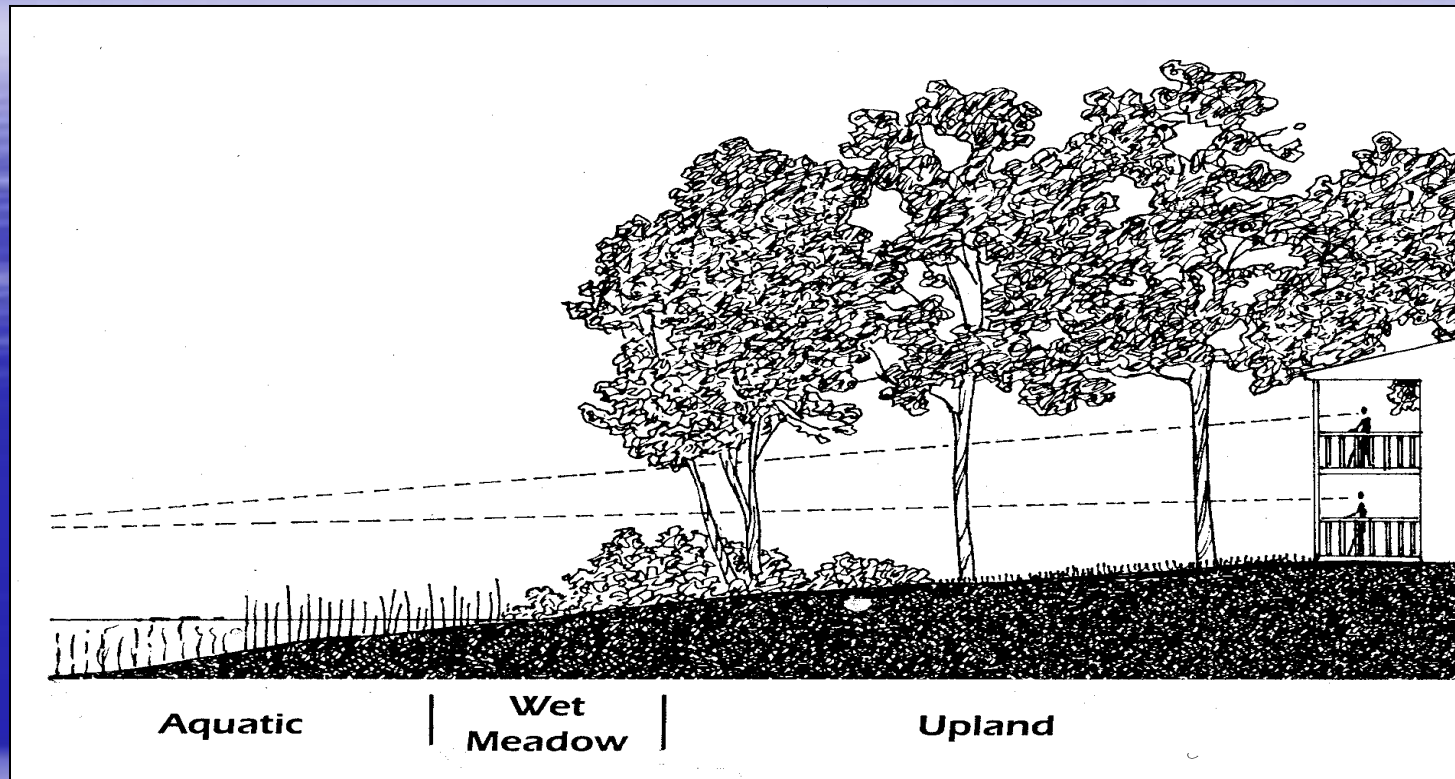


# Structural, Non-Structural and Hybrid Options for Shoreline Protection

Dr. Mary Blickenderfer

UNIVERSITY OF MINNESOTA  
**EXTENSION**

# The natural shoreline “big picture”



**Protect  
bank  
from  
wave  
action**

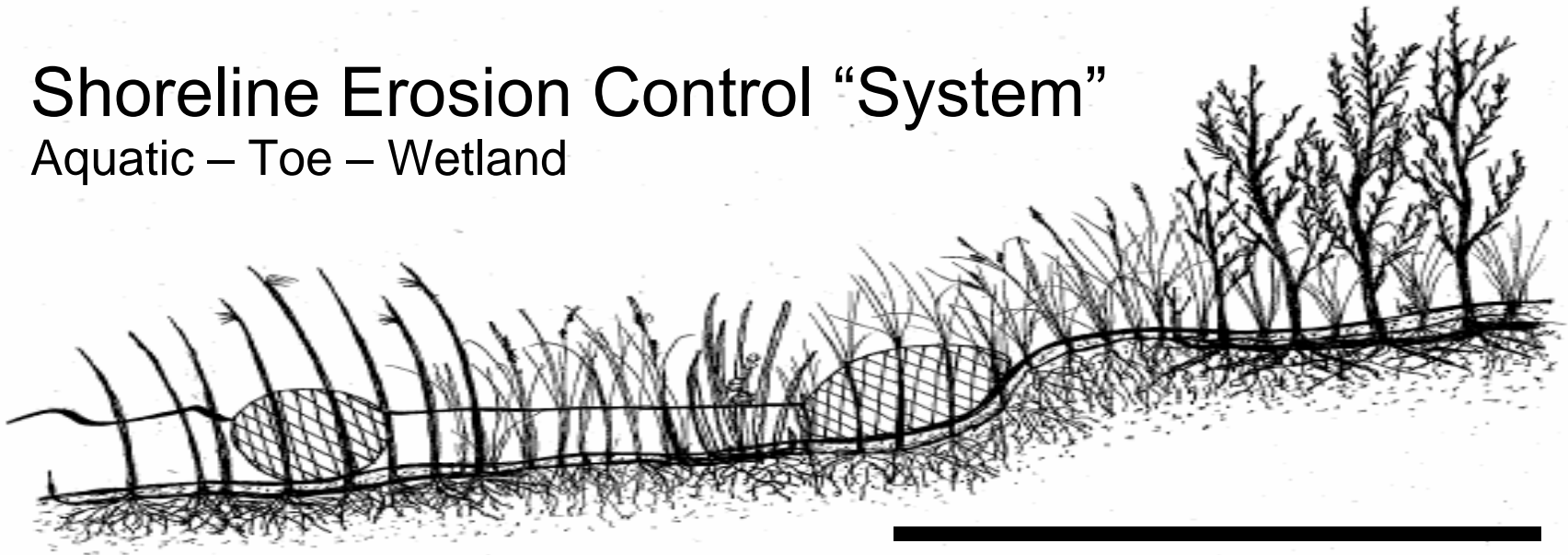
**Deep  
roots  
bind  
the  
soil**

**Reduce run-off and  
pollutant inputs  
from the land**

**Plants provide critter habitat**

# Shoreline Erosion Control “System”

Aquatic – Toe – Wetland



## Wave Break

- Brush bundle
- Wrapped bundle
- Tree revetment
- Coco log
- Rock berm

## Emergent Aquatic Plants

- Containerized plants
- Prevegetated mats
- In-lake transplants

## Exclosure

- Fence/posts

## Toe Protection

- Brush bundle
- Wrapped bundle
- Coco log
- Flax log
- Photo-bag/corn bale
- Coco lift
- Vegetated geogrid
- Geo-bag/soil
- Stump revetment
- Tree revetment
- Log raft
- Gabion tube
- Rock riprap

## Wetland Plants

- Seeded plants
- Live stakes
- Live posts
- Live fascines
- Willow wattles
- Brush mattresses
- Bare root shrubs
- Plant plugs
- Containerized plants
- (Erosion blanket)



# Site evaluation

- What indicators do we use to predict soft armor/bioengineering success?



Photo: Bill Bartodziej



Photo: Greg Berg



# Plant selection and sequencing

- Plant rhizomatous species first
- Add showy, clump-formers later





# Rhizomatous Plants

Sedges

(*Carex* spp.)



Bill Bartodziej

Bulrush

(*Schoenoplectus* spp.)



## Bur-reed

(*Sparganium* spp.)

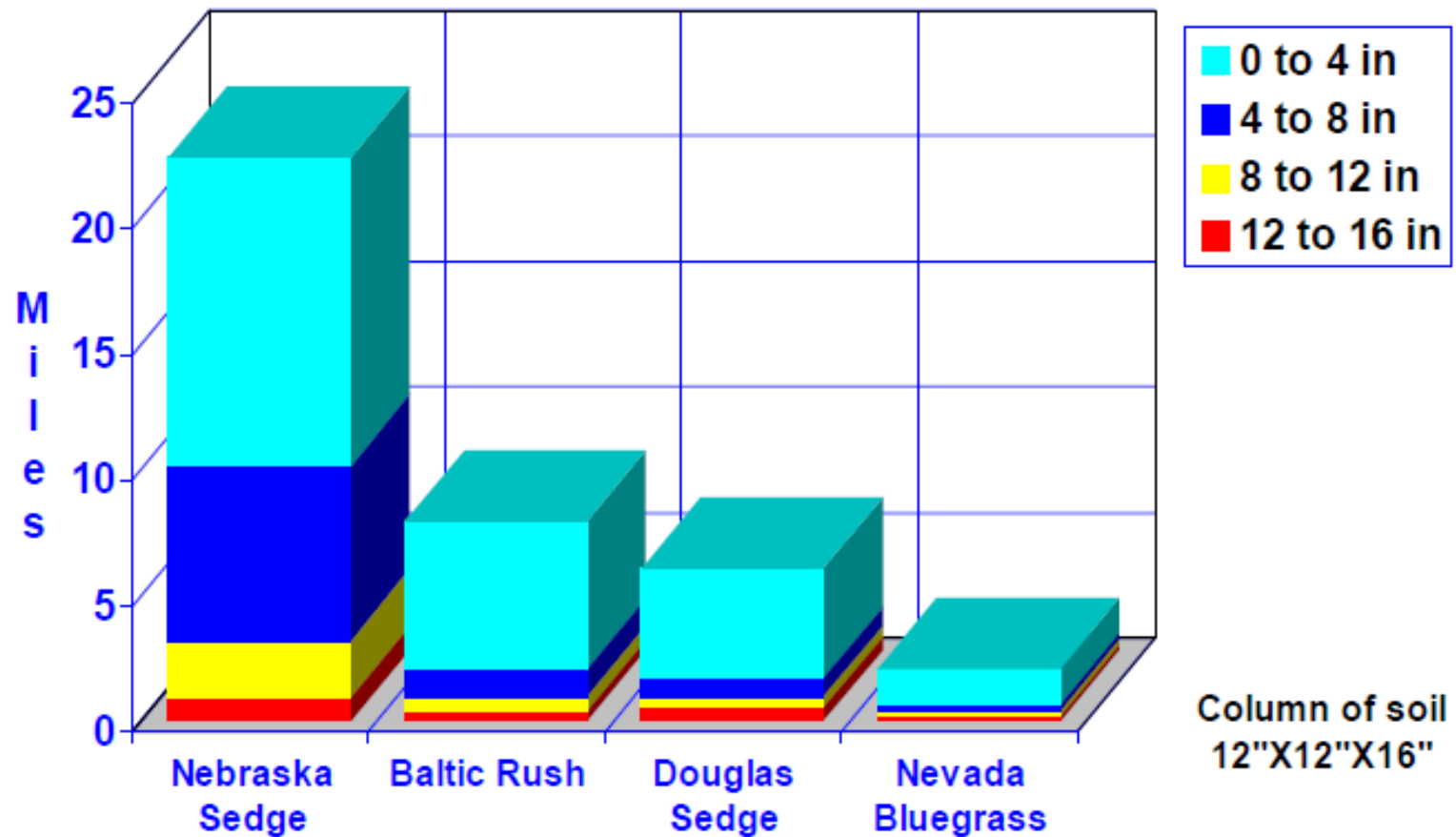


## Bulrush

(*Bolboschoenus* spp.)



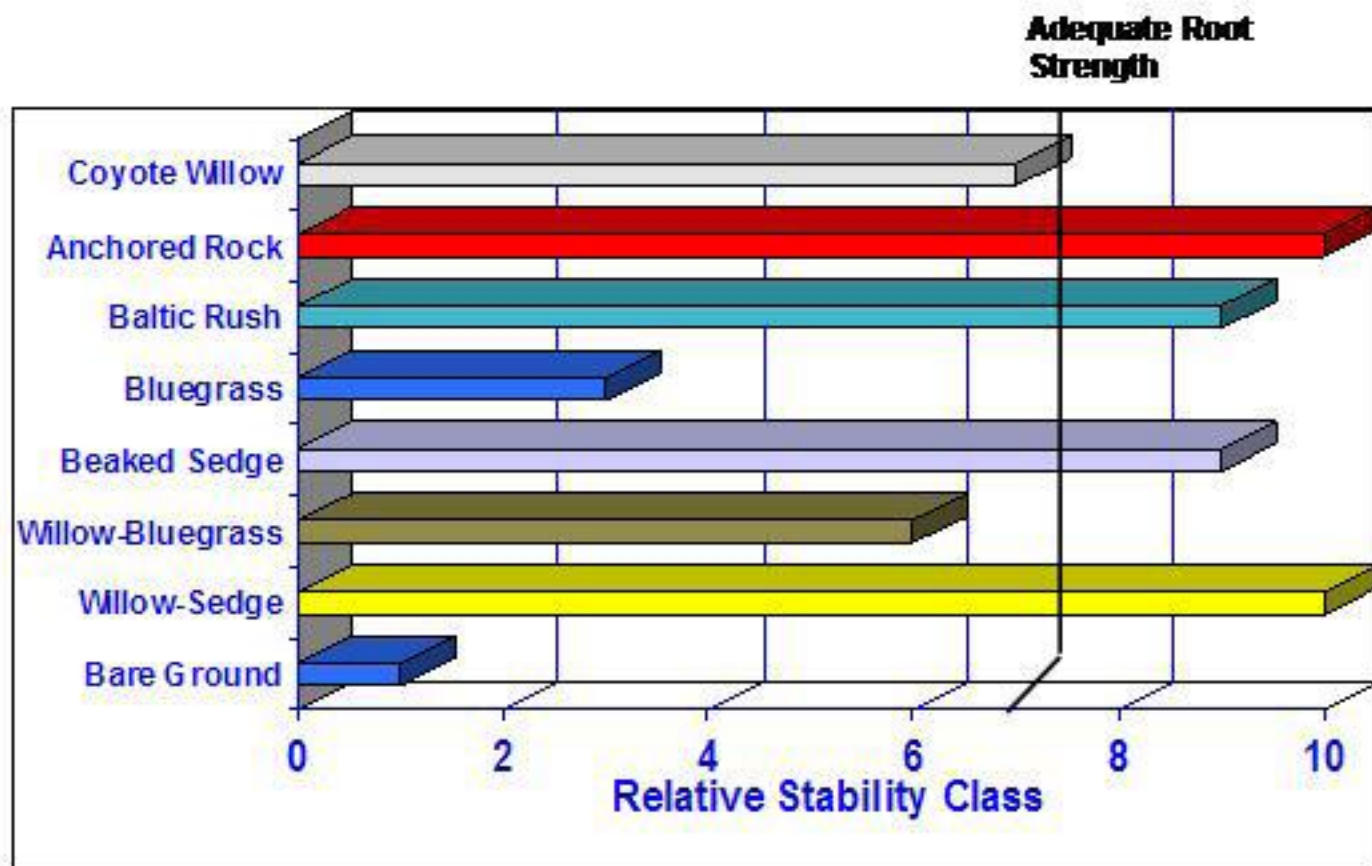
# Root Length



Manning, M.E., et al, 1989

# Erosion Control

## Channel Stability Rating (Vegetation)



Winward 2000  
Appendix B



sedge

# Bioengineering Methods

- Which bioengineering products, techniques and combinations will succeed?
- (U of MN research 2009-2012)

Bio products  
have a  
limited  
lifespan...  
plan for it!

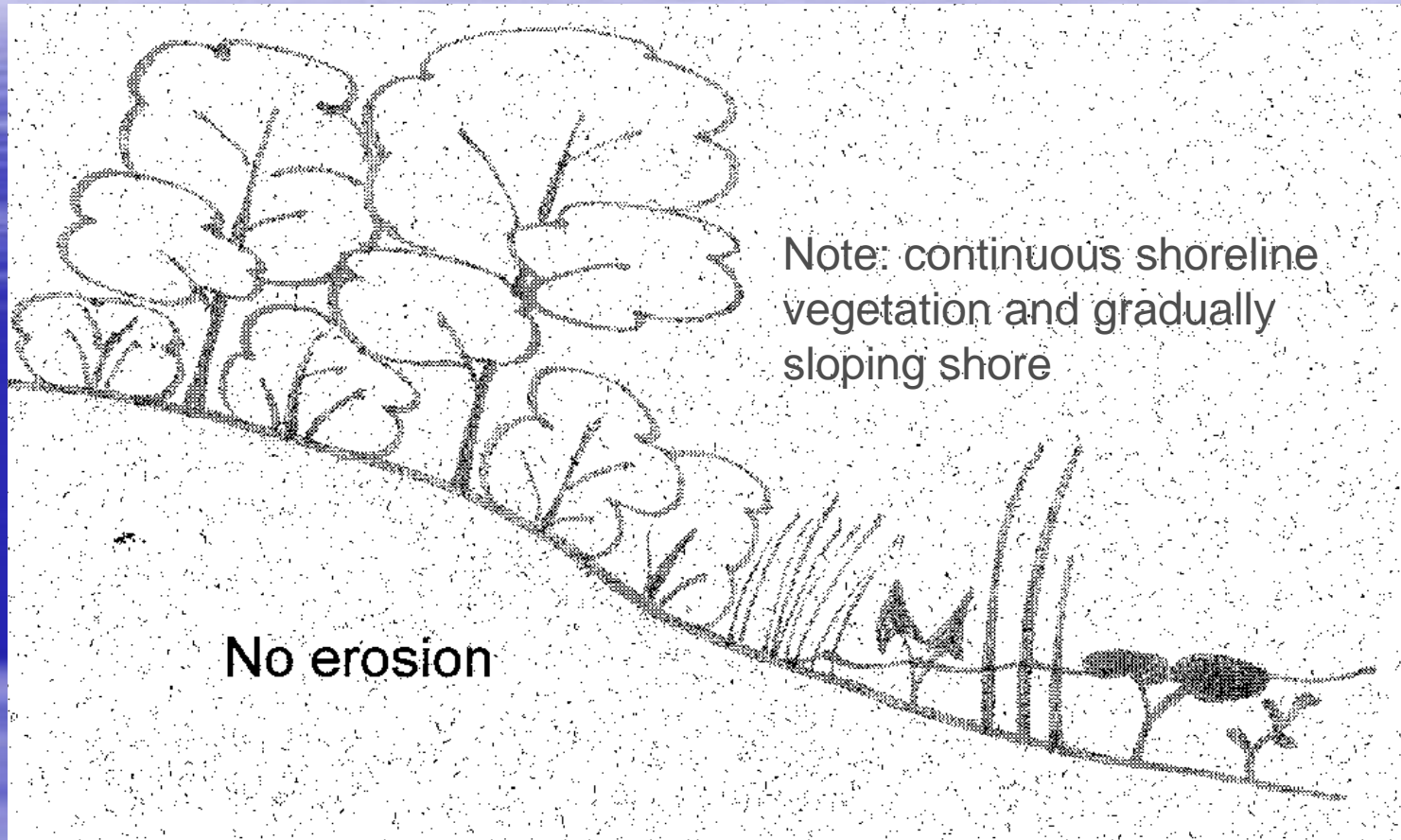


Coco log (toe protection)

Wrapped brush bundle  
(wave break)

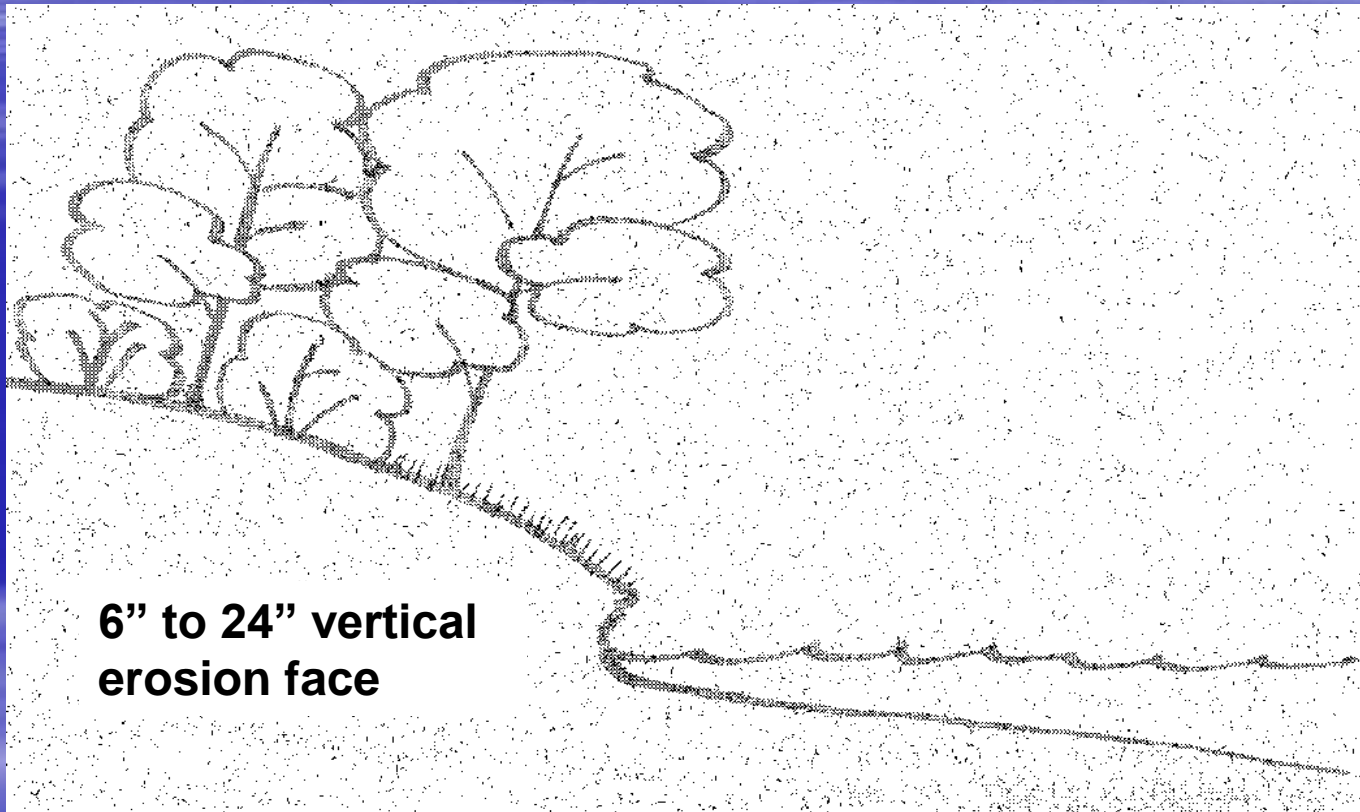


# For shorelines with little/no erosion:



Maintain or enhance native vegetation

# For shores undercut up to 2 ft:



Install toe protection and native plants



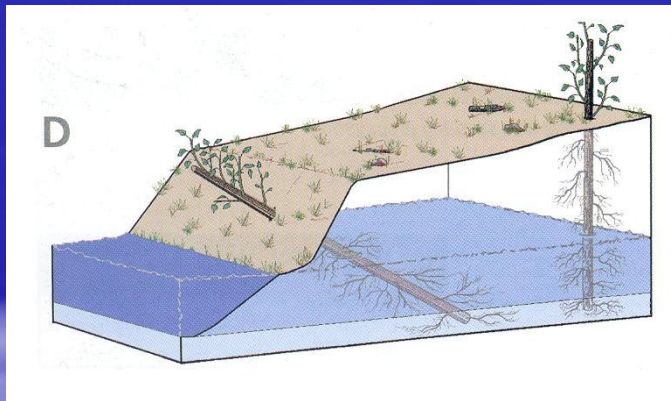
# Upland and wetland native plants - plugs and containerized



**Cost/20 linear ft: \$200 (10 ft wide)**  
**Installation time: 0.5 hr**  
**Maintenance time: watering yr 1**  
**Notes:**



# Live stakes and posts



Greg Berg – Stearns SWCD

**Cost/20 linear ft: \$0**  
**Installation time: 0.5 hr**  
**Maintenance time: 0 hr**  
**Notes:**



# For Toe Protection: bio logs



**Cost/20 linear ft: \$150**  
**Installation time: 0.5 hr**  
**Maintenance time: 0**  
**Notes: combine with plantings**



# Brush bundles



Swarming Along the River Bank Like Ants, Coolies Drag Long Strands of Woven Willow Sticks to the water's edge. Others carry packs of kaoliang stalks to the water's edge. Both materials rot in the water after a few years. Then new stacks are placed on the riverbank and the decayed mass is pushed into the mud on the river bottom. Often the entire construction is destroyed when the current scours out the mud.

Wrapped bundles





# Photodegradable bag/corn bale



**Cost/20 linear ft: \$1,160**  
**Installation time: included**  
**Maintenance time: 0**  
**Notes: installed only by trained contractor; last only 1 yr in high energy site**



# Stump revetment



**Cost/20 linear ft: \$140 (hauling)**  
**Installation time: included**  
**Maintenance time: 0**  
**Notes: installed by contractor;**  
**used for traffic control**



# Aquatic emergent plants

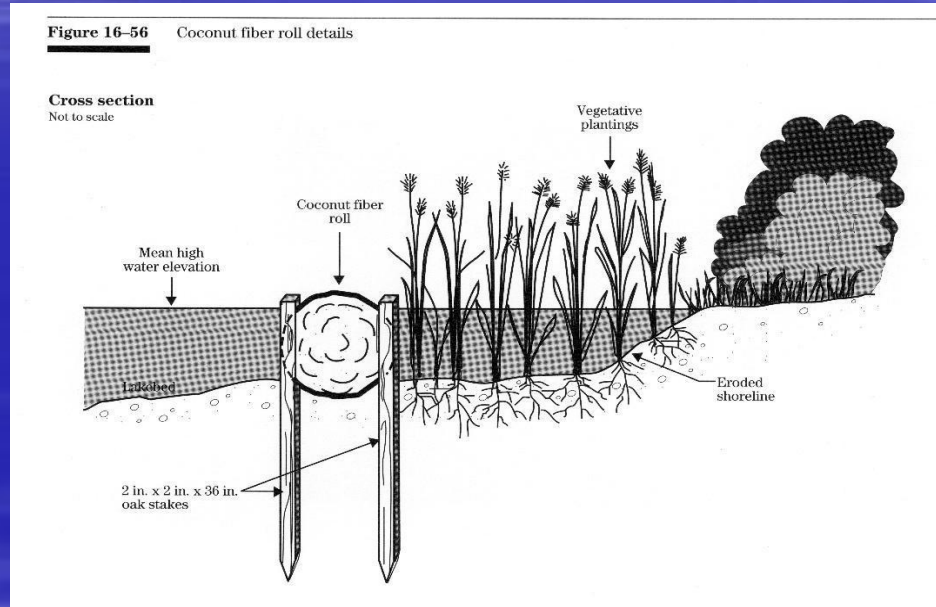


**Remember: Obtain a DNR permit before planting below the OHW**

**Cost/20 linear ft: \$0-200  
Installation time: 0.5 – 1 hr  
Maintenance time: 0 hr  
Notes: critter protection?**



# Planted shores may require temporary **Wave Break** using a coco log or...



**Cost/20 linear ft: \$150**  
**Installation time: 0.5 hr**  
**Maintenance time: 0 hr**  
**Notes:**



*Note: Wave breaks, aquatic and wetland plants, and toe protection can “collect” suspended sediment and help rebuild the shoreline lost to erosion, as well as protect it from future erosion.*

# ...cedar trees or brush bundles



**Cost/20 linear ft: \$20**  
**Installation time: 0.5 hr**  
**Maintenance time: 0.5 hr**  
**Notes: remove prior to freeze-up?**

**Cost/20 linear ft: \$60**  
**Installation time: 1 hr**  
**Maintenance time: 0**  
**Notes: sediment collects between/behind bundles**





Coco log and wrapped  
brush bundle







Post Planting

Gregg Thompson - AMSWCD





First spring after planting

Gregg Thompson - AMSWCD





First summer after planting

Gregg Thompson - AMSWCD





Second summer after planting

Gregg Thompson - AMSWCD





Tree revetment, bio log, live stakes –  
post installation



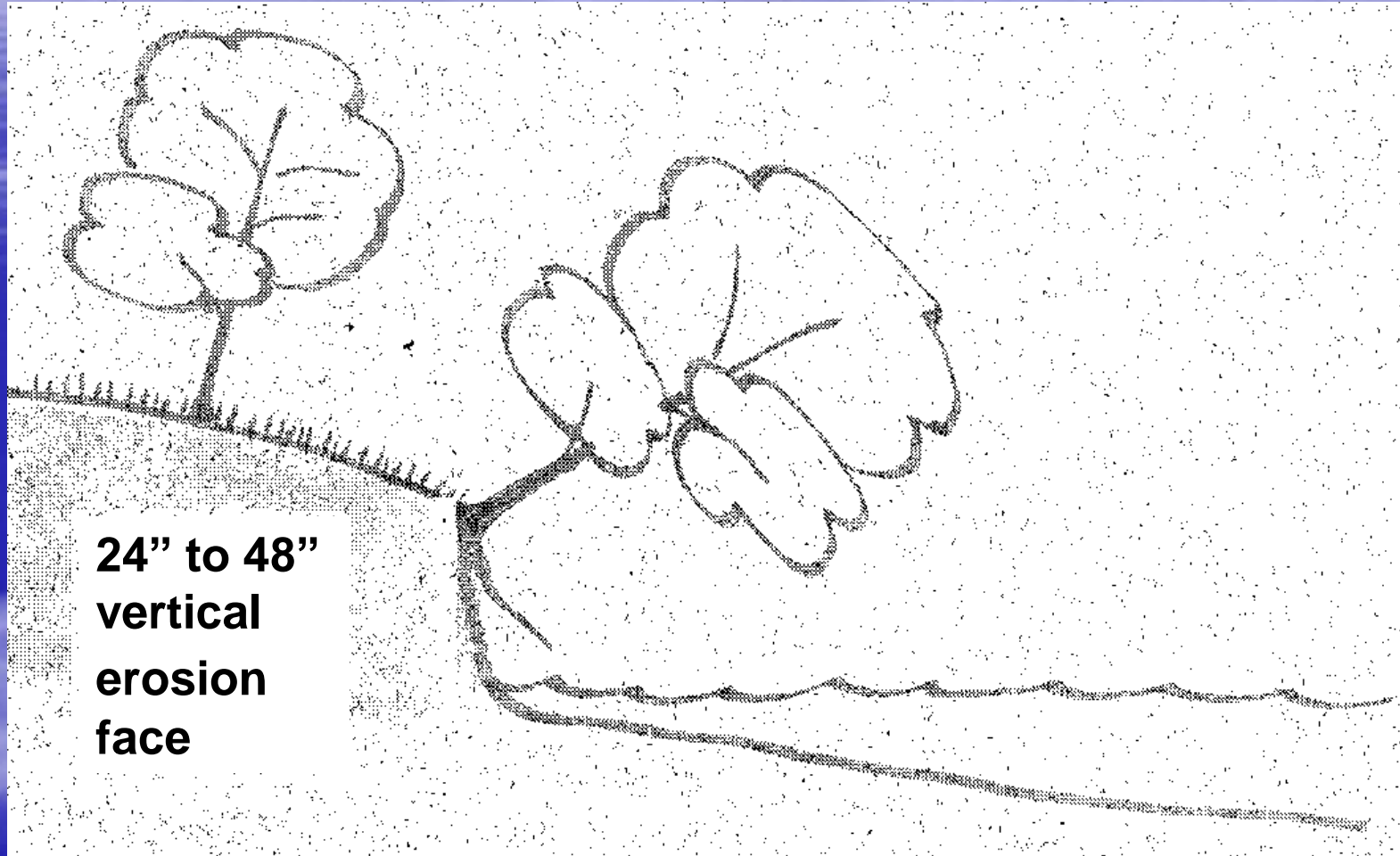
They may also need an **exclosure**  
(a fence to protect the plants from critters)



Gregg Thompson - AMSWCD

**Cost/20 linear ft: \$55**  
**Installation time: 1 hr**  
**Maintenance time: 0.5 hr**  
**Notes: remove prior to freeze-up?**

# For shores undercut 2 to 4 ft



Install toe/slope protection and native plants

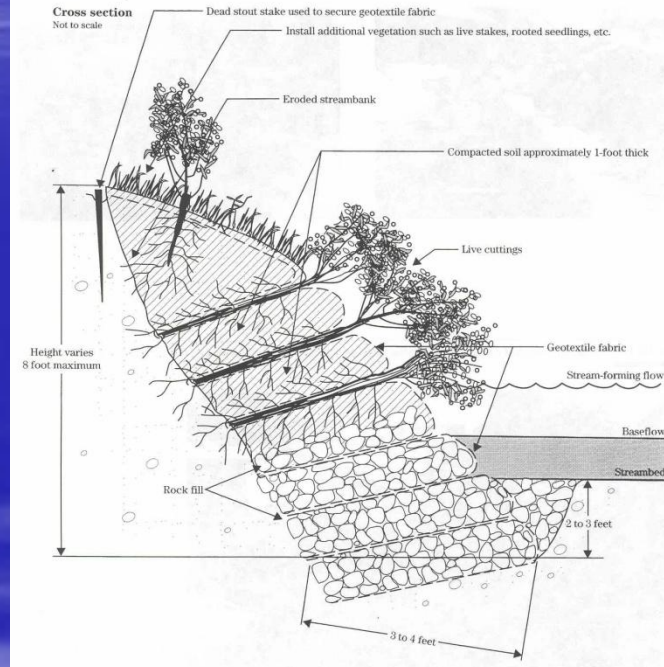


# Vegetated geogrid



**Note: Requires a shoreland alteration permit**

Figure 16-12 Vegetated geogrid details



**Cost/20 linear ft: ~\$400 (by hand)**

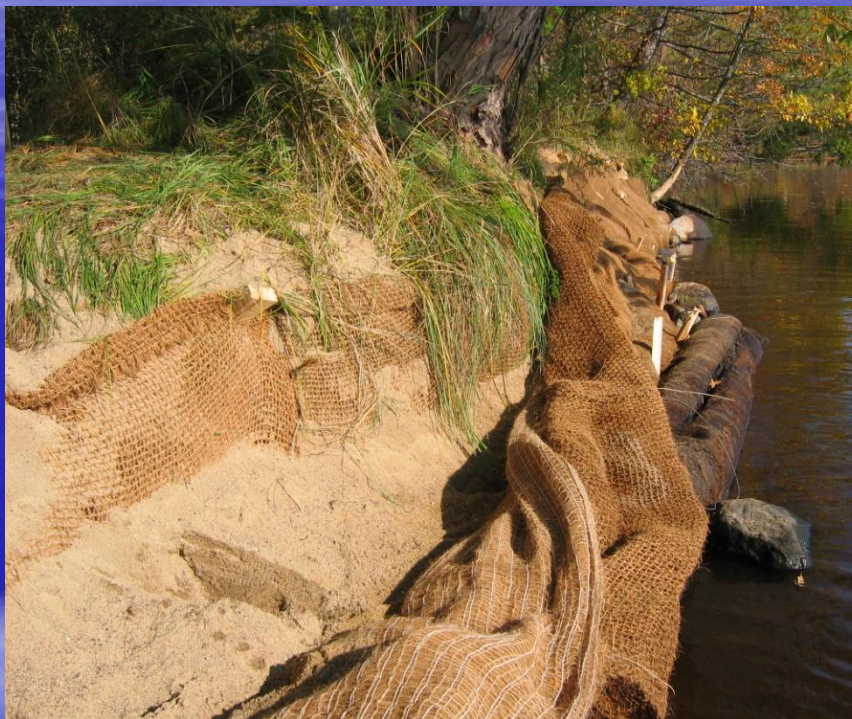
**Installation time: 5 hrs**

**Maintenance time: 0**

**Notes: requires dormant live stakes**



# Coco lift (with live stakes & plants)



**Note: may require a shoreland alteration permit**

**Cost/20 linear ft: \$340  
Installation time: 5 hrs  
Maintenance time: 0  
Notes: requires plants and/or live stakes**



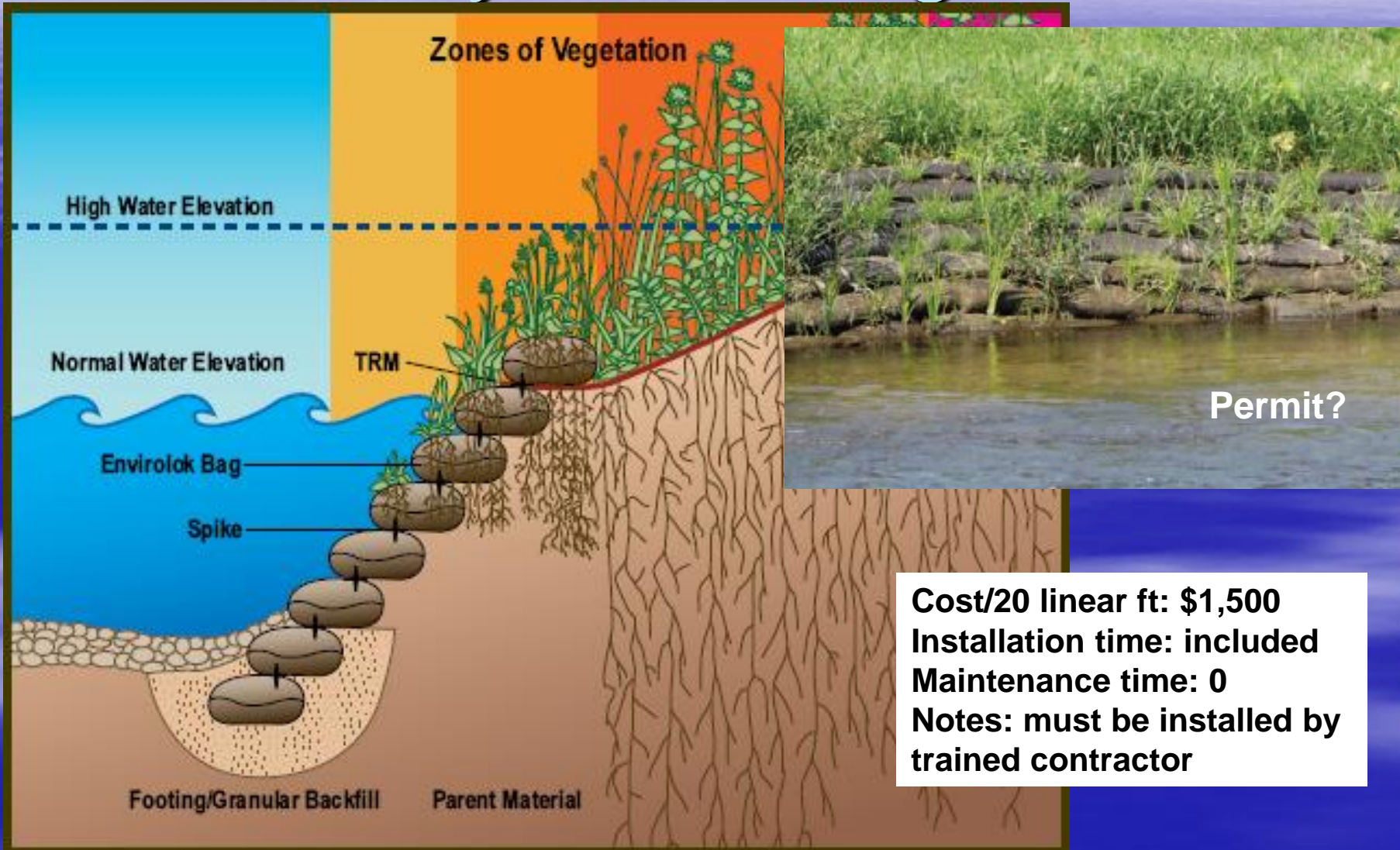
Oops!

Retaining wall is not such a good idea





# Geosynthetic bag/soil



**Cost/20 linear ft: \$1,500**  
**Installation time: included**  
**Maintenance time: 0**  
**Notes: must be installed by trained contractor**



# Shape slope, blanket, plant



**Note: requires a  
shoreland  
alteration permit**

**Cost/20 linear ft: \$1,000  
Installation time: 3 hrs  
Maintenance time: 1 hr  
Notes: requires equipment**





For shores with erosion bank  $> 4$  ft:



Greg Berg – Stearns SWCD



# Shape slope, blanket, plant



Greg Berg – Stearns SWCD

**Note: requires a shoreland alteration permit**



Greg Berg – Stearns SWCD

**Cost/20 linear ft: \$1,500**  
**Installation time: 6 hrs**  
**Maintenance time: 1 hr**  
**Notes: requires equipment**



# Tree Revetment



**Cost/20 linear ft: \$50**  
**Installation time: 0.5 hr**  
**Maintenance time: 0**  
**Notes: use duck-bill anchors**

Greg Berg – Stearns SWCD



# Live fascines



Greg Berg – Stearns SWCD





Live fascines 5 yrs after installation



# Rock rip rap & native plants

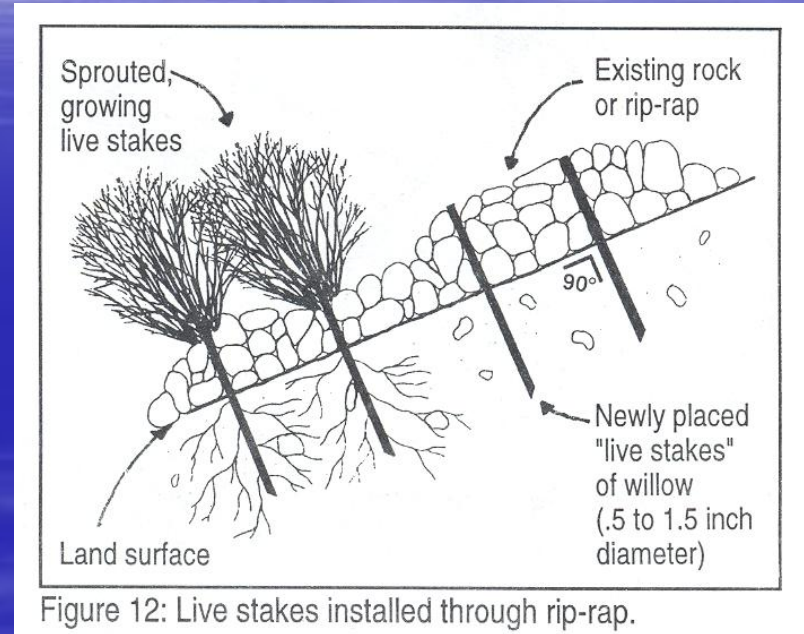


Figure 12: Live stakes installed through rip-rap.

**Cost/20 linear ft rip rap: \$1,200**  
**Installation time: included**  
**Maintenance time: varies**  
**Notes: installed by contractor**



# Project Examples



# Little Bass Lake

- Small lake
- Small resort
- Upland and aquatic vegetation removed on 400' of shoreline; turf seeded on upland
- Shore eroding 6"/year; 1-2' undercut toe
- Owner preference: "My customers come to the north woods - give them the north woods"
- Total cost: \$800 (\$2.00/linear shoreland foot)



# Aerial view







Before planting





Install willow wattle  
along eroding shore





Install coconut log – note sedge transplant after only one year



# Install aquatic and upland plants







Shoreline after  
two years





Shoreline five years after planting



# Snake River

- Private owner (4 years)
- 400' shoreline on narrow channel
- Shore eroding 6"/year
- Boat traffic; seasonal flooding; muskrats
- Project cost: \$5,000 (\$12.50/linear shore ft.)
  - Coco logs, coco blankets, stakes, mulch
  - Plants



Lay out site





Apply mulch for  
weed control





- C-125 coco blanket to hold mulch in place during floods





Native plant plugs on  
1.5' centers





# Coco log wave break





Prevegetated plant  
mats

Continuous row  
(on 2' centers)

5 species





After installation





# One year post-installation





## McCarrons Lake

68 acres – heavy boat traffic

Site on west side – maximum fetch = 3,000 ft

Shallow water zone – 1ft depth out 10 ft from shore



All photos in this sequence provided by Bill Bartodziej - RWMWD



Wall and turf removed

Shore regraded





# Coconut logs staked on top of the NAG C-350





# Soil over NAG C-350, seeded, and then covered with C-125





Plants are installed through the erosion C-125 blanket @ 1.5 ft centers





Emergents – mainly bulrush, some arrowhead and pickerel plant – 1 gallon containers @ 3-4 ft centers





September 2004





Summer 2005

Shoreline becoming well established, emergents set back by muskrats and waves





# Summer 2006 – Shore stable - Lake sedge enveloping the coconut logs





Summer 2006





# What would we do differently?

- Use wave breaks in front of emergents
- Plant a higher percentage of burreed – more resistant to muskrat feeding
- Probably would not need NAG C-350 at the toe of the slope if emergents became well established





# Take-home messages:

- The goal is to recreate a gradually sloping shoreline stabilized with native plants
- It is possible on some sites to “reclaim” lost shoreline
- On extreme sites bioengineering may be very costly and/or ineffective



# Take-home (continued)

- Use components of the “system” that are site appropriate
- Inert bio materials have a limited lifespan – make sure you choose plants that will stabilize the site within this time
- Never underestimate the appetite of muskrats, carp, geese, beavers etc.



# Resources

- The Practical Streambank Bioengineering Guide  
<http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba>
- NRCS Engineering Field Handbook, Chapter 16: Streambank and Shoreline Bioengineering  
<http://plant-materials.nrcs.usda.gov/pubs/idpmcpustguid-appA.pdf>



# Resources (continued)

- University of MN Extension  
<http://www.extension.umn.edu/shoreland/>
- The Shoreland Management Resources Guide  
[www.shorelandmanagement.org](http://www.shorelandmanagement.org)
- Sebastian the Goose encourages natural shorelines  
<http://www.youtube.com/watch?v=ZkJF6x48fwU&feature=related>