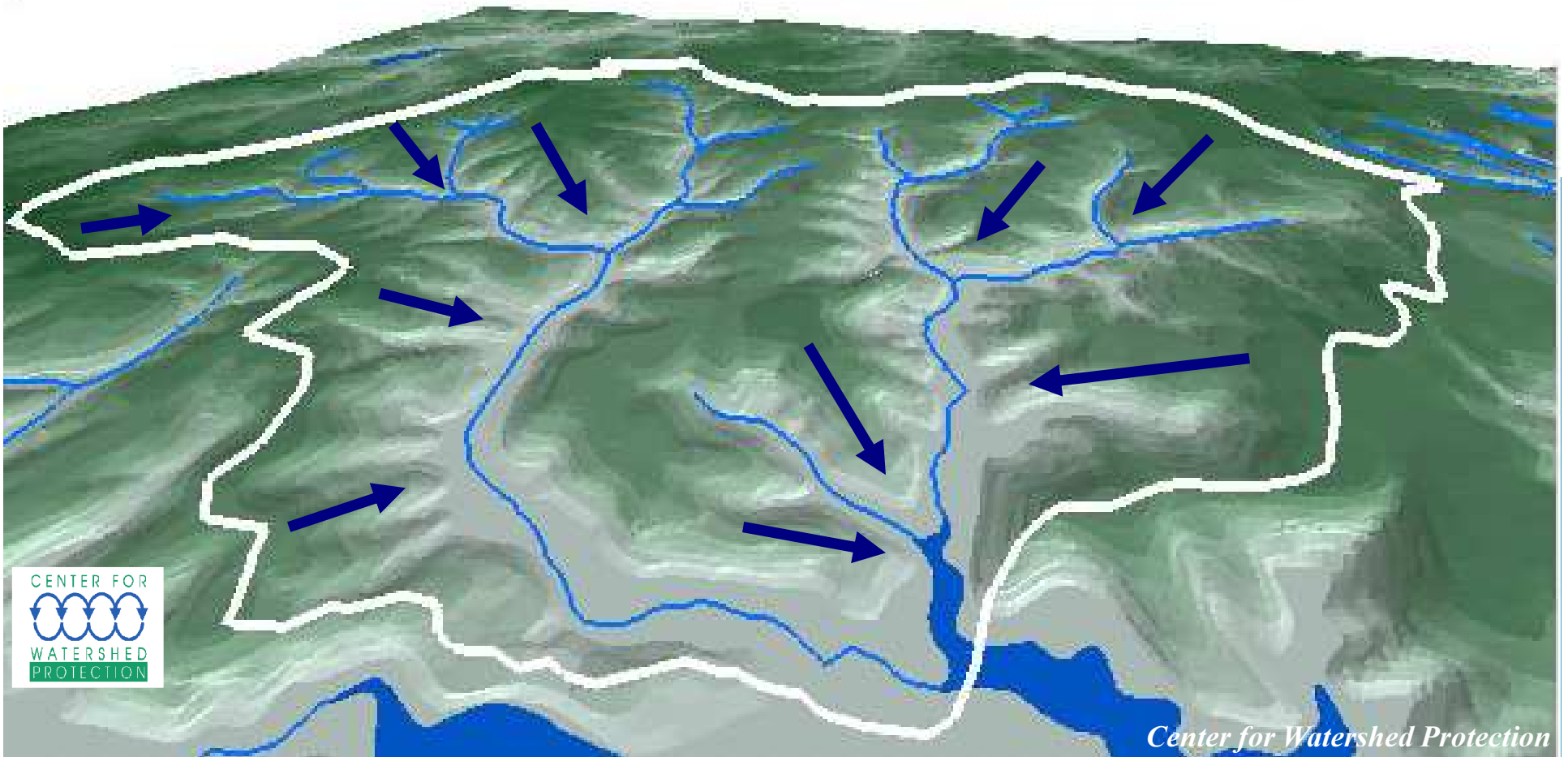
In 1972, with major public support, Congress passed the Clean Water Act to begin a massive cleanup of our waterways, ponds, and lakes.

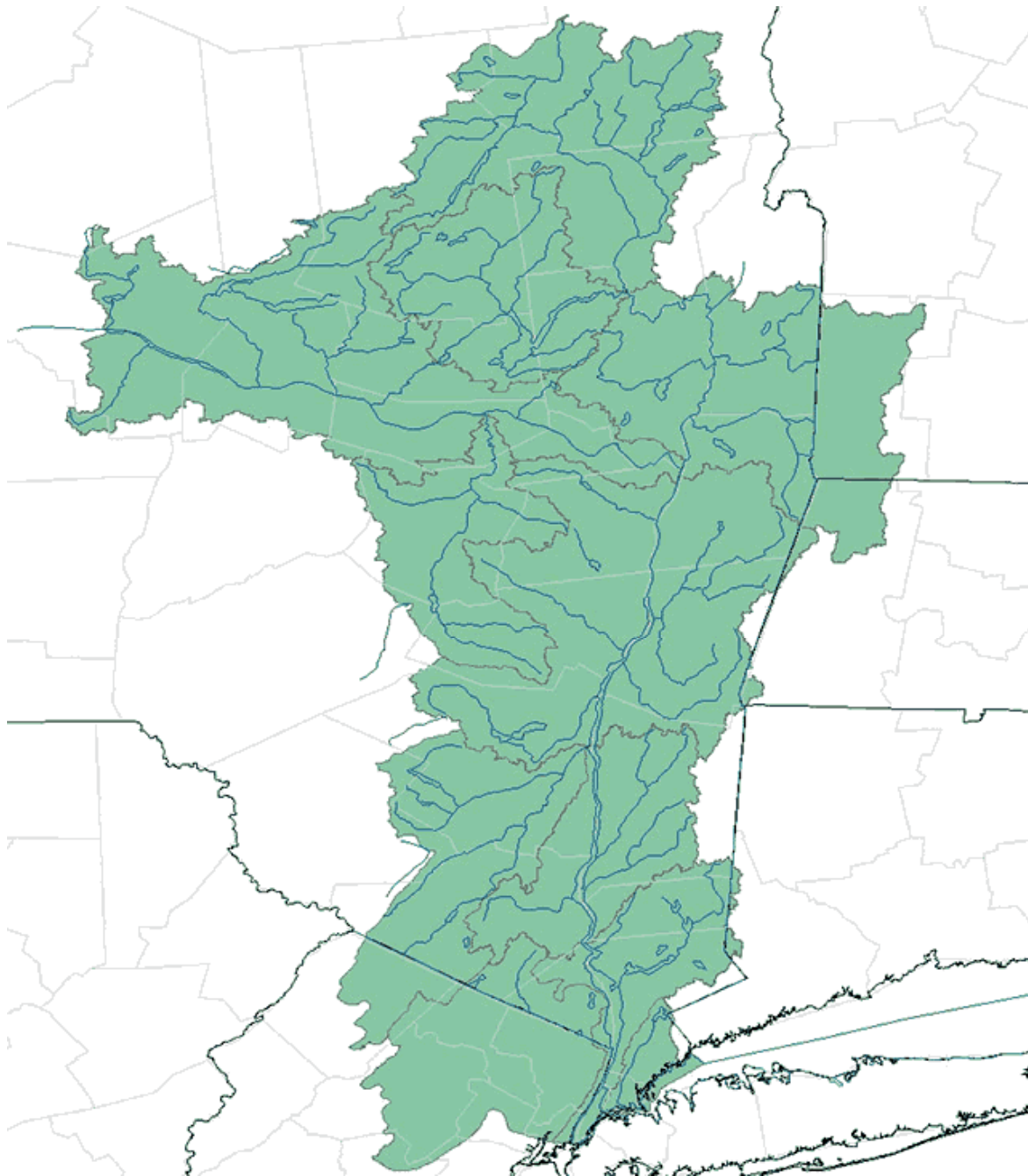
* Phase I These regulations required all large municipal separate storm sewer systems (MS4s), serving over 100,000 people to implement a stormwater management program. Today some 40% of our rivers now meet federal clean water standards.

*In 2003 we entered Phase II. These regulations cover all small MS4s (between 50,000 and 100,000 people) and construction projects one acre or greater under a permit system. This phase mandates the cleanup of nonpoint source pollution—everyday pollution that all of us can prevent.

What Is a Watershed?

A watershed is the area of land that drains to a particular point along a stream





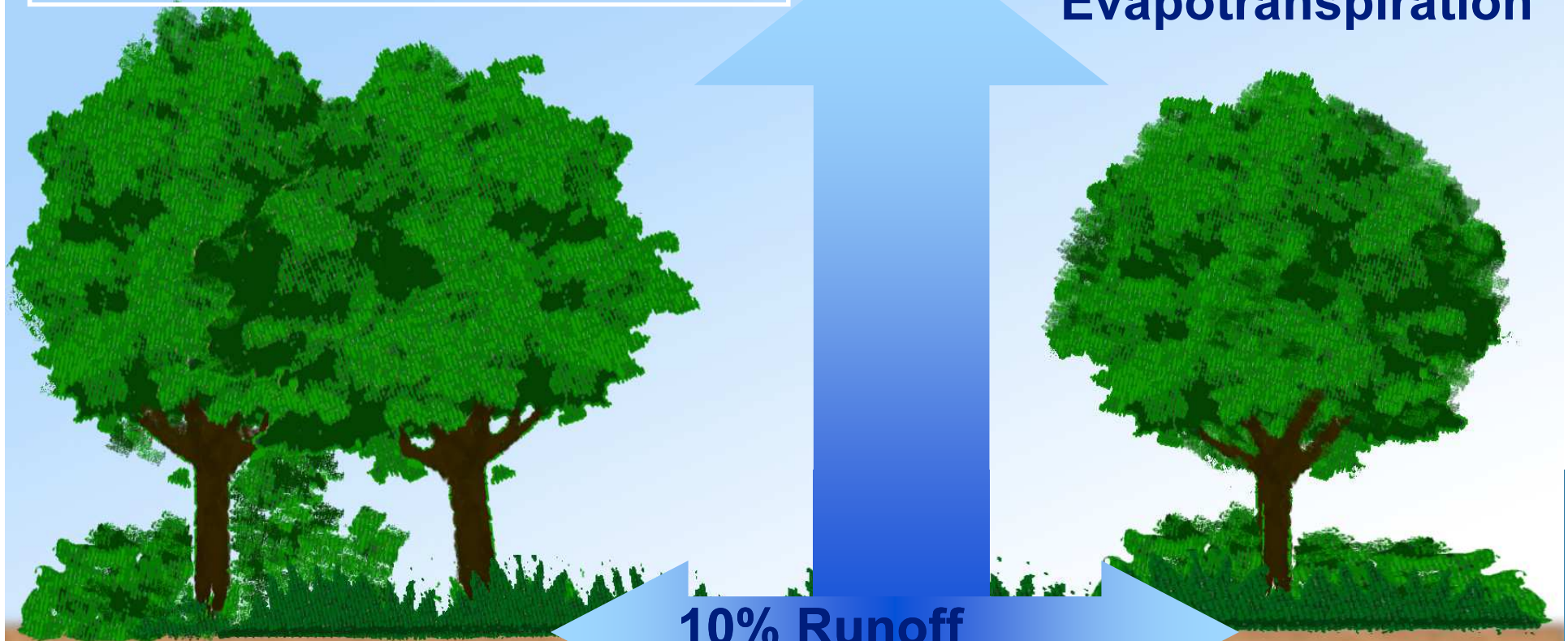
Hudson River Watershed



Bronx River Watershed

Natural Ground Cover

**40%
Evapotranspiration**



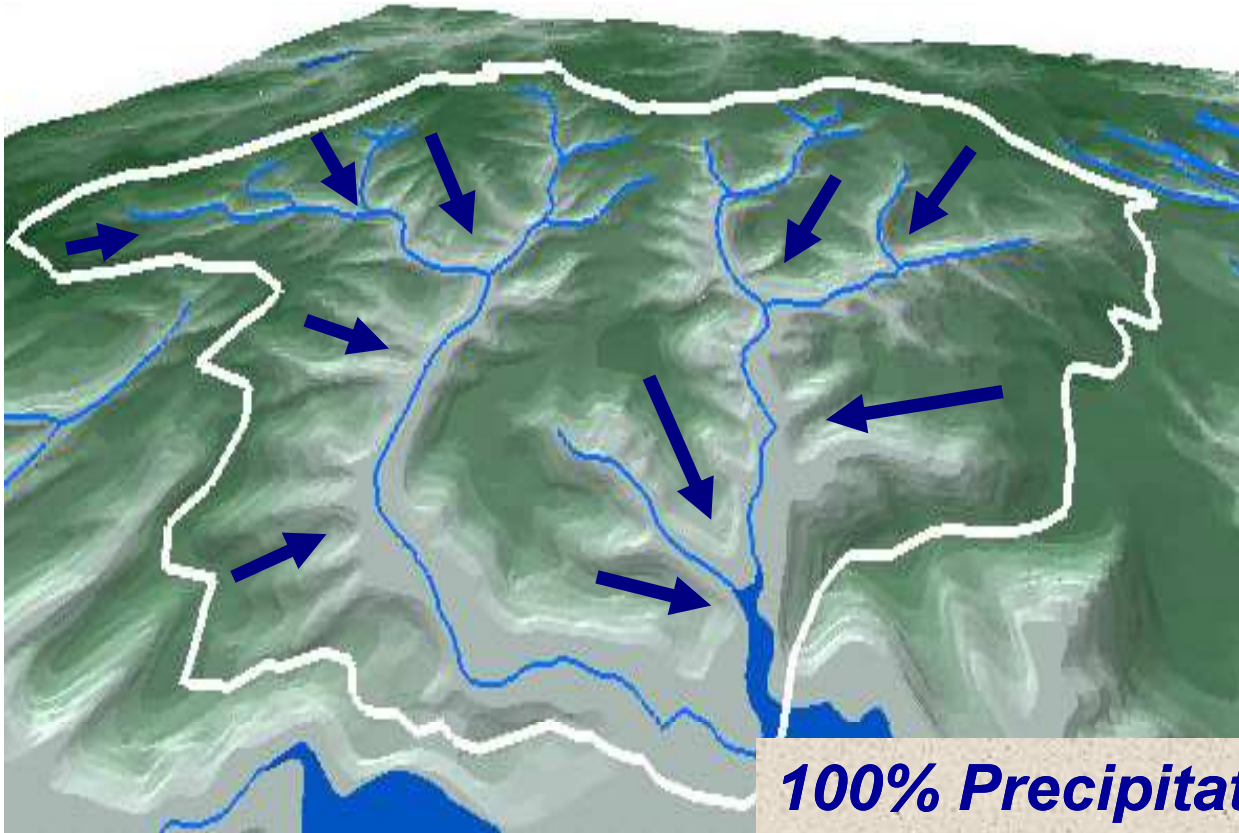
10% Runoff

**25%
Shallow
infiltration**
(10 inches)

**25% Deep
infiltration**

Infiltration

Source: U.S. EPA



Impervious Cover and Storm water Runoff

100% Precipitation over Watershed

	<u>Natural</u>	<u>Developed</u>
<i>Evaporation</i>	40%	25%
<i>Surface Runoff</i>	10%	50%
<i>Groundwater</i>	50%	30%

Source: U.S. EPA and Center for Watershed Protection "Site Planning for Urban Stream Protection", Dec 1995

Impervious Cover and Storm water Runoff



***Surface Runoff Generated
from a One-Inch Rainstorm***

One-Acre Open Meadow - 363 cubic feet

One-Acre Paved Parking Lot - 3,460 cubic feet



Source: U.S. EPA and Center for Watershed Protection
"Site Planning for Urban Stream Protection", Dec 1995
(adjusted to reflect prior slide)



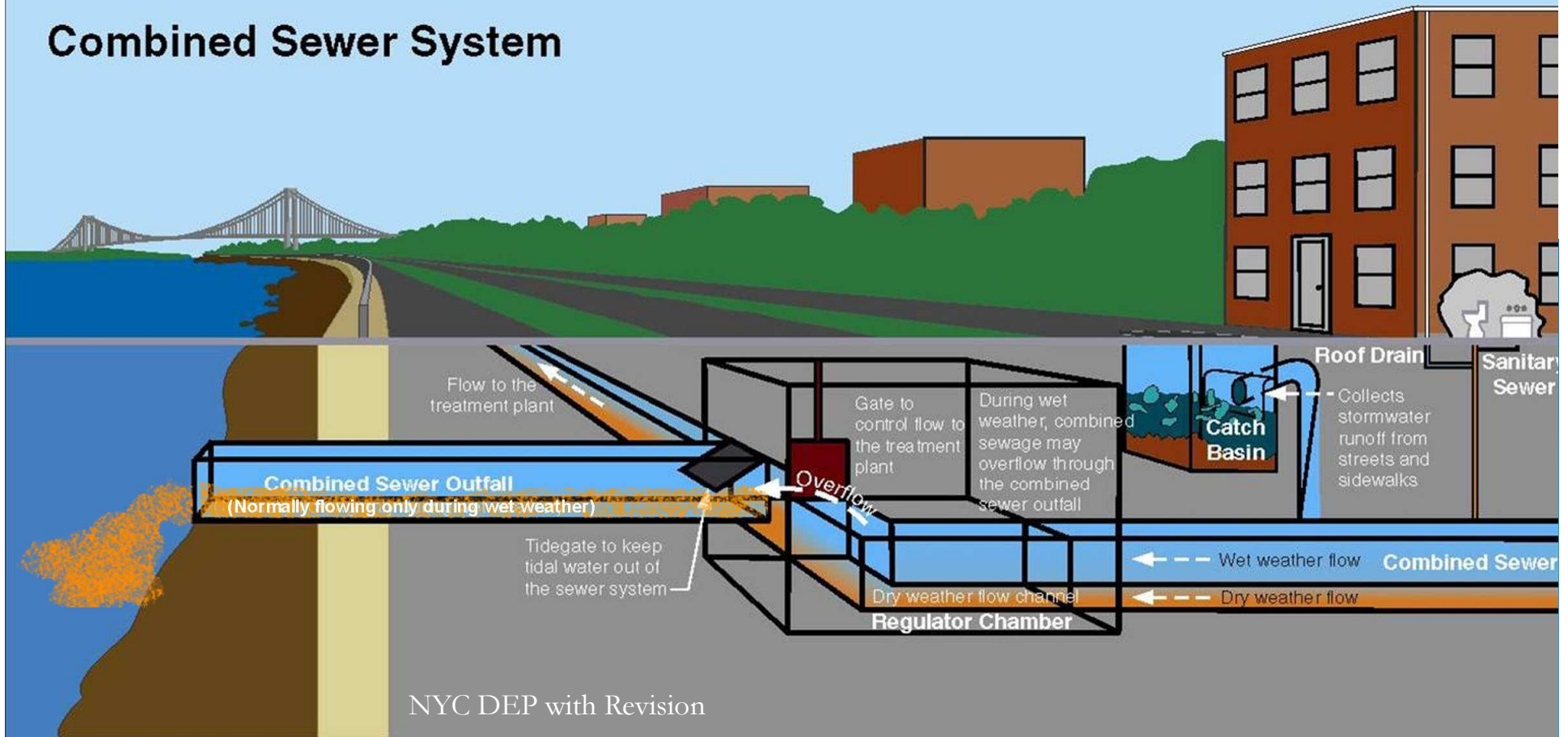
Discuss methods for reducing point and non-point source pollution

Discuss methods for reducing point and non-point source pollution

- **Point sources:** A point source is a readily identifiable source. A typical example is a pipe leading from an industry directly to a river. The pipe is easily identified and can be traced back to the industry. Some examples of point sources are industrial plants, wastewater treatment facilities, landfills, restaurants, etc. Most point sources have already been identified and are highly regulated.
- **Non point sources:** Not easily traced such as road run off that makes its way to the river. CSOs capture large amount of non point source pollution.

The Sewershed and CSOs

Combined Sewer System



Wetlands

Wetlands provide values that no other ecosystem can, including natural water quality improvement, flood protection, shoreline erosion control, opportunities for recreation and aesthetic appreciation, and natural products for our use at no cost. Wetlands that extend into the estuary provide breeding ground and nursery for a variety of fish and wildlife. Protecting wetlands in turn can protect our safety and welfare.

Natural Water Quality Improvement

- Wetlands have important filtering capabilities for intercepting surface- water runoff from higher dry land before the runoff reaches open water. As the runoff water passes through, the wetlands retain excess nutrients and some pollutants, and reduce sediment that would clog waterways and affect fish and amphibian egg development.



Native wetland grasses



Spartina alterniflora



Spartina patens

Riparian = Edge of Water

- **Riparian Habitat:** Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

What changes to the aquatic ecosystem can occur do to an alteration to the aquatic habitat ?

- *Removal of trees along the banks and shore
 - Increase temperature
 - reduction in food source and biomatter
 - Bank destabilization
- *Straightening of rivers
 - Increased erosion
 - Scouring
- Invasive species
 - Reduced biodiversity

Invasive Plants



Japanese Knotweed

Purple Loosestrife



Water Quality Assessment

- **Biological:** bacteria, algae, aquatic insects, fish, vegetation
- **Physical:** temperature, turbidity and clarity, color, salinity, suspended solids, dissolved solids, flow,
- **Chemical:** pH, dissolved oxygen, biological oxygen demand, nutrients (including nitrogen and phosphorus), organic and inorganic compounds (including toxics)
- **Aesthetic:** odors, taints, color, floating matter

Biological Assessment

- Many types of bacteria are found in natural waters. For the most part bacteria are beneficial; breaking down organic material and thus releasing nutrients back into the water. Nutrients that are then used for growth of algae and plants.
- Other bacteria in water, when found in large numbers, may cause illness and death in people and animals.
- These bacteria are known as pathogens. The source of these pathogens is typically human and animal feces entering the waterways through direct discharge from illegal connections or CSOs, or indirectly from surface runoff.
- Testing of bacteria is routinely performed on many waterways; but it is time consuming and fairly expensive.

Biological Assessment

- Many types of insects live part of their life cycles in water.
- Aquatic insects are often sensitive to pollutants in water. This tolerance of different organisms to water pollution has been measured.
- This information can be used to indirectly assess water quality.
- By sampling the water, the presence or absence of different organisms can be quantified.
- Conclusions about the water quality can be drawn from this information.

Biological Assessment

- Fish, worms, mollusks, and arthropods are other organisms that are often sensitive to pollutants in water.
- Assessments of water quality can be made by sampling these organisms and noting their relative presence or absence.

Identify common aquatic organisms through the use of a key

- Using a dichotomous key:
 - All keys are based on distinguishing characteristics
 - The size or shape of head, thorax, or abdomen can be a distinguishing characteristics

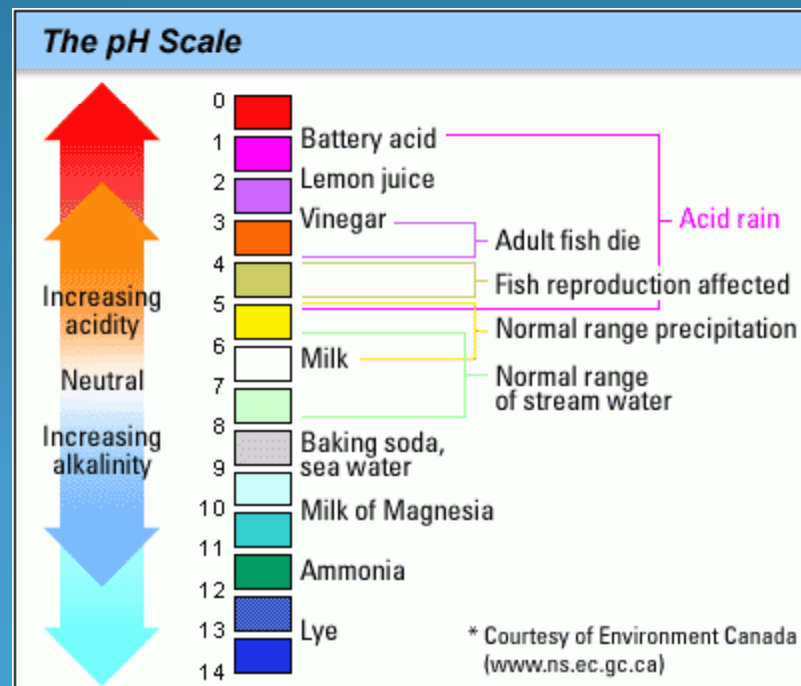


Physical Assessment

- The physical characteristics of the watershed, flood plain, and riparian area greatly influence water quality and the quality and quantity of available habitat for organisms.
- Extremes of water temperature are moderated by the amount and type of vegetation in the riparian areas (shading)
- The amount of turbidity, suspended solids, dissolved solids directly relates to soils present in the watershed, also to the amount of soil disturbance.

Chemical Assessment

- pH range in most inland water is 6-9 standard units.



Chemical Assessment

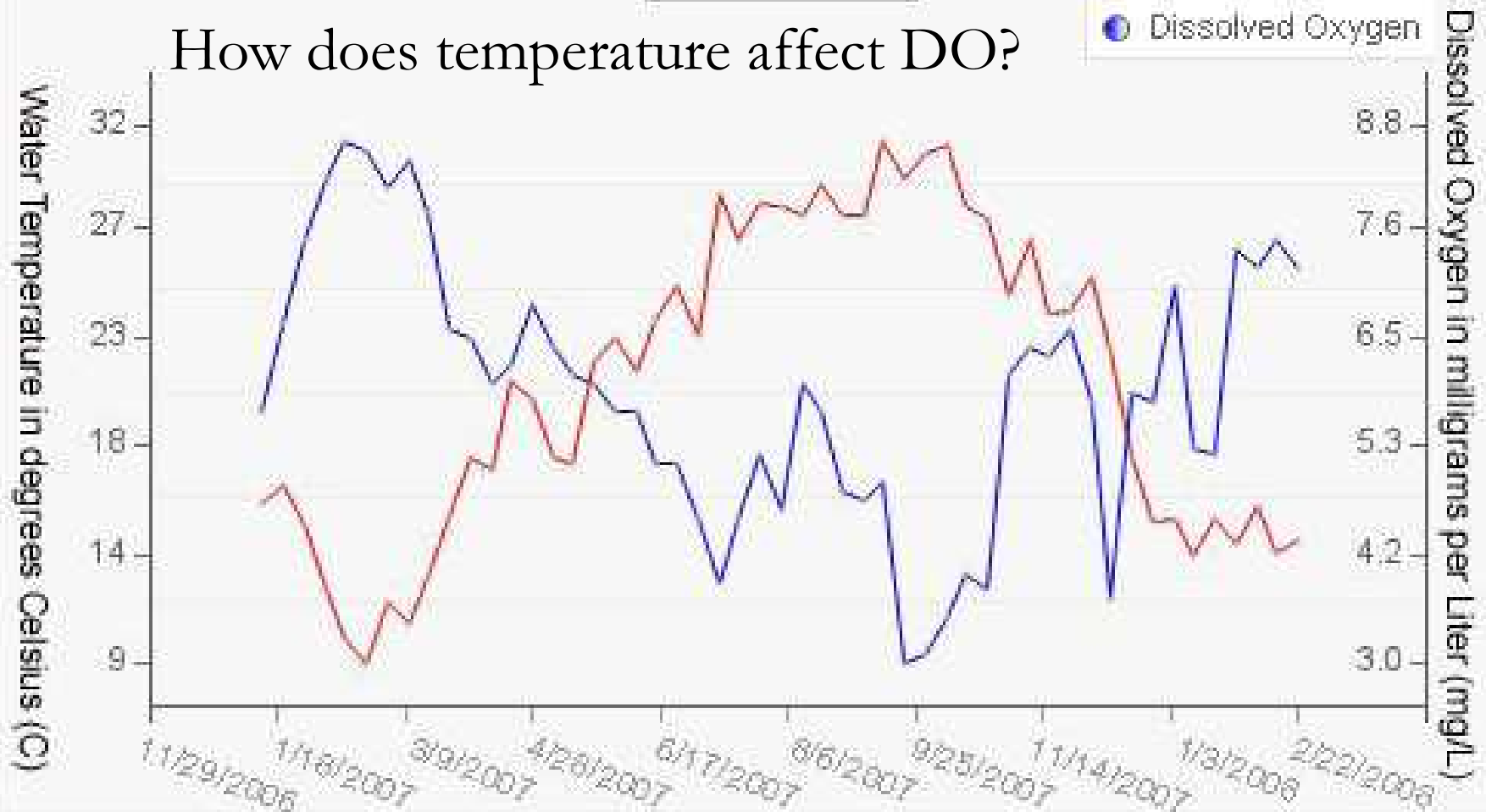
- The amount of dissolved oxygen is critical to most aquatic organisms.



Photosynthesis is the primary source of oxygen in most waters. wind-driven wave aeration and aeration by falling water can also be significant.

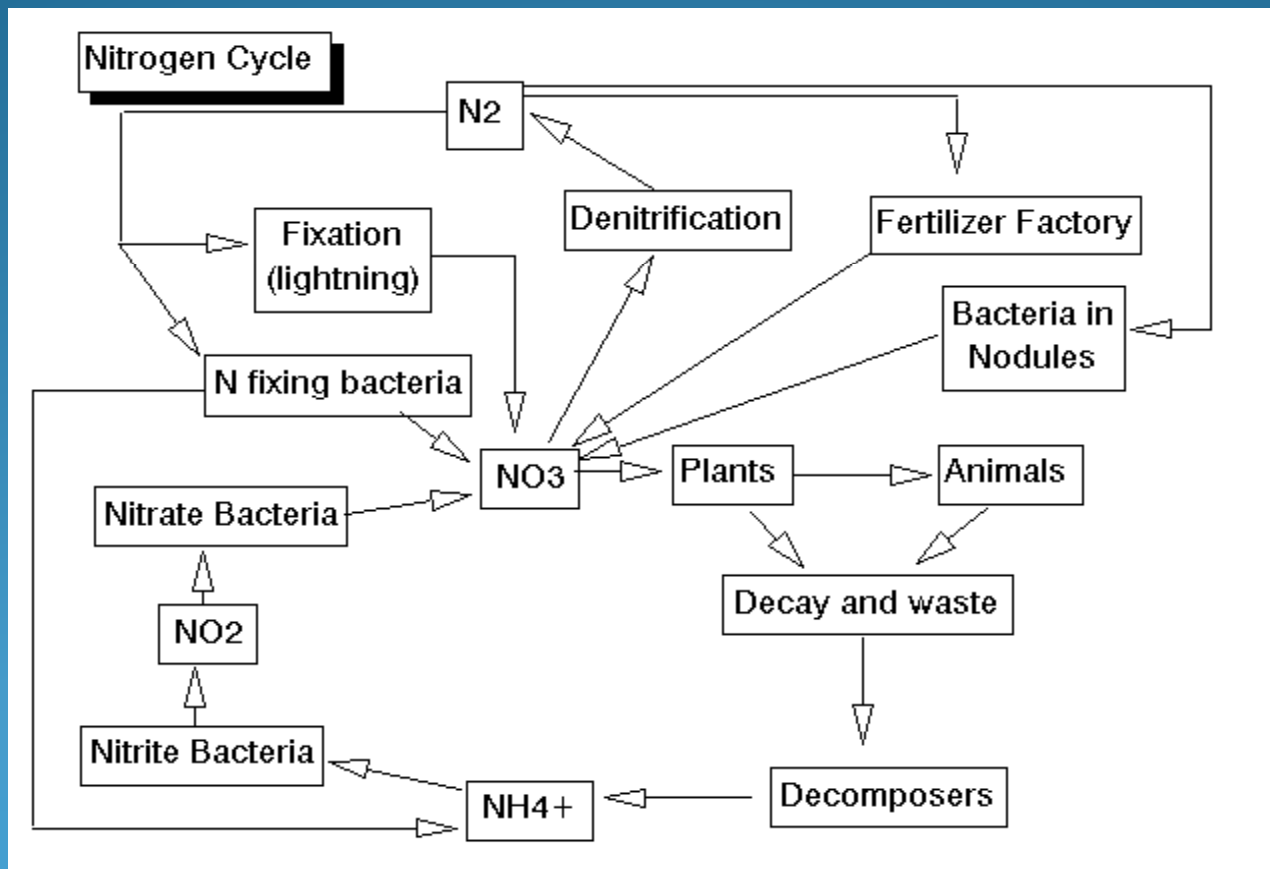
ACE Basin

How does temperature affect DO?



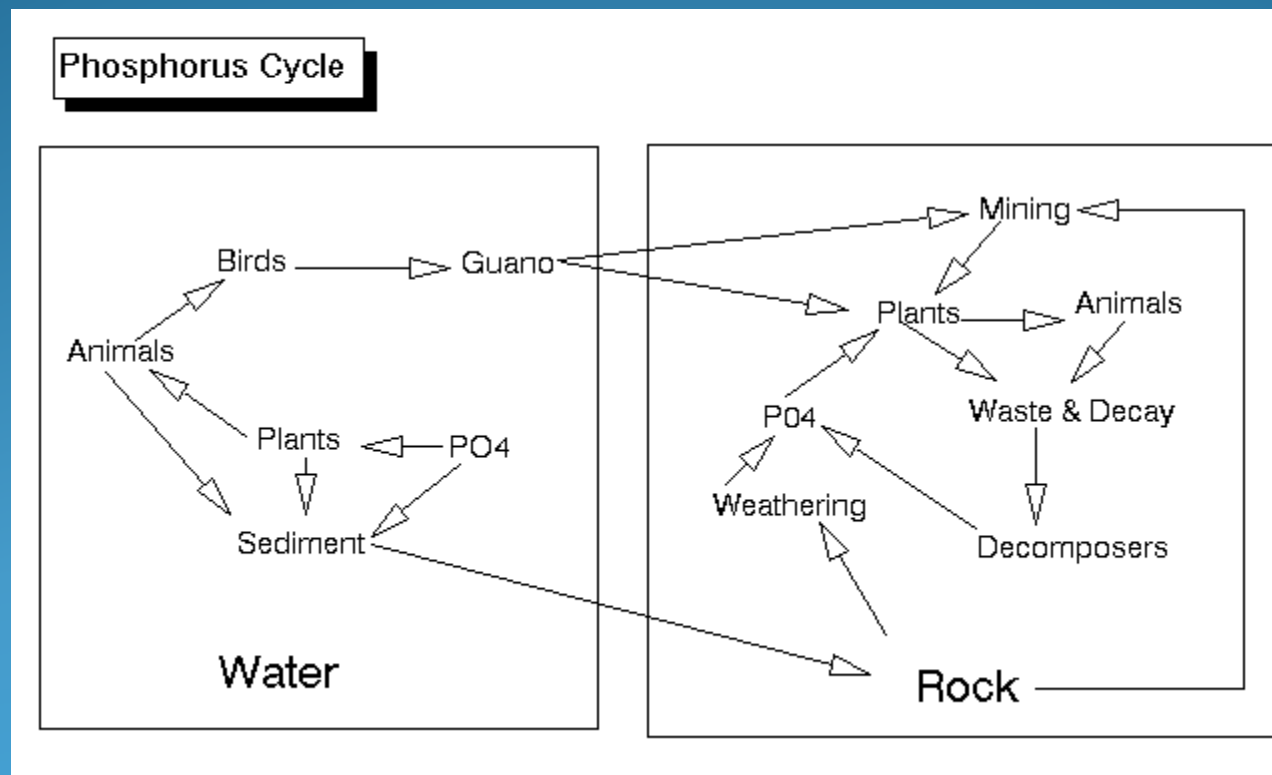
Chemical Assessment

Nitrogen Cycle

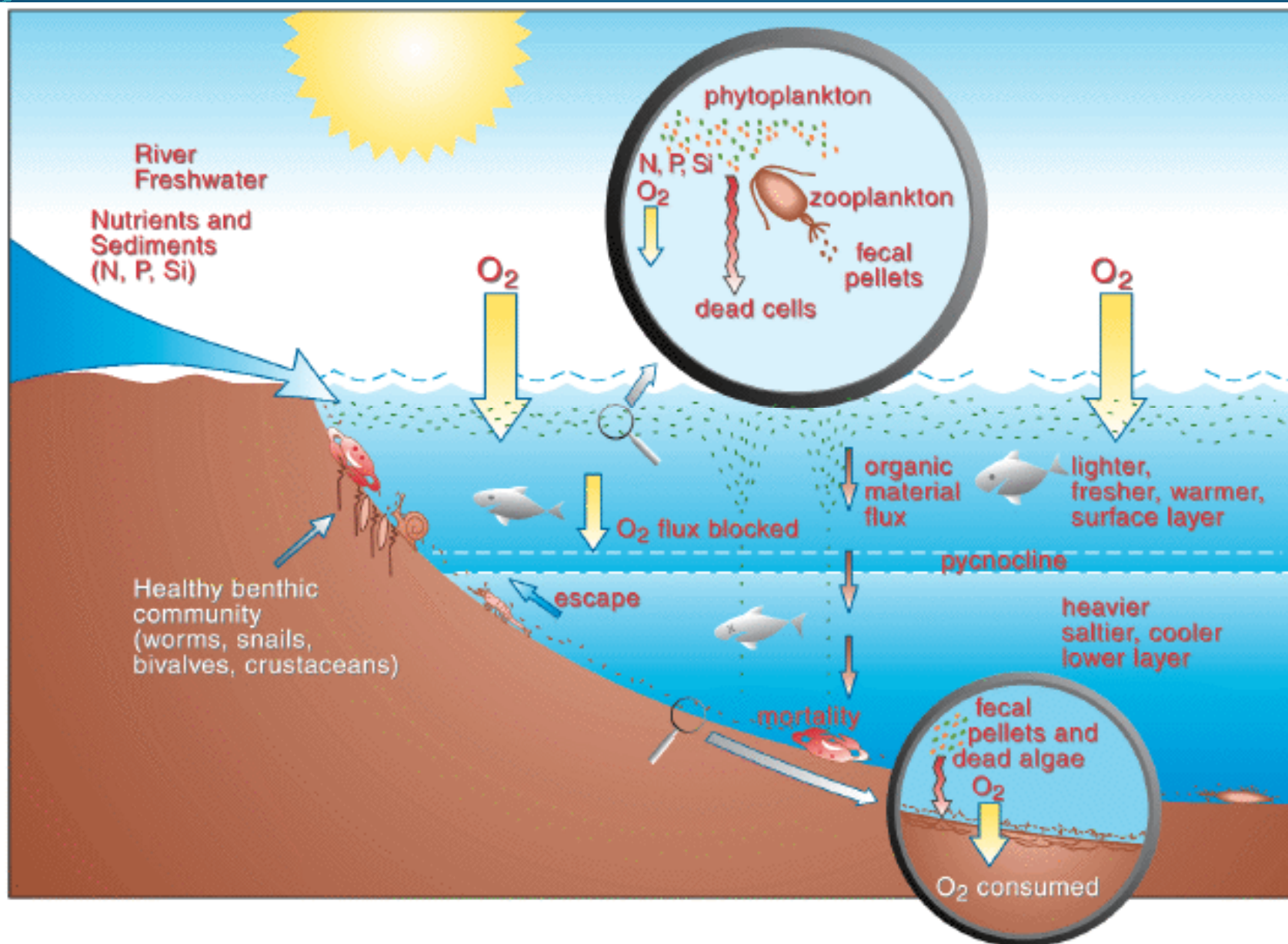


Chemical Assessment

Phosphorus

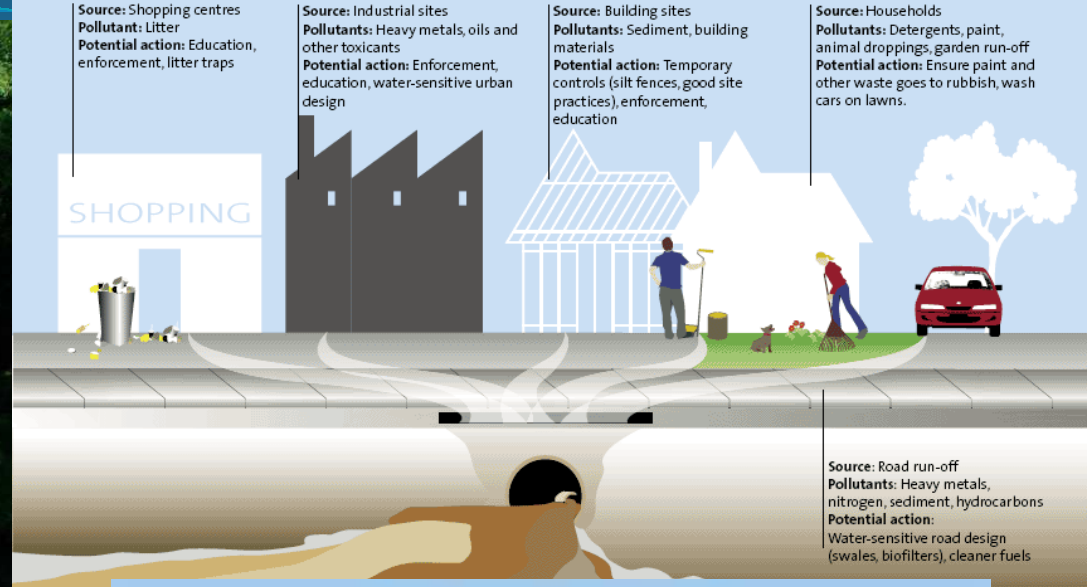


What can be the affect of excessive nutrients?



Bioremediation

Major sources of stormwater pollution in urban areas – and some solutions

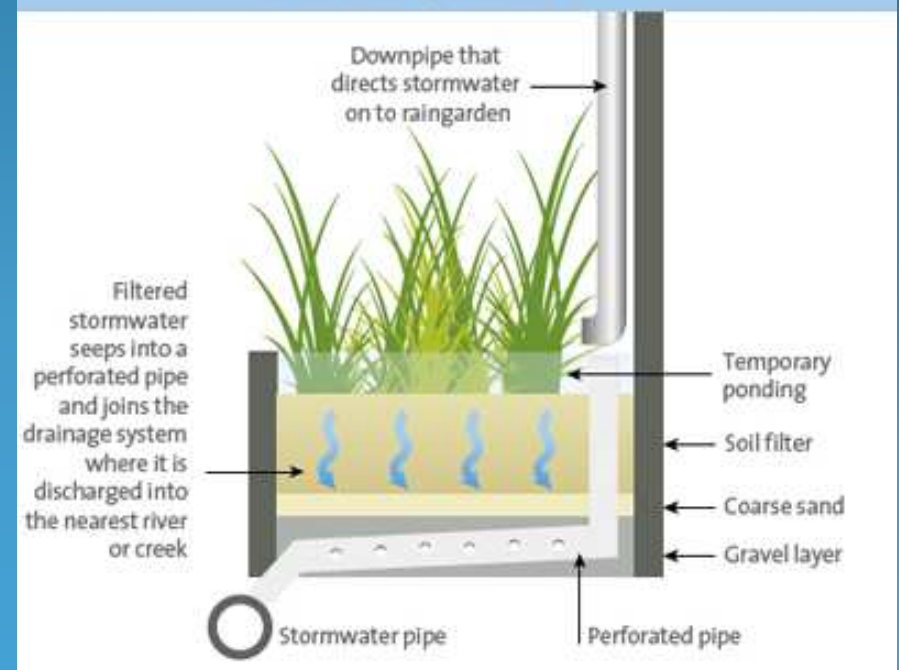


Before



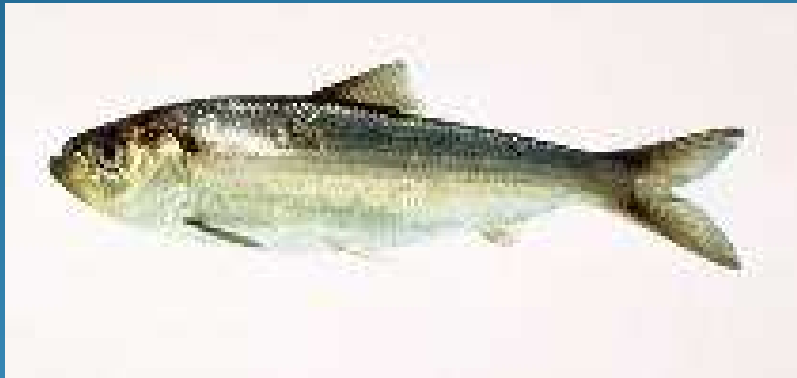
After

How raingardens work



Diadromous fish

- Species that lives in one environment throughout its life, but moves to another for spawning
- Anadromous: Lives in marine environment, spawns in fresh water. Alewife herring



- Catadromous: American eel
- Lives in fresh water, spawns in marine environment





Oyster gardening

Counting and measuring the spat

Envirothon
2009
Aquatics

