Bioengineering Shoreline Protection

Agrecol LLC
Evansville WI

rob.walker@agrecol.com

A little about Agrecol…

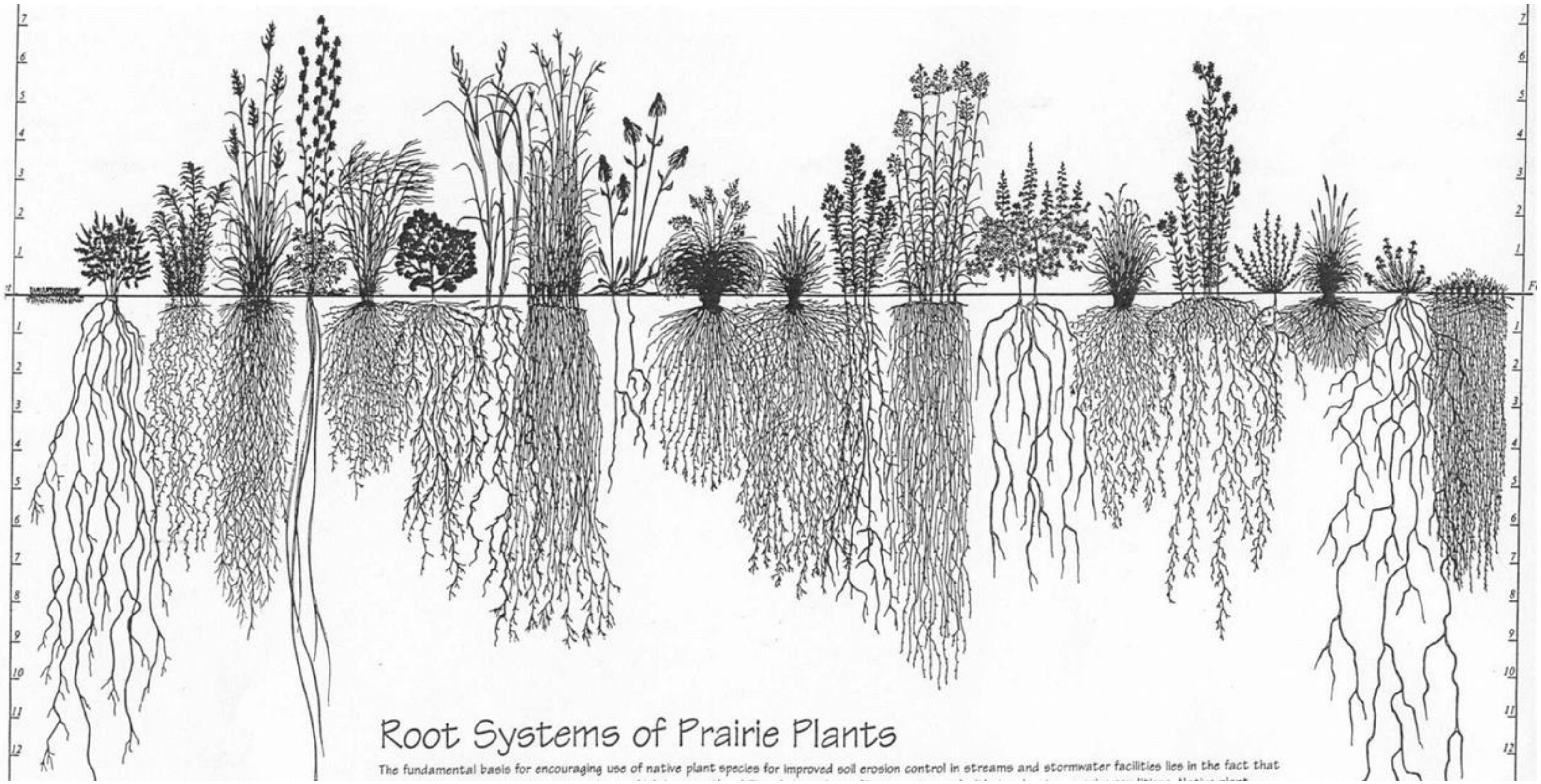
- 1,100 acres in production in SC WI
- Produce 3.5 million greenhouse plants yearly
- 300 species on 350 production beds
- Produce 100,000 lbs of pure live seed
- Envirolok™ vegetative green wall system

Native Seed Production

Diverse species mix promotes succession. Species diversity of plant communities over time.

Pure Live Seed (PLS) Purity multiplied by the Germination , Divided by 100

Root Comparison!



- Have deeper roots that stabilize & reinforce soil - living Geogrid
- Lessen raindrop impact & erosion
- Stay upright in runoff to filter sediment
- Increase Infiltration and Percolation

Native Vegetation modifies the mechanical properties of soil in several ways:

- Root Reinforcement
- Anchorage, arching, and buttressing
- Surface mat effect
- Wind loading
- Root wedging

Native Vegetation and Water Quality

- Improves clarity by sequestering sediments and pollutants.
- Binds nutrients that would be used by algae.
- Provides food, shelter and nesting for wildlife.
- Can mitigate erosion and runoff.
- Creates spawning beds in emergent plants for fish.

Important Ecological Services

- Improve water clarity by holding sediment in place.
- Take up nutrients that would be used by algae.
- Provide shelter for wildlife.
- Provide wildlife food and nesting areas.
- Reduce erosion and runoff.
- Provide spawning beds in sedges /emergent plants for fish.

80-90% of all lake life is born, raised and fed in the area where land and water meet.

Human Considerations

- Aesthetic desires
- Sight Lines
- Property use
- Ecological sensitivity
- Family

Environmental Considerations

- Soil Type
- Soil Structure
- Site Aspect
- Sun Exposure
- Slope
- Shading – Canopy
- Micro sites
- Depressions

Native Plant Diversity

- Sedges
- Rushes
- Grasses
- Wildflowers
- Shrubs
- Trees

Native Plant Diversity Selection

- Natural Site Evaluation
- Historical Aerial Photos
- University Research Studies
- Publications
- Performing sites for community and density
- Professional networking
- Personal Research

Infiltration

Turfgrass grass typical infiltration rate of 0.29 inches per hour.

Native Vegetation typical infiltration rate of 7.5 inches per hour

Mechanics of Root Reinforcement

- A root or fiber reinforced soil behaves as a composite material in which elastic fibers of relatively high tensile strength are embedded in a matrix of relatively plastic soil.
- Shear stresses in the soil mobilize tensile resistance in the fibers, which in turn imparts greater strength to the soil.
- The net effect of fiber reinforcement on the stress-strain response of soils is to increase the shear strength of the soil. Another important effect is to make some soils tougher (able to resist large deformation without loss of residual strength).

Summary of Mechanical Effects

Roots bind soil particles and permeate the soil, resulting in:

- restraint of soil movement reducing erodability
- increase in shear strength through a matrix of tensile fibers
- network of surface fibers creates a tensile mat effect, restraining underlying strata

Roots penetrate deep strata, giving:

- anchorage into firm strata, bonding soil mantle to stable subsoil or bedrock
- support to up-slope soil mantle through buttressing and arching

Stems and leaves cover the ground surface, so that:

- impact of traffic is absorbed, protecting soil surface from damage
- foliage is flattened in high velocity flows, covering

Summary of Hydrological Effects

- Foliage intercepts rainfall causing:
  - absorptive and evaporative losses, reducing rainfall available for infiltration
  - reduction of kinetic energy of raindrops and thus erosivity
  - increase in drop size through leaf drip, thus increasing localized rainfall intensity
- Stems and leaves interact with flow at the ground surface, resulting in:
  - higher depression storage and higher volume of water for infiltration
  - greater roughness on the flow of air and water, reducing its velocity
  - tussocky vegetation may give high localized drag, concentrating flow and increasing velocity
- Roots permeate the soil, leading to:
  - opening up of the surface and increasing infiltration
  - extraction of moisture which is lost to the atmosphere in transpiration, lowering pore-water pressure and increasing soil suction, both increasing soil strength
  - accentuation of desiccation cracks, resulting in higher infiltration

Anchorage, Arching, and Buttressing

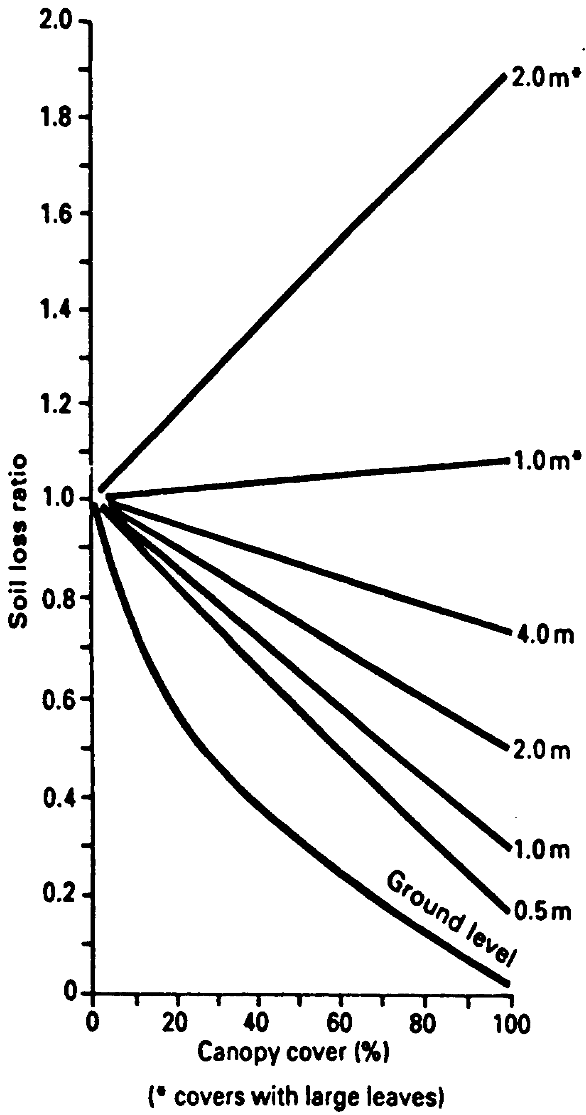
If root systems penetrate into deeper soil layers or even weathered bedrock, the trunks and principal roots can act in a similar manner to piles driven into a slope. This has the same action as toothpicks in a layered cake preventing the layers from sliding on the soft frosting in the middle.

The magnitude of the arching effect is influenced by:

- spacing, diameter and embedment of trees
- thickness and inclination of the slope
- shear strength properties of the soil.

Surface Protection

- The roots of vegetation are very effective at holding soil particles together, preventing detachment and particle transport.
- The canopy of the vegetation intercepts rainfall, reducing its impact velocity. Since the erosion potential of raindrops is a function of the rainfall energy or momentum (related to velocity), the canopy reduces the erosive potential of rainfall.
- Different vegetation types produce different levels of protection from soil detachment. With grasses or low shrubs, the soil loss decreases dramatically with increasing percentage cover. For tall vegetation (>0.5m) the soil loss decreases with percentage cover but not as dramatically.
- Vegetation litter (dead plant remains) also protects soil from raindrop impact. It also promotes the activity of burrowing insects and animals.



So how do we do it?

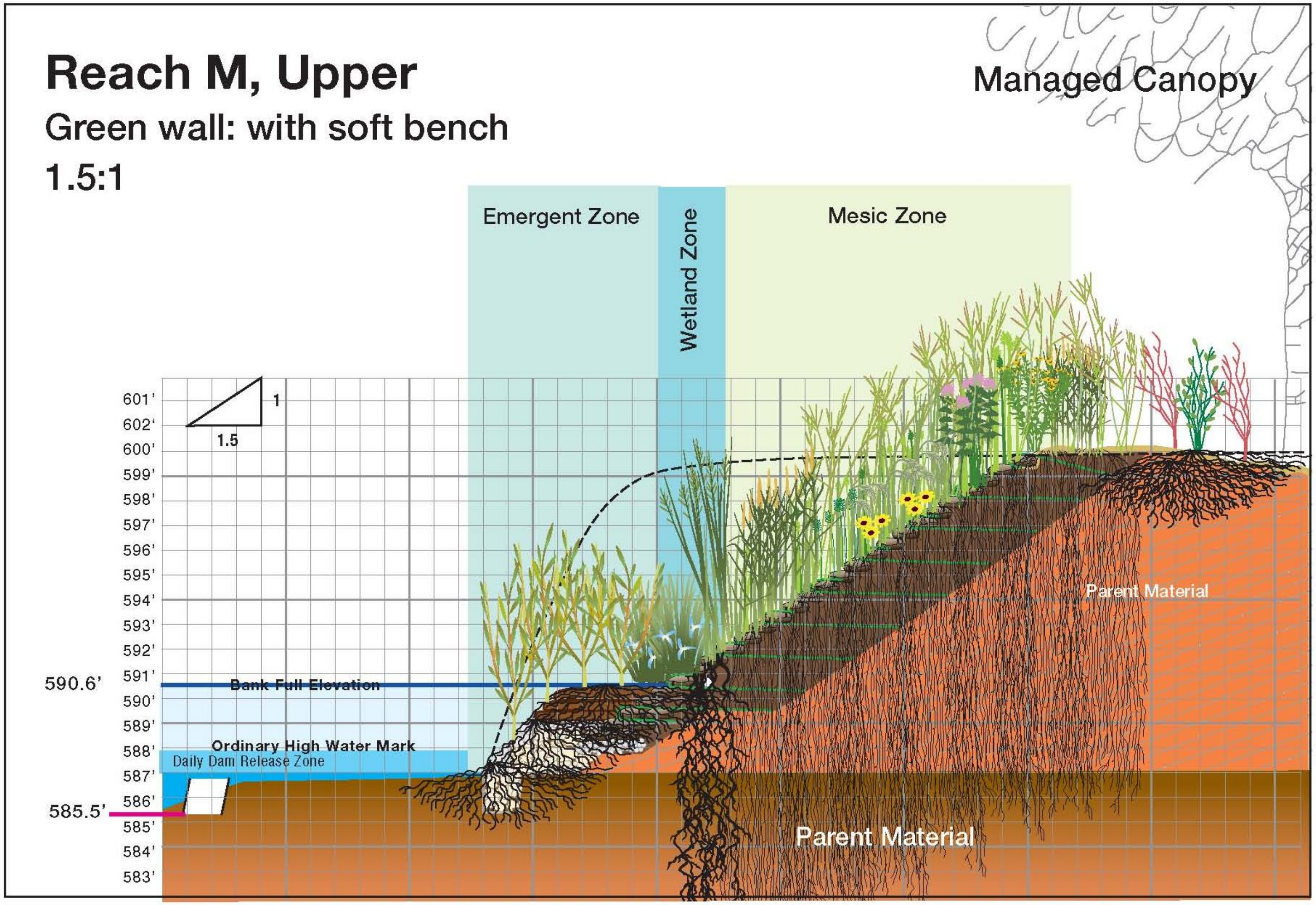
- Prepare site!
- Goal: good soil structure: water infiltration & percolation
- Installation timing
- Plant selection
- Use erosion control
- Consider polymer
- Long term maintenance plan!!!!

Case Study; Low Energy Shoreline

Even a low-energy shoreline benefits from stabilization and thriving vegetation.

Rushes and sedges create Mallard Duck nesting and feeding habitat.

Case Study; Shoreline Restoration



Native Vegetated Mat

Core material fit to site requirements

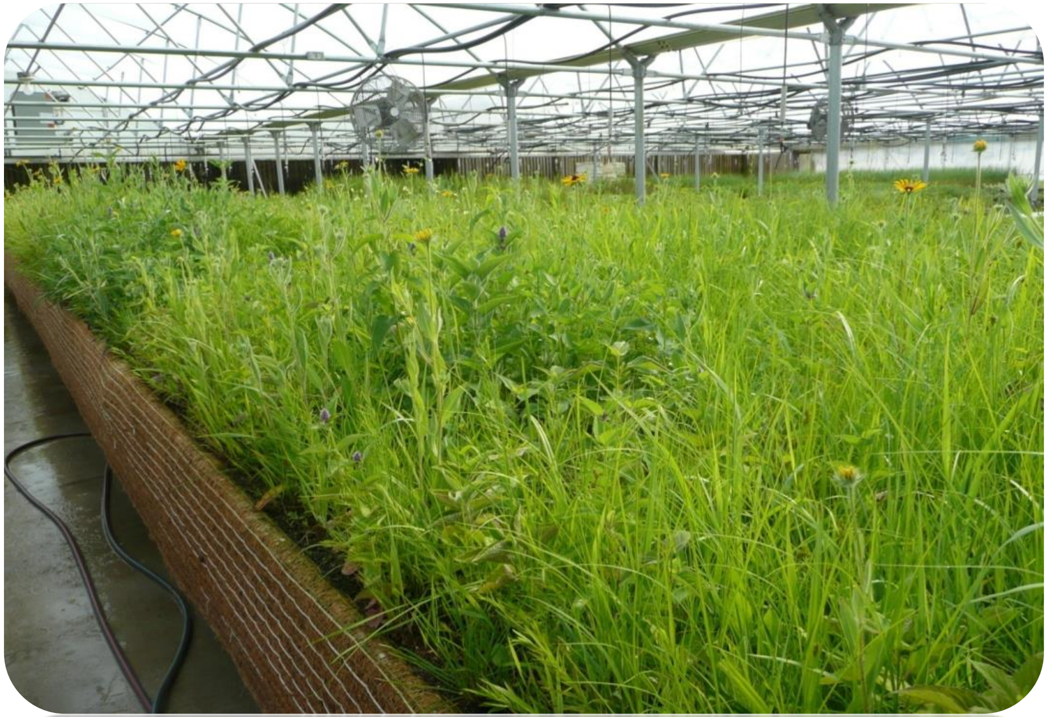
Vegetation grown to specification

Minimizes chance of failure

Native Vegetated Mat

Growout in controlled greenhouse or hoop house contributes to quality control.

12-16 week growout period



Native Vegetated Mat

Initial root growth is horizontal due to underlayment. Root systems bind growing medium (soil) to the core material, creating a sod-like mass.

Native Vegetated Mat

Vegetation is grown in pre-cut mats; 40" x 11'. Sheeting underlayment allows for easy rolling and palletizing.

Native Vegetated Mat

Mats can be rolled out on site and placed with staples or wood stakes. With adequate hydration, mats 'knit' down within thirty days.

Native Vegetated Mat

Shoreline is vegetated and root system is penetrating native soil within thirty days.

Utilizing reference sites!

- http://dnr.wi.gov/topic/Lands/naturalareas/
- http://plants.usda.gov/java/
- http://www.wildflower.org/collections/collection.php?collection=WI
- http://wisplants.uwsp.edu/