Webinar Host
Holli.Kuykendall@gnb.usda.gov

USDA Natural Resources Conservation Service
Science and Technology

Conservation Webinar

Date	2016 Conservation Webinars Topics
May 5	**Strategies to Mitigate the Impacts of Sea Level Rise and Salt Water Intrusion on Cropland**
May 10	Integrating Warm Season Annuals into Cool Season Perennial Grazing Systems
May 17	Alternative Strategies for Grazing Annual Crops
May 24	Online Tool for Designing Manure Pit Ventilation Systems to Reduce Entry Risk
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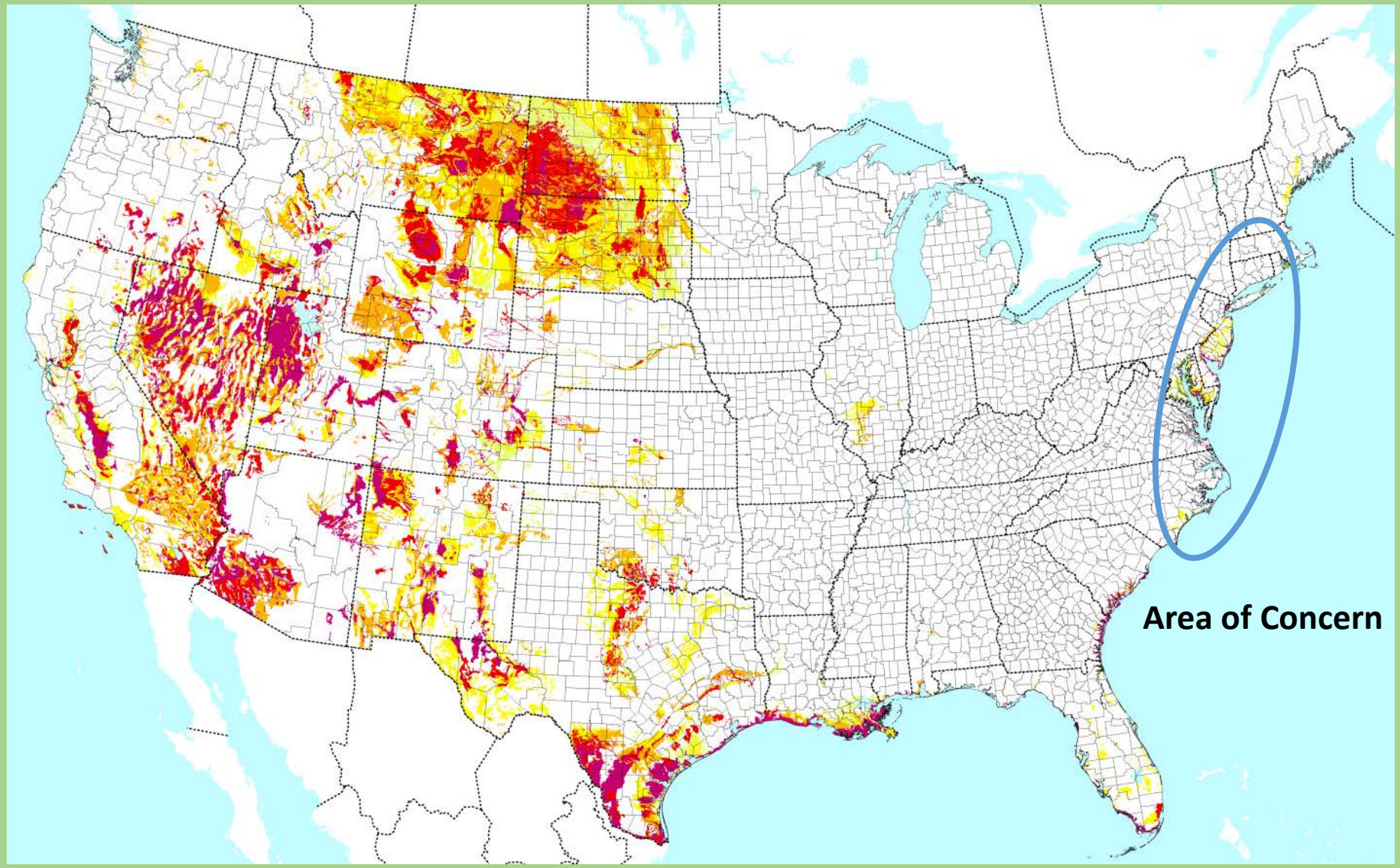
SREF

Strategies to Mitigate the Impacts of Sea Level Rise and Salt Water Intrusion on Agricultural Lands

Christopher Miller, USDA-NRCS, Cape May Plant Materials Center
Jack Gallagher, University of Delaware- Halophyte Biotechnology Center
Denise Seliskar, University of Delaware- Halophyte Biotechnology Center

Land in the U.S. Impacted by Salt

6 % of land globally is impacted by salt including 42 million acres of irrigated land in the U.S.



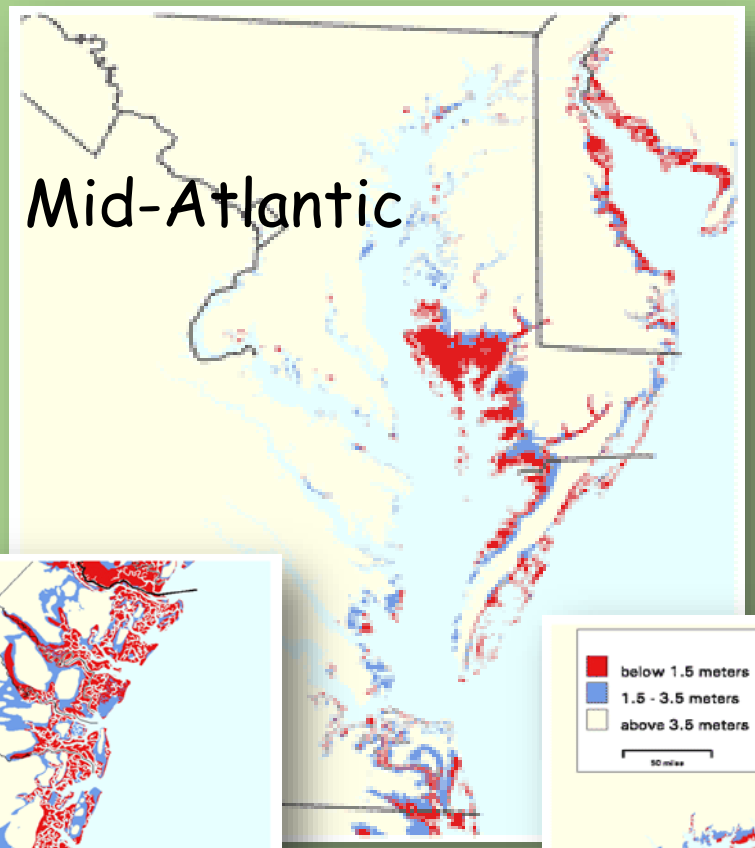
Salt Affected Soil Classification

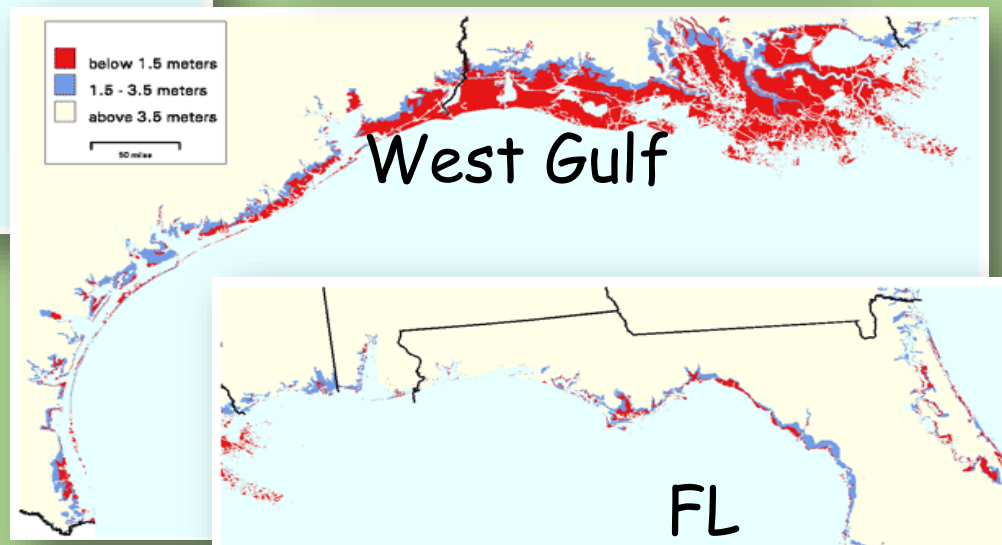
Classification	Electrical Conductivity (dS/m)	Sodium Adsorption Ratio (SAR)	pH
Saline	>4.0	<13	<8.5
Sodic	<4.0	>13	>8.5
Saline-Sodic	>4.0	>13	<8.5

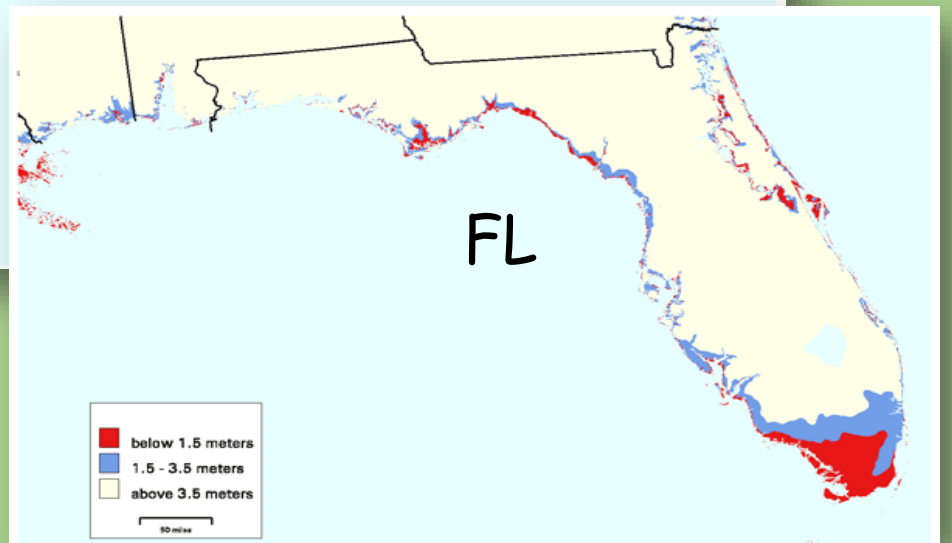
Interpretation of electrical conductivity

EC (dS/m)	Salt rank	Interpretation
0-2	Low	Very little injury to plants
2-4	Moderate	Sensitive plants may suffer
4-8	High	Non-salt tolerant plants will suffer
8-16	Excessive	Only salt-tolerant vegetation will grow
16+	Very Excessive	Very few plants will grow

Coastal land subject to spring tide flooding with a 2 ft. rise in sea level.

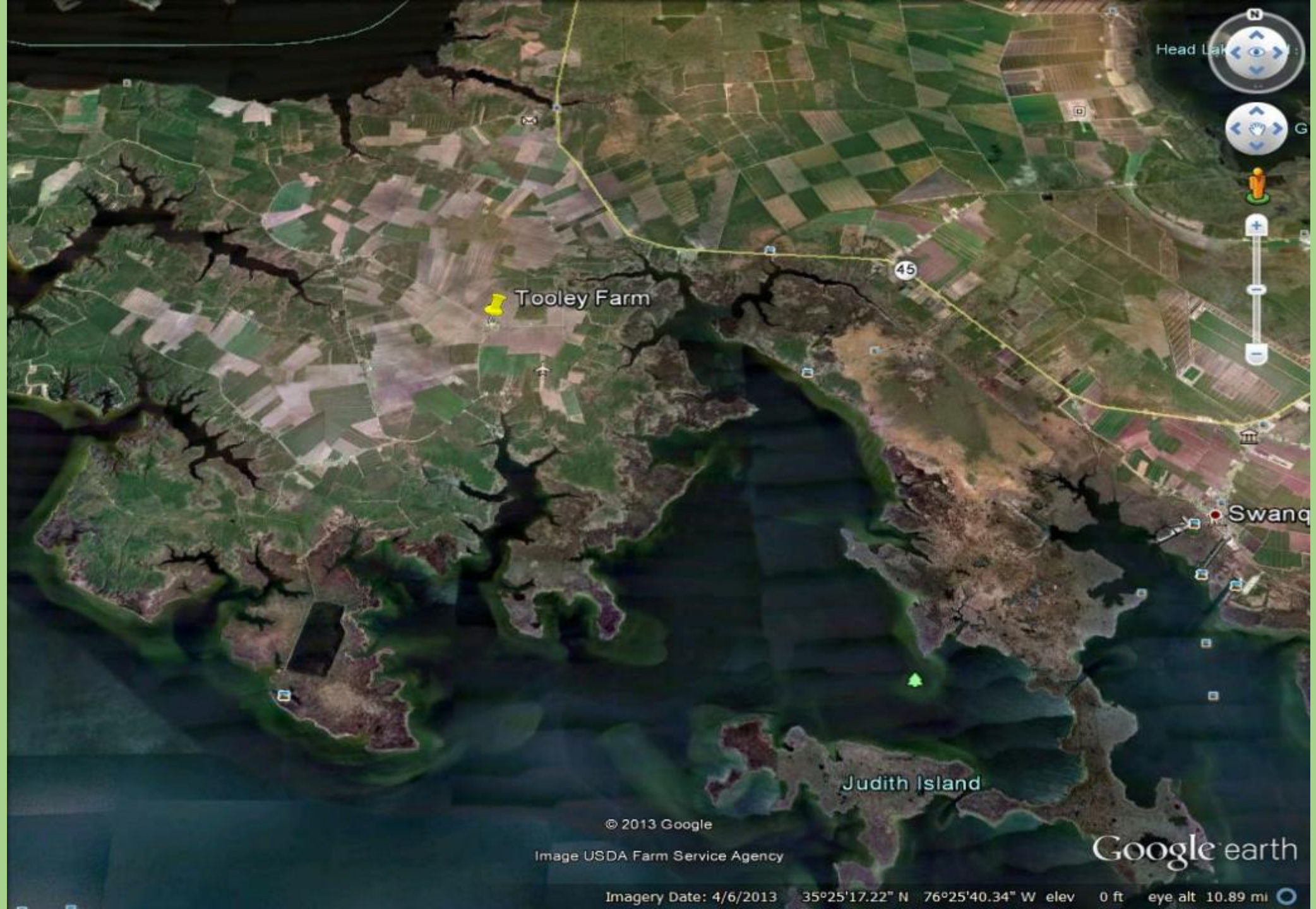






USDA NRCS Climate Change Vulnerability Assessment and Adaptation Plan-2014

- 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.


Tooley Farm
45
Judith Island
© 2013 Google
Image USDA Farm Service Agency
Google earth
Imagery Date: 4/6/2013 35°25'17.22" N 76°25'40.34" W elev 0 ft eye alt 10.89 mi

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.

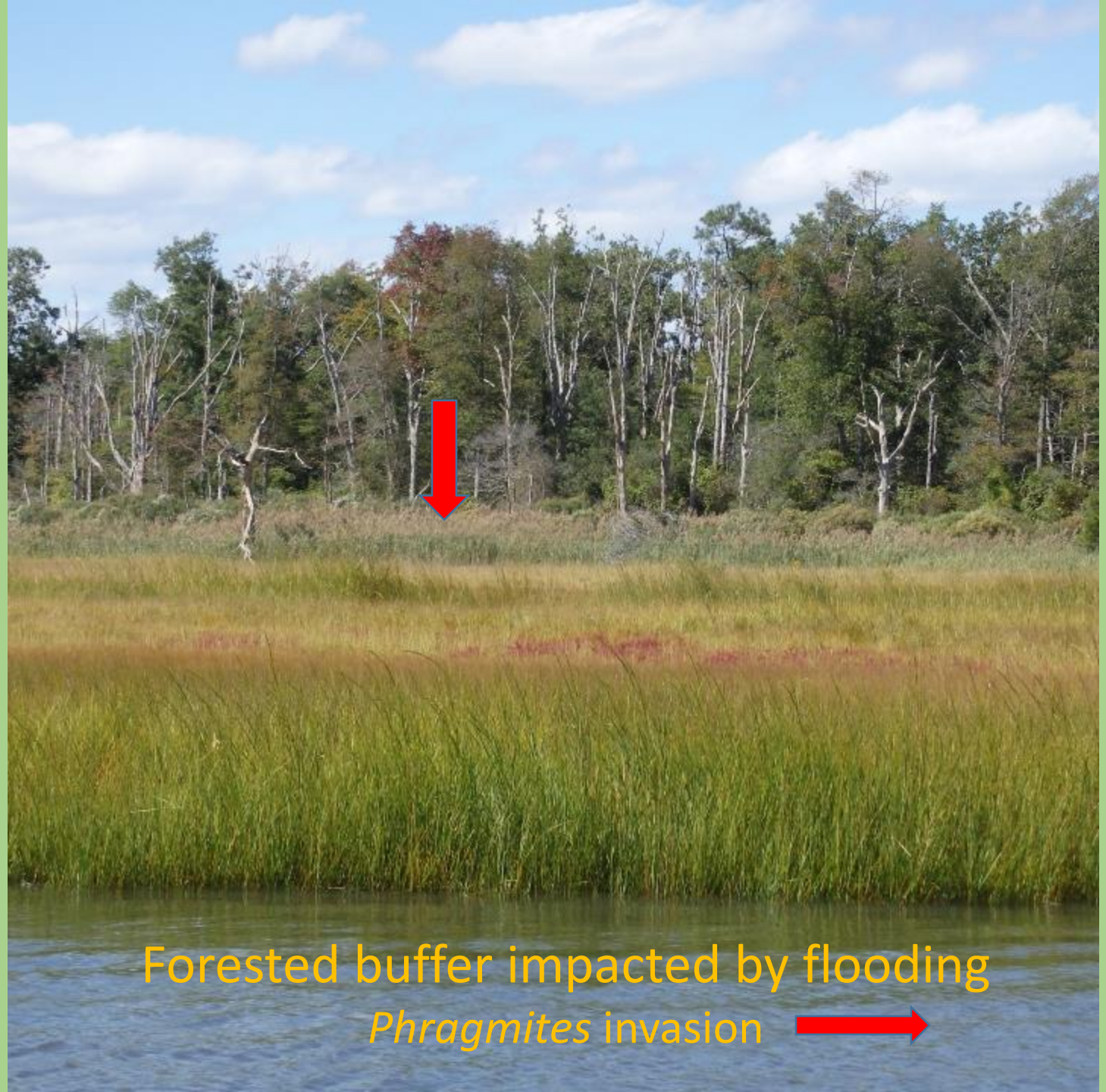
NRCS Resource Concerns Addressed with Plant Solutions

- **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 Salts


Forested buffer impacted by flooding
Phragmites invasion

State's Identified NRCS Plant Materials Needs 2014-2015

- Saltwater buffer recommendations for marginal cropland/edge of field. Explore alternative crops for production. (DE, NC)
- Need more refined coastal plant selection guidelines. (RI)
- Plant recommendations for saltwater intrusion-determine upper salinity tolerances of coastal species. (DE, NJ)
- Address shoreline/streambank erosion in areas adjacent to cropland. (NC, NY, VA)
- Control/Suppress spread of invasives like Phragmites into production fields by incorporating native plants, preferably.(CT)

BMP's for Coastal Resilience

- Select plant species that are tolerant to salinity changes and increased temperature.
- Planting flood and salt tolerant plants inland from wetland systems to prolong viability to rising waters and increased flood frequency (in tidal systems).
- Maintaining and enhancing diversity of plantings to help with changing salinity and flooding conditions.

Source: Maryland's Adaptation Website: www.dnr.state.md.us/climatechange

- The Cape May PMC continues the work to develop plant solutions to these issues.

Approaches to Regenerating Our Coastal Landscape

Arrowood Viburnum | Pokeweed | Shadbush | Highbush Blueberry | Virginia Creeper

Highly recommended and preferred by migratory songbirds:

Common Name	Scientific Name	Nutrient Content[1] Fat	Carbohydrate	Protein
Arrowood Viburnum	*Viburnum dentatum*	High	High	Inadequate
Pokeweed	*Phytolacca Americana*	Low	High	**Adequate**
Virginia Creeper	*Parthenocissus quinquefolia*	Low	High	**Adequate**
Highbush Blueberry	*Vaccinium corymbosum*	Low	High	Inadequate
Shadbush	*Amelanchier spp.*	Low	High	**Adequate**

Recommended and eaten by many migratory songbirds:

Common Elderberry	*Sambucus candensis*	Low	High	**Adequate**
Red Elderberry	*Sambucus racemosa*		Low	**Adequate**
Chokecherry	*Prunus virginiana*	Low	High	Inadequate
Spicebush	*Lindera benzoin*			**Adequate**
Silky Dogwood	*Cornus amonum*	Low	High	**Adequate**
Gray Dogwood	*Cornus racemosa*			Inadequate
Red Osier Dogwood	*Cornus sericea*	N/A		
Maple-leafed Viburnum	*Viburnum acerifolium*	Low	Low	Inadequate
Black Raspberry	*Rubus spp.*	Low		**Adequate**

Recommended and eaten by a few migratory songbirds:

Northern Bayberry	*Myrica pennsylvanica*	High	High	Inadequate
Winterberry	*Ilex verticillata*	Low	High	Inadequate

[1]Nutrient Content for fat and carbohydrate is "High" if >40% dry wt and "Low" if <10% dry wt. Nutrient Content for protein is "Adequate" if >5% dry wt and "Inadequate" if <4% dry wt. "N/A" means information is not available on nutrient content. From Smith et al. 2007 (Wilson Journal of Ornithology 119: 419-428), and Langlois and McWilliams 2010 (The Auk 127: 850-862).

Nature's Cue: PROVIDE PREFERRED FOOD FOR MIGRATORY BIRDS

Mitigation vs Adaptation

- **Mitigation**- **1**. lessening the force or intensity of something unpleasant, as wrath, pain, grief, or extreme circumstances: **2**. the act of making a condition or consequence less severe. **3**. the process of becoming milder, gentler, or less severe. **Syn.** Alleviation, lessening, relieving

- **Adaptation**- **a.** the alteration or adjustment in structure or habits, often occurring through natural selection, by which a species or individual becomes better able to function in its environment. **b.** A structure or habit that results from this process. **c.** Change in behavior of a person or group in response to new or modified surroundings.

Mitigation vs Adaptation

- **Mitigation**- Short term solution to lessen the damage from salt water flooding. May be implemented if the event is infrequent and/or less severe.
- However, as the frequency of occurrence increases, the more prudent approach is to employ various **adaptation strategies.**
  - **Crop diversification**
  - **Improved soil health practices**
  - **Newly adopted management practices**

Mitigation of Salt Affected Soils

- **Potential short term, quick fixes*:**
  - **Salinity and Sodic Soil Management (610**)
  - **Allow excess salts to leach through natural rainfall events or irrigate with fresh water.**
  - **Add gypsum-**Conservation Practice Code 333-Amending Soil Properties with Gypsum Products
  - **Incorporate composts that don't contain salts.**
    - Avoid sewage sludge, most manures and mushroom compost
  - **Grow cover crops for one season-**
    - Barley, sorghum, sorghum/sudangrass and millets have especially good salt tolerance.
  - **Deep tillage-**Conservation Practice Code-324
    - Till dead plant material into the soil.
    - Only use if the salt affected zone is at a shallow depth.

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

Restore economic value to damaged farm land.

Adaptation Strategies

- Move crop production to higher ground (further inland)
- 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 a Value-Added, Alternative Crop

Seashore Mallow

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

Resilience at the Edge of the Estuary: Seashore Mallow and the 3 E's

- Ecology

- Energy

- Economics

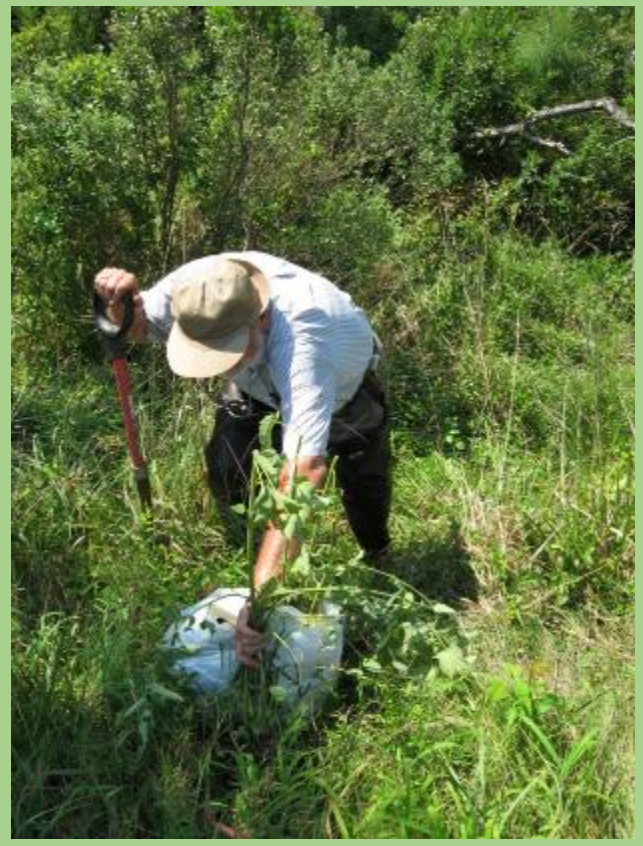
Meet the Plant

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).


2009
2010
We had identified 900 locations where seashore mallow had been found in the past.
We visited about 200 of these locations.
We found seashore mallow at about 20% of these sites.
Kansas
Missouri
Kentucky
West Virginia
Virginia
Maryland
Washington
Delaware
Lewes
Appalachian Mountains
Arkansas
Tennessee
North Carolina
South Carolina
Mississippi
Alabama
Georgia
Louisiana
Florida
Sanford, FL
Great Abaco Island
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2011 Google
© 2011 Europa Technologies
© 2011 INEGI
©2010 Google
32°53'59.71" N 86°26'25.70" W elev 484 ft
Eye alt 1249.88 mi

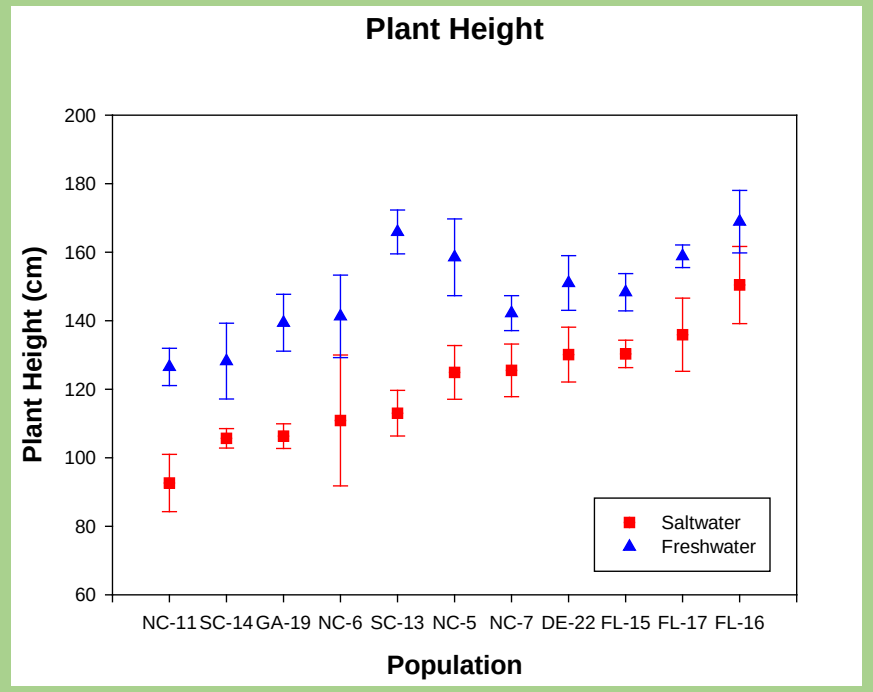
Collecting germplasm along the latitudinal gradient for breeding.

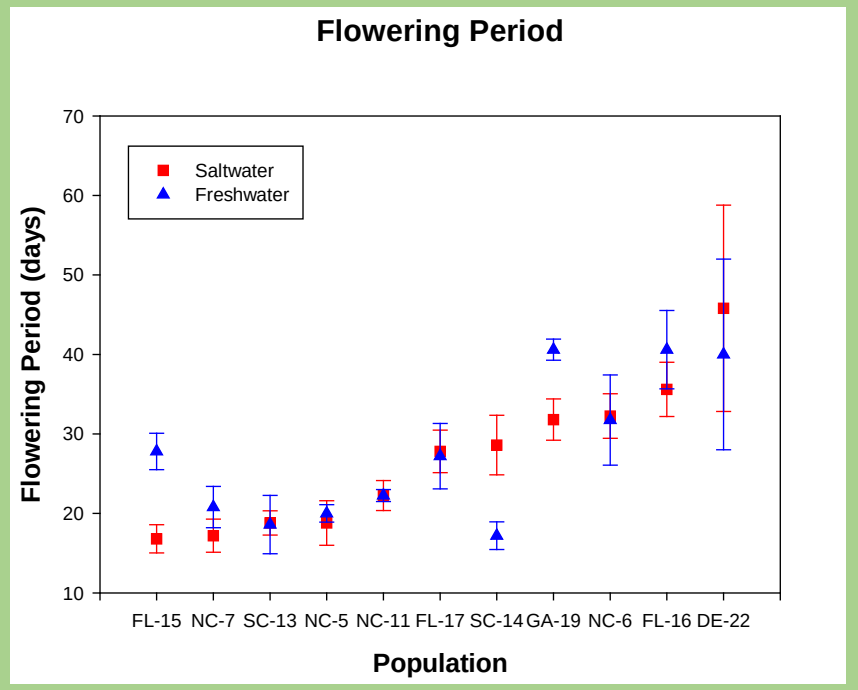


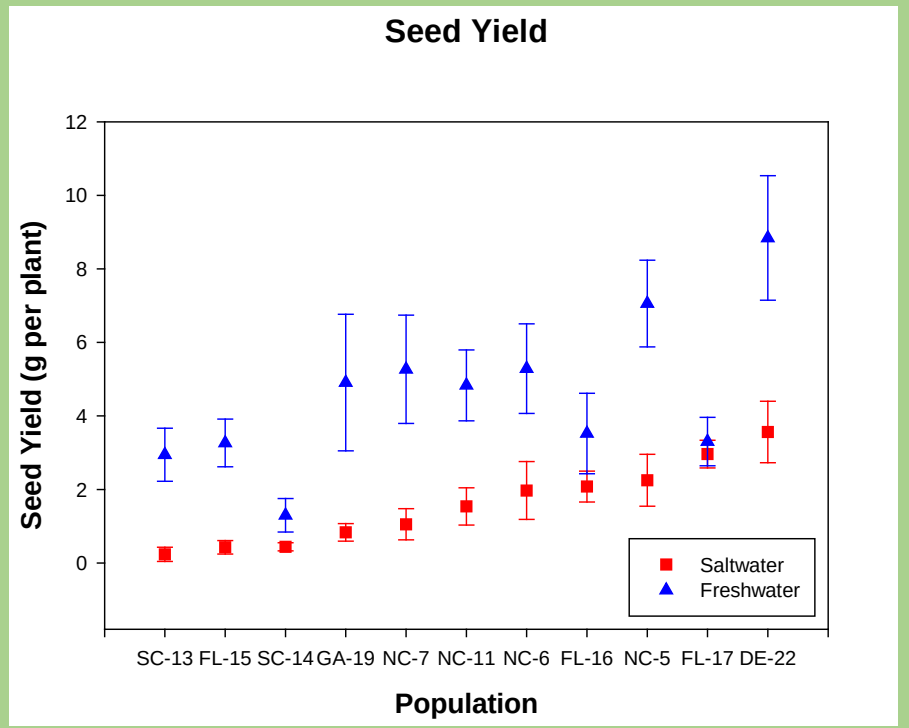
400
200

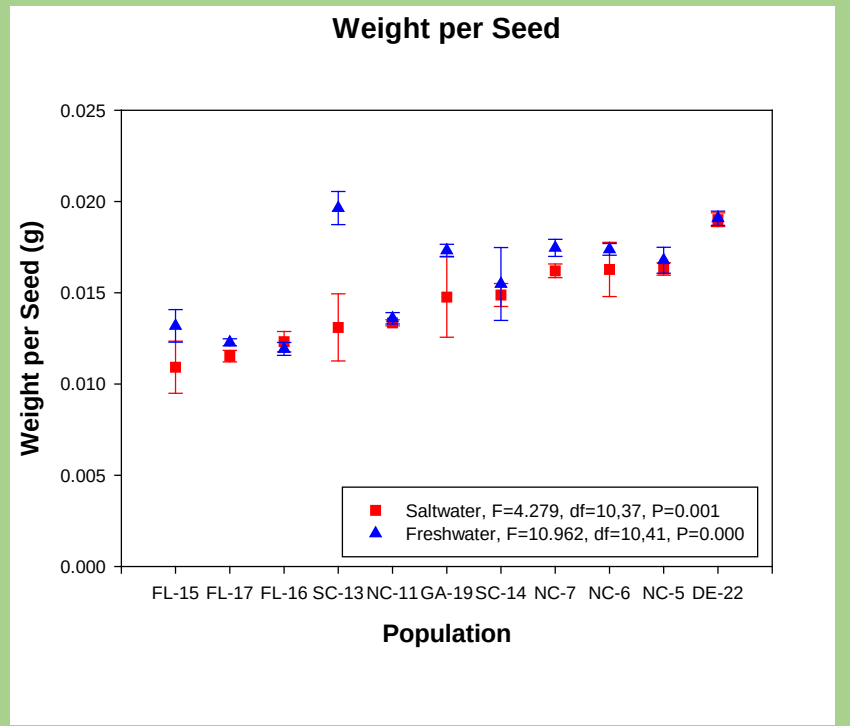

Plant of special interest from Freeman Farm
Collected 29 September 2011
89% mature green pods
11% dark pods
0% shattered
5
6
7
8

Seed size varies among accessions.

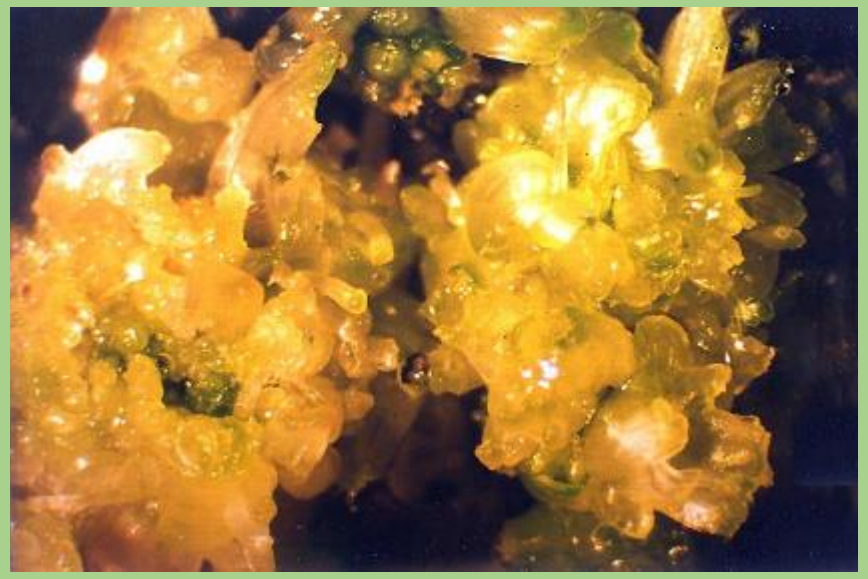

Plant Height
Plant Height (cm)
200
180
160
140
120
100
80
60
NC-11 SC-14 GA-19 NC-6 SC-13 NC-5 NC-7 DE-22 FL-15 FL-17 FL-16
Population
Saltwater
Freshwater

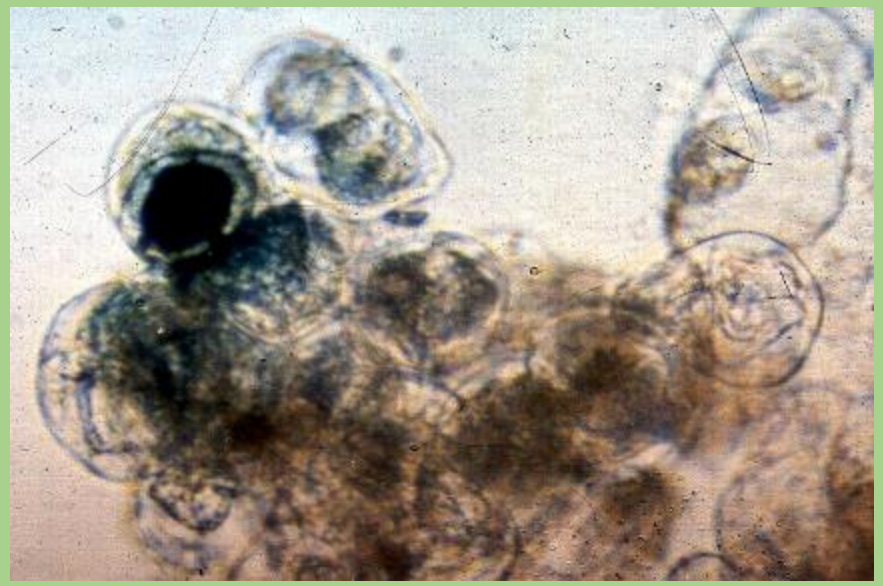

Flowering Period
Flowering Period (days)
70
60
50
40
30
20
10
FL-15 NC-7 SC-13 NC-5 NC-11 FL-17 SC-14 GA-19 NC-6 FL-16 DE-22
Population
Saltwater
Freshwater


Seed Yield
Seed Yield (g per plant)
12
10
8
6
4
2
0
SC-13 FL-15 SC-14 GA-19 NC-7 NC-11 NC-6 FL-16 NC-5 FL-17 DE-22
Population
Saltwater
Freshwater


Weight per Seed
Weight per Seed (g)
0.025
0.020
0.015
0.010
0.005
0.000
FL-15 FL-17 FL-16 SC-13 NC-11 GA-19 SC-14 NC-7 NC-6 NC-5 DE-22
Population
Saltwater, F=4.279, df=10,37, P=0.001
Freshwater, F=10.962, df=10,41, P=0.000

Genetic improvement





Corn field impacted by flooding

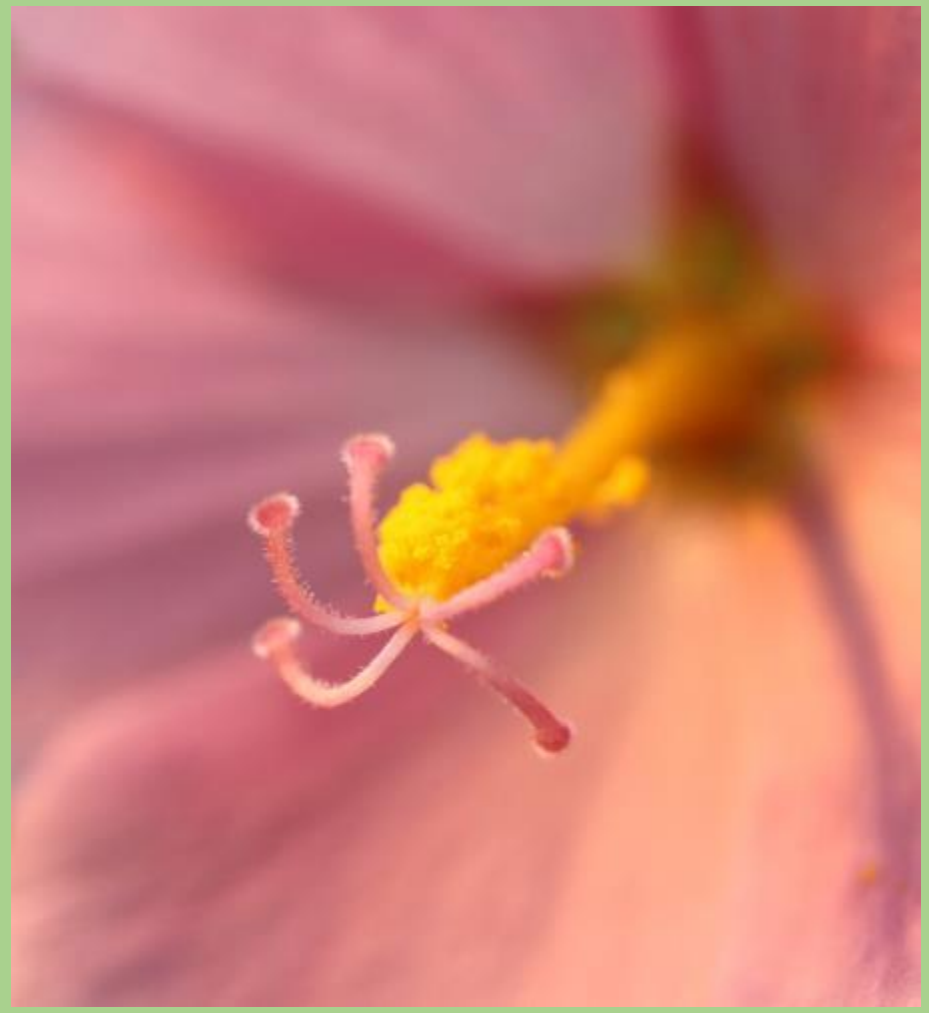
Prevent the establishment of invasive undesirable plant species and encourage the establishment of desired wetland plants.

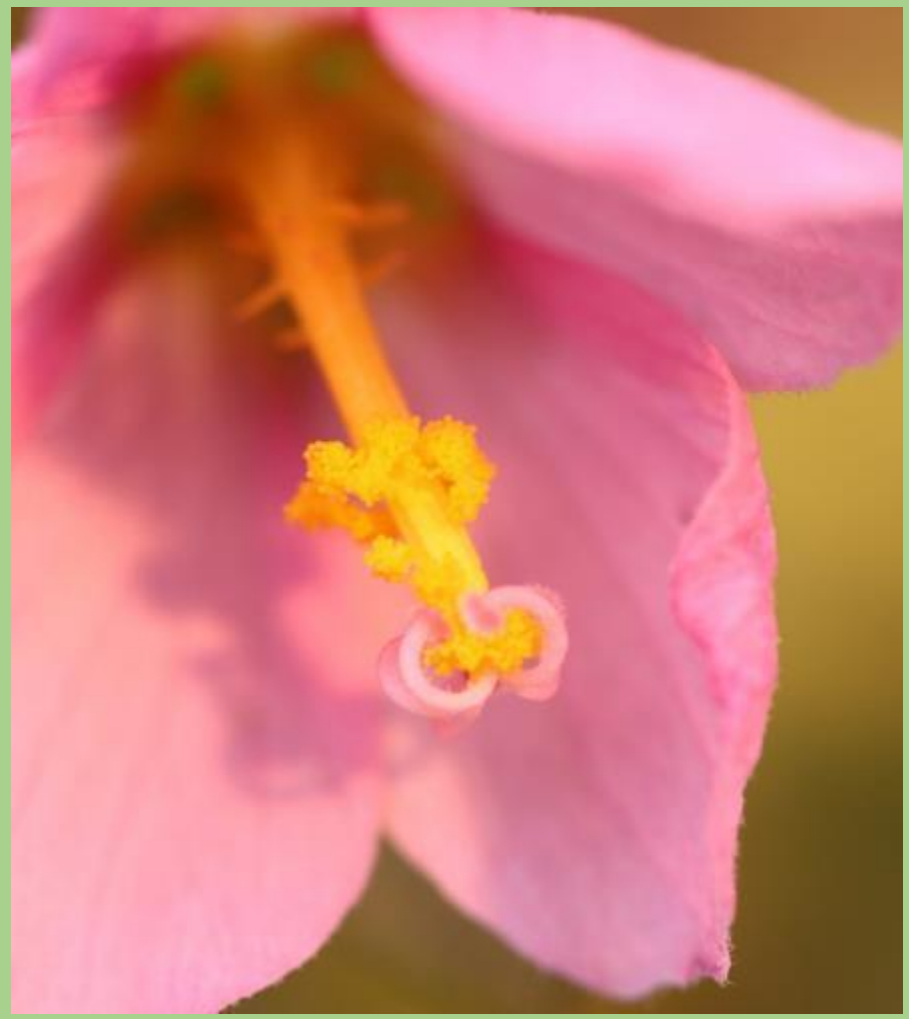
Phragmites invasion

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.





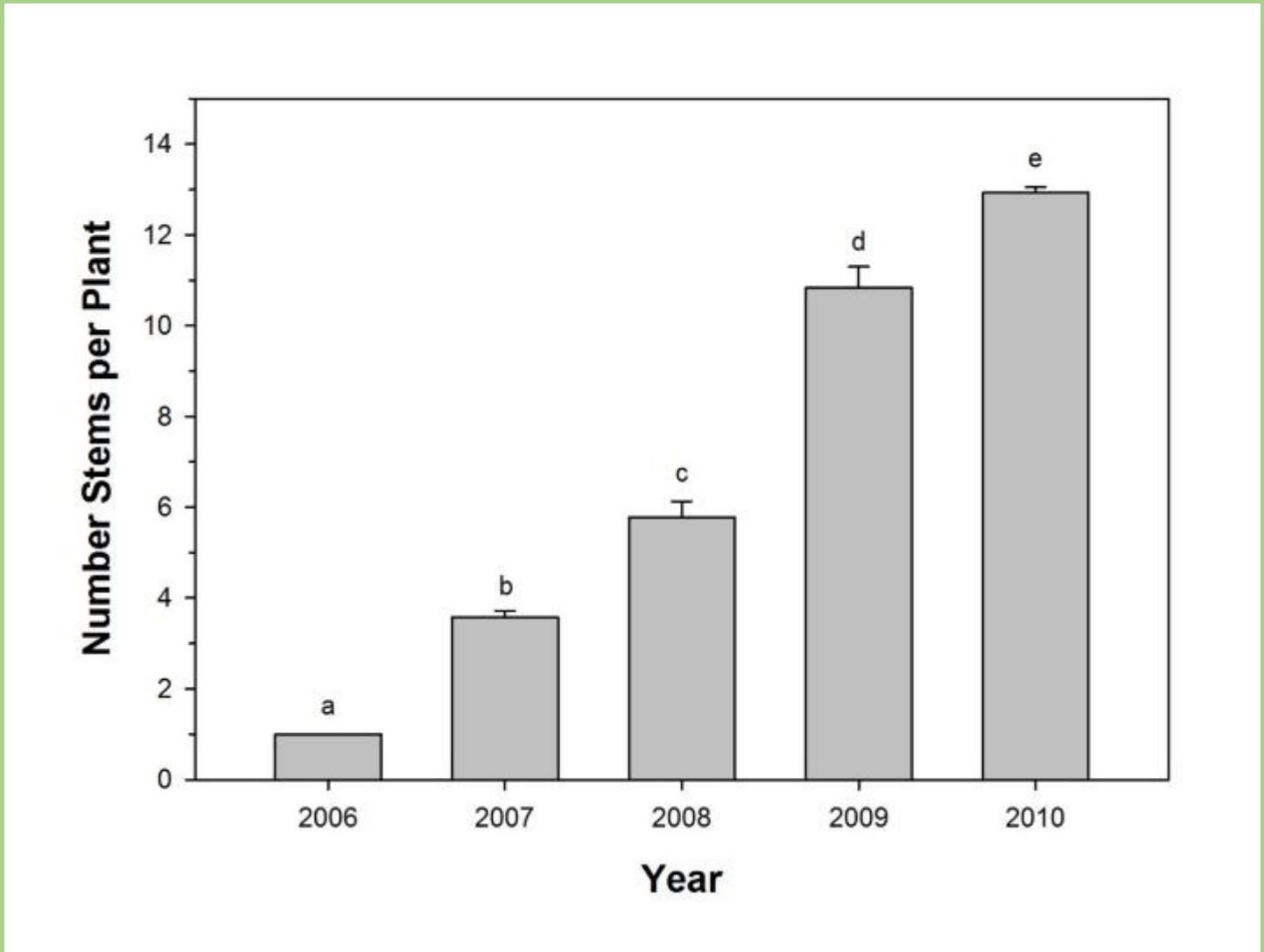
Ford hay conditioner with crimping rollers held apart

Mallow windrowed for drying.

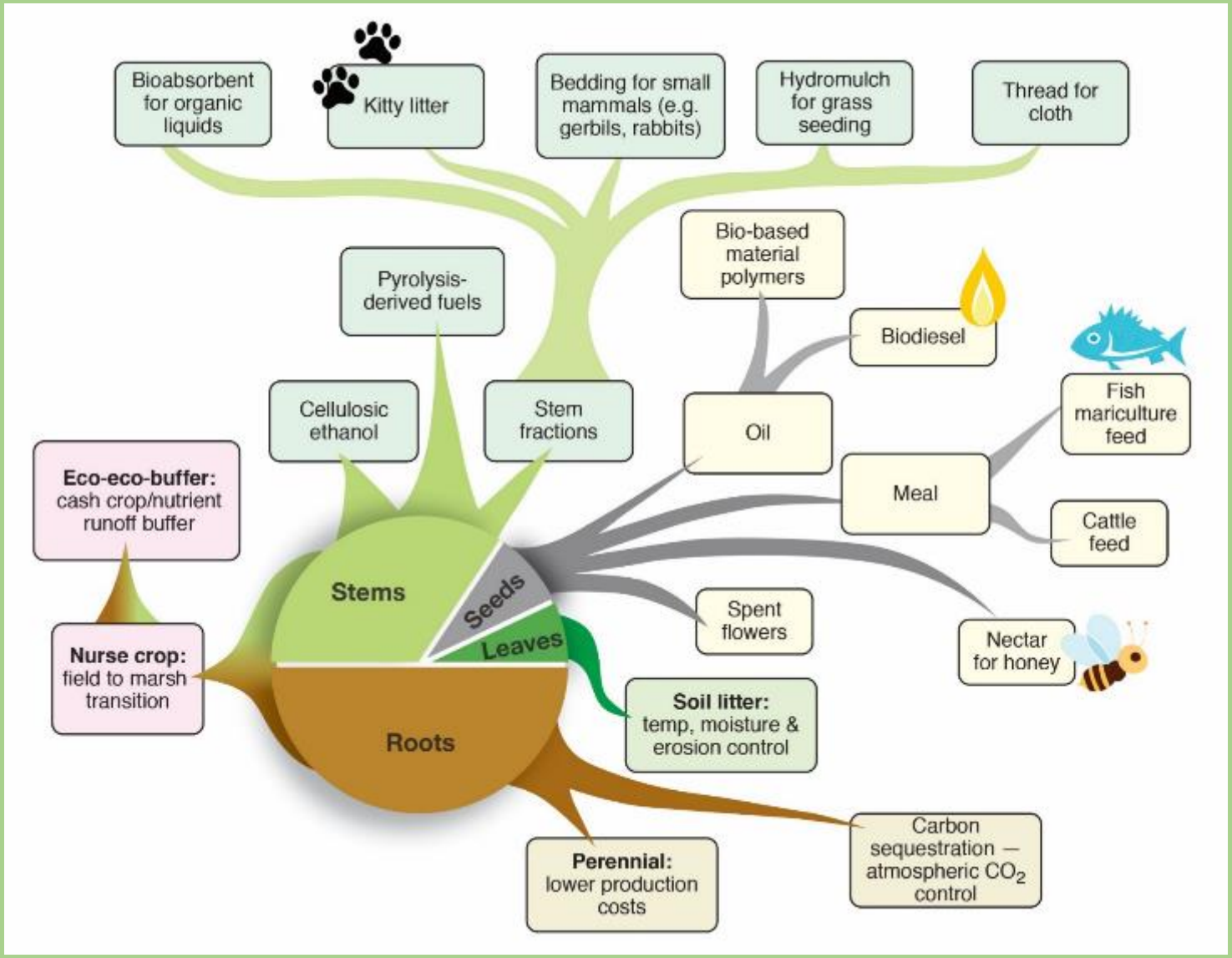
Massey-Ferguson 510
Combine with pick-up reel.

Bags of seeds and bales of stems

Single stem first year, multiple stems subsequent years



Product Development

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Seed Products

seed

oil

meal

Pellets for feed – cattle, chickens, or fish?

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*

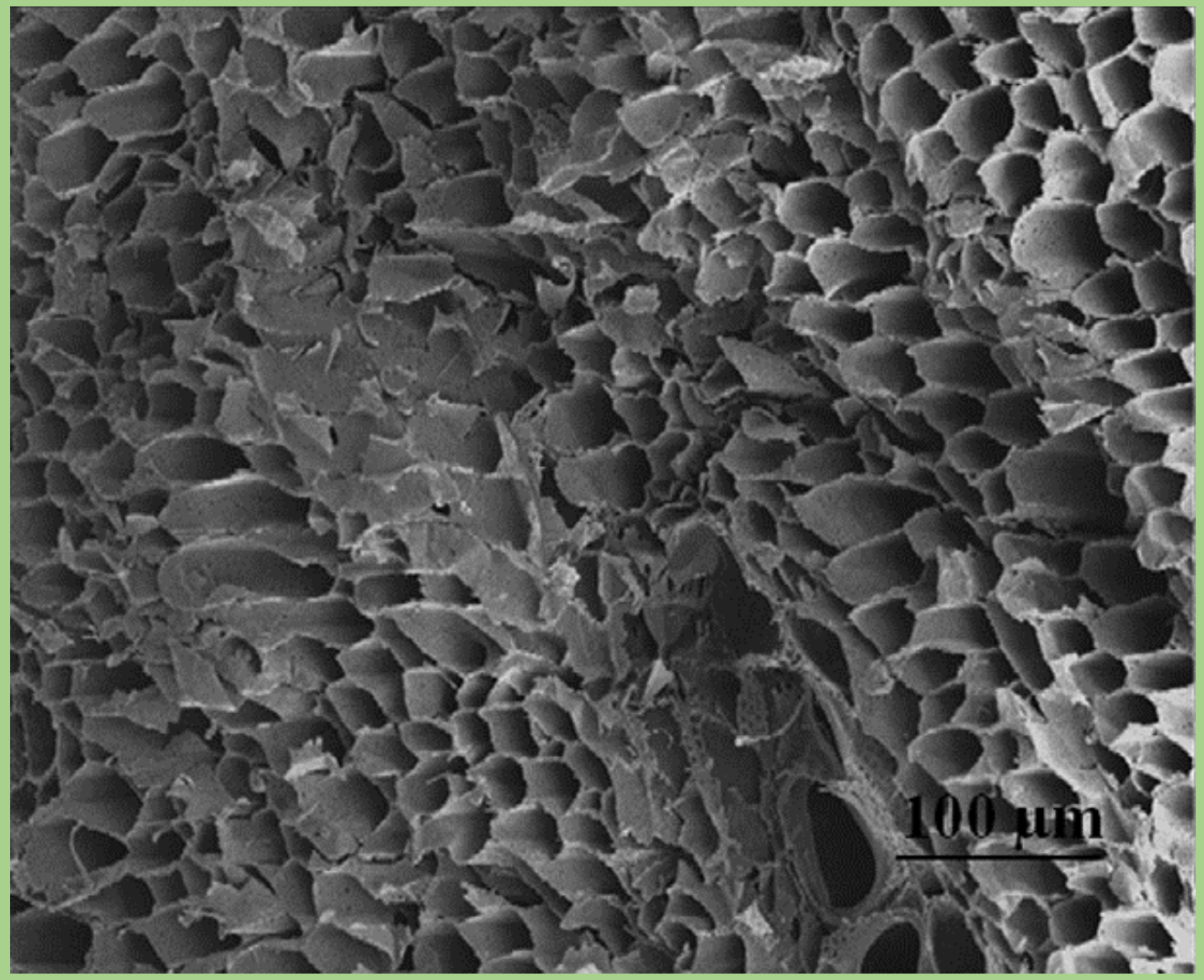
[c] *Halophyte Biotechnology Center, College of Earth, Ocean, and Environment, University of Delaware, Lewes, DE 19958, USA*

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.



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).

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*

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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.

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

Bast fibers for cloth

Transitioning Refreshable Buffer Zones

Abundant fine roots
for nutrient absorption.

Harvesting refreshes
capacity for retention.

Cat litter

Saltwater Vegetables

Seaside greens pasta

Not formally tested for human consumption

Salicornia

Batis maritima

Saladilla

Multiple Harvests

Growing/Establishing Conservation Plants on Marginal Lands

- Establishing saltmeadow cordgrass (*Spartina patens*) for harvesting as a **salt hay** crop.
- Harvest native shrub stems for **soil bioengineering** applications on brackish shorelines
  - Groundsel bush (*Baccharis halimifolia*)
  - High tide bush *(Iva frutescens*), sweetfern (*Comptonia peregrina*), 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*)

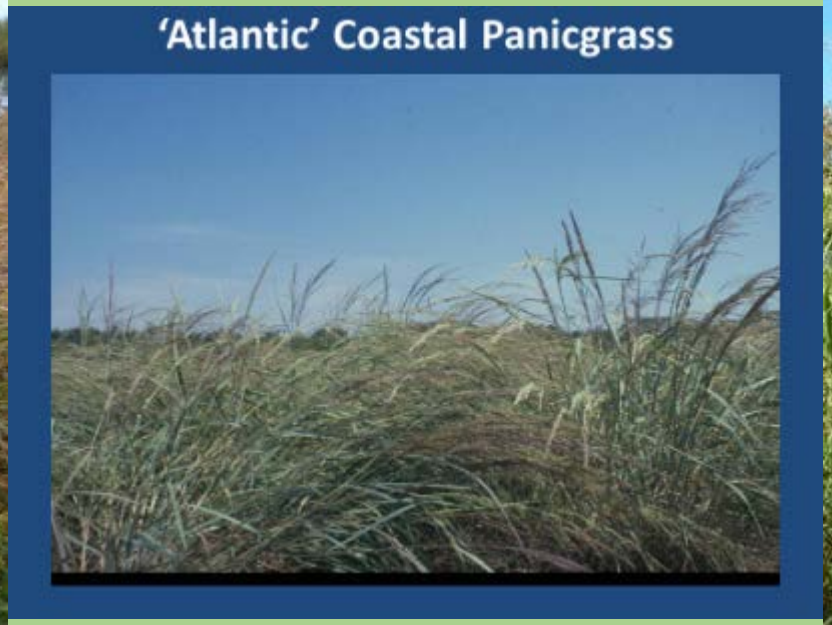
Expand Availability of Dormant Cuttings for Soil Bioengineering Applications

Groundsel Bush

Willow/Dogwood

Herbaceous Biofuel Species

Switchgrass



Prairie Cordgrass

Marshy Hay Cordgrass (*Spartina patens*)

Once harvested from the marsh. Valued as a weed free mulch and for curing concrete. Demand is still high but supply is low. Result: high cost. Selections will be evaluated for optimal harvest potential. An upright variety: ‘Flageo’ may be desired.

This Thai farmer is standing in a field of *Sporobolus*, a halophyte developed for saline agriculture in the Halophyte Biotechnology Center Lab.

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)

  - 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)*

BEACH PLUM: This long-lived native species thrives in environments with salt, apparent drought and frequent disturbances, where their neighbors are often short lived.

Established Beach Plum Orchard

Growing to the size of a large bing cherry, edible fruits of deep purple

Value added beach plum products

Why Grow 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, biofuels, agroforestry (windbreaks/buffers), shoreline stabilization and water quality applications.
- **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.

Applicable USDA Conservation Programs

- EQIP-Climate Change Mitigation Building Blocks
  - Climate change/adaptation $ funded through EQIP (2016)
  - Conservation Practices that support soil health (carbon sequestration), nitrogen management, grazing management, forest improvement, and energy efficiency.
  - Increase resilience of soils and cropping systems against impacts of climate variability and extreme events such as flooding and drought.
- AMA-Enterprise Diversification- some limited potential.
- WRE Program-Wetland Easements ?

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/
- University of DE-Halophyte Biotechnology Center
  - http://www.ceoe.udel.edu/halophyte/index.html
- USDA-NRCS- http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/
- Cooperative Extension Service (state specific)

Further Information

Christopher Miller, Manager

USDA-NRCS, Cape May Plant Materials Center

(609) 465-5901 x 102

chris.miller@nj.usda.gov

Jack Gallagher

University of Delaware

jackg@udel.edu

Denise Seliskar

University of Delaware

Seliskar@udel.edu

QUESTIONS?