Selection and Use of Conservation Plants to Alleviate the Impacts of Salt Water Inundation on Agricultural Lands

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USDA-NRCS Climate Change Vulnerability Assessment and Adaptation Plan-2014

- Key Climate Change Predictions:
  - Coastal storms are expected to increasingly contain damaging winds leading to greater extreme wave heights (Storm surges) and coastal damage.
  - Sea Levels are projected to rise 6-8 inches over the next 40 years
- Resulting Impacts:
  - Increased salinization of near-coastal waters
  - Increased flooding frequency of marginal lands
  - Changes in plant adaptability in specific locations due to environmental shifts
  - Increased competition from weeds/invasive plants
  - Increased soil health challenges due to potential increased erosion and changes in soil chemical and biological processes.

Agricultural land surrounding intertidal salt marsh in New Jersey along the Delaware Estuary (Google Earth).

- With sea level rise, such farmland will be intermittently flooded and become saline, thus suitable for salt-tolerant crops for, food, feed, non-food products, and biofuels.

NRCS Resource Concerns

Plant Solutions Addressed through the Plant Materials Program

- **Soil Erosion**-Excessive bank erosion from streams, shorelines, and water conveyance channels threaten to degrade water quality and limit use of land for intended purpose.

- **Soil Quality Degradation**-Concentration of salts leading to salinity and/or sodic soils reducing productivity of land for desired use.

- **Water Quality Degradation**-Excessive salts in surface and ground waters results in salts being transported to irrigation water and/or surface runoff that degrades water quality.

Sod Production in southern NJ Impacted by Sea Level Rise and Saltwater Inundation

Restore economic value to damaged farm land.

Mitigation of Salt Affected Soils

- **Potential relatively short term, quick fixes*:**
  - **Allow excess salts to leach through natural rainfall events or irrigate with fresh water.**
    - Incorporate rotations of salt tolerant crops alternating with applying water.
  - **Add gypsum-**Conservation Practice Code 333-Amending Soil Properties with Gypsum Products. Not as effective on sandy soils with lower CEC
  - **Incorporate composts that don't contain salts.**
    - Avoid sewage sludge, most manures and mushroom compost
  - **Grow cover crops for one season or in rotations**
    - Small grains esp. barley, Triticale, sorghum, sorghum/sudangrass, canola, some millets and tall wheatgrass have especially good salt tolerance.

***Site/soil specific, as well as producer specific**

Adaptation Strategies

- Move crop production to higher ground (further inland)
- Plant more salt tolerant crop varieties (Inherent or genetically improved)
- Apply appropriate conservation practices:
  - Riparian Herbaceous Cover (390)
  - Filter strips (393)
  - Field Borders (386)
  - Conservation Cover (327)
  - Streambank and Shoreline Protection (580)
  - Critical Area Planting (342)
- Establish salt tolerant native plant buffers
  - Grow value-added, alternative crops/conservation plants.

Corn field impacted by flooding

Prevent the establishment of invasive undesirable plant species and encourage the establishment of desired wetland plants.

***Phragmites* invasion**

Let’s Focus on Opportunities

Growing/Establishing Conservation Plants on Marginal Lands for Ecosystem Services.

- Establishing saltmeadow cordgrass (*Spartina patens*) for harvesting as a **salt hay** crop. (demand is high, supply is limited)
- Harvest dormant native shrub stems for **soil bioengineering** applications on brackish shorelines/streambanks
  - Groundsel bush (*Baccharis halimifolia*)
  - High tide bush *(Iva frutescens*), Arrowwood (*Viburnum spp*.), Indigobush (*Amorpha fruticosa*), Elderberry (*Sambucus spp*.)
  - Willow (*Salix spp.*)-identify salt tolerant selections
- Planting a **bioenergy crop** in marginal areas for on-farm energy use.
  - Switchgrass (*Panicum virgatum*)
  - Coastal Panicgrass (*Panicum amarum var. amarulum*)
  - Prairie cordgrass (*Spartina pectinata*)

Marshy Hay Cordgrass (*Spartina patens*)

Once harvested from the marsh. Valued as a weed free mulch and other uses. Selections will be evaluated for optimal harvest potential**. An upright variety: 'Flageo' may be more desired as a hay crop.**

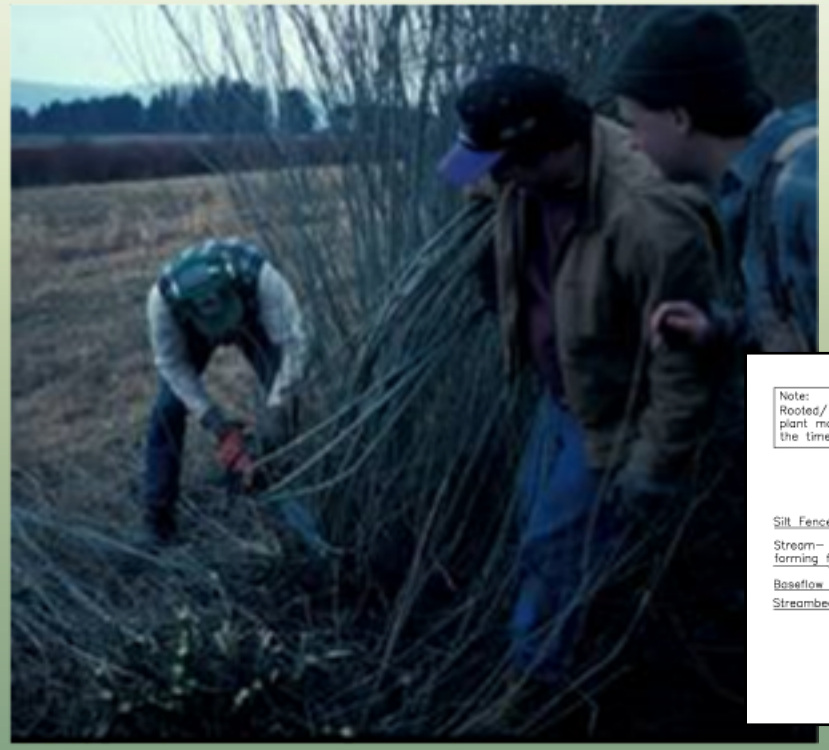
Expand Availability of Dormant Cuttings for Soil Bioengineering Applications

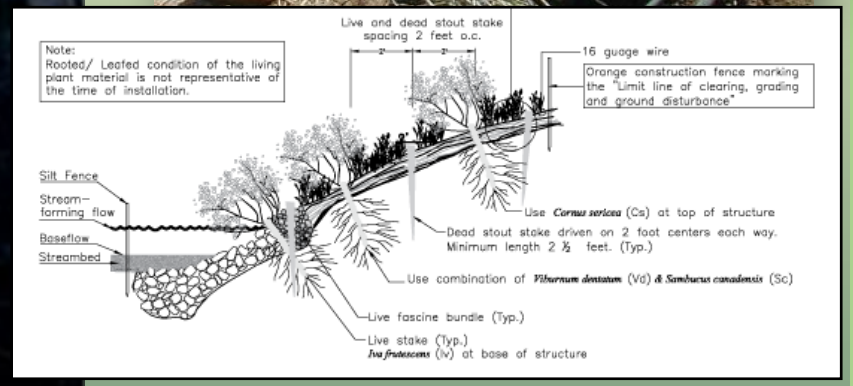
Groundsel Bush

Willow/Dogwood

Soil Bioengineering: Using Plants in a Structural Function

- **3:1 to 2:1 horizontal/ vertical**
- **Low to moderate energy environment**
- **Seeding may be included**





Herbaceous Buffers-Biomass Production

Plant variety matters!

High Tide Switchgrass

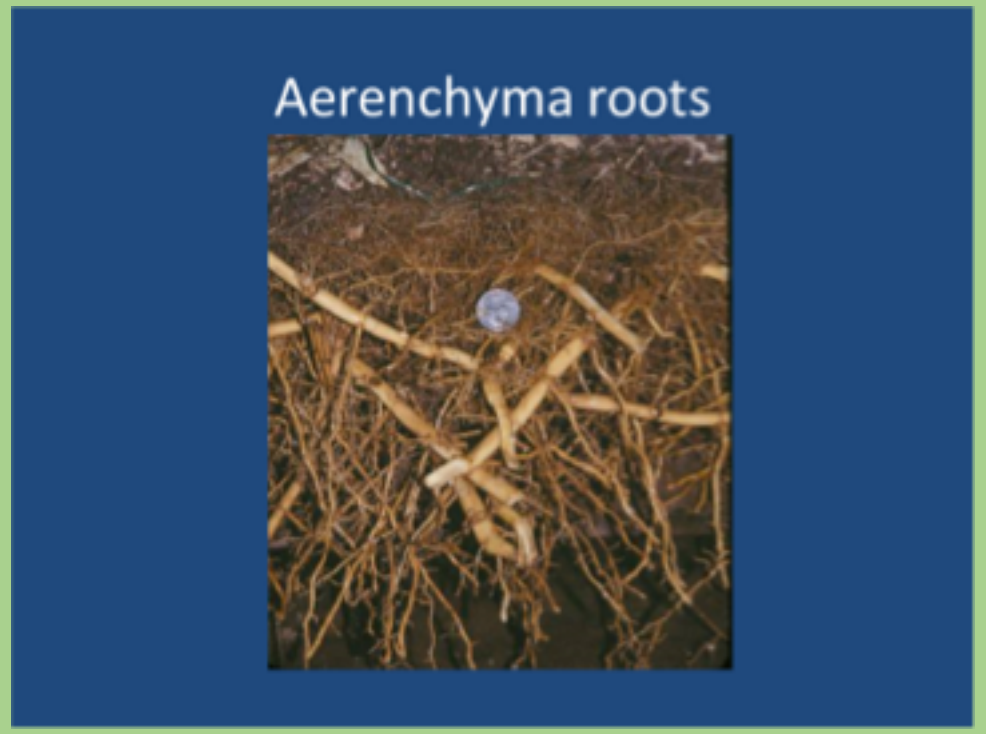
Southampton Prairie Cordgrass

Eastern Gamagrass
(Tripsacum dactyloides)

Wetland restoration, shoreline stabilization, forage, soil health improvement

Anaerobic adapted roots

Eastern gamagrass



switchgrass

Willow species

Native Warm Season Grass

Riparian Zone Study(w/USDA-ARS)

Cultivar	Survival (2006)	Vigor (2006)	Yield (2005)	Overall
	Relative ranking (1=best, 9=worst)			
Red River PC*	1	1	4	2.0
Hightide SG*	2	3	1	2.0
NY EG *	4	2	2	3.0
Shelter SG	3	4	3	3.3
Osage IG	7	5	7	6.3
Niagara BB	5.5	6	8	6.5
Suther BB	5.5	8.5	6	6.7
Suther IG	8	8.5	5	7.2
Bonilla BB	9	7	9	8.3

* Salt tolerant species

Controlling Invasive Species

- Strategic planting of competitive native species to control spread of phragmites:
  - *Spartina pectinata* (prairie cordgrass)
  - *Spartina patens* (saltmeadow cordgrass)
  - *Panicum virgatum* (switchgrass)
  - *Panicum amarulum* (coastal panicgrass)
  - *Tripsacum dactyloides* (Eastern gamagrass)
  - *Kosteletzkya pentacarpos* (seashore mallow)

  - Other potential species to add:
    - *Spartina cynosuroides* (giant cordgrass)
    - *Sporobolus virginicus* (seashore dropseed)
    - *Arundinaria gigantea* (giant cane)
    - *Iva frutescens* (High tide bush)*
    - *Baccharis halimifolia* (Groundsel)*

Growing a Value-Added, Alternative Crop

Cooperative work with the University of DE-Halophyte Biotechnology Lab - Lewes, DE

Seashore Mallow

(***Kosteletzkya pentacarpos*** **(a.k.a. *K. virginica*)**

Meet the Plant

Kosteletzkya pentacarpos (a.k.a. *K. virginica*)

- Seashore Mallow (Malvaceae)
- Brackish marshes – grows interspersed among other species
- Delaware to Florida and Gulf of Mexico coast
- Self or cross-pollinated
- Perennial (lives 10 years)
- Non-invasive
- Relative of cotton & okra
- No known diseases; little insect damage
- Large seeds that contain 18-20% oil
- Oil composition is similar to cottonseed oil which is used for biodiesel
- Stems can be used to produce cellulosic ethanol
- Seeds contain 20% protein.
- Seeds can be planted and harvested with traditional farm equipment (on upland).
- Salt-tolerant – can use resources not usable by food crops (saline land and water).

Growing and harvest techniques

Planting in tilled sandy loam on the same farm.

Planting Seashore Mallow in a no-till setting on the Freeman farm in Sussex County, Delaware.

Massey-Ferguson 510
Combine with pick-up reel.

Bags of seeds and bales of stems

Pellets for feed – cattle, chickens, or fish?

Seashore mallow (*Kosteletzkya pentacarpos*) as a salt-tolerant feedstock for production of biodiesel and ethanol

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ABSTRACT

Seashore mallow (*Kosteletzkya pentacarpos*) is a non-invasive perennial nonclonal halophytic oilseed-producing dicot that was investigated as a feedstock for production of biodiesel from seeds and ethanol from residual stem biomass. Seashore mallow seeds contained 19.3 mass % oil, which after extraction with hexane and pretreatment with catalytic sulfuric acid was converted into methyl esters in 94 mass % yield utilizing homogenous base catalysis. The principal components identified were methyl linoleate (48.9%), palmitate (24.4%) and oleate (18.3%). Fuel properties were characterized and compared to biodiesel standards ASTM D6751 and EN 14214. Also investigated were blends with petrodiesel. Lastly, seashore mallow stems were rich in neutral carbohydrates (51.8 mass %). After simultaneous saccharification and fermentation employing a native *Saccharomyces cerevisiae* yeast strain, the stems provided ethanol and xylose yields of 104 g/kg and 47.8 g/kg, respectively. Of the four pretreatment methodologies explored, dilute ammonium hydroxide provided the highest yield of sugars.

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Seashore mallow (*Kosteletzkya pentacarpos*) stems as a feedstock for biodegradable absorbents☆

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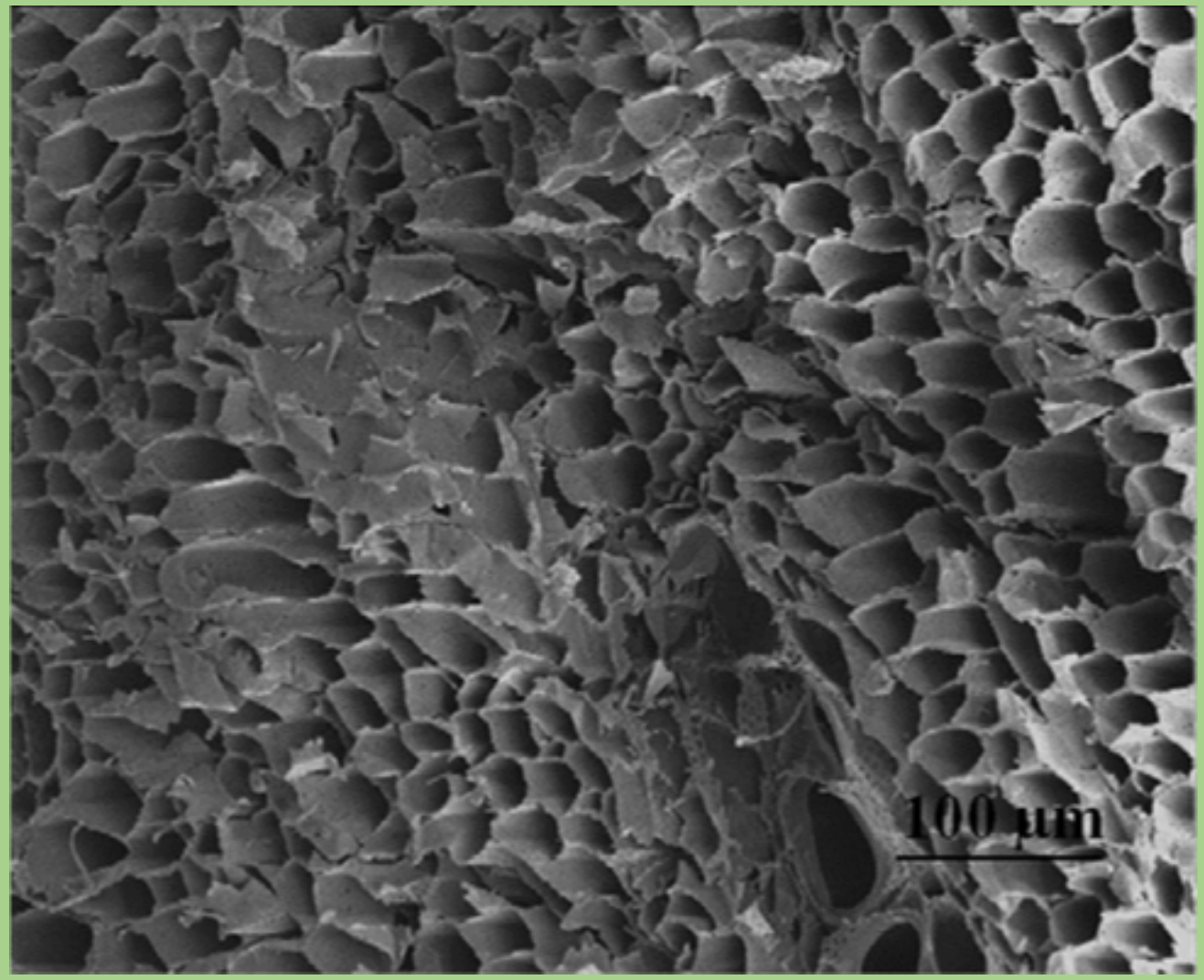
ABSTRACT

Seashore mallow (*Kosteletzkya pentacarpos* (L.) Ledebour) is a perennial halophyte producing multiple, harvestable stems per year which were examined for several bioabsorbent applications. Larger, debarked stems were milled and separated into three fractions by sieving. The largest fraction absorbed water readily and appeared to be an excellent bedding material for birds and small animals. The mid-sized fraction made an excellent base for biodegradable cat litter. The finest fraction efficiently absorbed diesel fuel which could be subsequently burned as a fuel. Smaller stems with bark (bast fibers) intact were milled to produce a material which performed excellently as hydraulically-applied mulch (hydromulch), with comparable properties to a commercial hydromulch.



Scanning electron micrograph of the core of mature seashore mallow stems showing prismatic cells approximately 25-60 µm in diameter. They average over 500 µm in length. The small diameter cells absorb liquids via capillary action (Vaughn et al. 2013).

Cat litter

Poultry Bedding

Foot Pad Dermatitis Ratings and Downgrade Percentage

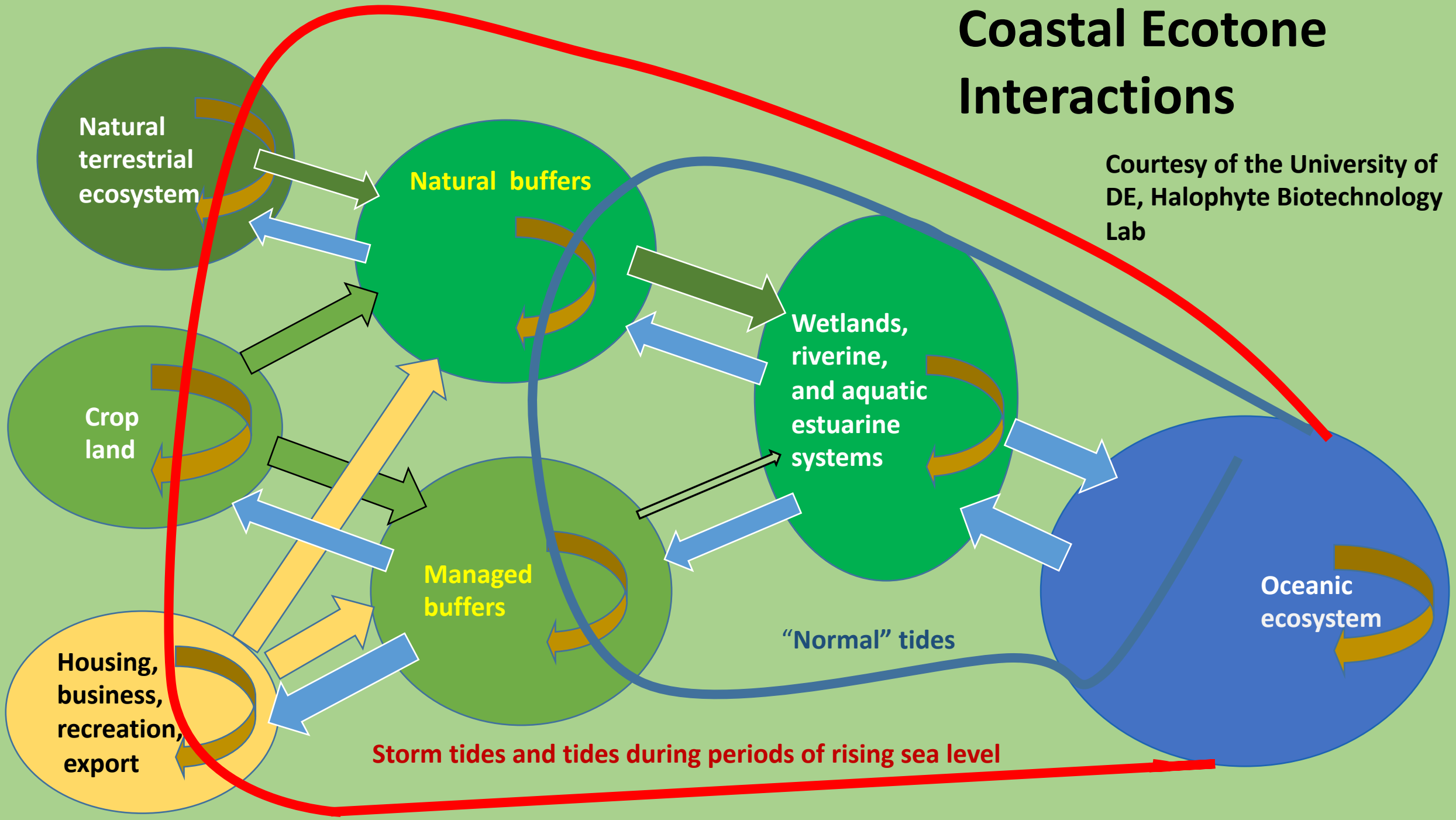
Bedding Treatment	FPD Rating (mean score)	% downgrade PAWS
Pine Shavings	.50	8.4
Sea Shore Mallow	.18	0
Switch Grass Bedding	.38	7.8
Colony Pine Sawdust (2 reps)	.30	3.8
Miscanthus (1 Rep)	.53	7.9

Refreshable
Managed Buffer Zones

Abundant fine roots
for nutrient absorption.

Harvesting refreshes
capacity for retention.

Coastal Ecotone Interactions



Why Grow Salt Tolerant Conservation Plants for Coastal Environments?

- **Diversification:** Niche/specialty crop; alternatives to row crops/vegetables. Some species may provide off-season income. Potential benefit to limited resource farmers.
- **New Markets:** Plants for soil bioengineering (streambank/shoreline stabilization), biofuels, and agroforestry (windbreaks/buffers)
- **Foundation "starter" Plants** provided by the Plant Materials Centers.
- **Technical Support/ Production Guidelines** provided by the Plant Materials Program through planting guides, plant release brochures, plant source directories, etc.

Technical Resources

- USDA Climate Hubs - http://www.climatehubs.oce.usda.gov/
- USDA-NRCS Plant Materials Program- http://www.nrcs.usda.gov/wps/portal/nrcs/site/plantmaterials/home/
- NJ Climate Adaptation Alliance- http://njadapt.rutgers.edu/
- University of DE-Halophyte Biotechnology Center
  - http://www.ceoe.udel.edu/halophyte/index.html
- Cooperative Extension Service (state specific) University of Delaware, Rutgers, and Cornell.