USDA

United States Department of Agriculture

Natural Resources Conservation Service

Developing Adaptive Management Strategies to Minimize the Impacts of Saltwater Inundation on Agricultural Lands

Christopher Miller, USDA Northeast/Southeast Climate Hubs Liaison

Natural Resources Conservation Service

nrcs.usda.gov/

Cape May Plant Materials Center

- Established: 1965
- Size: 84 acres
- Primary Resource Concerns:
  - Coastal Shorelines
  - Critical Areas
- Service Area Includes all or Portions of Nine States:
  - Connecticut
  - Delaware
  - Maryland
  - Massachusetts
  - New York
  - New Jersey
  - North Carolina
  - Rhode Island
  - Virginia

Developing Coastal Plant Technology for NRCS since 1965.

Cape May Plant Materials Center

Purpose/Mission

To test and select plants and planting techniques for stabilizing Atlantic coastal sand dunes/shorelines. In addition, studying/testing plants for their applicability to droughty, sandy and low nutrient soils of the coastal plain.

NRCS Resource Concerns-Salt Impacts

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.

NRCS Conservation Plant Selection

"Nature has evolved a plant for every purpose."

- Dr. Franklin J. Crider

General Concept:

Comparative Observation/Selection

Plant Materials Centers evaluate accessions both on and off Center.

We're Not Just Beachgrass!

Past Projects

- Pollinator plant study-CIG (Rutgers)
- Carbon sequestration under warm season grasses (ARS)
- Biomass production of NWSG (Rutgers)
- Evaluation of plants for filter strips (URI)-1990's
- Plant applications for Herbaceous Windbarriers-1990's

Current/Future (including salt impacted areas)

- Cover crop species evaluations for soil health improvement (ARS)
- Riparian buffer applications of native warm season grasses (ARS)
- Planting strategies to suppress spread of invasive species
- Determining upper salt tolerance limits of coastal plants
- Conservation plant adaptability to land applied dredge material

USDA Climate Hubs Project

Christopher Miller, NRCS Project Liaison

Managing the impact of saltwater inundation from coastal flooding, will require producers to use more adaptive agricultural practices. This project will:

1. **Develop assessment guidelines for agricultural producers in vulnerable coastal areas of the Eastern US and Gulf Coast.**

2. **Based on assessments, provide potential mitigation (short term) and/or adaptation (long term) options in order to reduce lost farm and forest productivity.**

3. **Establish pilot plant materials demonstration and evaluation plantings to help determine various plant species' adaptability to salt affected fields.**

Vulnerable Agriculture in Coastal Areas

Ablemarle-Pamilco Sound-North Carolina

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

sea level rise, such farmland will be intermittently flooded and bec
uitable for salt-tolerant crops for, food, feed, non-food products,

Sod Production in southern NJ Impacted by Sea Level Rise and Salts

What happens when farming stops?

Desirable and/or undesirable (Invasive) vegetation. Can we intentionally improve the vegetation community to perform ecosystem services?

Let's Focus on Opportunities

Potential Adaptation Strategies

- Move crop production to higher ground/apply for wetland easement.
- Plant more salt tolerant crops (Inherent or genetically improved)
- Establish salt tolerant native plant buffers
- 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)
- Grow value-added, alternative crops/conservation plants.

Growing/Establishing Conservation Plants on Marginal Lands

Establish saltmeadow cordgrass (*Spartina patens*) for harvesting as a salt hay (mulch) crop.

Plant a biomass/fiber crop as a multifunctional buffer

- Switchgrass (*Panicum virgatum*)
- Coastal Panicgrass (*Panicum amarum var. amarulum*)
- Prairie cordgrass (*Spartina pectinata*)
- Seashore mallow (*Kosteletzka virginica*)

Harvest native shrub stems for soil bioengineering applications on brackish shorelines

- Groundsel bush (*Baccharis halimifolia*)
- High tide bush *(Iva frutescens*), Arrowwood (*Viburnum spp*.), Indigobush (*Amorpha fruticosa*)
- Willow (*Salix spp.*)-identify salt tolerant selections

Saltmeadow Cordgrass a.k.a. salt hay (*Spartina patens*)

Once harvested from the natural marsh for salt hay.

Valued as a weed free mulch.

Demand is still high but supply is low resulting in high cost.

Varietal selections being evaluated.

Native Grass Biomass Species

High Tide Switchgrass

'Atlantic' Coastal Panicgrass

Southampton Prairie Cordgrass

Eastern gamagrass

Multifunctional Riparian Buffer

Lower Chesapeake Bay (Maryland) farm field

Plant Species:

Eastern gamagrass
Switchgrass
Coastal Panicgrass
Prairie Cordgrass

Vulnerable Crop Field

Natural Resources Conservation Service

nrcs.usda.gov/

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

* Top 3 performing grasses also have some level of salt tolerance


High Tide Germplasm switchgrass

High Tide Germplasm switchgrass

- Collected in freshwater tidal-upper Chesapeake Bay.
- Stabilizing scoured bank on Sedge Island (Dredge Containment Facility) on back bay behind Stone Harbor.
- Tolerates salinity-25 ppt

Seashore Mallow

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

- 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).

Seeding a transition crop

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.

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

Bryan R. Moser [a,*], Bruce S. Dien [b], Denise M. Seliskar [c], John L. Gallagher [c]

[a] *Bio-Oils Research Unit, National Center for Agricultural Utilization Research, Agricultural Research Service, United States Department of Agriculture, 1815 N. University St., Peoria, IL 61604, USA*
[b] *Bioenergy Research Unit, National Center for Agricultural Utilization Research, Agricultural Research Service, United States Department of Agriculture, 1815 N. University St., Peoria, IL 61604, USA*
[c] *Halophyte Biotechnology Center, College of Earth, Ocean, and Environment, University of Delaware, Lewes, DE 19958, USA*

ARTICLE INFO

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.

Published by Elsevier Ltd.

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

Steven F. Vaughn[a,*], *Bryan R. Moser*[a], *Bruce S. Dien*[a], *Loren B. Iten*[a], *Arthur R. Thompson*[a], *Denise M. Seliskar*[b], *John L. Gallagher*[b]

[a] *United States Department of Agriculture, Agricultural Research Service, National Center for Agricultural Utilization Research, 1815 N. University St., Peoria, IL 61604, USA*
[b] *Halophyte Biotechnology Center, University of Delaware, Lewes, DE 19958, USA*

ARTICLE INFO

Article history:
Received 21 February 2013

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.

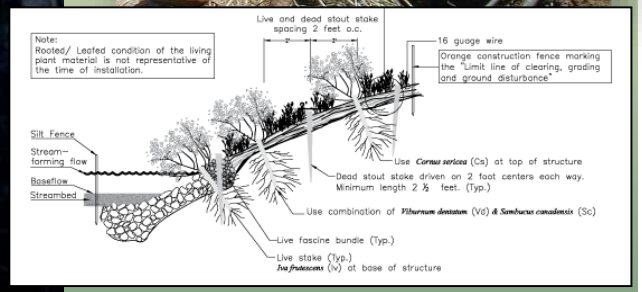
Expand Availability of Dormant Cuttings for Soil Bioengineering Applications

Groundsel Bush

Willow/Dogwood

Soil Bioengineering: Using Plants in a Structural Function

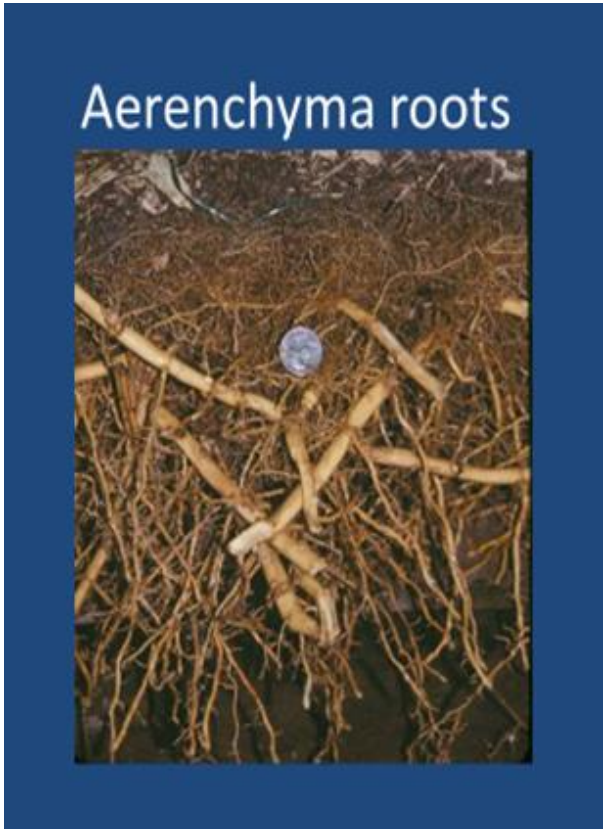
- 3:1 to 2:1 horizontal/ vertical
- Low to moderate energy environment
- Seeding may be included



Natural Resources Conservation Service

nrcs.usda.gov/

Eastern Gamagrass



Willow

Switchgrass

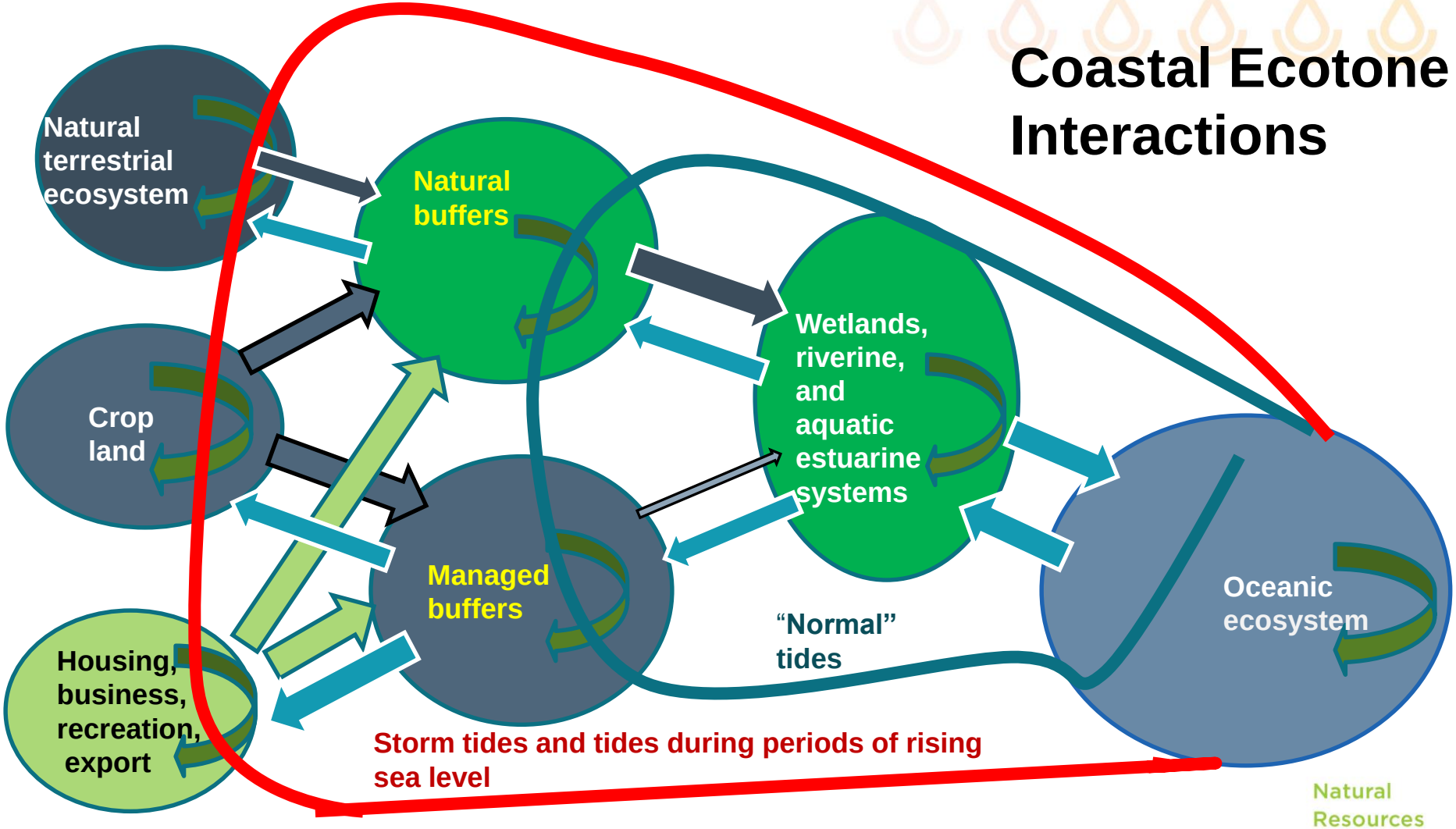
It’s ALL in the ROOTS!

Transitioning Refreshable Buffer Zones

Abundant fine roots
for nutrient absorption.

Harvesting refreshes
capacity for retention.

Coastal Ecotone Interactions



Natural Resources Conservation Service

nrcs.usda.gov/

Source: Dr. Jack Gallagher, University of Delaware

Beneficial Use of Dredge Project- Southern New Jersey

Natural Resources Conservation Service

nrcs.usda.gov/

Dredge Material Planting

Natural Resources Conservation Service

nrcs.usda.gov/

Controlling Invasive Species Spread

Strategic planting of competitive native species to control phragmites:

- *Spartina pectinata* (prairie cordgrass)
- *Spartina patens* (saltmeadow cordgrass)
- *Panicum virgatum* (switchgrass)
- *Tripsacum dactyloides* (Eastern gamagrass)
- *Kosteletzkya virginica* (Seashore Mallow)

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

Conventional/Historical "Wisdom"

Seawater/Saline incursions/Occurrences
Detrimental-to-Disastrous for
Agriculture

Unconventional

Saline Agriculture is a Viable-to-Desirable Alternative to Conventional Agriculture

Source: Dennis Bushnell, Chief Scientist, NASA- Langley Research Center

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), biomass/biofuels, and agroforestry (windbreaks/buffers)

Foundation "starter" Plants provided by the USDA Plant Materials Centers.

Technical Support/ Production Guidelines provided by the Plant Materials Program through planting guides, plant release brochures, plant source directories, etc.