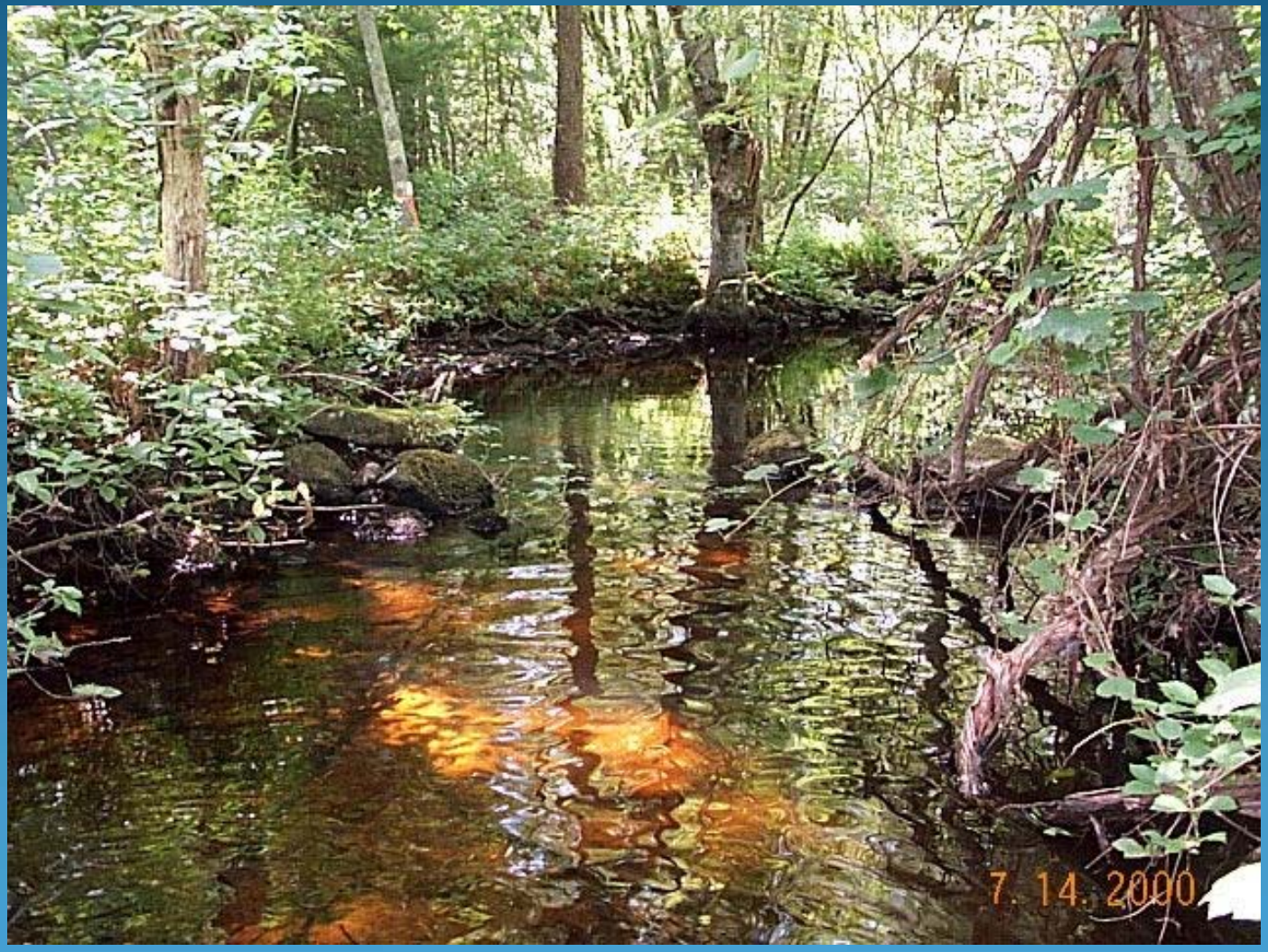
Water Quality



Impacts to Aquatic Habitats from Land-Use or Is It Polluted?

Water Pollution is:

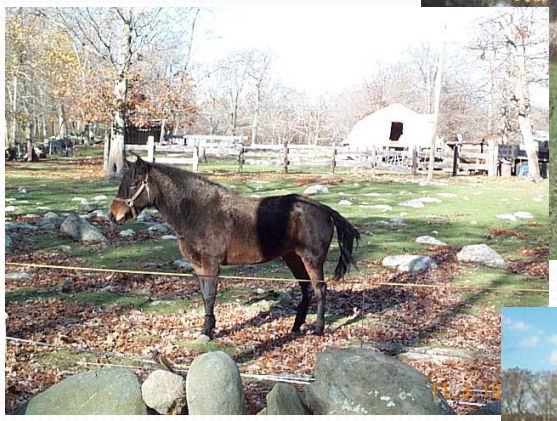
- The addition of excessive carbon to a system
- The addition of large amounts of materials to water that causes adverse changes in a system
- Effects upon water bodies caused by human activities
- To make foul or unclean; dirty

Classification of Pollution: Point Sources of Water Pollution

- End of Pipe
  - Waste water treatment plants
  - Industrial plants
- Landfills
- Gas stations
- Any known source

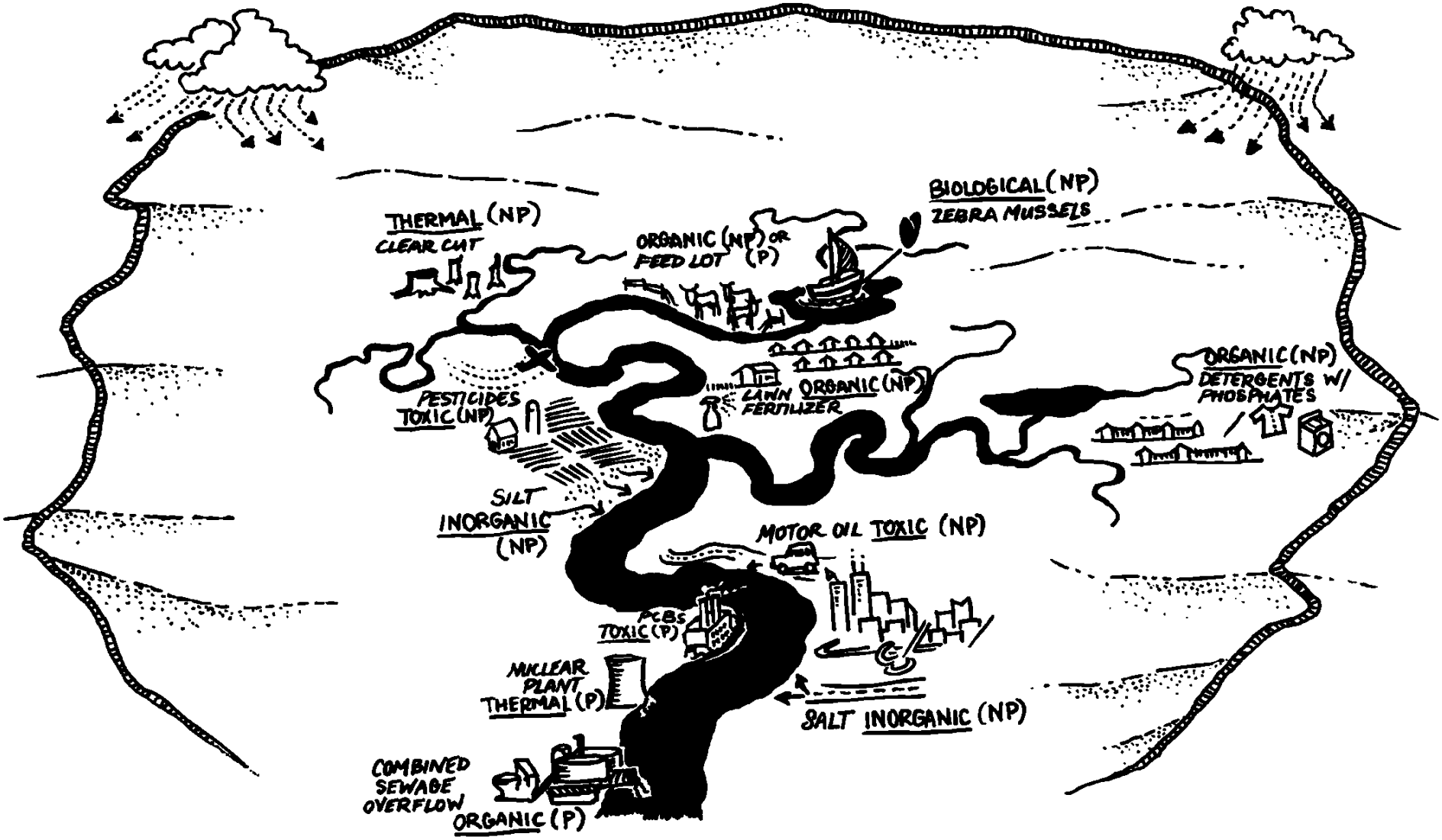
Non-Point Sources of Water Pollution

- Agriculture
  - Fertilizers
  - Herbicides
  - Pesticides
  - Manure
  - Water withdrawals
  - Sedimentation
  - Soil impaction



Sources of Non-Point Water Pollution

- Roads/Bridges
- Parking lots
- Construction
- Storm drains
- Homes
  - Lawns
  - Cleaning supplies
  - Pets
  - Leaking Septic systems
- Golf Courses
- Water fowl



NON POINT SOURCE POLLUTION = (NP)
POINT SOURCE POLLUTION = (P)

Examples of Pollutants

- Nutrients
  - Nitrogen
  - Phosphorus
- Bacteria
- Sediment
- Temperature
- Acid (pH)
- Salt
- Insecticides/Pesticides
- Heavy metals
  - Mercury
- VOC's/PCP's
- Personal medicines
- Household and industrial cleaners

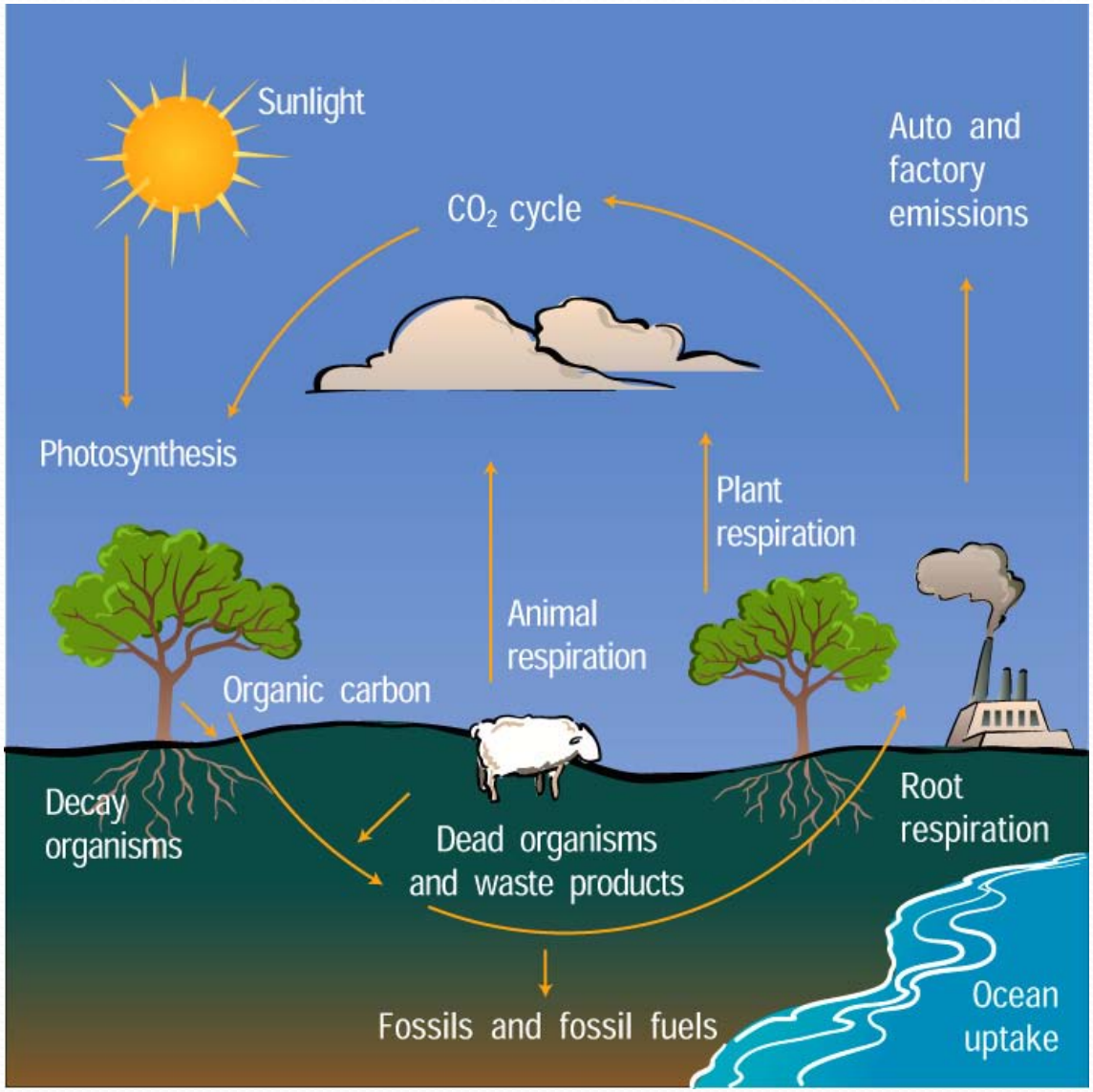
Possible Effects on Water Quality

- Adds chemicals which may be toxic to aquatic animals and plants
- Adds sediment which smothers animals and plants
- Raises water temperature
- Adds nutrients which cause noxious plant growth
- Reduces or changes water flow
- **Reduces available oxygen**

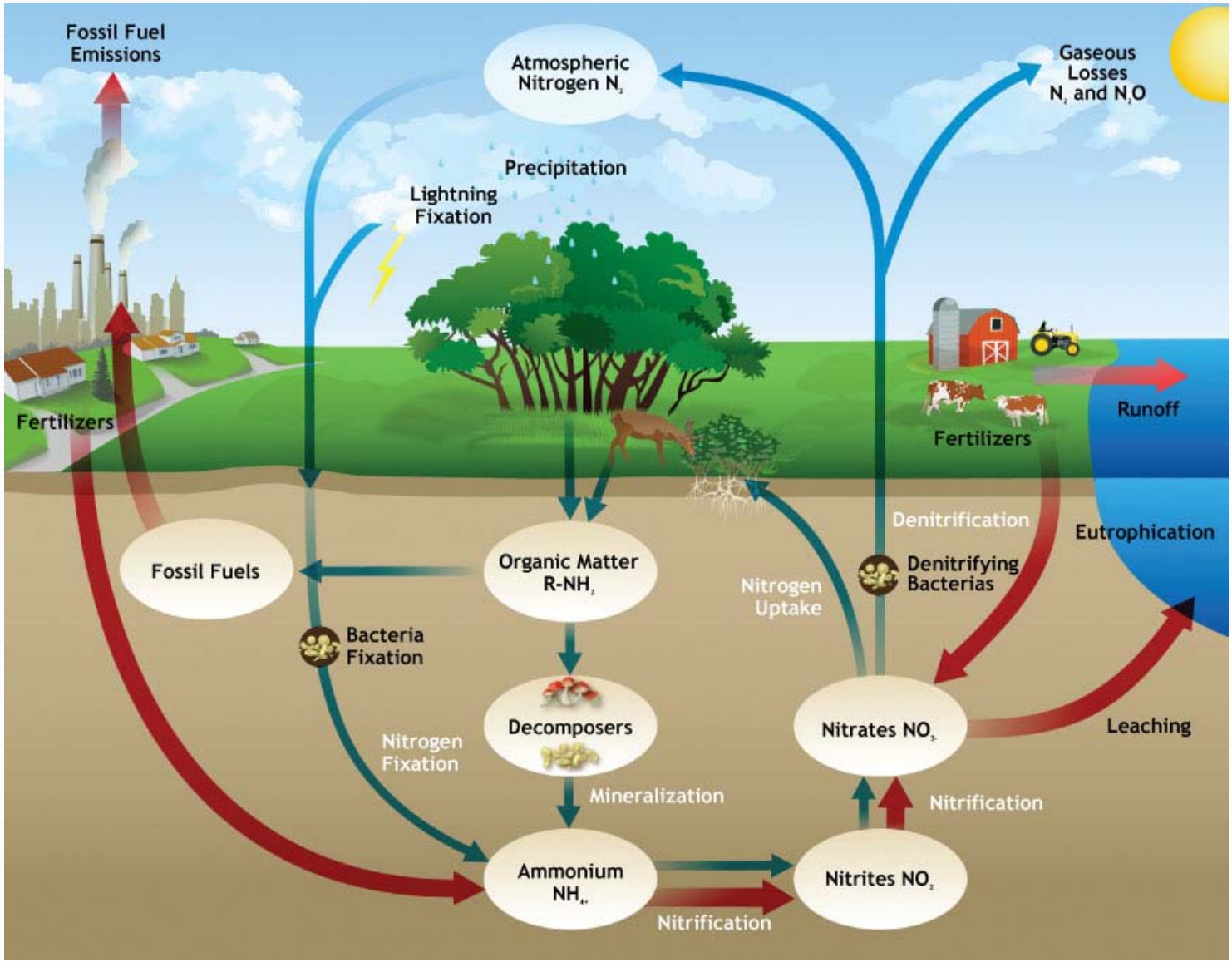
Limiting Factors

- For plants:
  - Sunlight
  - Water
  - CO_2
  - Climate
  - Phosphorous
  - Nitrogen
  - Calcium
  - Micronutrients
  - Slope
- For animals:
  - O_2
  - Water
  - Shelter
  - Food
  - Climate
  - Predation
  - Inter- and intra-species competition

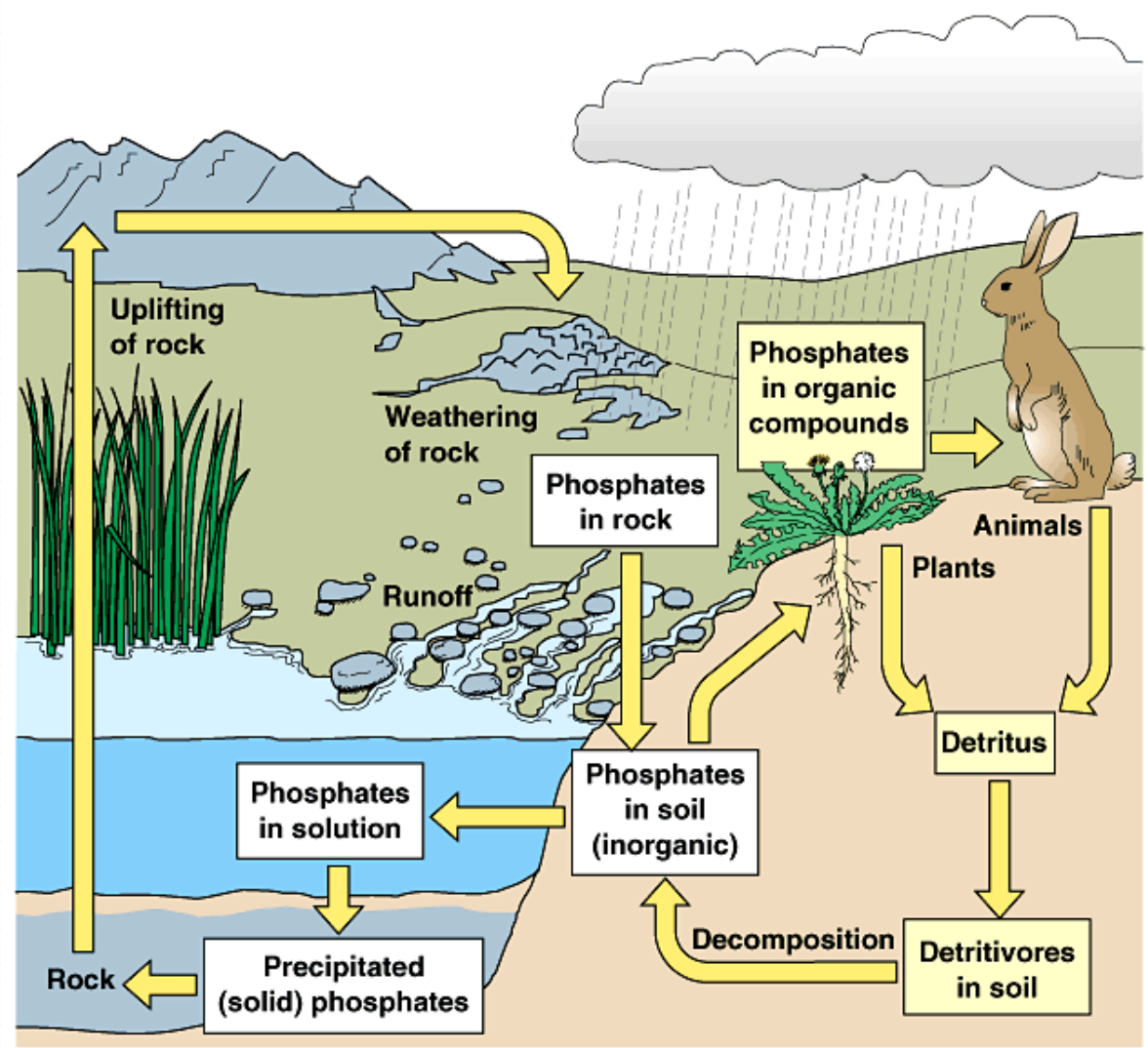
Carbon Cycle



Nitrogen Cycle (N)



Phosphorus (P)



Total Maximum Daily Limits

- Total Maximum Daily Load (TMDL) means the amount of a pollutant that may be discharged into a waterbody and still maintain water quality standards. The TMDL is the sum of the individual waste load allocations for point sources and the load allocations for nonpoint sources and natural background taking into account a margin of safety.

TMDLs

- Section 303(d) federal Clean Water Act requires the State to prepare a list of all surface waters in the state for which beneficial uses of the water are impaired by pollutants.
- Waterbodies on the 303(d) list require preparation of TMDLs to ID and quantify sources of the impairments and establish acceptable pollutant loads.
- TMDLs also include implementation strategies for reducing these point and nonpoint source loads.

Oligotrophic Lakes

- Low nutrients: low productivity, small quantity of organic matter
- Phytoplankton, zooplankton, algae, macrophytes (aquatic weeds), bacteria, and fish are all present as small populations
- Low accumulation organic sediment on bottom: small populations of bacteria.
- Low consumption of O2 from deeper waters: lots of O2 from surface to bottom
- Good water clarity
- Low chlorophyll readings
- Low phosphorus
- Bottoms often sandy and rocky and usually their watersheds are the same
- Nice clean water, no weed problems and poor fishing.
- Often deep with cold water
- Seldom in populated areas

Eutrophic Lakes

- Rich in plant nutrients and high productivity
- Low visibility
- High zooplankton > small fish> larger fish
- High organic matter drifts to the bottom
- Sediment provides food for high numbers of bacteria
- Respiration uses up much or all O2 from the lower depths
- Typically summertime depletion of O2 at lower waters
- High chlorophyll levels
- High phosphorus levels
- Often shallow with weed beds
- Fishing is often quite good in eutrophic lakes!

Mesotrohic Lakes

- Intermediate in most characteristics between the oligotrophic and eutrophic
- Production of plankton is intermediate, so some organic sediment accumulating and some loss of O2 in the lower waters
- Water is moderately clear
- Phosphorus and chlorophyll levels between those characteristic of oligotrophic and eutrophic lakes.
- Some scattered weed beds
- Fishing is often reasonably good, but cannot handle as much fishing pressure as can eutrophic lakes

Methods for Water Quality Monitoring

Chemical Sampling

- Dissolved Oxygen (DO)
- pH (acidity)
- Nutrients (Phosphorus & Nitrogen)
- Salinity
- Heavy Metals (Mercury, Copper, etc.)
- VOC's, pesticides, oil, etc.

Chemical Sampling

- Advantages
  - Relatively easy to collect
  - Cost effective for some parameters
  - Good statewide program in place through URI Watershed Watch
  - Volunteers easily trained to collect samples
- Disadvantages
  - Only provides a “snap shot” of water quality
  - Does not measure everything that could affect habitat quality
  - Usually requires laboratory analysis

Bacteria

- **Bacteria, Enterococci Data, MPN/100 mL**
  - RI DEM freshwater contact criteria: 61 (single sample), 54 (non-beach geomean), 33 (beach geomean).
  - RI DEM saltwater contact criteria: 104 (single sample), 35 (geomean).

- **Bacteria, E. coli Data, CFU**
  - Stopped monitoring in 2004.
  - EPA fresh water standards for recreational contact: 126/100 mL.

Chloride (mg/L)

- Low < 100 mg/L
- Moderate 100 - 250 mg/L
- High > 250 mg/L
- National Aquatic Life Criteria: 860 mg/L for acute exposure, 230 mg/L for chronic exposure
- EPA suggested drinking water standard = 250 ppm. The EPA standard is the point at which a salty taste becomes generally apparent.

Phosphorus, Total (ug/L)

- Rivers: Council for Environmental Quality recommend
  - Maximum of 100 ppb TP in-stream
  - Maximum of 50 ppb TP where a river enters a lake
  - EPA guidelines suggest a limit of 31 ppb.
- Lakes and Ponds:
  - Low (Oligotrophic) TSI<40 (<12 ug/L),
  - Moderate (Mesotrophic) TSI 40-50 (12-24 ug/L),
  - High (Eutrophic) TSI 50-65 (25-66 ug/L),
  - Extremely high (Hypereutrophic) TSI >= 65 (>66 ug/L)
  - TSI_Calc = (14.42 *N(Mean TP))+ 4.15.

Nitrogen, Total (ug/L)

- Low (Oligotrophic) < 320
- Moderate (Mesotrophic) 320 - 710
- High (Eutrophic) 710 - 1000
- Extremely high (Hypereutrophic) >1000
- EPA suggested limits for rivers and streams : not to exceed 0.71 ppm (710 ug/L)

Physical Parameters

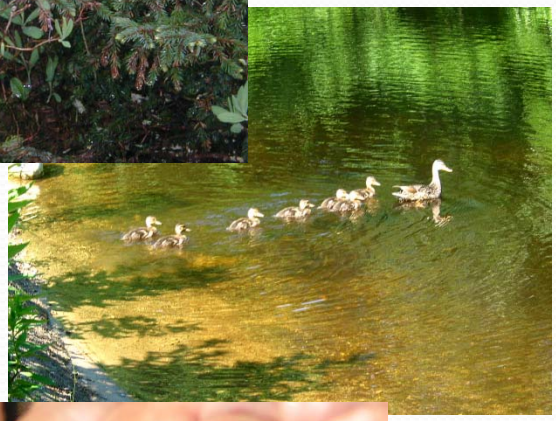
- Temperature
- Suspended solids or turbidity
- Substrate composition
- Stream flow
- Vegetated banks
- Debris for habitat

Physical Parameters

- Advantages
  - Gives a more holistic view of habitat
  - Identifies likely stream populations
  - Can be used to make initial assessments
- Disadvantages
  - Requires training
  - Relies on subjective measurements
  - Does not measure everything that could affect habitat quality
  - Does not look at water chemistry

Biological Sampling

- Aquatic plants
- Obligate mammals
- Birds
- Fish
- Reptiles and amphibians
- Macroinvertebrates
  - Insects
  - Arachnids
  - Crustaceans
  - Mollusks
  - Worms
- Invasive Species



Biological Sampling

- Advantages
  - Animals live in the water a good portion of their lives
  - Species richness and population distributions can indicate current or recent disturbances
  - Macroinvertebrates are easy to collect
- Disadvantages
  - Requires training
  - Family identification can be difficult
  - Data base difficult to maintain
  - Must have standardized collection and ID methods