

# Restoration of Riparian Zones on Surface Mines



Before



During



After

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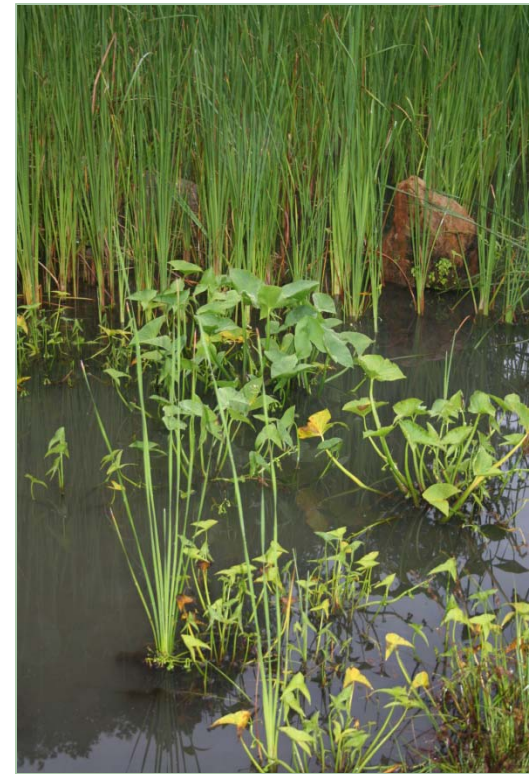
# Ecological Restoration

Ecological Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

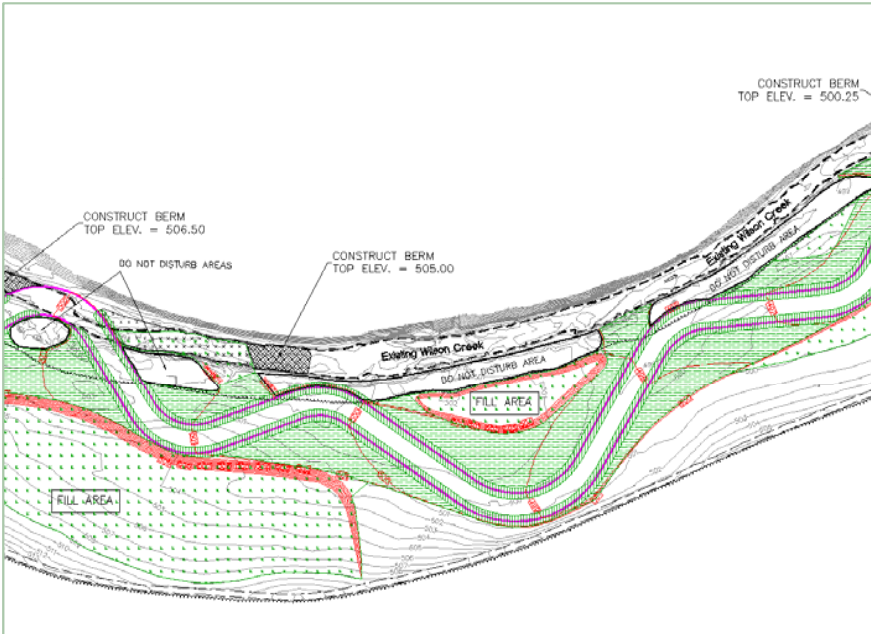


# Ecological Restoration

Restoration *accelerates* ecosystem recovery with respect to its health (functional processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience).



# Stream Restoration

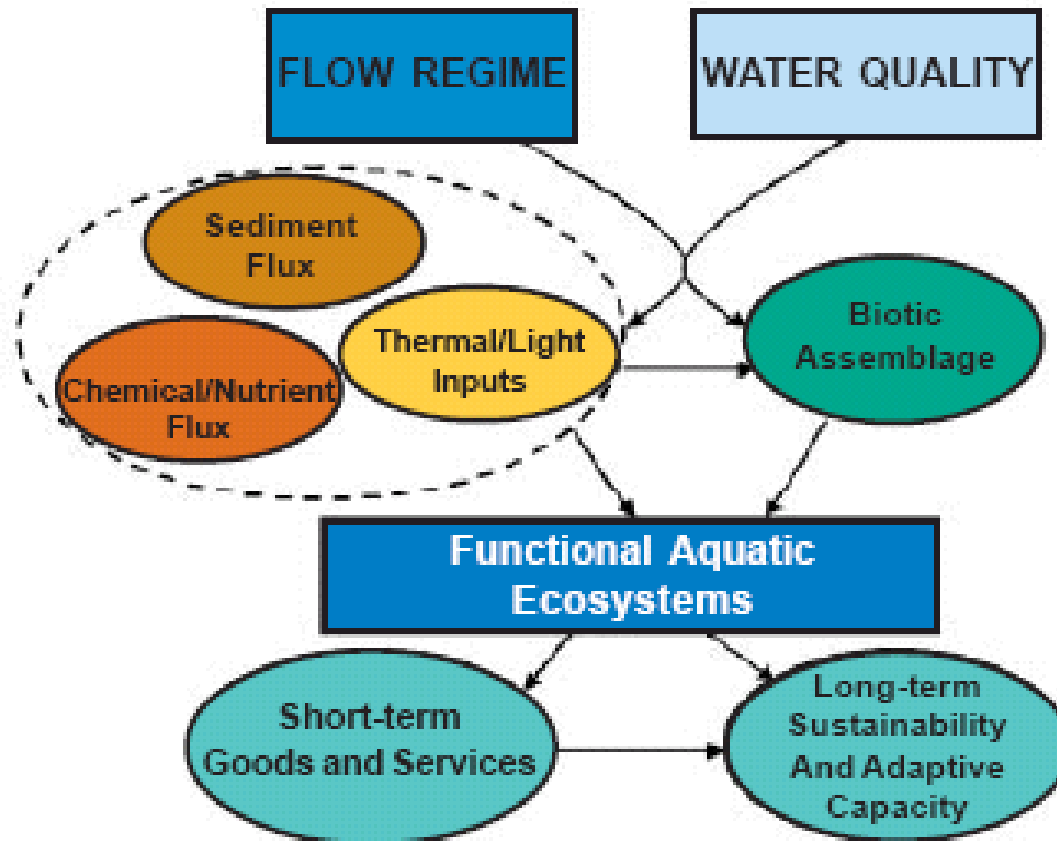


Form



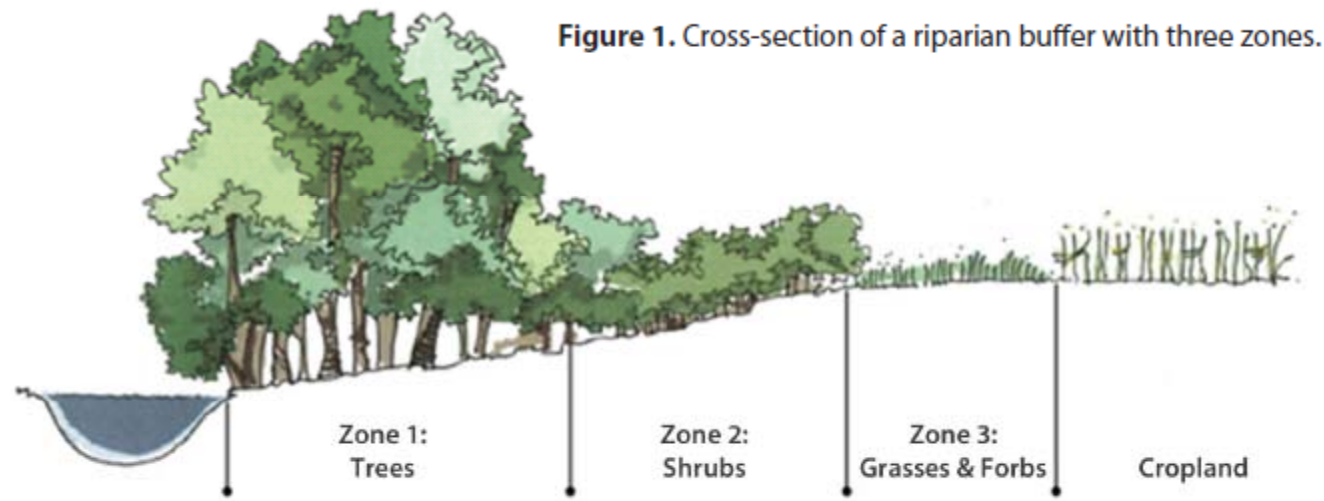
Function

Restoring stream *function* is not an easy task!



# The Riparian Corridor

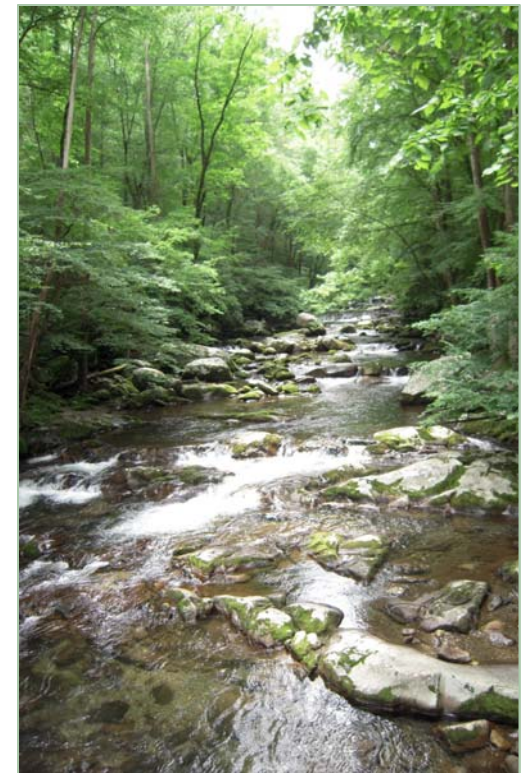
Riparian Areas are three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems, that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain into the water, laterally into the terrestrial ecosystem and along the water course at a variable width.



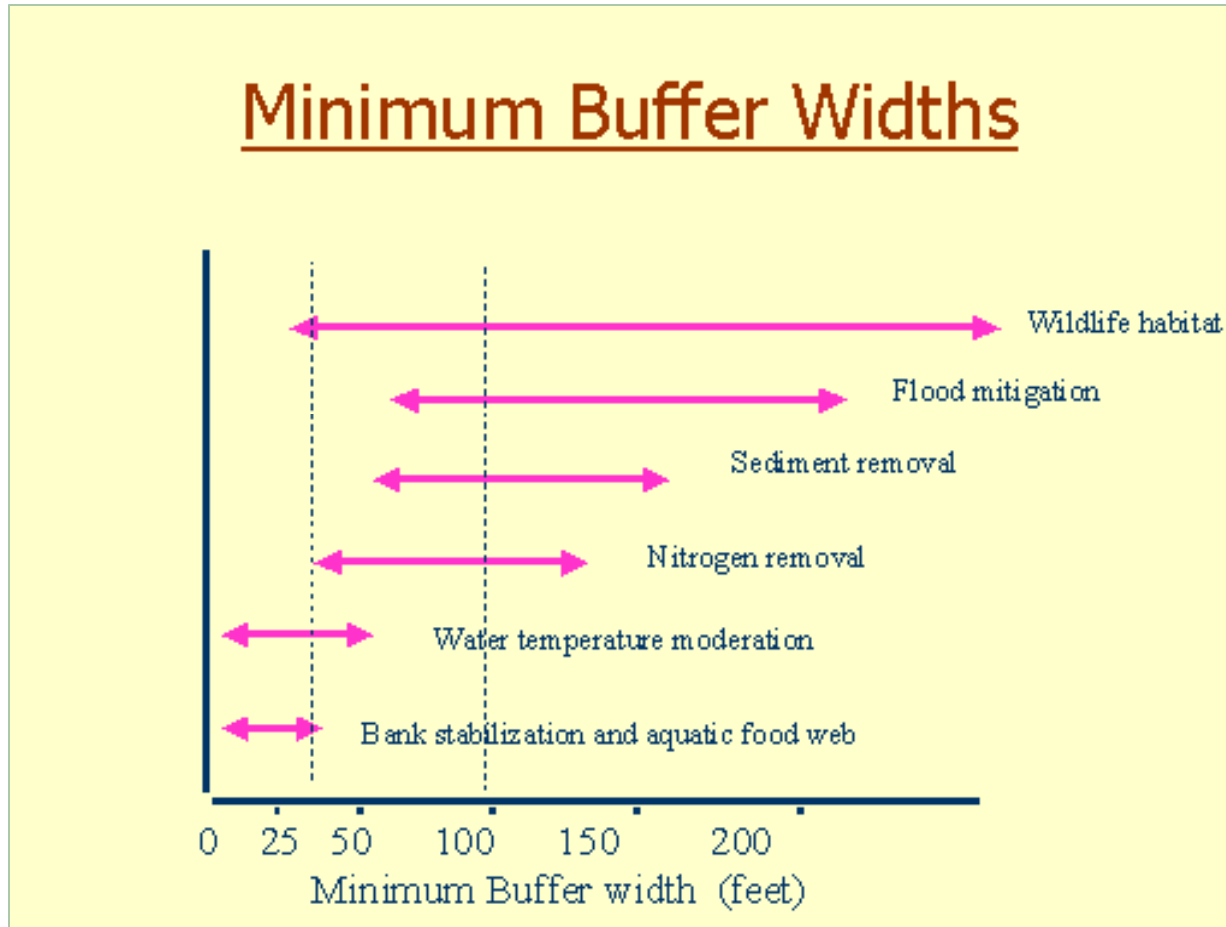
# The Riparian Corridor

- Provide shade that reduces water temperature.
- Reduce nutrient (pollution) loads to streams.
- Stabilize streambanks with vegetation and roots.
- Reduce erosion caused by uncontrolled runoff.
- Provide riparian wildlife habitat (rare and threatened).
- Filter sediments and other contaminants.
- Protect fish habitat.
- Provide carbon and nutrients.
- Maintain aquatic food webs.
- Provide a visually appealing greenbelt.
- Provide recreational opportunities.

USACE, 1991



# The Riparian Corridor – How Wide?



Depends upon slope, geology, upland activities, wildlife communities, public need and perception.....



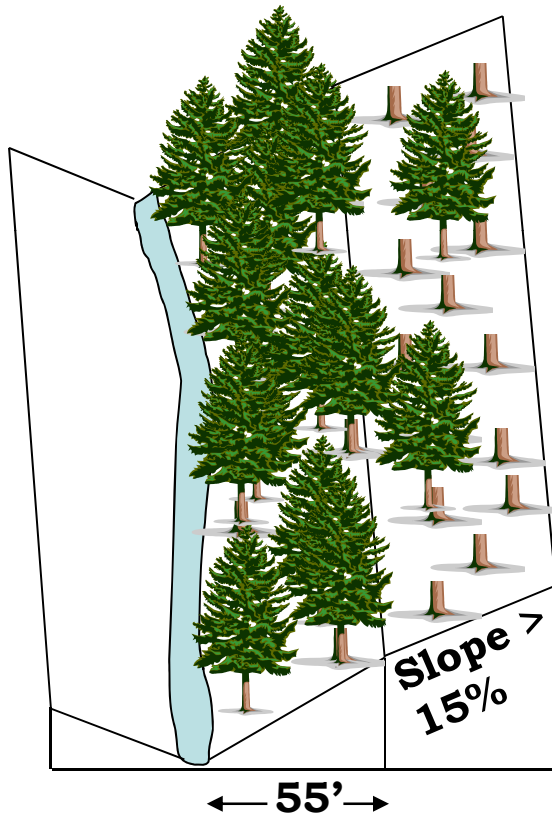
## The Riparian Corridor – How Wide?

- USDA Forest Service historically used one chain length (66 ft.)
- Daniel Boone National Forest uses 100 ft.
- Kentucky Division of Forestry has regulations on width based upon slope of the land and habitat type
- Chesapeake Bay varies by land-use 25 – 100+ ft.
- Based upon faunal usage (Semelich and Bodie, 2003)
  - Salamanders 30 m
  - Turtles 200 m
  - Frogs 1600 m(They recommend a wetland buffer of 250 -440 meters for herpetofauna species! Is this possible?)

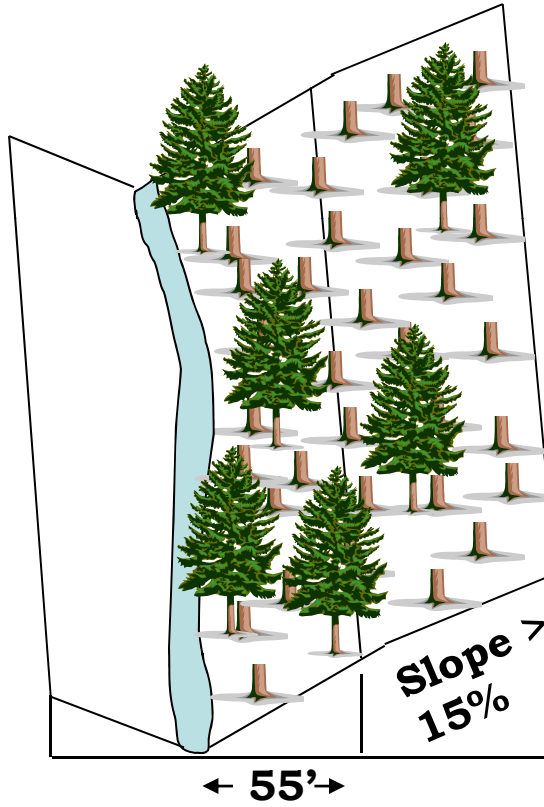


# The Riparian Corridor – How Wide?

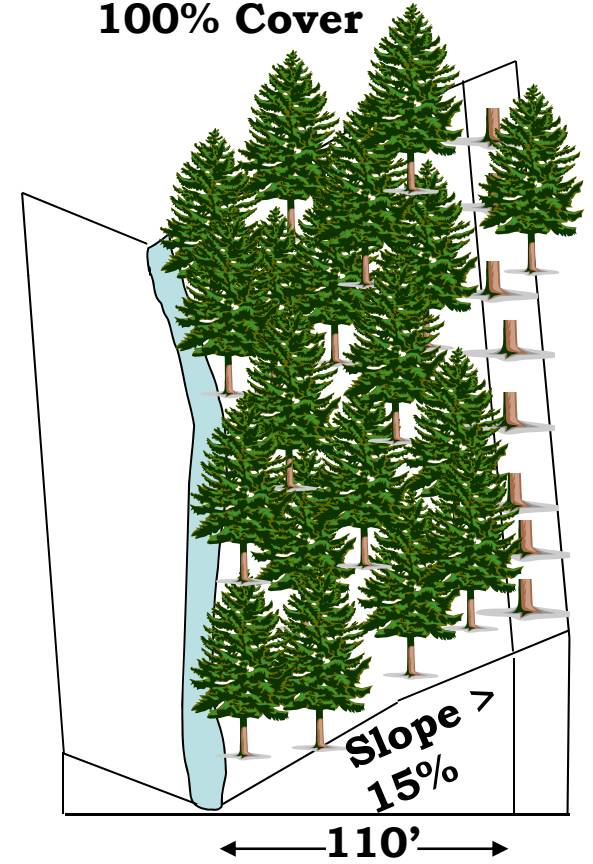
Normal SMZ Width  
100% Cover



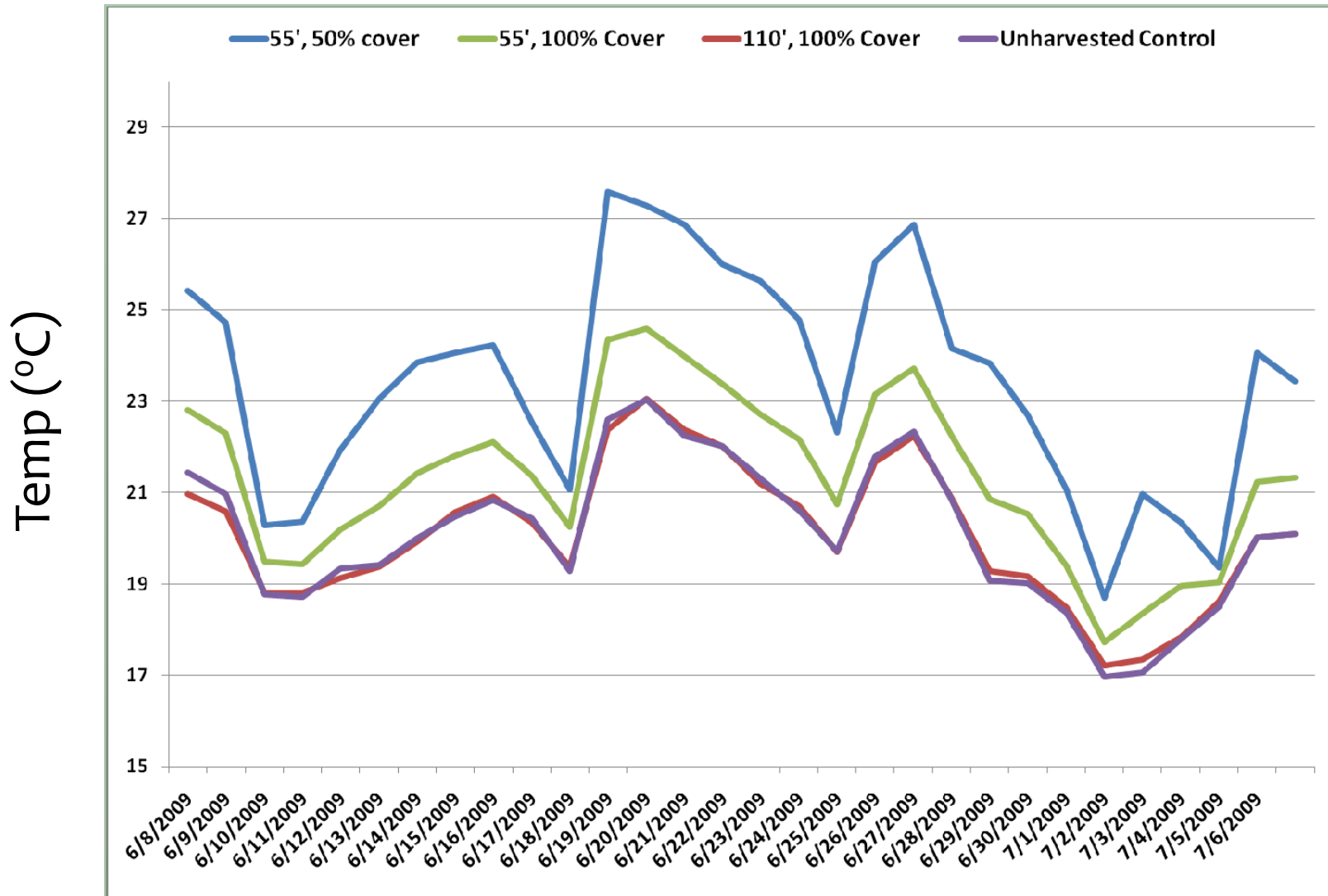
Normal SMZ Width  
50% Cover



2X Normal SMZ Width  
100% Cover

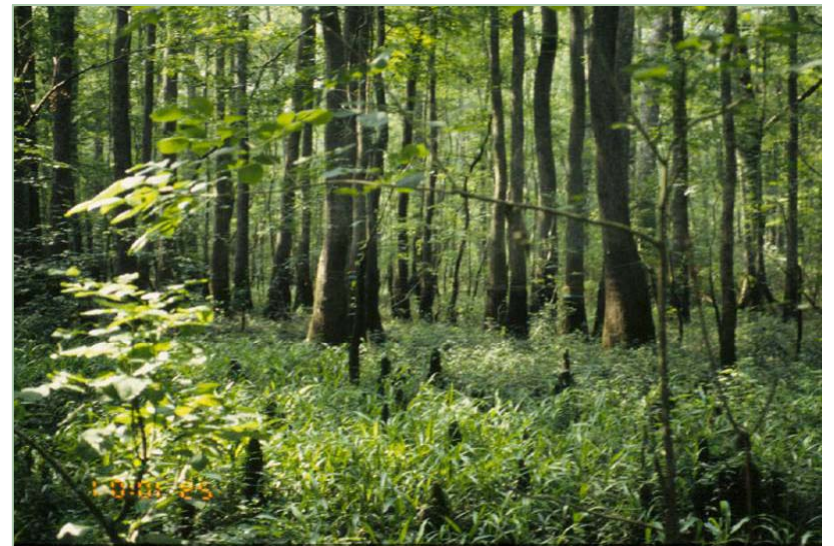


# The Riparian Corridor – How Wide?



# Selecting the Right Species

1. Mimic the natural system
  - Preserve natural vegetation on the site for seed dispersal,
  - View pre-disturbance records if available,
  - Use a reference reach and plant accordingly
  - Seed bank study.
2. Restore vegetation by “Self-Design” (fence it off)
3. Use locally recommended species  
(UK, NRCS, KSNPC, EPA, COE, DOW etc.)
4. What’s locally available?



# Selecting the Right Species

1. Use native trees of local genotype when possible
2. Early and late succession species
3. Over story and mid-story species
4. Wildlife considerations (exfoliating bark , mast producers)
5. Facultative wet and obligate wet species



Rhododendron, American sycamore



Eastern hemlock, American beech

# Establishing a Riparian Zone

1. Prepare soil (rip, till, amend)
2. Sprig, sod, seed (essential to get cover crop established)
3. Live stakes for bank erosion (if necessary)
4. Transplant
5. Monitor and Maintain



# Bank Erosion Control



**Live Stakes**



**1- Week! 15-Dead  
5- Soon to be Dead**

# Determine Desired Spacing

**Table 1.** Common grid patterns for planting tree seedlings: trees per acre planted and surviving assuming 70% survival rate.

Spacing (feet)	Trees per acre	
	Planted	Surviving @ 70%
7 x 7	889	622
7 x 8	778	544
8 x 8	681	476
8 x 9	605	423
9 x 9	538	376
9 x 10	484	338
10 x 10	436	305





# Methods for Planting Tree Seedlings

*(Bare Root Seedlings)*

- Keep seedlings cool and moist (coolers, tarps, seedling bags),
- Planting bags or 5-gal buckets to transport seedlings to field,
- Root pruning (only if absolutely necessary)



# Methods for Planting Tree Seedlings



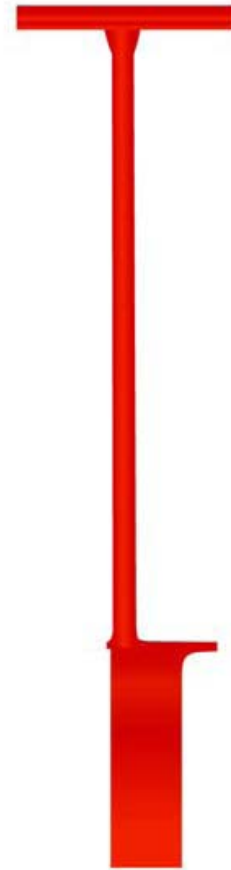
Hoedad



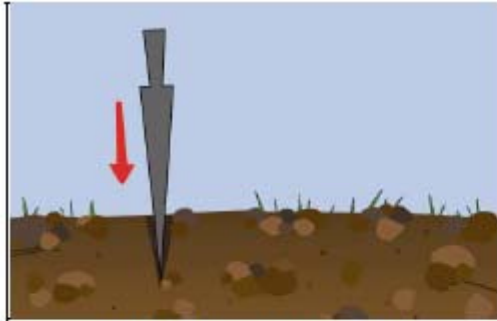
Planting Bar



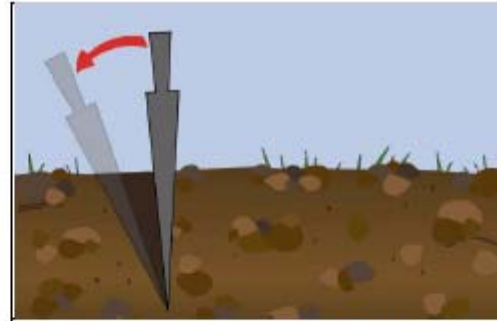
Sharpshooter



Dibble



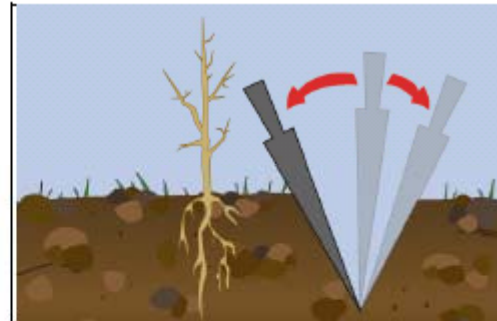
**Step 1:** Drive the planting bar into the soil to the depth necessary to accommodate the entire root system.



**Step 2:** Push the handle back and forth to open the hole.



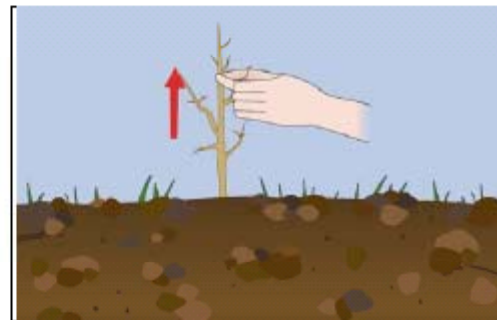
**Step 3:** Remove the bar and place the seedling in the hole 1-2 inches below the root collar, making sure that all roots are pointing down and contained within the planting hole.



**Step 4:** Drive the planting bar into the soil at an angle toward the bottom of the planting hole about 3-4 inches behind the seedling. Push planting bar back and forth to close the top and bottom of the planting hole making sure that all air pockets are removed and the entire root system is in contact with the soil.

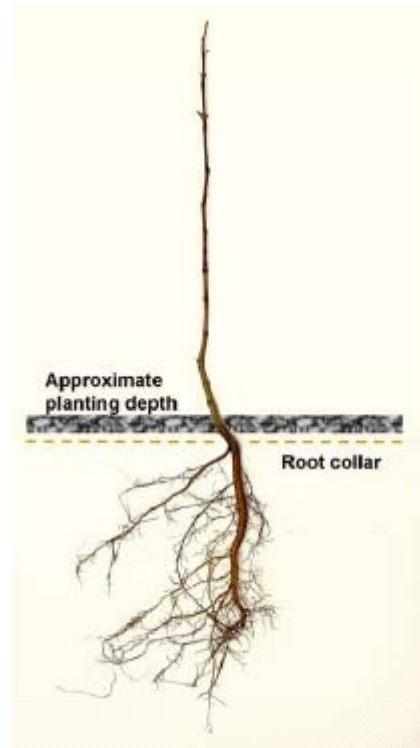


**Step 5:** Remove the planting bar and fill the second hole with soil.



**Step 6:** Test for secure planting by grabbing the top shoot between two fingers and pulling up. If the seedling is loose, place additional soil around the seedling and pack with your heel.

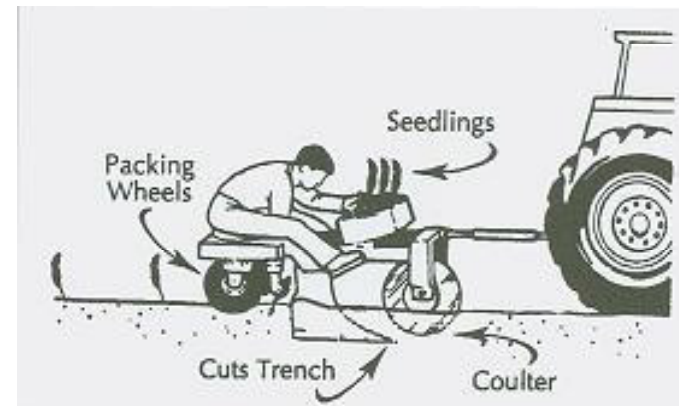
# Methods for Planting Tree Seedlings



# Methods for Planting Tree Seedlings

## (Mechanical Planters)

- Not practical for small jobs,
- Typically only used on flat land that can be plowed,
- EKY mines (no way), WKY mines (maybe on Prime Farmland),
- Good practice for rodeo !!



# Methods for Planting Tree Seedlings

*(Containerized Plants)*

- Advantage is that the entire root system is transplanted ,
- Disadvantage is that the potting material has a tendency to dry ,
- Care must be given to ensure that they are watered frequently, and that they don't become root-bound in their pots.



# Methods for Planting Tree Seedlings

*(Balled and Burlapped)*

- Advantage is that trees are large, provide quick shade,
- Disadvantage is that they require special equipment to plant,
- Expensive.



# Methods for Planting Tree Seedlings

(Coppice)





# Competition/Herbivory/Predation

1. Beaver, deer, weeds, voles, pioneer species, shade.....
2. Tree shelters and fabric mats
3. Herbicides – approved for use in wetlands and aquatic areas (Rodeo, Garlon 4).
4. Burn?
5. Nurse Crop???



# Tree Shelters



**Continental**

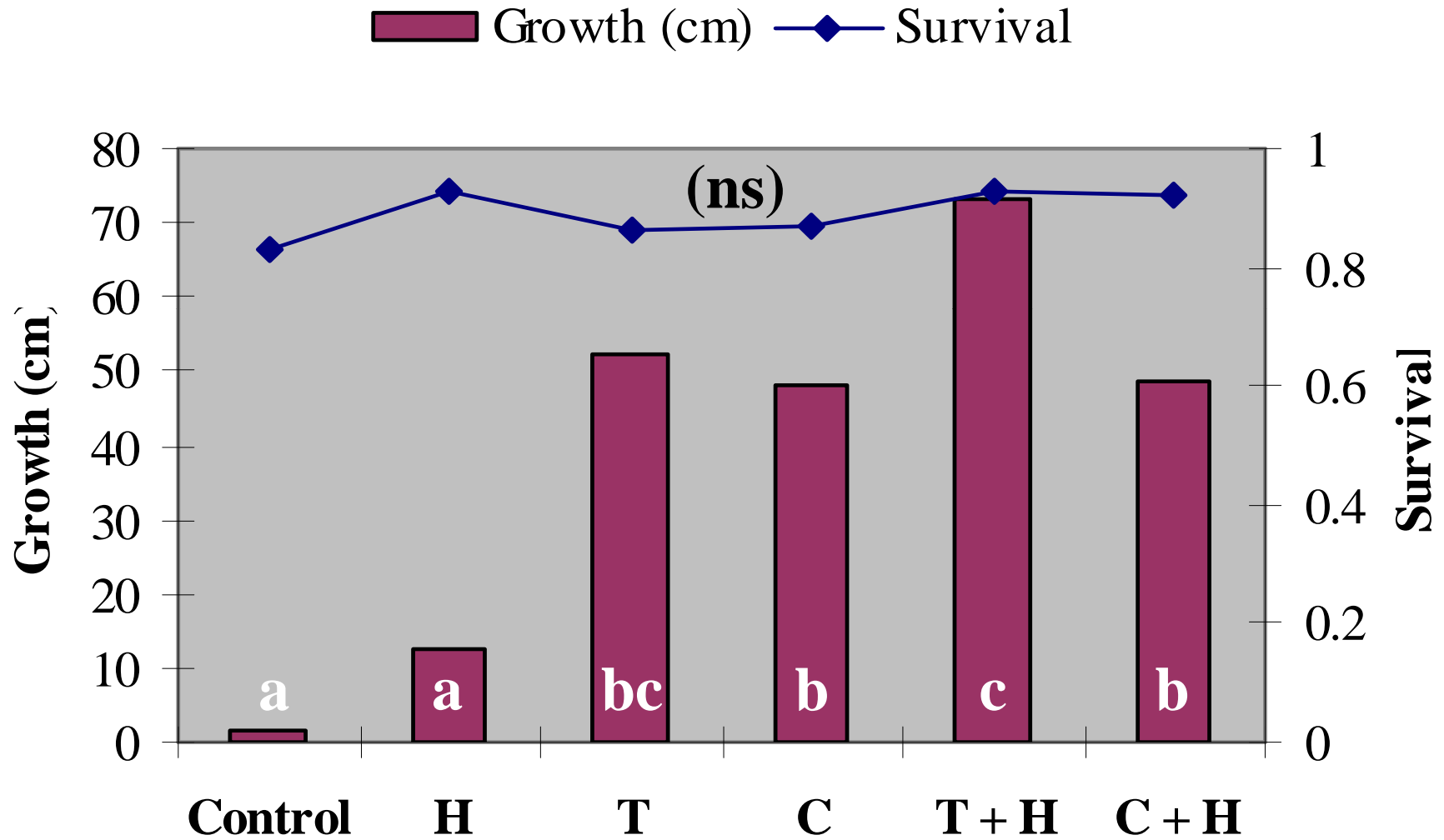


**Tubex**



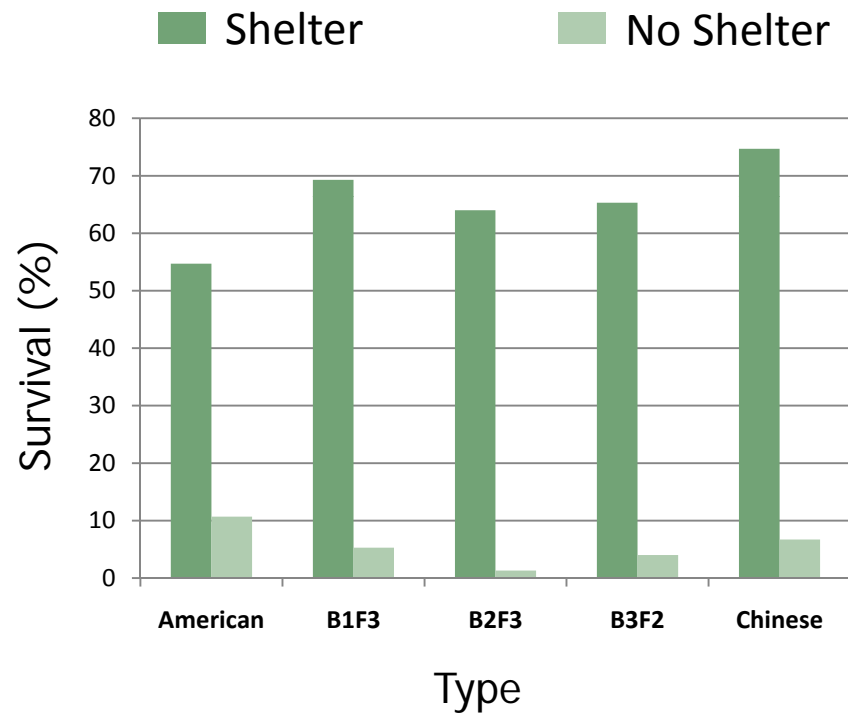
**Control**

# Tree Shelters

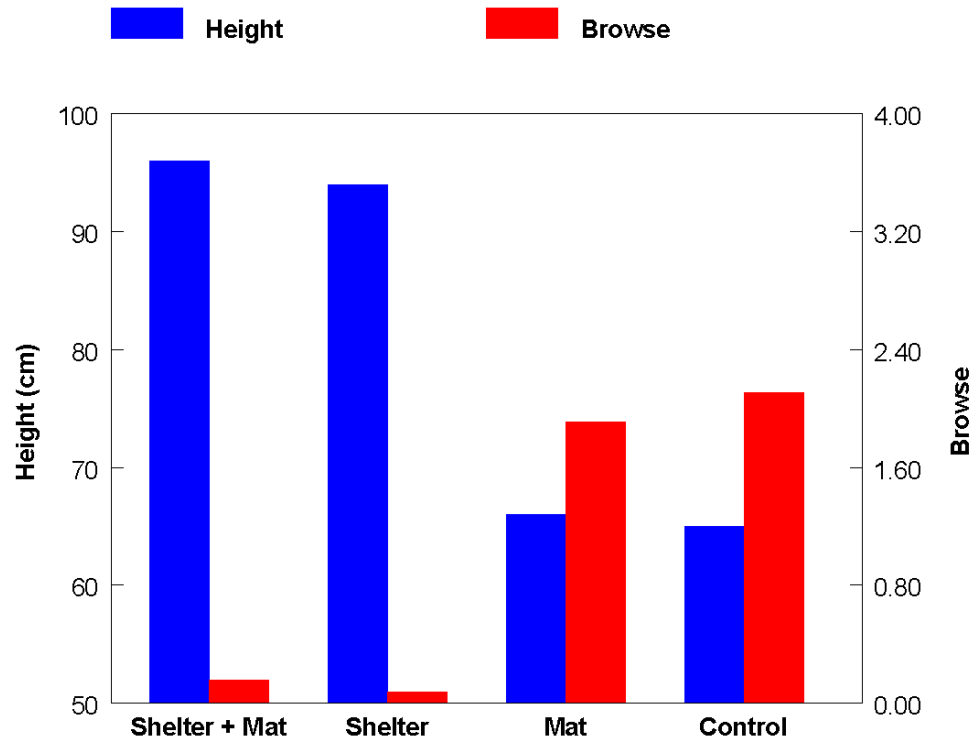


# Tree Shelters

(Direct Seeding)



# Tree Shelters



**Browse: 0 = none; 1 = light; 2 = moderate; 3 = heavy; 4 = severe.**



# Tree Shelters

*(CWD Accumulation)*



# Fabric Mats

- Used to suppress herbaceous competition (frequently used in old-field sites and mine lands),
- Mixed results,
- Inexpensive, but timely to install (can create a mess).



# Browse Prevention



Bud Capping





# Maintenance & Monitoring

