Aquatic Station

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Envirothon Curriculum

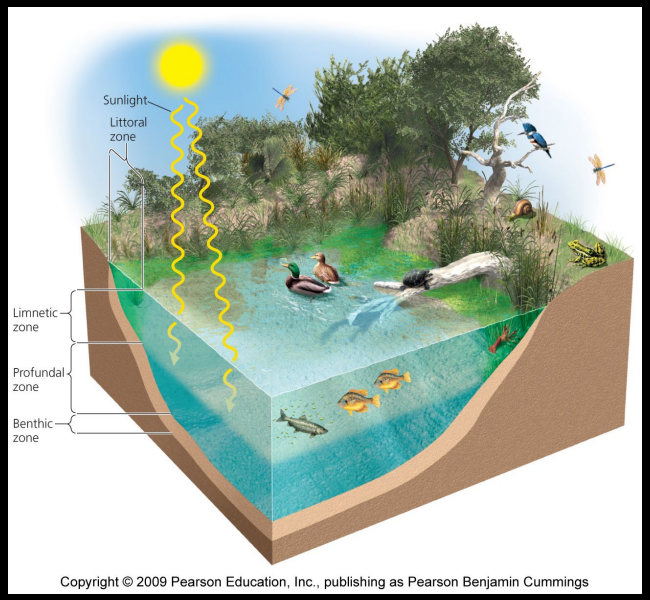
- Hydrosphere
- Aquatic Ecosystems
- Organisms
- Aquatics and Society
- Field Skills

Learning Objective 1: Hydrosphere

- Identify different types of water bodies/how they are formed

Rivers

Wetlands



Lakes

Study Area 1: Hydrosphere

- Types of Wetlands
  - Tidal salt marshes
  - Tidal freshwater marshes
  - Non-tidal marshes
  - Swamps
  - Carolina Bays
  - Vernal pools
  - Bogs/pocosins

Study Area 2: Aquatic Ecosystems

- Describe structure of aquatic ecosystms

Productivity

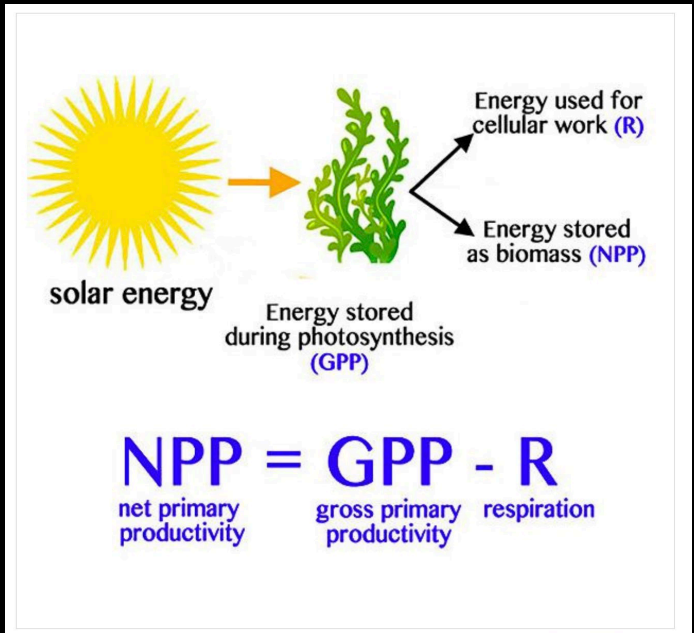
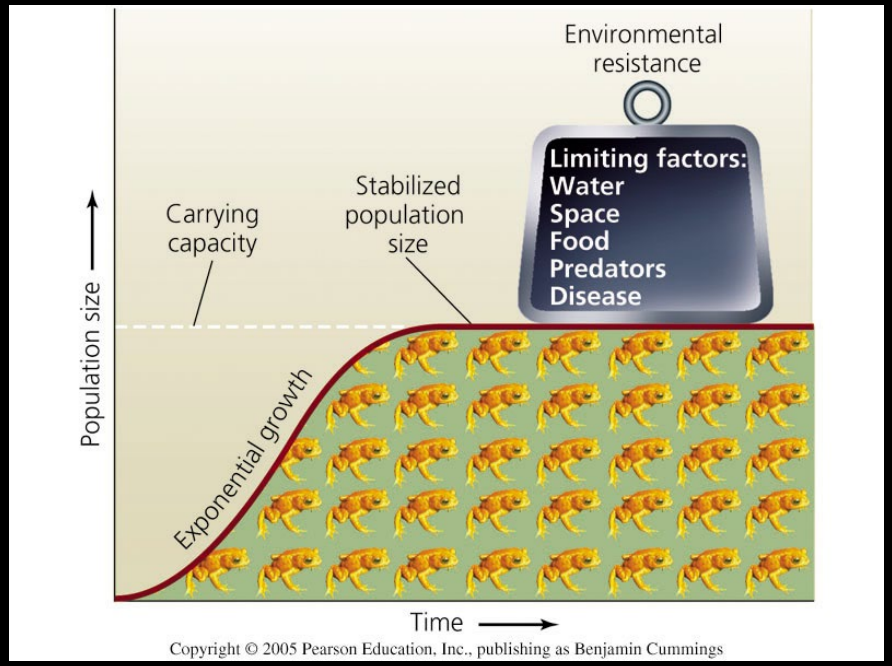


Figure 1: Look at the figure to understand the basic difference between NPP and GPP. Image Credit: Miami.edu.

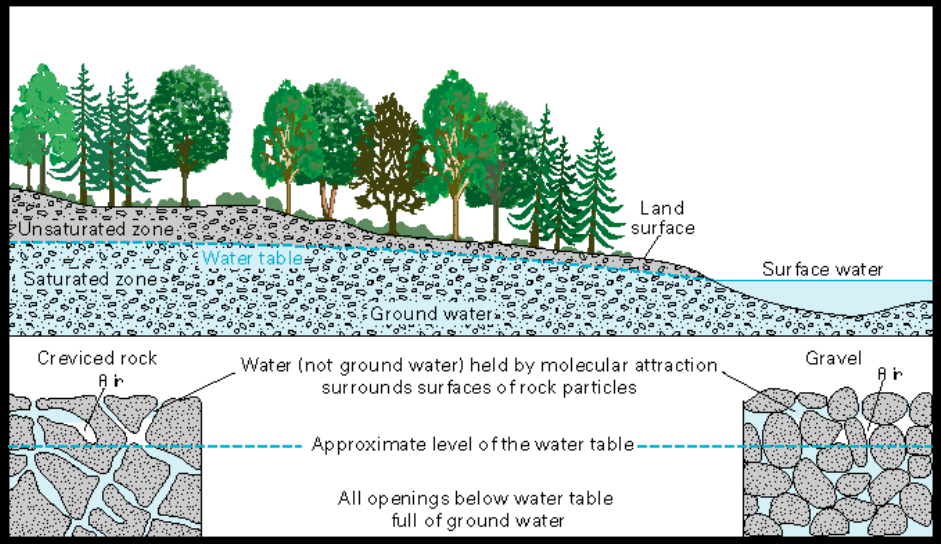
https://www.bio.miami.edu/dana/pix/npp.jpg

Carrying Capacity

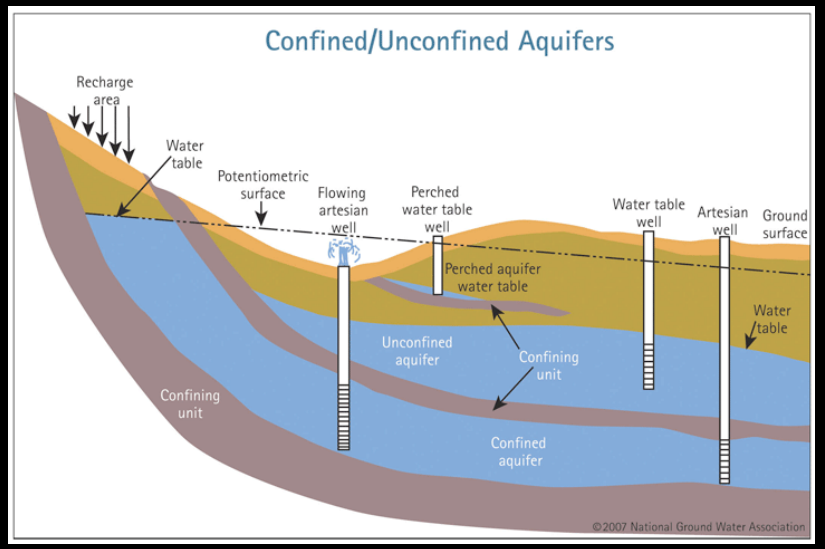


Study Area 2: Aquatic Ecosystems

- Define and aquifer and elaborate on how they relate to local and global water supply



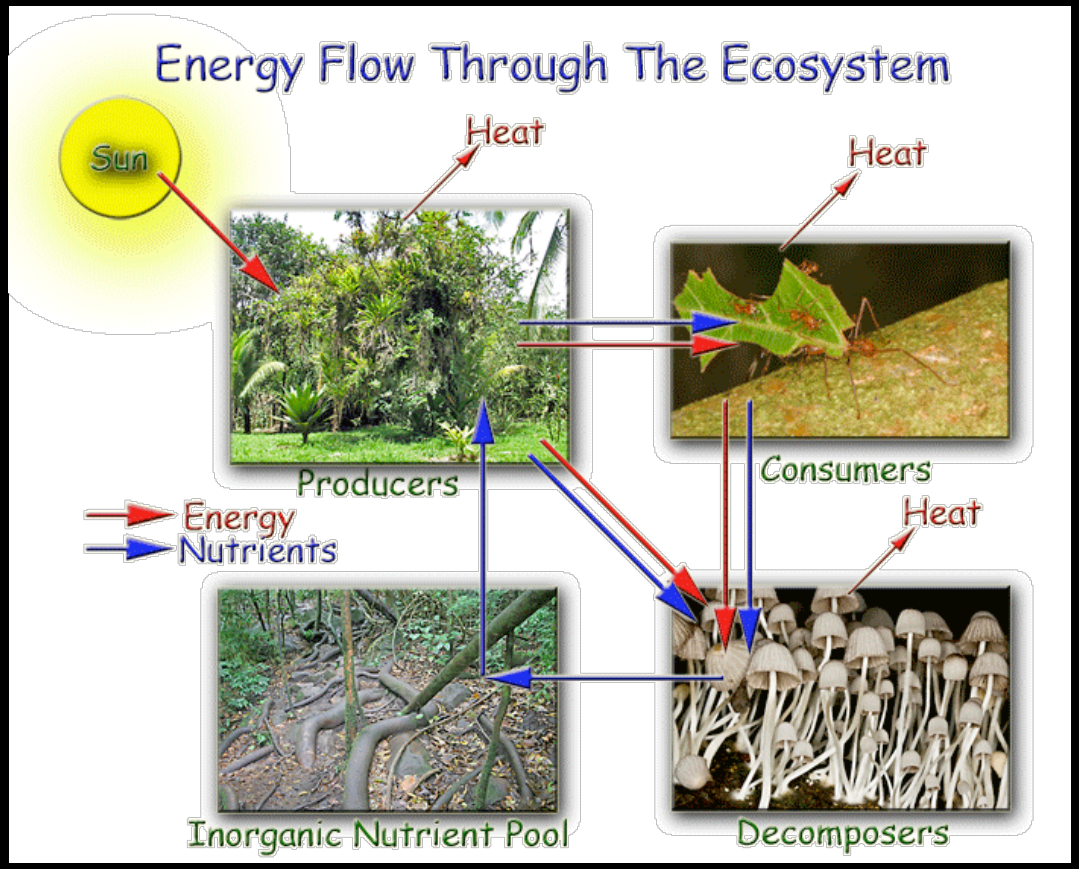
http://ga.water.usgs.gov/edu/earthgwaquifer.html



http://www.ngwa.org/Fundamentals/use/Pages/Groundwater-facts.aspx

Study Area 2: Aquatic Ecosystems

- Diagram a food web and describe the flow of energy within it



http://www.marietta.edu/~biol/biomes/ecosystems.htm#Energyflowthroughtheecosystem3

Study Area 2: Aquatic Ecosystems

- Stream Order
  - Starts with 1: smallest, permanently flowing stream
  - Stream of same order come together, to create next order
    - 1+1 =2; 2+2 = 3, etc.

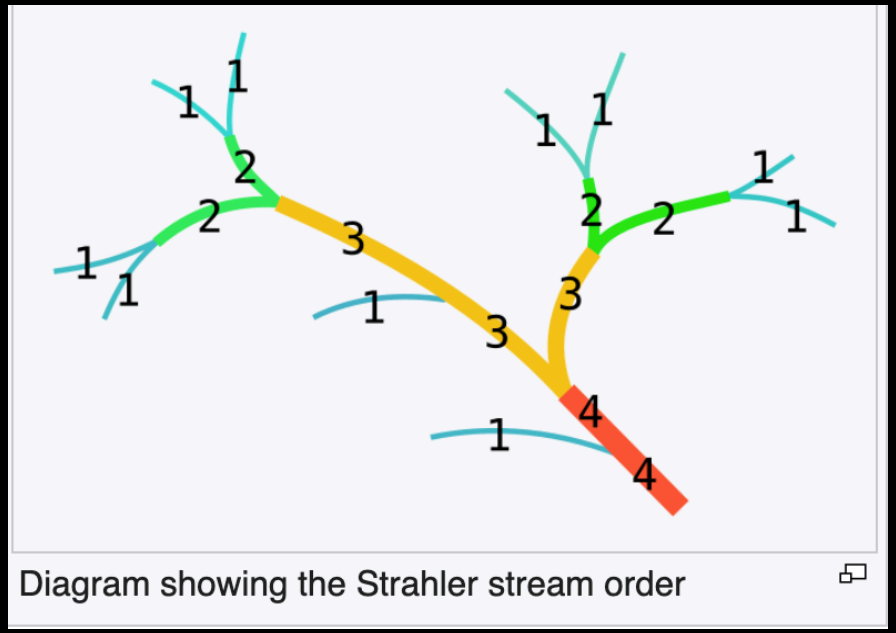
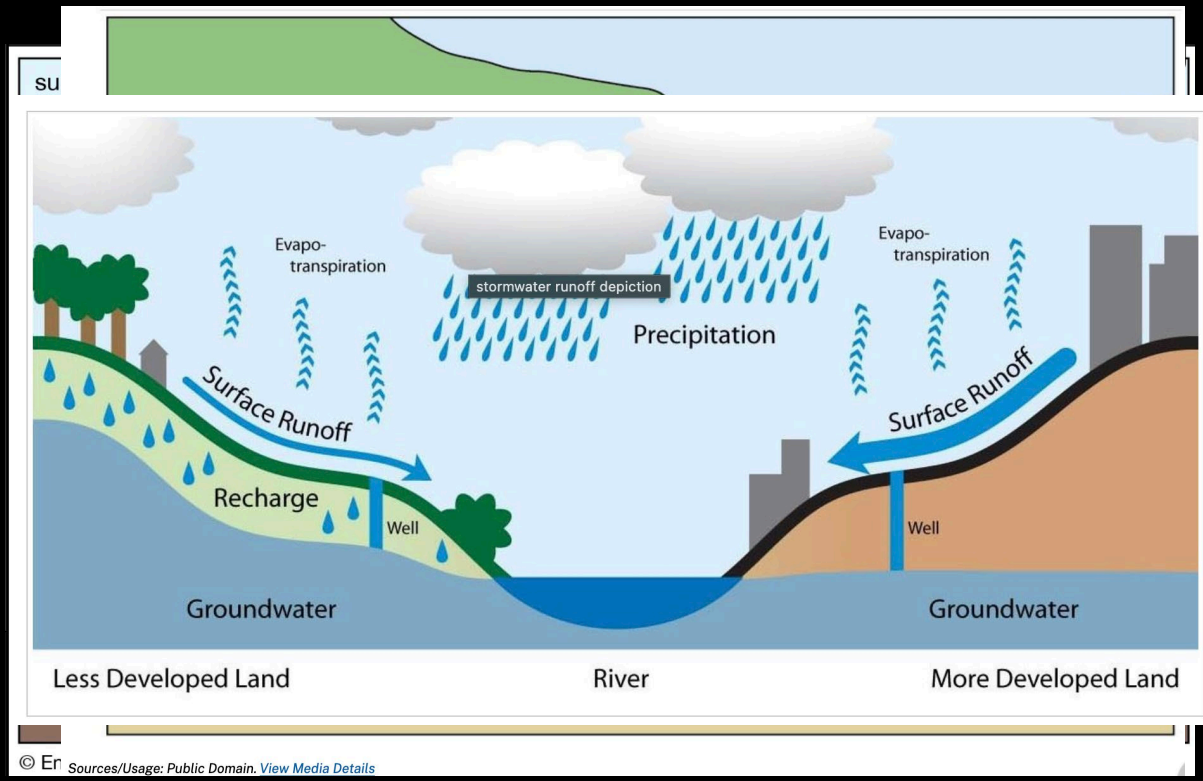


Diagram showing the Strahler stream order

https://en.wikipedia.org/wiki/Strahler_number

Study Area 2: Aquatic Ecosystems

- Describe the basics of hydrology, including
  - Stratification
  - Discharge
  - Runnoff



Sources/Usage: Public Domain. View Media Details

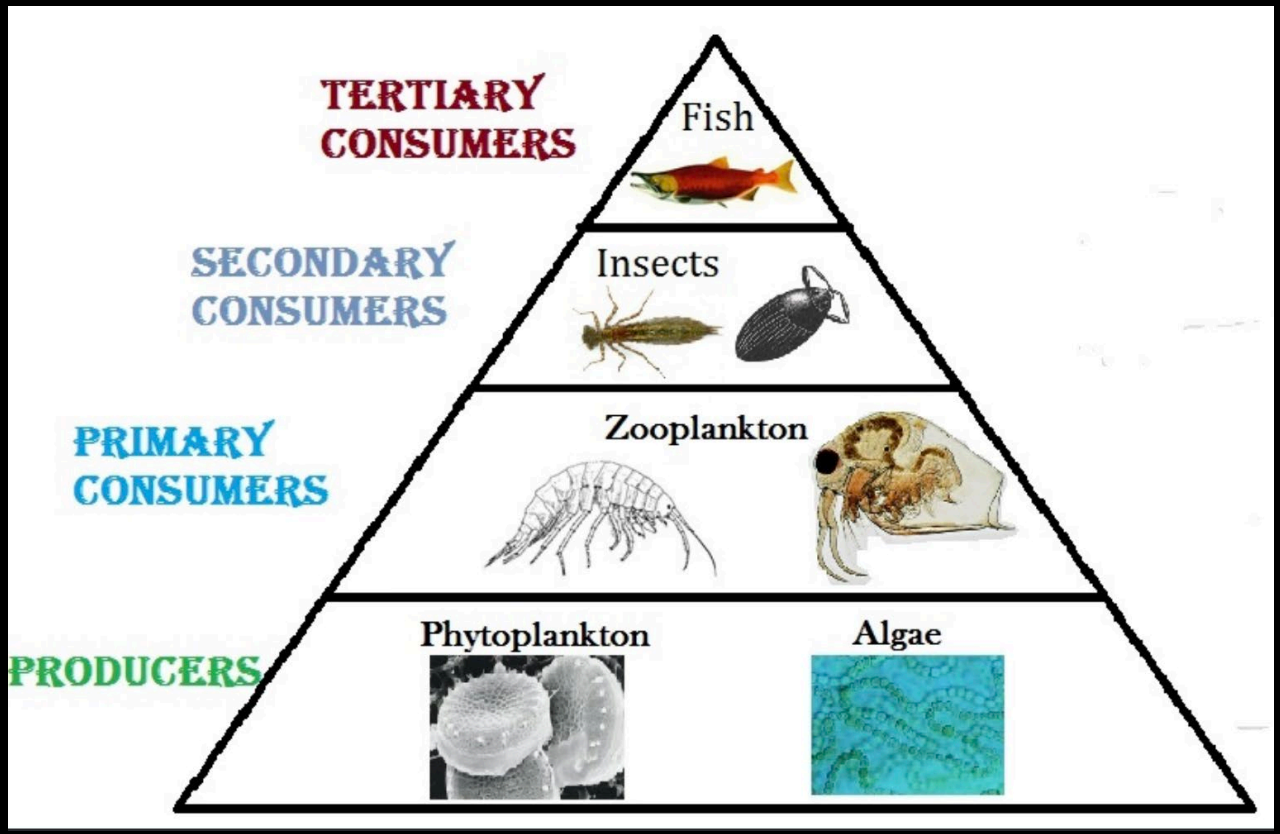
https://www.britannica.com/science/inland-water-ecosystem/Permanent-bodies-of-standing-fresh-water#ref588630

https://www.usgs.gov/special-topics/water-science-school/science/how-streamflow-measured

https://www.westonma.gov/253/Stormwater-FAQs

Study Area 3: Organisms

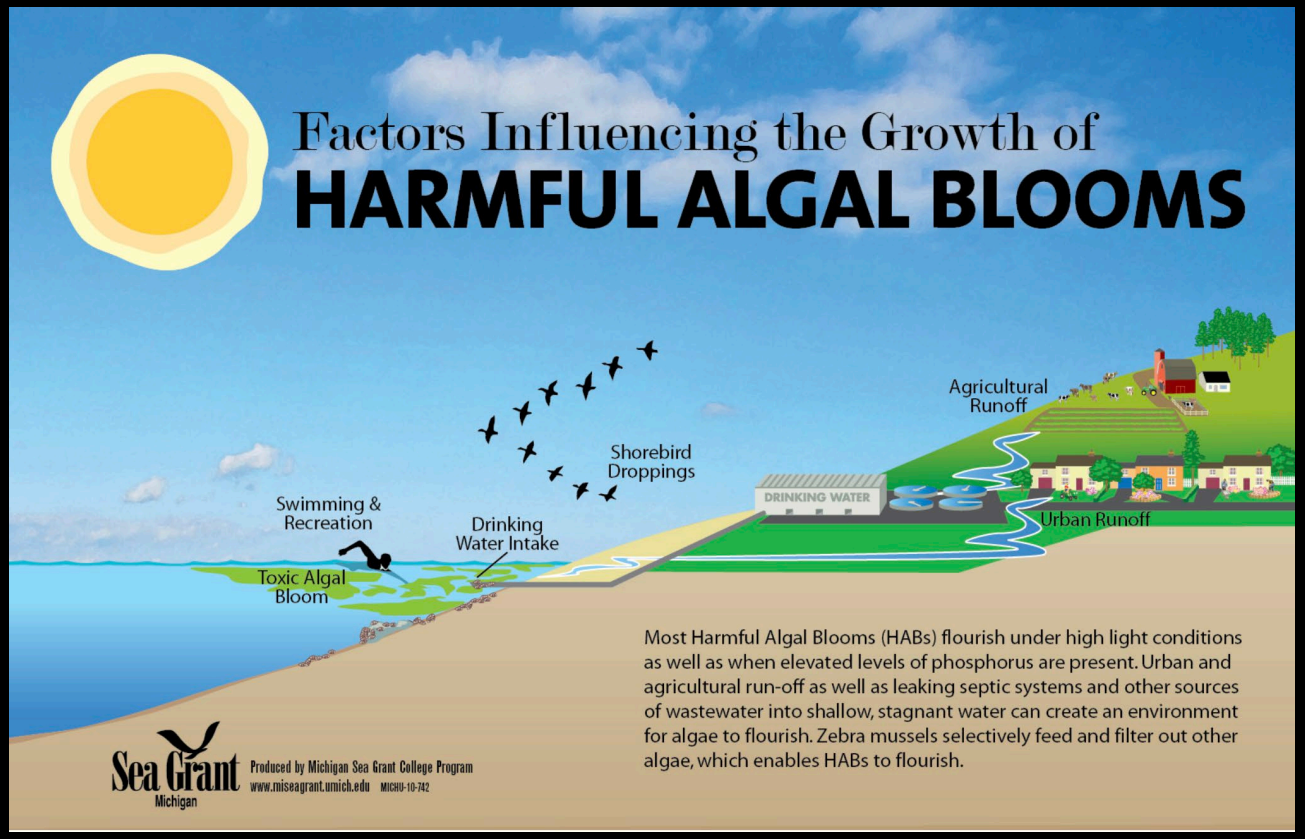
- Describe the roles of producers, consumers and decomposers and identify their trophic levels



https://craterlake-wes-apbio.weebly.com/ecosystem-relationships.html

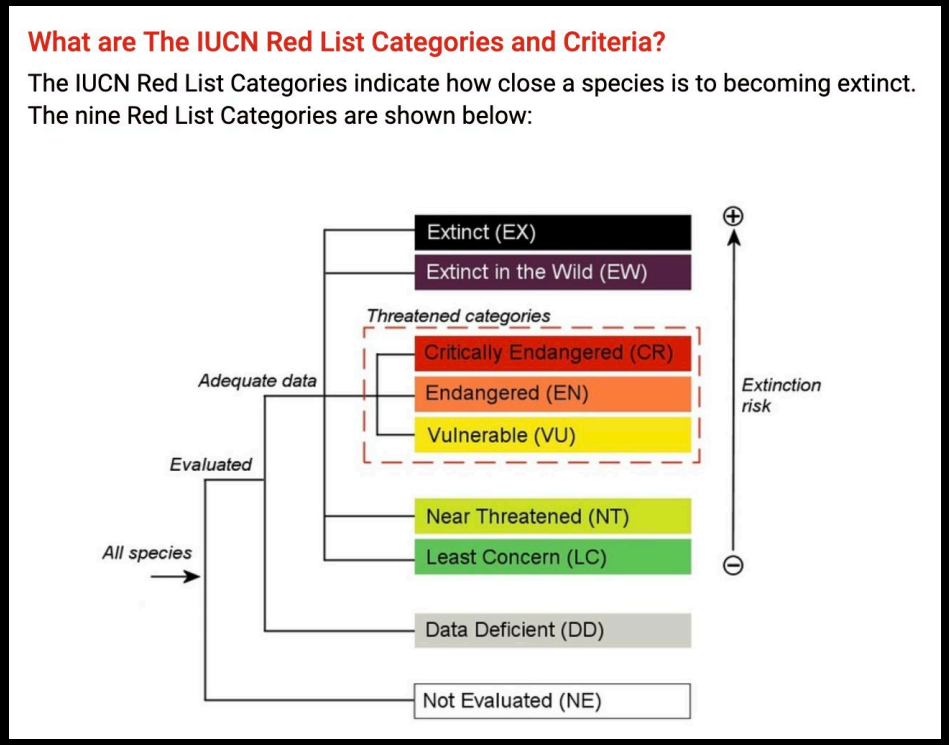
Study Area 3: Organisms

- Describe the roles cyanobacteria and their role in harmful algal blooms (HABs)



Study Area 3: Organisms

- Explain the distictions between species designations (such as common, threatened, endangered, etc.)

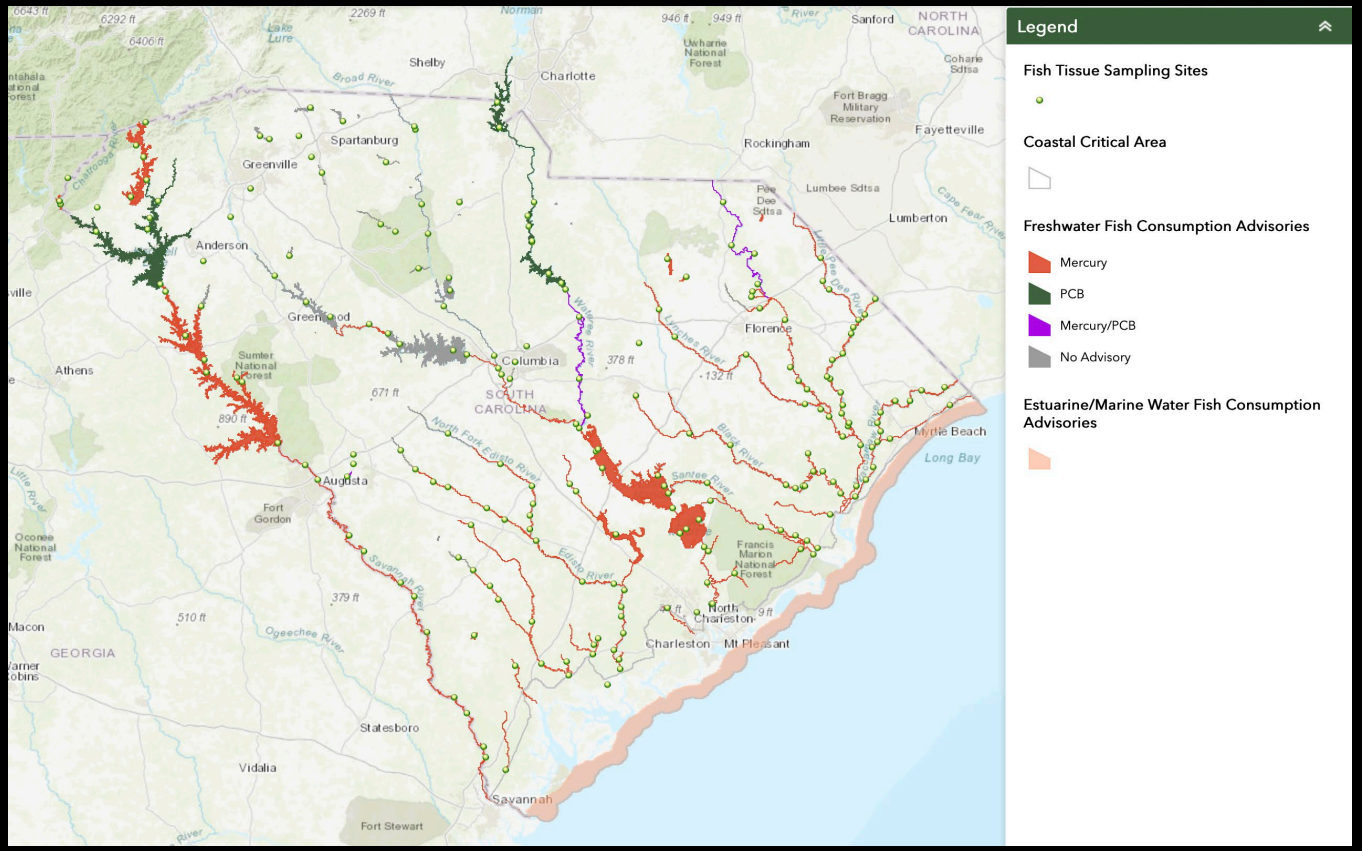


US EPA Categories	
Endangered	Organisms that have become so rare they are in danger of becoming extinct
Threatened	Organisms that are likely to become endangered within the foreseeabel future throughout all or a significant portion of their range

https://www.iucnredlist.org/about/faqs

Study Area 4: Aquatics and Society

- Human impact on water quality
  - Fish consumption advisories



https://gis.dhec.sc.gov/gisportal/apps/webappviewer/index.html?id=c71943bc743b4ca196e0ef0406b1d7ab

Study Area 4: Aquatics and Society

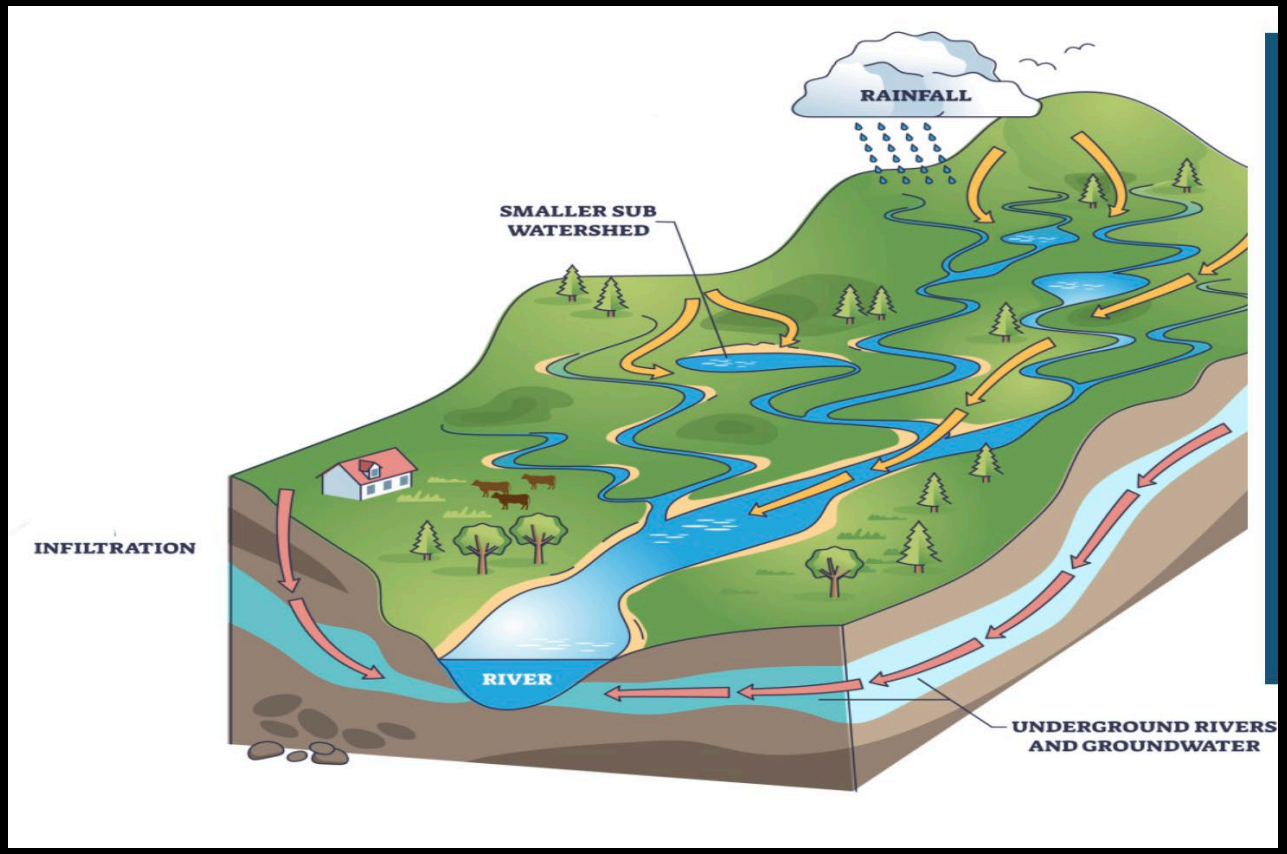
- Identify how major legislation protects water resources
  - Clean Water Act
    - Goal:
      - To restore and maintain the chemical, physical, and biological integrity of the Nation's watersMechanism:
    - Legal mechanisms:
      - Illegal to discharge into navigable water way without a permit

Study Area 4: Aquatics and Society

- Identify key stakeholders, agencies and organizations that oversee water resource protection and management
  - U.S. EPA
    - Protects surface, ground and drinking water; administers Clean Water Act, Safe Drinking Water Act
  - U.S. Bureau of Reclamation
    - Oversees water storage, delivery, diversions, hydropower in Western U.S.
  - U.S. Geological Survey
    - Provides information on hydrology of U.S., including maps, stream gauging, etc.
  - U.S. Army Corps of Engineers
    - Oversees water navigation, flood control, recreation, hydroelectric power, shore protection, water supply, some restoration work
- **State (for SC, will vary by state)**
  - DES
    - Monitor water quality, issue permits, enforce state & federal regulation, etc.
  - DNR
    - Monitor fisheries / wildlife
- **Local**
  - Supply drinking water / treat waste

Study Area 4: Aquatics and Society

- Explain why it's important to consider the entire watershed when planning for water quality



https://www.nrcs.usda.gov/programs-initiatives/watershed-programs

Study Area 4: Aquatics and Society

- Identify state river basins

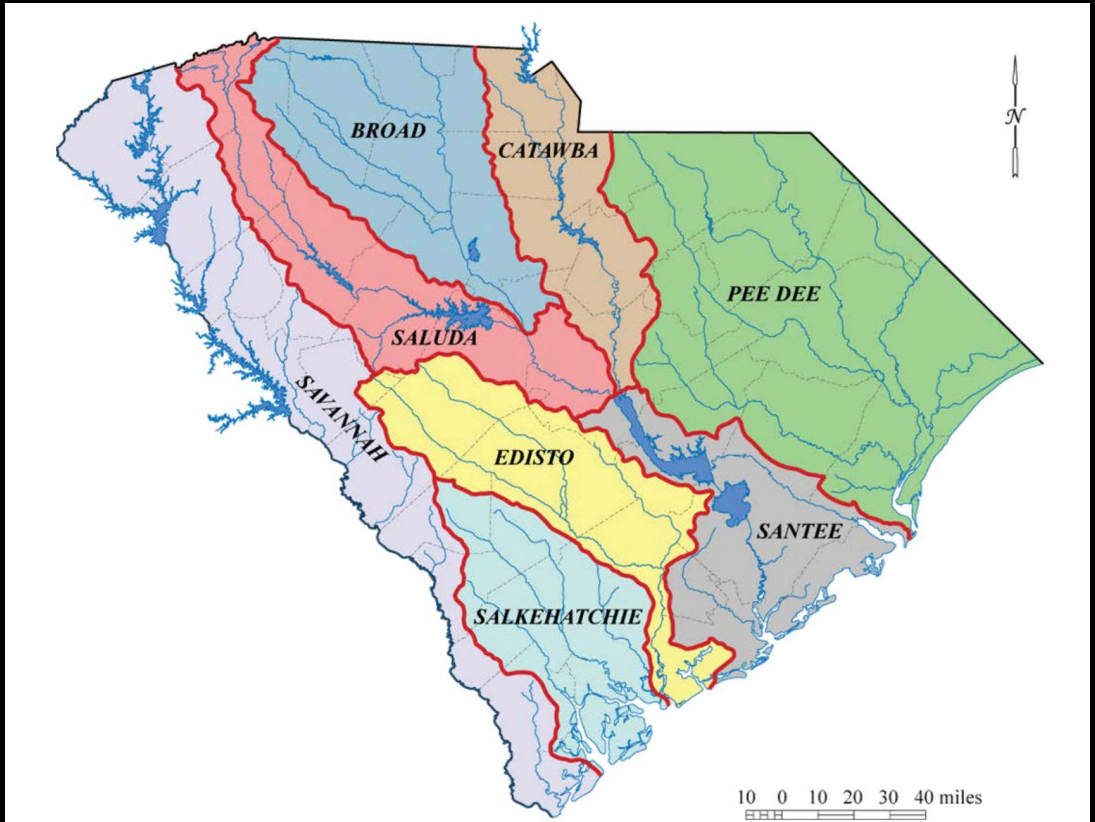


Figure 1. Map showing the eight major surface-water basins in South Carolina.

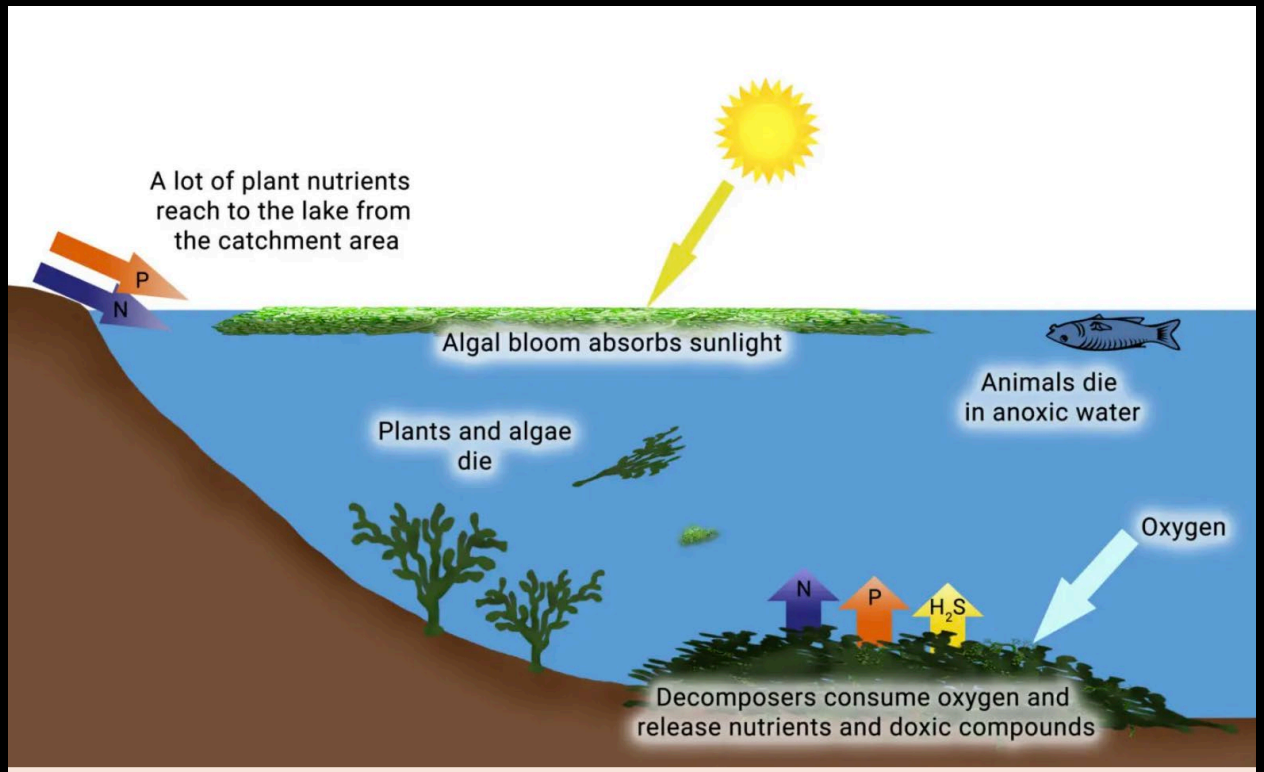
https://www.dnr.sc.gov/water/waterplan/pdf/Major_Basins_of_South_Carolina.pdf

Study Area 4: Aquatics and Society

- Describe water conservation practices
  - Agricultural and industrial
    - E.g. drip irrigation, center pivot maintenance/optimization, cover crops, etc.
  - Personal
    - water saving showerheads (2.5 gallons per minute vs. 5 to 8), low flush toilets (1.6 vs. 7 gallons of water), etc.

Study Area 4: Aquatics and Society

- Describe eutrophication and how it affects lakes and ponds



he consequences of eutrophication for the lake ecosystem. Figure: Piret Vutt.

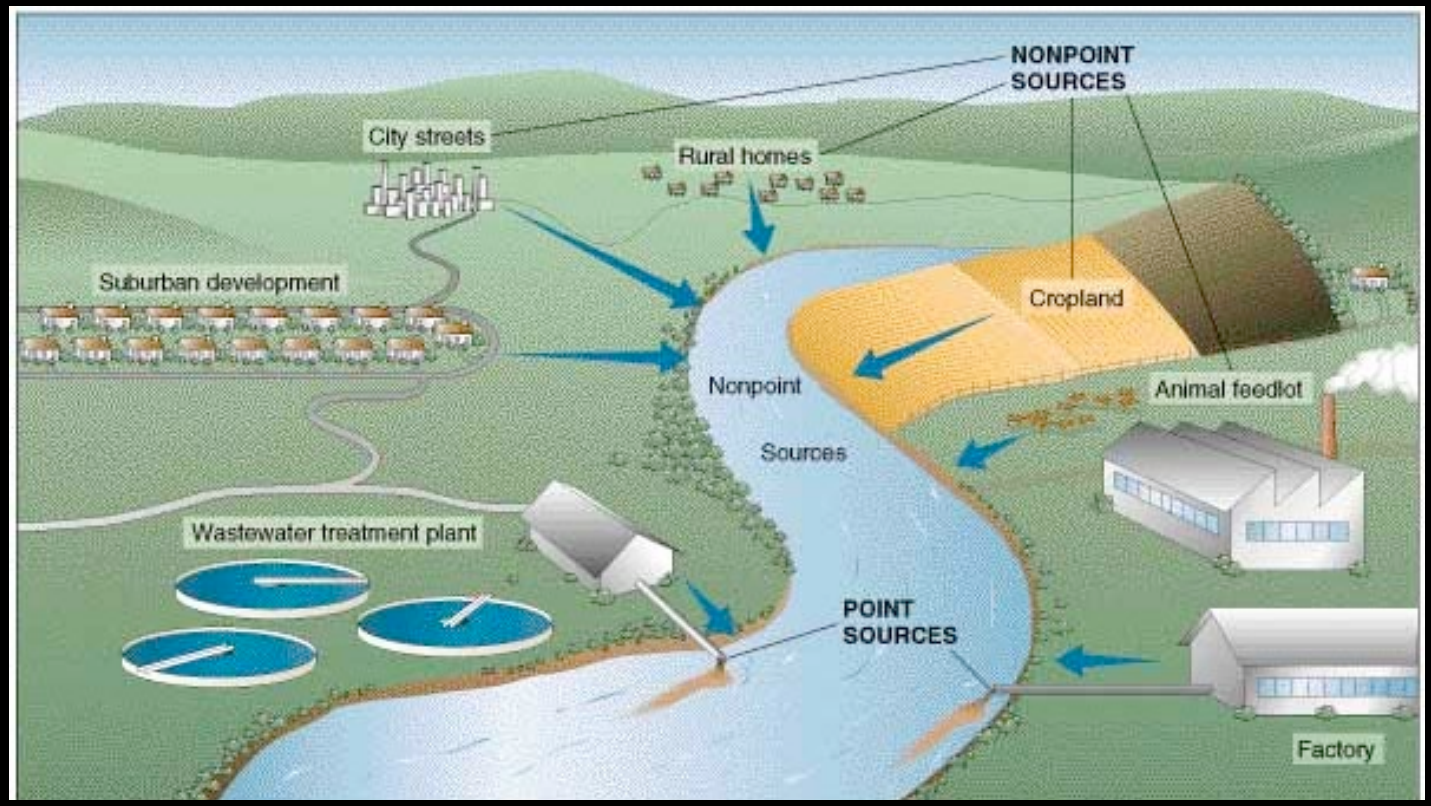
Study Area 4: Aquatics and Society

- Recommend best management practices for improving water quality such as riparian buffers

http://dodgeswcd.org/conservation-buffers/

Study Area 4: Aquatics and Society

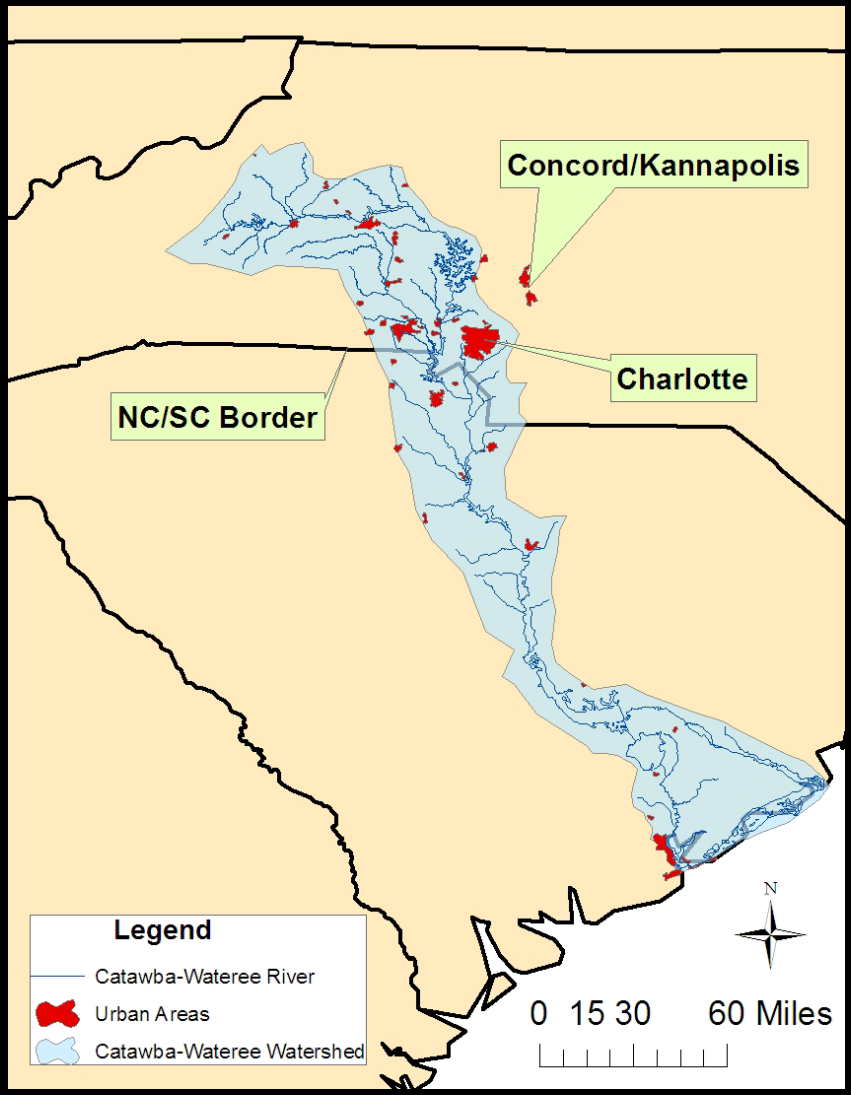
- Disntinguish between point and nonpoint sources of pollution



http://apesnature.homestead.com/chapter17.html

Study Area 4: Aquatics and Society

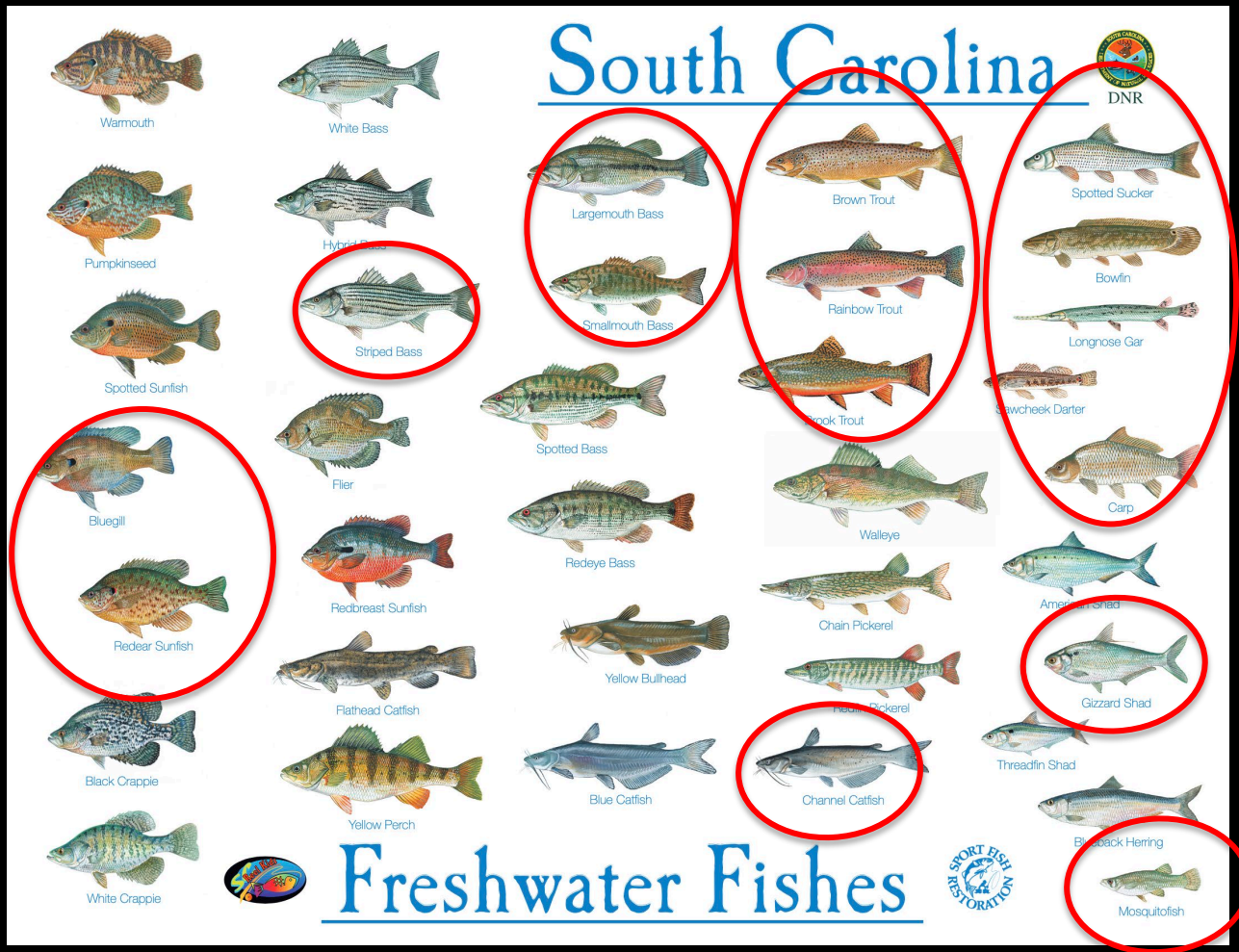
- Explain economic/societal/etc. impacts on water resources, such as fight between NC and SC over Catawba River



https://www.circleofblue.org/2011/world/north-vs-south%E2%80%94carolina-states-settle-water-dispute-without-supreme-court/

Study Area 5: Field Skills

- Identify common fish in SC



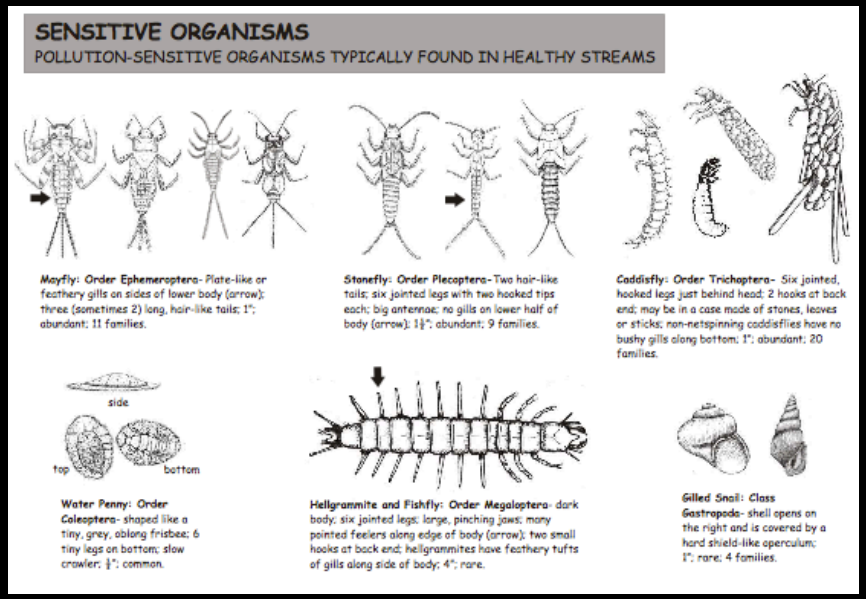
https://www.dnr.sc.gov/freshwater.html

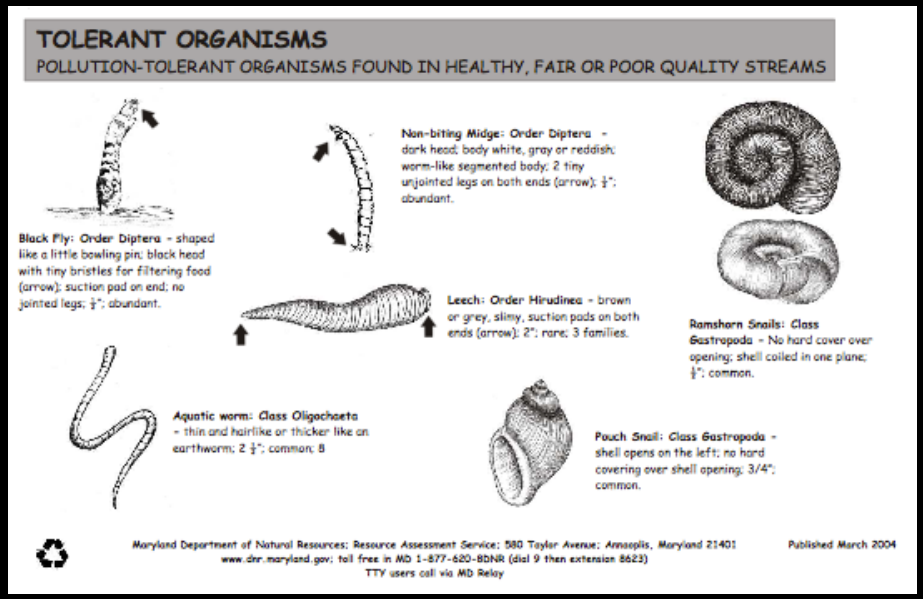
Study Area 5: Field Skills

- Identify common aquatic macroinvertebrates
  - See guide at end of this PowerPoint

Study Area 5: Field Skills

- Identify macroinvertebrates pollution tolerances
  - Some species more tolerant than others
    - Type / number of organisms reflects water quality
    - https://dnr.maryland.gov/streams/Documents/dnr_bugsheet.pdf





Study Area 5: Field Skills

- Calculate a biotic index and determine water quality for freshwater systems
  - See key/guides here: https://stroudcenter.org/macros/key/
  - https://www.macroinvertebrates.org/key

Study Area 5: Field Skills

- Indentify common invasive aquatic species in SC
  - Examples:
    - Hydrilla
    - Asian clam
    - Zebra mussel
    - Flathead catfish
    - Lionfish
    - Nutria
  - Info here: http://www.dnr.sc.gov/water/envaff/aquatic/invaders.html
  - And in the Aquatic Invasive Species Plan here (link on left side): http://www.dnr.sc.gov/water/envaff/aquatic/ais.htm

Study Area 5: Field Skills

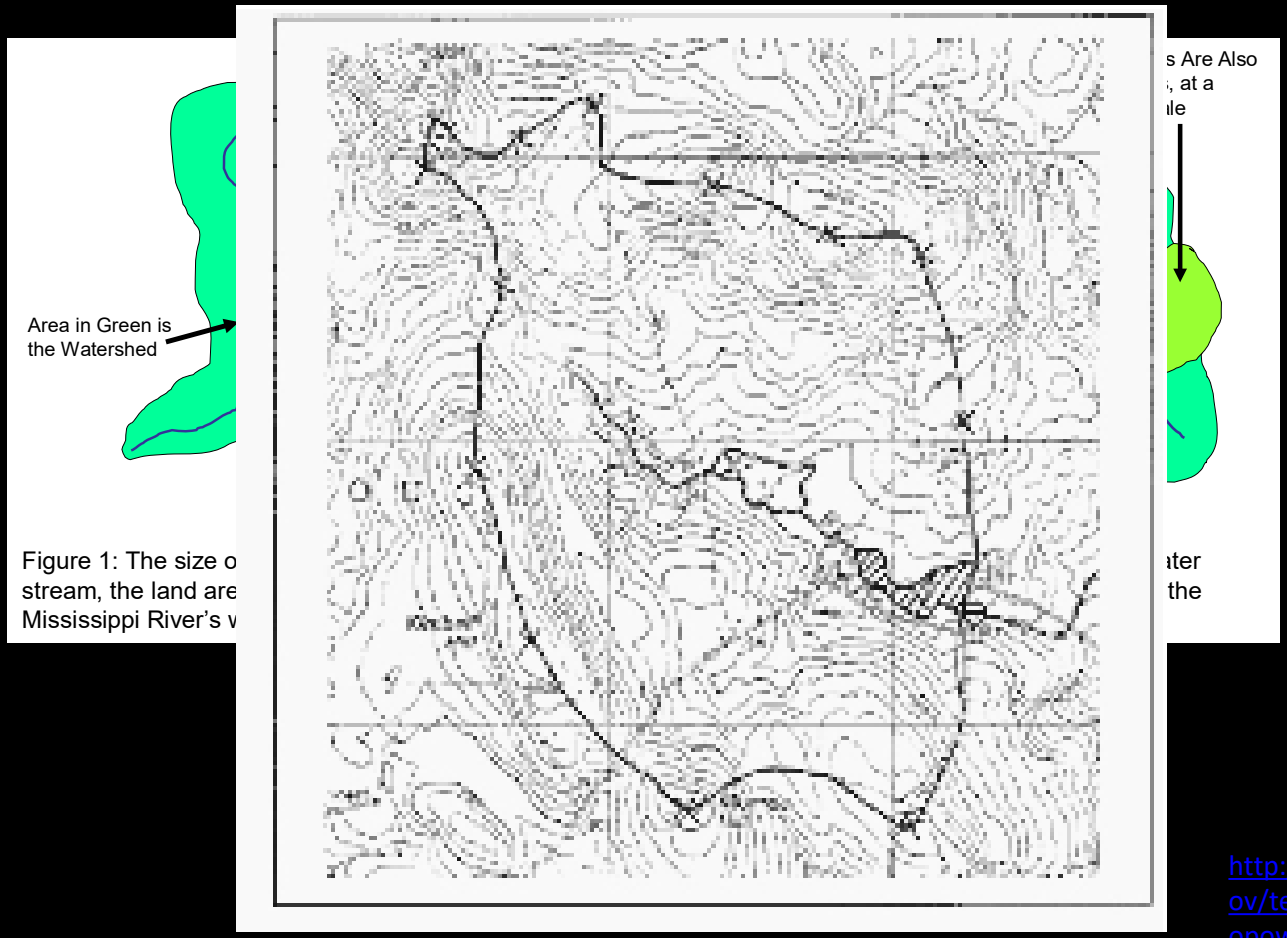
- Interpret results of water quality measures

SC DES Water Quality Standards - Quick Guide			
Category	**Criteria**	**SC DES Standard**	**Notes**
Nutrient criteria	Chlorophyll a	not > 40 ug/L ; for coastal plain	Different criteria for other ecoregions
Nutrient criteria	Total phosphorous	not > 0.09 mg/L; for coastal plain	Different criteria for other ecoregions
Nutrient criteria	Total nitrogen	not > 1.5 mg/L; for coastal plain	Different criteria for other ecoregions
Bacteria	E coli	monthly ave of 126 MPN per 100 ml; daily max of 349 MPN	
Water chemistry	Dissolved oxygen	daily ave of not less than 5.0 mg/L; low of 4.0 mg/L	
Water chemistry	pH	6-8.5	Does not recognize naturally occuring low pH in blackwater systems
Water chemistry	Turbidity	Not > 50 NTUs (not> 25 NTUs for lakes)	
Water chemistry	Mercury	1.6 ug/L (CMC); 0.91 ug/L (CCC)	CMC = Criterioin maxium concentration (acute toxicity number); CCC = Criterion continuous conenctration (chronic toxicity number)

https://des.sc.gov/sites/des/files/Library/Regulations/R.61-68.pdf

Study Area 5: Field Skills

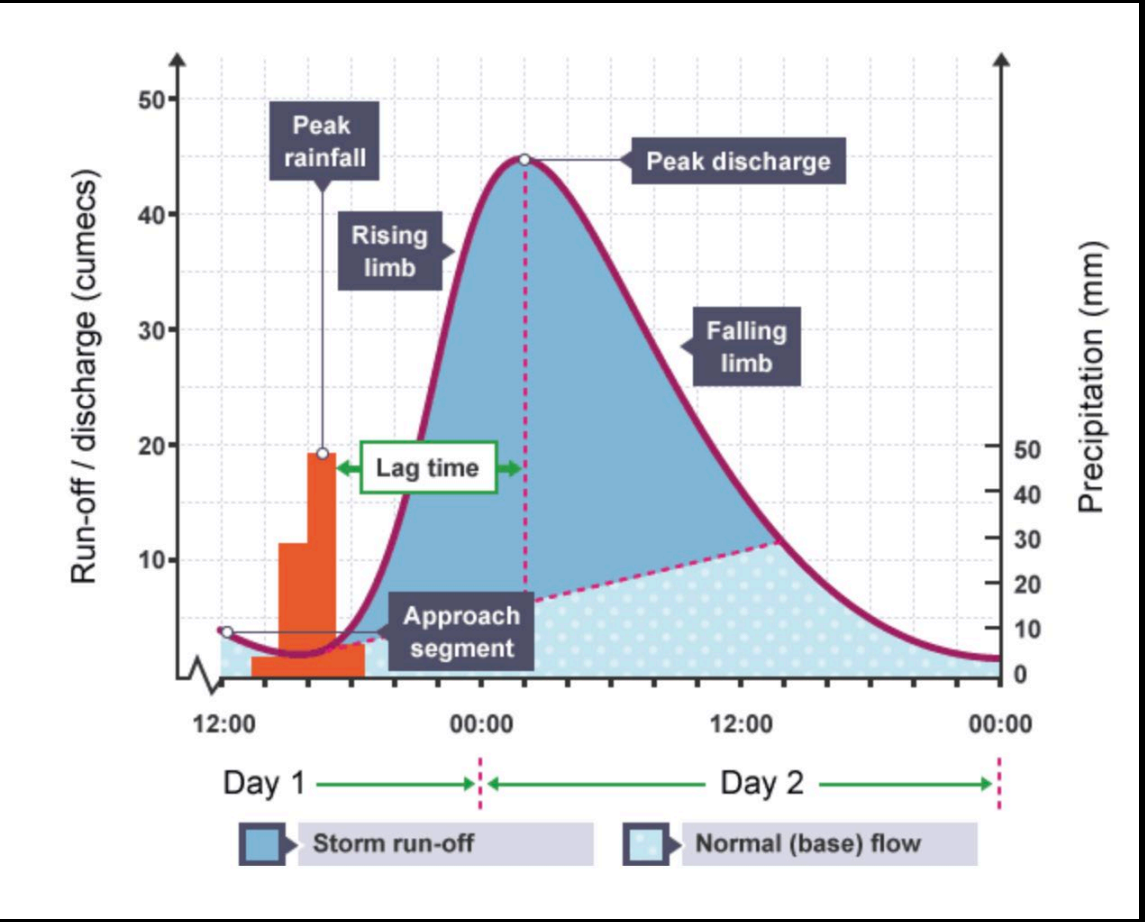
- Delineate a water shed using a topographic map



http://www.nh.nrcs.usda.gov/technical/Publications/Topowatershed.pdf

Study Area 5: Field Skills

- Interpret a hydrograph



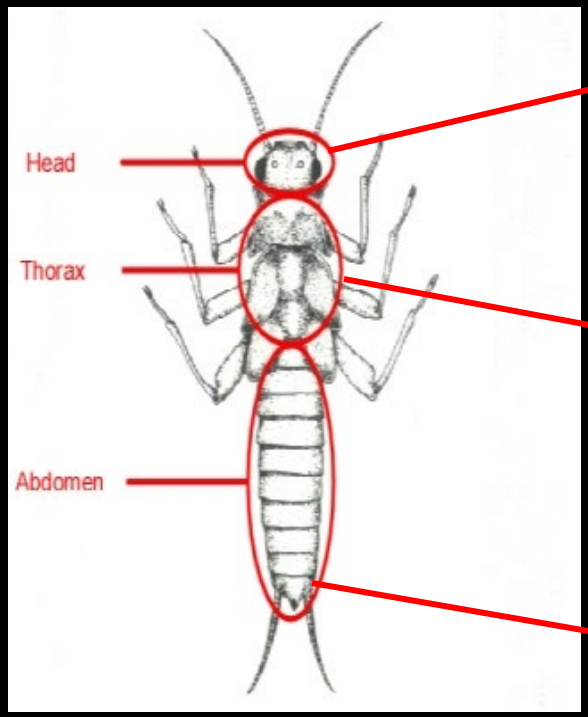
https://www.bbc.co.uk/bitesize/guides/zv4r7nb/revision/1

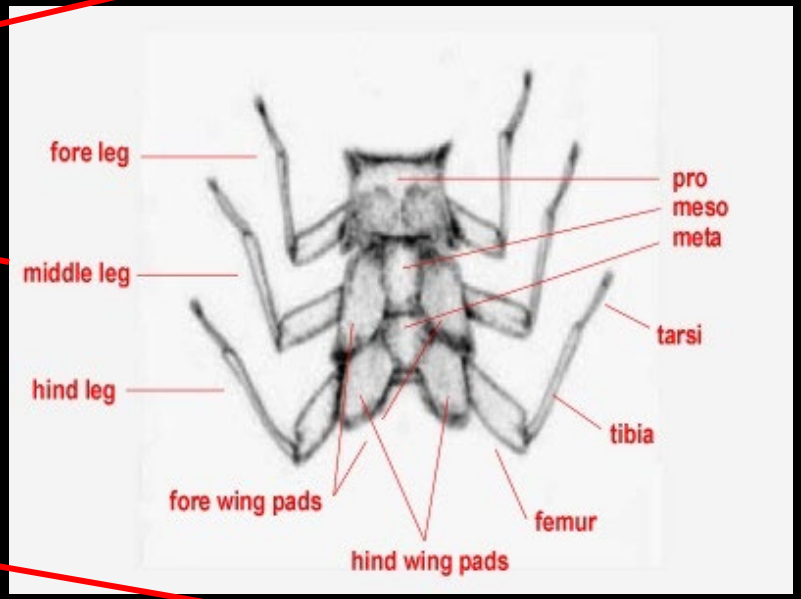
Identification of common stream macroinvertebrates

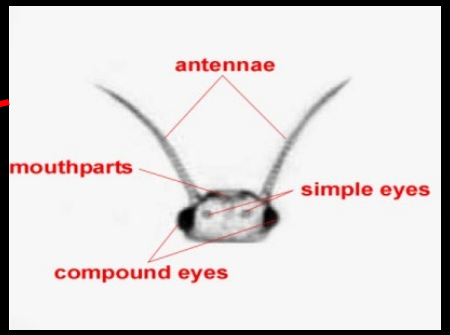
Scientific Nomenclature

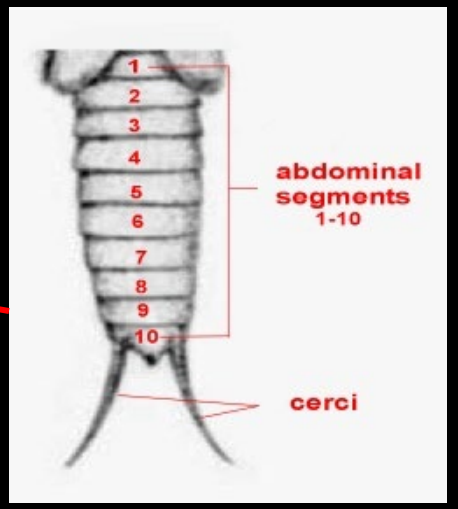
- Way of naming all living things
- Major divisions:
  - Domain → Kingdom → Phylum → Class → Order → Family → Genus → Species
    - Can be other division (e.g. sub-Order, supra-Family, etc.)
- Identification of unknown organisms usually done with dichotomous keys
  - Asks series of paired questions to identify organism

Insect Anatomy



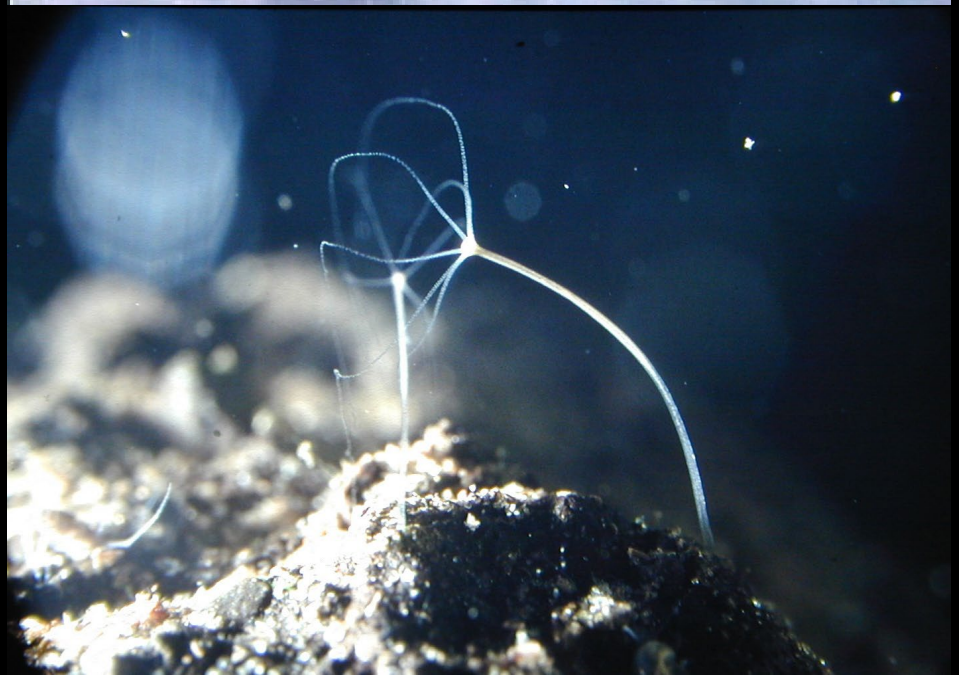






Phylum: Cnidaria

- Only one Freshwater Class
  - Hydrozoa
    - Some have symbiotic relationship with green algae



Phylum: Annelida

- Legless, segmented
- Two main classes
  - Oligochaeta
    - Worms
      - Scavengers
  - Hirudinae
    - Leeches
      - Predators


Oligochaetes


Leeches

Phylum: Mollusca

- Two classes:
  - Gastropoda
    - Snails, Limpets
      - Spiral, single valved shell
      - Grazers
  - Bivalvia
    - Mussels
      - Body enclosed in two hinged, shell valves
      - Filter feeders
      - Most endangered freshwater taxa

Phylum: Arthropoda

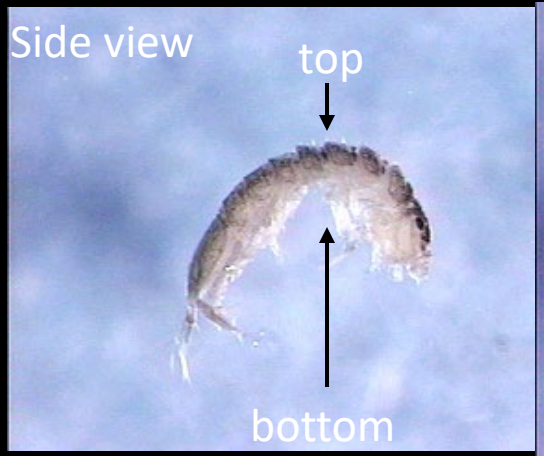
- Key traits:
  - Chitinous exoskeleton
  - Jointed appendages modified as legs, mouth parts and antennae
- Three subphyla
  - Chelicerata (water mites and semi-aquatic spiders)
  - Crustacea (crayfish, fairy shrimp, copepods, isopods, amphipods, etc.)
  - Uniramia (springtails and aquatic insects)

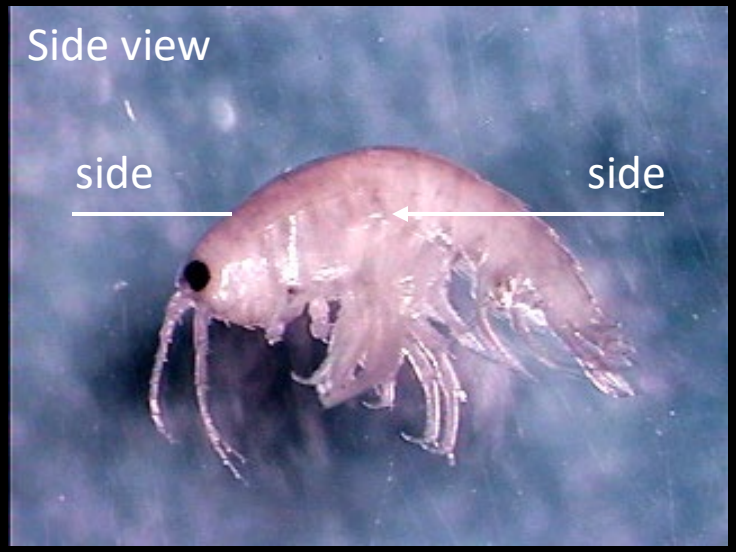
Class: Chelicerata

- Major Class is Acari
  - Water mites
  - No antennae, four pairs of jointed legs
  - 1 m^2 weed bed in eutrophic lake can contain 2,000 mites from 75 species!

Class: Crustacea

- Order Isopoda
  - Like pillbugs in gardens
  - Dorso-ventrally (top-bottom) compressed
- Order Amphipoda
  - Side-swimmers
  - Lateral (side) compression
- Other Orders include:
  - crayfish, shrimp, zooplankton





Class Entognatha

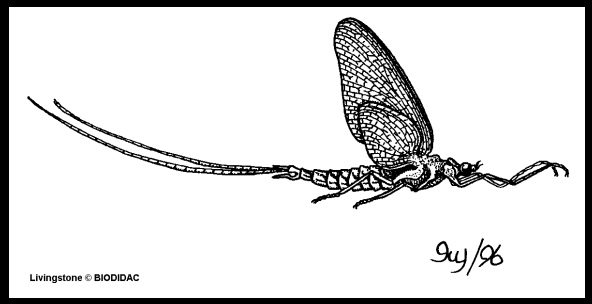
- Order: Collembola
- Springtails
  - Semi-aquatic
    - Live in moist environments, on surface film
  - Abdominal appendage used for springing
  - Eat algae, detritus in surface film

Class: Insecta

- Eight common Orders, plus two less common ones
- All contain mandibles and one pair of antennae
- Adults have three pairs of legs (may be absent in larvae) and wings

Order: Emphemeroptera

- Mayflies
  - Gills on sides of abdomen
  - Usually 3 tail filaments, but sometimes 2
  - Tarsi with one claw
  - Collectors or grazers

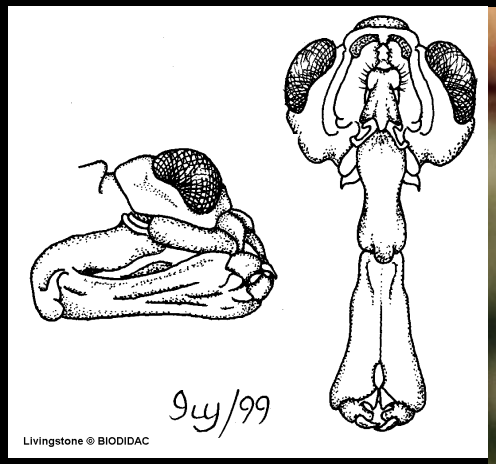


Order: Plecoptera

- Stoneflies
  - Always two tail filaments
  - Tarsi with two claws
  - Sometimes can see gill tufts at base of legs
  - Predators or shredders

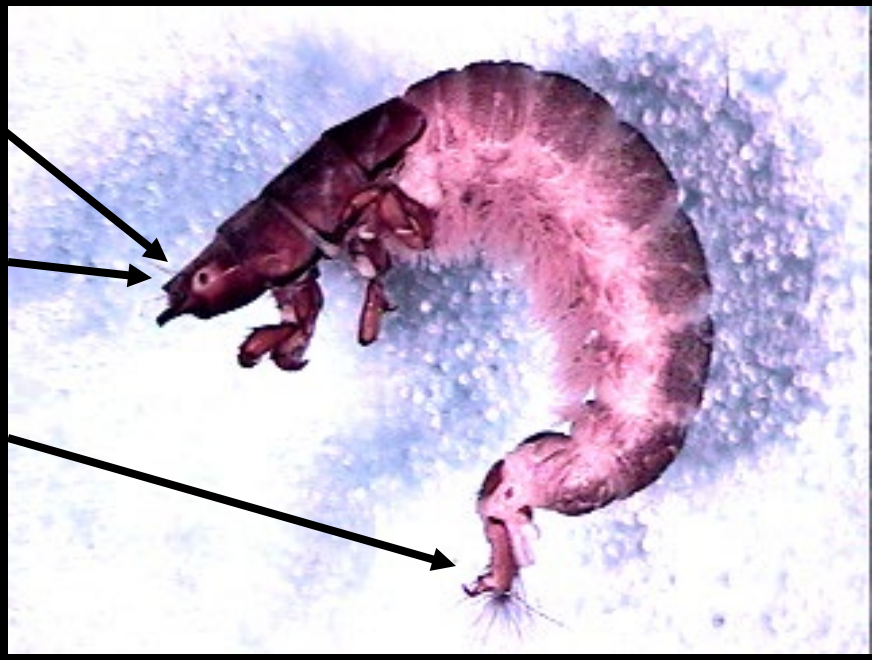
Order: Odonata

- Dragonflies/Damselflies
  - Extendable, grasping mouthparts
  - Hine's Emerald Dragonfly one of few listed endangered insect species
  - Predators

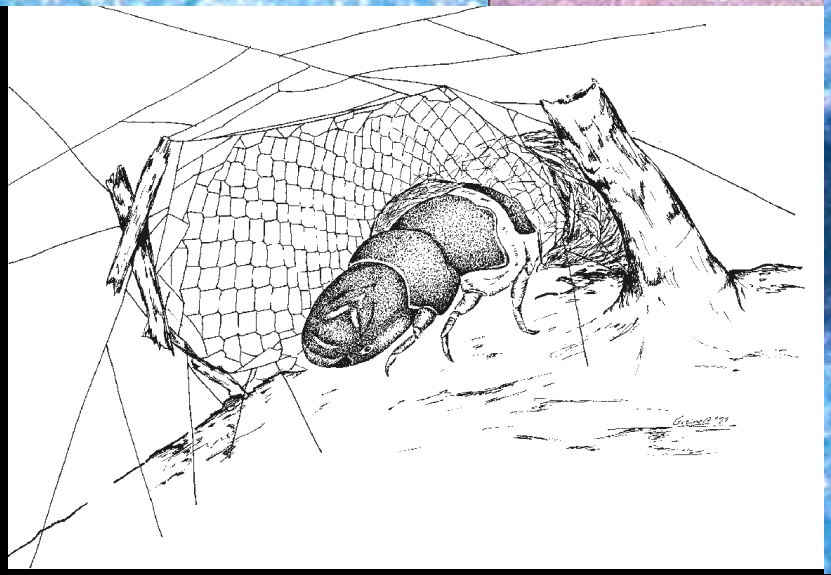


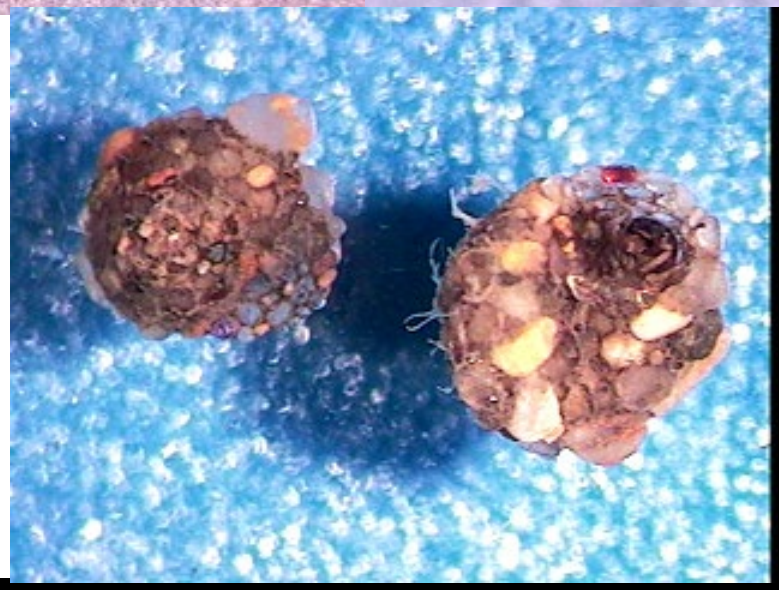
Order: Trichoptera

- Caddisflies
  - Small, inconspicuous, one segemented antennae
  - Hard exoskeleton around head,sometimes parts of thorax
  - Usually one pair of prolegs at end of abdomen
  - Some spin webs, live in retreats; others make portable cases
  - Filter feeders or grazers, a few predatory species



Caddisfly cases and retreats

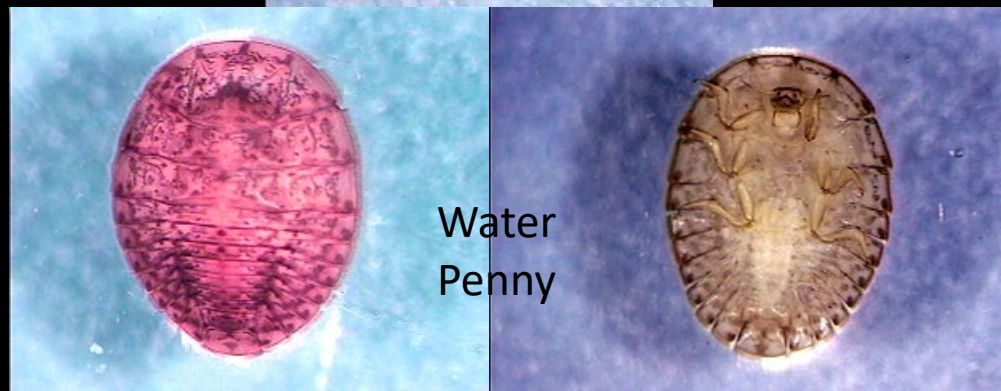




Order: Coleoptera

- Beetles
  - Adults: hard, shell like wings, chewing mouthparts
  - Larvae: generally long, thin, may or may not have filaments coming off abdomen
  - Most predators, grazers

Riffle beetle adult and larvae



Water Penny

Order: Hemiptera

- True Bugs
  - Piercing, sucking mouthparts
  - Includes water striders, water boatmen
  - Most are predators: insects, fish

Order: Diptera

- Flies
  - Larvae lack three pairs legs
  - May have prolegs or psuedopods on one or more segments
  - Includes mosquitos, black flies, midges, etc.
  - Collecters: filter feeders or gatherers


Midge Larvae


Black Fly Larvae

Order: Megaloptera

- Dobsonflies and alderflies
  - Large, conspicuous mandibles
  - 7 or 8 pairs of lateral, abdominal filaments
  - Predators on other insects

Less common orders

- Order: Lepidoptera
  - Aquatic catepillars

- Order: Neuroptera
  - Live in and feed on freshwater sponges