Streamside Management Zones and Water Quality

How the area around your pond effects the water.

Stream(pond)side Management Zone

- A streamside management zone (SMZ) is a strip of land immediately adjacent to a water of the state where soils, organic matter and vegetation are managed to protect the physical, chemical and biological integrity of surface water adjacent to and downstream from forestry operations.

-Alabama's BMP for Forestry

- Areas of riparian forest that are adjacent to bodies of water
- Differ from upland forests in their hydrology, plant community, soils, and topography.
- Generally biologically diverse and fulfill several roles in the ecosystem.
- Serve as filter strips that reduce the volume and flow of surface runoff, filter sunlight to maintain plant systems and reduce water temperature change in the water body, and provide pathways for animal movement.

-ADCNR: Wildlife and Outdoors

What do SMZs do?

- **Remove excess nutrients**
- **Trap sediment**
- **Trap other chemicals**
- **Moderate water temperatures**
- **Enhance bank stability**
- **Mitigate stormwater and flood effects**
- **Provide aquatic and wildlife habitat and corridors**

Nutrients and Water Quality

- Common additions to the soil that have minimal affect on water quality
  - Potassium: normally bound tightly in biological systems, depending on the soil type, addition may be necessary. Leaching to groundwater.
  - Calcium and Magnesium: common additions to buffer soil pH, added as lime ($CaCO_3$) or dolomite (Ca-Mg CO_3). Added as a sulfate salt when pH buffering not needed

Nutrient Additions and Water Quality

- Common additions to the soil that have dramatic affects on water quality:
  - Nitrogen
  - Phosphorus

Nitrogen

- **Application rates based on plants**
- **Applied in soluble forms that are readily available for plant uptake and in organic forms**
- **Also, in slow release products**

Nitrogen

- Nitrate and ammonium-based fertilizers are water soluble, uptake by plants is rapid but so is the potential for loss


Science
Alert!

Nitrogen

- **Organic nitrogen** requires the **enzymatic activity of soil bacteria** to be converted nitrate/ammonium to turf use

- **NH3 + Nitrosomonas Bacteria + O2 + Alkalinity = NO2 (Nitrite)**

  NO2 + Nitrobacter Bacteria + O2 + Alkalinity = NO3 (Nitrate)

Nitrogen in the Environment

- *The Good*
  - Uptake by surrounding plants, turned into more plants
- **The Bad**
  - Upon conditions nitrogen converted to forms unavailable for plants
  - Runoff with stormwater causing water quality impacts
- The Ugly
  - Fish kills
  - Leaching to groundwater, soluble nitrogen in excess due to over-application

Phosphorus

- **Not controlled by biological processes**
- **Present in soil in plant unavailable forms: calcium, iron, manganese and aluminum phosphates**
- **Binds to soil particles**

Phosphate: Fate in the Environment

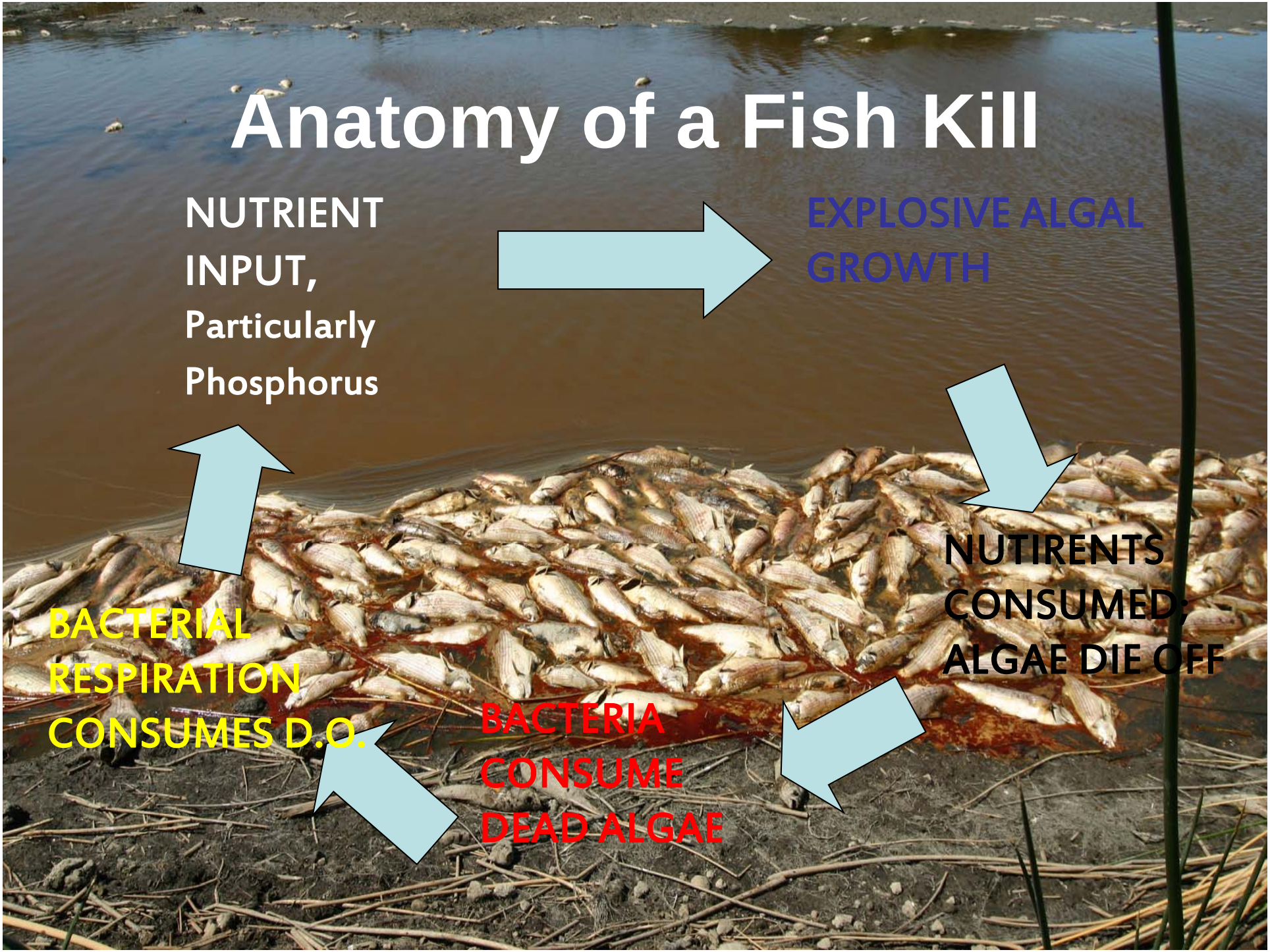
- *The Good*
  - Plants rapidly takes up phosphorus and converts it into biomass

Phosphate: Fate in the Environment

- The Ugly
  - Because phosphorus is attached to soil particles, sediment-laden surface runoff transports it into the aquatic environment

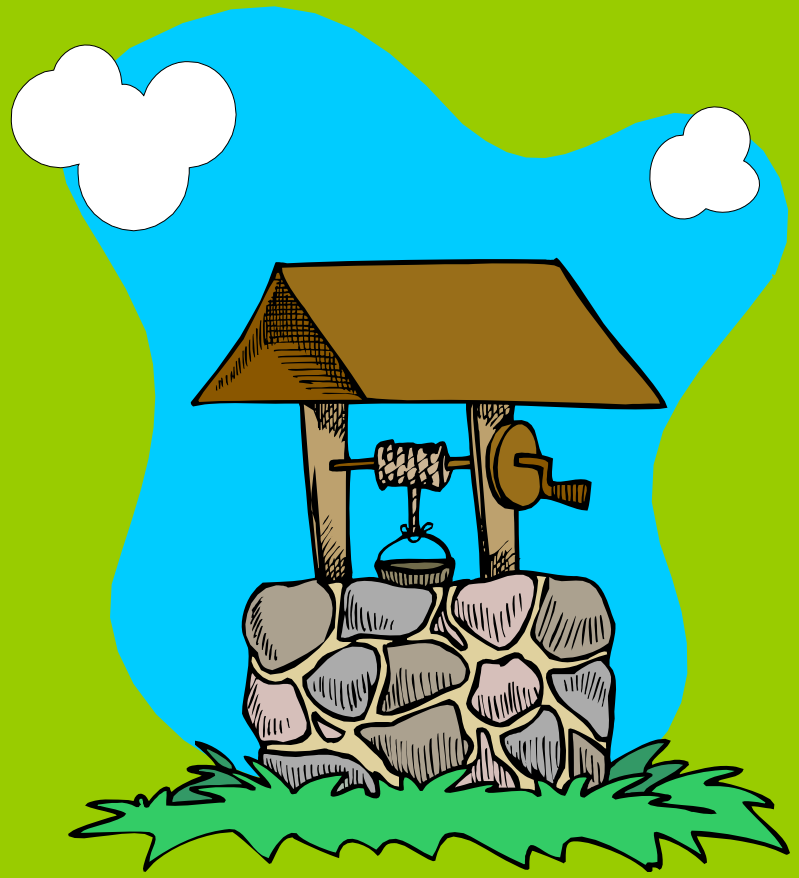
Water Quality Problems associated with Nutrient Mismanagement

- Eutrophication
  - Over stimulation of algal growth
  - Increases in turbidity: reducing light penetration
  - Decreases in aquatic plants: loss of habitat and reduction in dissolved oxygen
  - Toxic concentration of some nutrients


Anatomy of a Fish Kill
NUTRIENT INPUT, Particularly Phosphorus
EXPLOSIVE ALGAL GROWTH
NUTIRENTS CONSUMED; ALGAE DIE OFF
BACTERIA CONSUME DEAD ALGAE
BACTERIAL RESPIRATION CONSUMES D.O.

Sneaky Nitrogen

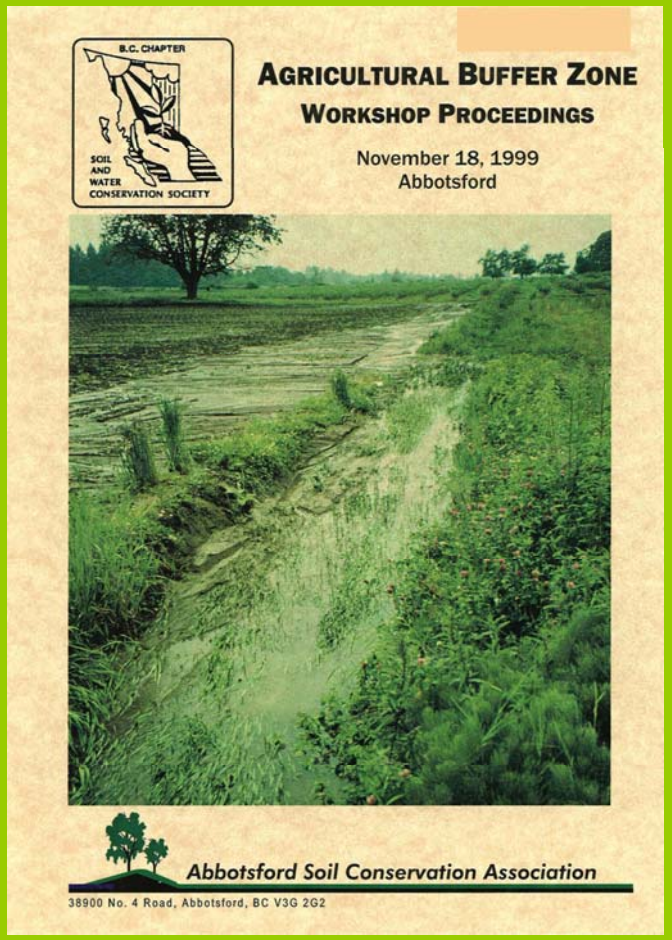
- Groundwater contamination
  - 10 ppm (mg/l) nitrate in drinking can be a human health threat



Erosion

- **Soil Loss**
- **Destabilizes Banks**
- **Releases Sediment into the Water Causing Turbidity**
- **Any Pollutants attached to Sediment Travel with it**

SMZs and Water Quality Protection



Maximizing uptake of nutrients and prevention of erosion by buffer zones

SMZs and Pollutant Management

- In surface runoff
  - Over 50% removal of nutrients and other chemicals
  - Approximately 75 % removal of sediment
    - Much of that sediment containing nutrients
- In groundwater
  - Nitrate removal

Factors Influences Nutrient Removal

- Surface Runoff
  - Like sediment, reducing concentrated flow and enhancing sheet flow, promoting retention in the riparian zone
  - Physical effects of permanently vegetated zone increases contact time with biologically active soils and root zones
  - SMZs with mixed vegetation including those adapted for wet condition enhance removal

Factors Influences Nutrient Removal Particularly Nitrate

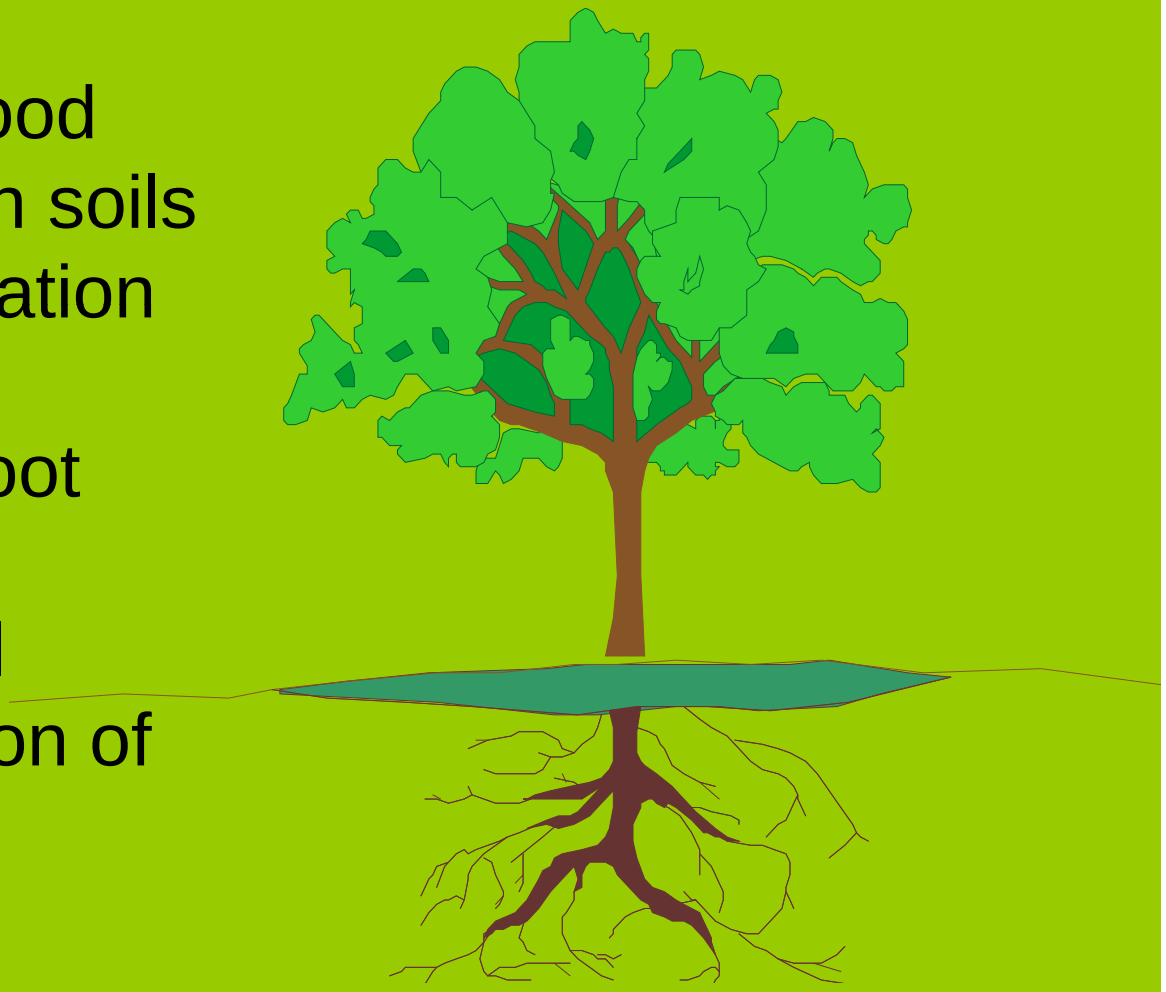
- Groundwater and subsurface flow
  - Depth of the flow
  - Depth of the root zone
    - Supports the need for a SMZ with mixed vegetation including those plant species that are adapted to near water ecosystem and deep root structure
    - Grassed zones not effective in groundwater nitrate removal

Plant Uptake

- **Active process, depends on the plant's metabolic activity**
  - Seasonal factors
  - SMZ plants efficiently remove nutrients and tend to respond to additional nutrient inputs (particularly nitrogen) by increasing uptake
- **Conversion to non-woody and woody biomass**
  - Best supported by mixed vegetation buffers
  - Trees represent long term attenuation of nutrients
  - Non-woody vegetation subject to short life cycles returning nutrients back to the environment

Plant Uptake

- Root growth of flood tolerant in riparian soils help promote aeration in more water saturated soils; root structure actually promotes internal downward diffusion of oxygen



Plant Uptake

- In areas of high atmospheric nitrogen conditions are established that phosphorus can become limiting factor for plant growth
- Studies have shown the SMZs to be a effective sink for the nutrient reducing potential impact on waterways

Microbial Processes

- **Denitrification**
  - Nitrate to gaseous nitrogen
- **Nitrification**
  - Ammonia to nitrate
  - Nitrates incorporated more bacteria to immobilize nutrients and remove them from the ecosystem
- **Biological degradation of chemical pollutants**
  - Bacteria use chemicals for growth or not
  - Mechanisms to store chemical pollutants making them less biologically available

- Like bacteria, some plants have the ability to compartmentalize chemical pollutants effectively removing them for the environment

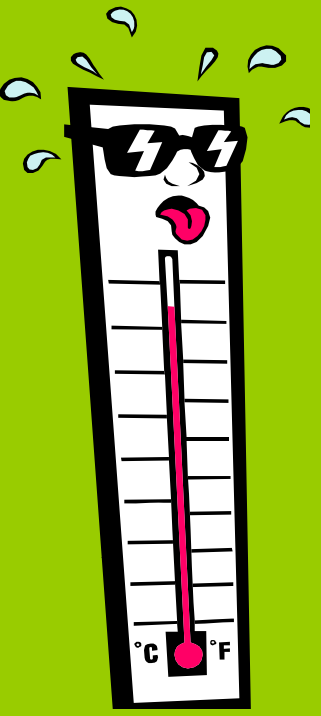
SMZs and Erosion

- Physical interception of surface runoff
- Flow slows to allow suspended soil particles to be deposited
- Plant roots stabilize banks
- SMZs integrated with in-field practices that prevent/reduce flow before it reaches the buffer zone
  - Conservation tillage
  - Avoiding Soil compaction
  - Preventing over irrigation

SMZs and Groundwater

- Effective removal under specific conditions
  - In areas where groundwater is close to the surface or where the roots run deep
  - A complex interaction of hydrology, plant, soil and microbiology

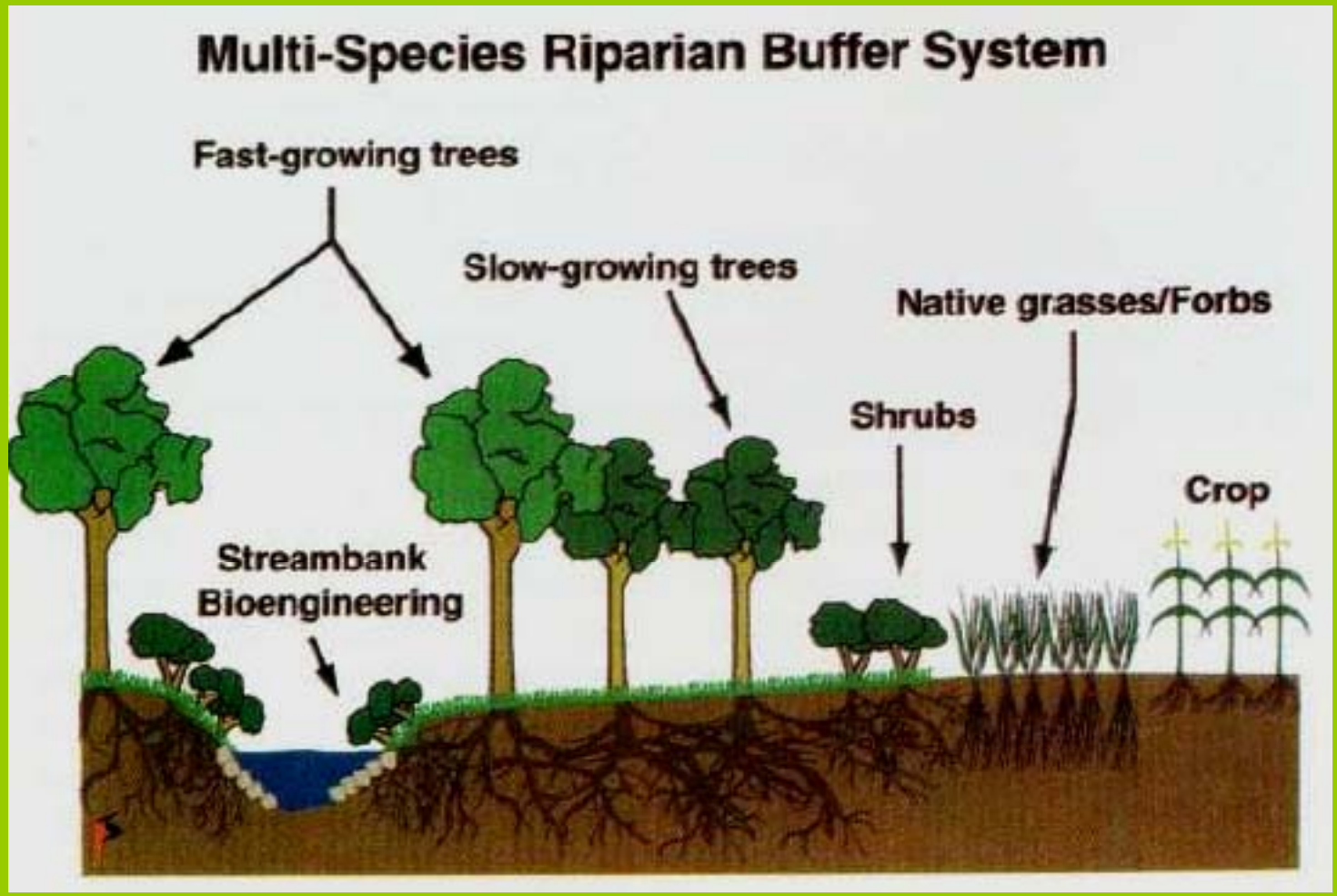
Habitat Enhancement



- **SMZs enhance the pond environment**
  - Reduces algal growth
  - Provides shade
  - Increases dissolved oxygen potential
- **Biological Diversity**
  - enhanced by the diversity of aquatic habitats
  - woody and leaf debris provides habitat
  - Shelter around the pond for larger animals and birds

SMZs and Erosion

- Mixed structure works best



Planting around Ponds

- Balancing Act
  - Want all of the good things that SMZs bring
  - Want your pond to be the pond you want it to be
  - Want to avoid the problems plants can cause

Trees

- **Weeping Willow**
  - nice and low maintenance shade canopy
- **Bald and Pond Cypress**
  - erosion control because of their extensive and close to surface level root systems
  - lowest for organic load on the pond
  - knees on the more mature trees annoy some folks
- **Deciduous trees**
  - Plant further away to avoid dropping leaves and seeds/acorns into pond

Hand waving and discussion time