

Coastal Area Restoration Webinar

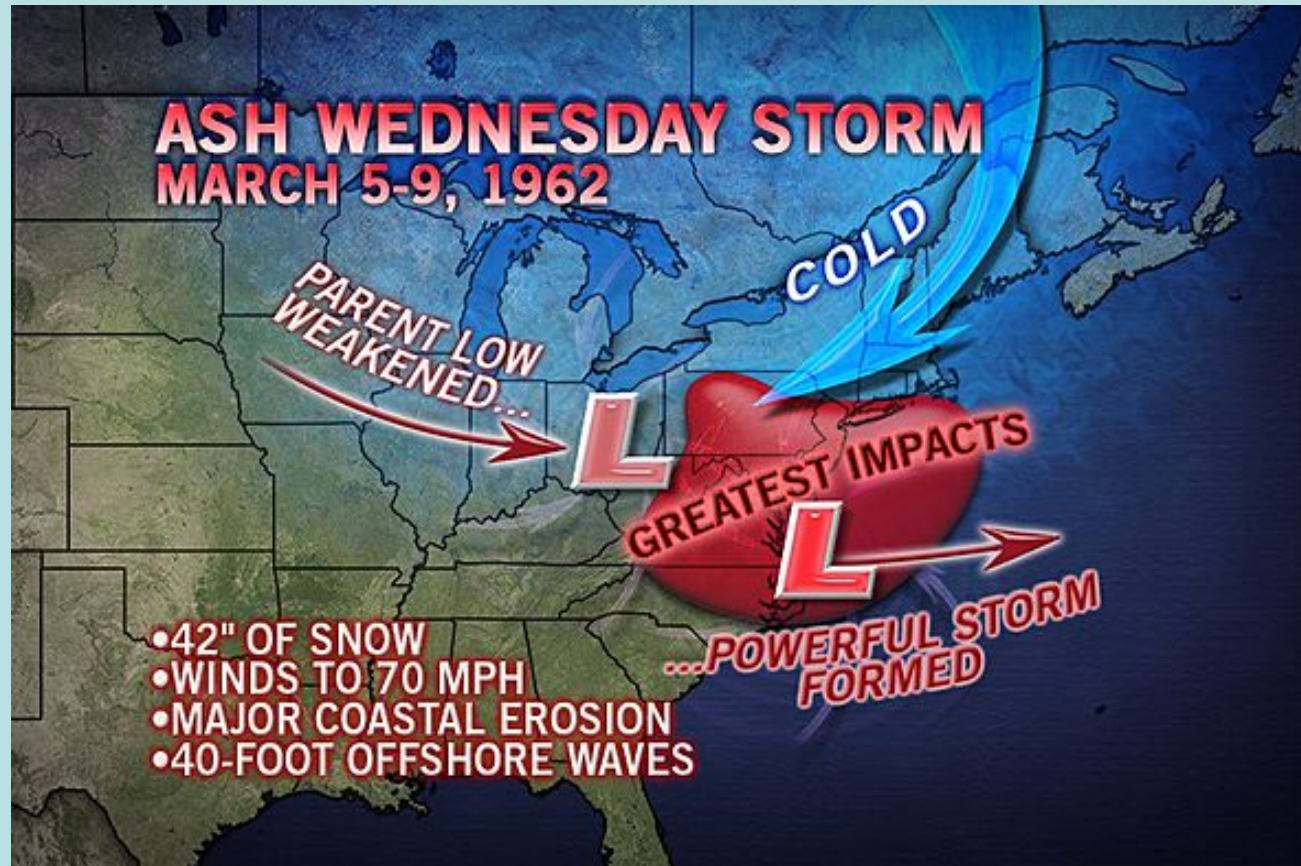
Developing Plant Science Technology for Coastal Ecosystem Restoration

Presented by Chris Miller
Manager/Plant Materials Specialist
USDA-NRCS
Cape May Plant Materials Center

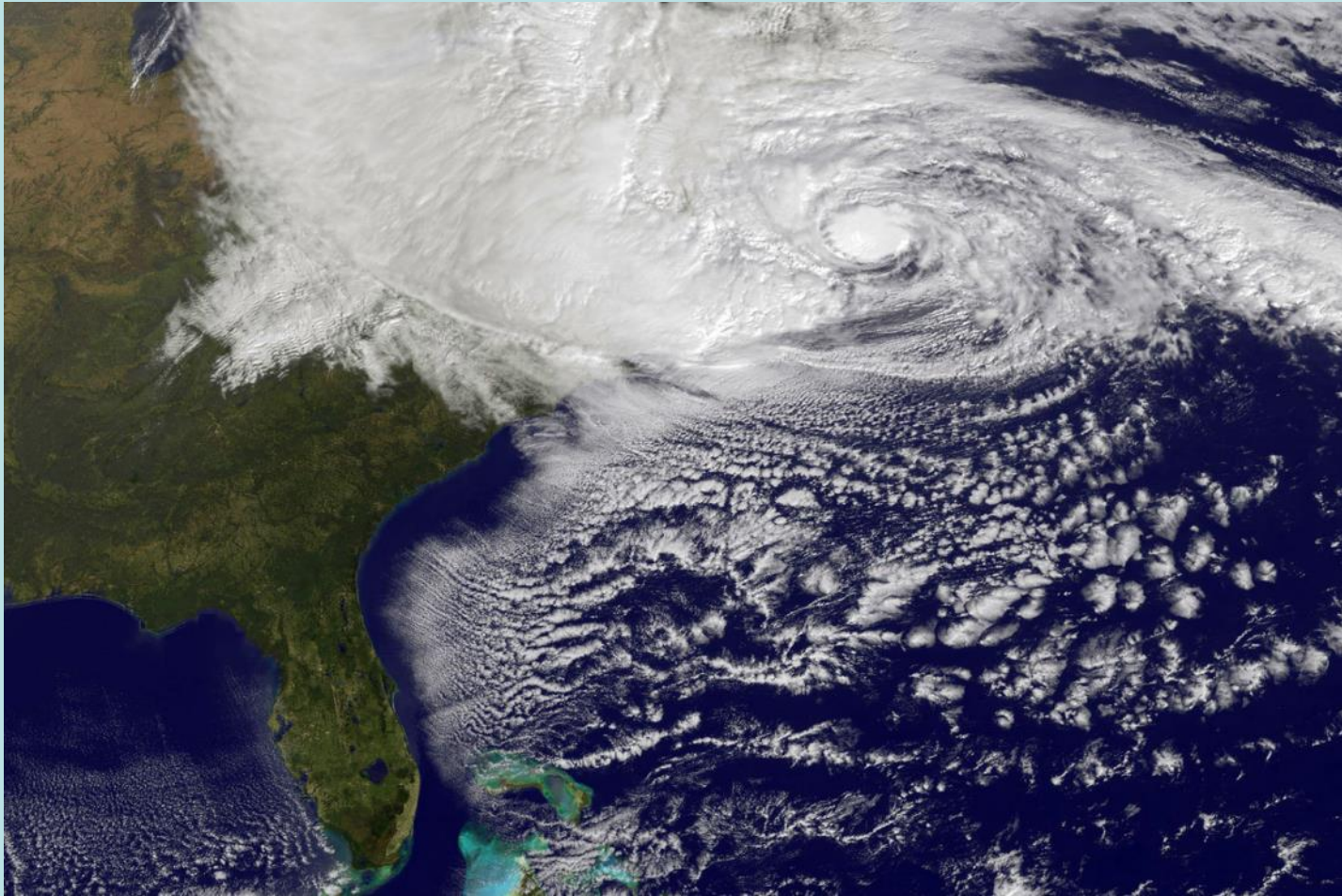
USDA History-Dunes

- **Methods used for Controlling and Reclaiming Sand Dunes.** Hitchcock. USDA-Bureau of Plant Industry. Bulletin No. 57. 1904.
- **Reclamation of Cape Cod Sand Dunes**
 - J.M. Westgate, Asst. in Sand Binding Work. USDA-Bureau of Plant Industry. Bulletin No. 65. 1904.
- **Controlling Coastal Sand Dunes in the Pacific Northwest.** McLaughlin and Brown. USDA Circular 660. 1942.
- **Sand Stabilization Factsheet.** R.E. Culbertson, Nursery Division, SCS. Upper Darby, PA. 1942.
- **Grasses That Fix Sand Dunes and Stabilizing Sand Dunes** Whitfield and Brown. USDA Yearbooks 1948, 1957

Great Nor'easter of 1962



Superstorm Sandy







1962 Storm Damage Surveys

- **Damage assessments by Soil Conservation Service indicated value of well established, well vegetated dunes.**
- **Development and Use of American Beachgrass for Dune Stabilization.** Thornton and Davis. Miscellaneous Publication. USDA-SCS. National PMC. Beltsville, MD. 1964.
- Feb. 1964. Pioneer Beachgrass Nursery. First commercial sale of beachgrass. Planting stock provided by National PMC to Church's Beachgrass Nursery in Cape May County. Origin: Seed Collected in Lewes, DE.



Establishment of the Cape May Plant Materials Center-1965

Purpose/Mission

Developing better plants and techniques for stabilizing Atlantic coastal sand dunes from Cape Cod to North Carolina. In addition, studying/testing plants for their applicability to droughty, sandy and low nutrient soils of the coastal plain.

A 50 Year History-Commercial Production





Cape May Plant Materials Center

- 'Cape' american beachgrass- Selection from Cape Cod. Released in 1972 to nurseries. First commercial release of beachgrass.
- Currently about 28 growers from Maine to Florida. Most concentrated in NJ, LI-NY, MA, NC
- Also used inland on mine sites and sandy roadsides.



Planting American beachgrass

2-seat vegetable transplanter



Notice “pencil like” dormant stems



Although a perennial plant, it is managed as an annual in agricultural production

Cape Cod-Beachgrass Production



A Brief History of USDA- NRCS Plant Selection

“Nature has evolved a plant
for every purpose.”

- Dr. Franklin J. Crider



General Concept:

**Comparative
Observation/Selection**

Plant Materials Centers evaluate
collections on-Center.

The Plant Selection Process

- Test for adaptation and applicability



The Plant Selection Process

- Increase for demonstration and distribution



Interface with the commercial seed and nursery industries to develop and release plant material for commercial availability



DOI-Bureau of Land Management Seeds of Success Program

- Expanding SOS Program-Eastern US as a result of Superstorm Sandy.
- Current focus on seed collections of coastal species.
- Focus on seed quality/plant propagation techniques.
- Ultimate goal to make a wider variety of coastal species commercially available.

Moving Forward: Main Themes

- How can we improve sustainability of plant systems in coastal areas?
 - Increasing plant diversity, improving soil biology, promoting pollinator/wildlife habitat
 - Selecting local ecotypes of coastal native plant materials
 - Proactive planting recommendations in light of climate change i.e. accelerate northern plant migration of southern species ?

Why are Dunes Important?

- First line of protection from erosion, coastal flooding and storm damage
 - Reduce energy of storm waves.
- Shelter homes and ecosystems from wind and sea spray
- Provide important sand reservoir for beaches
- Trap sand, preventing it from being blown inland where it becomes a problem



Why are Dunes Important?

- Midway Beach
 - Quarter-mile-long community within South Seaside Park, New Jersey
 - Mostly tiny, older, one-story bungalows, just south of the area where the famous roller coaster was washed into the ocean.
 - 25-foot-high dunes that community started building 30 years ago using sand fences and beach grass to grow the dune
 - Only one home in Midway Beach had water damage from Sandy



The photographs above were taken on September 13, 2012 (left) and November 8, 2012 (right).

Why are Dunes Important?

- Dunes provide vital habitat for many endangered species e.g. seabeach amaranth (*Amaranthus pumilus*) and piping plover (*Charadrius melodus*).
- Recent study found dunes and coastal beaches by far the most valuable ecosystem in New Jersey on a per-acre basis



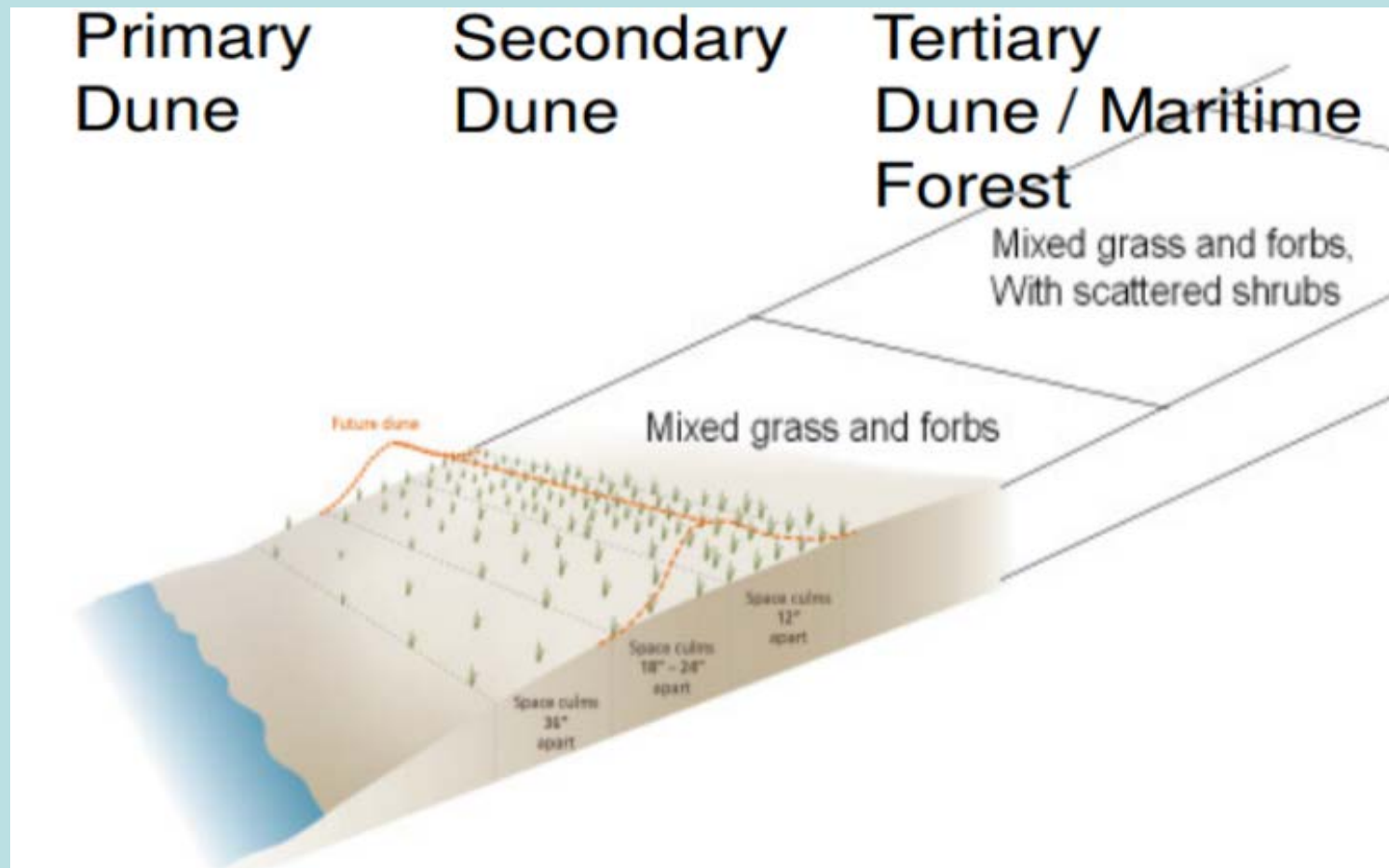
Seabeach amaranth



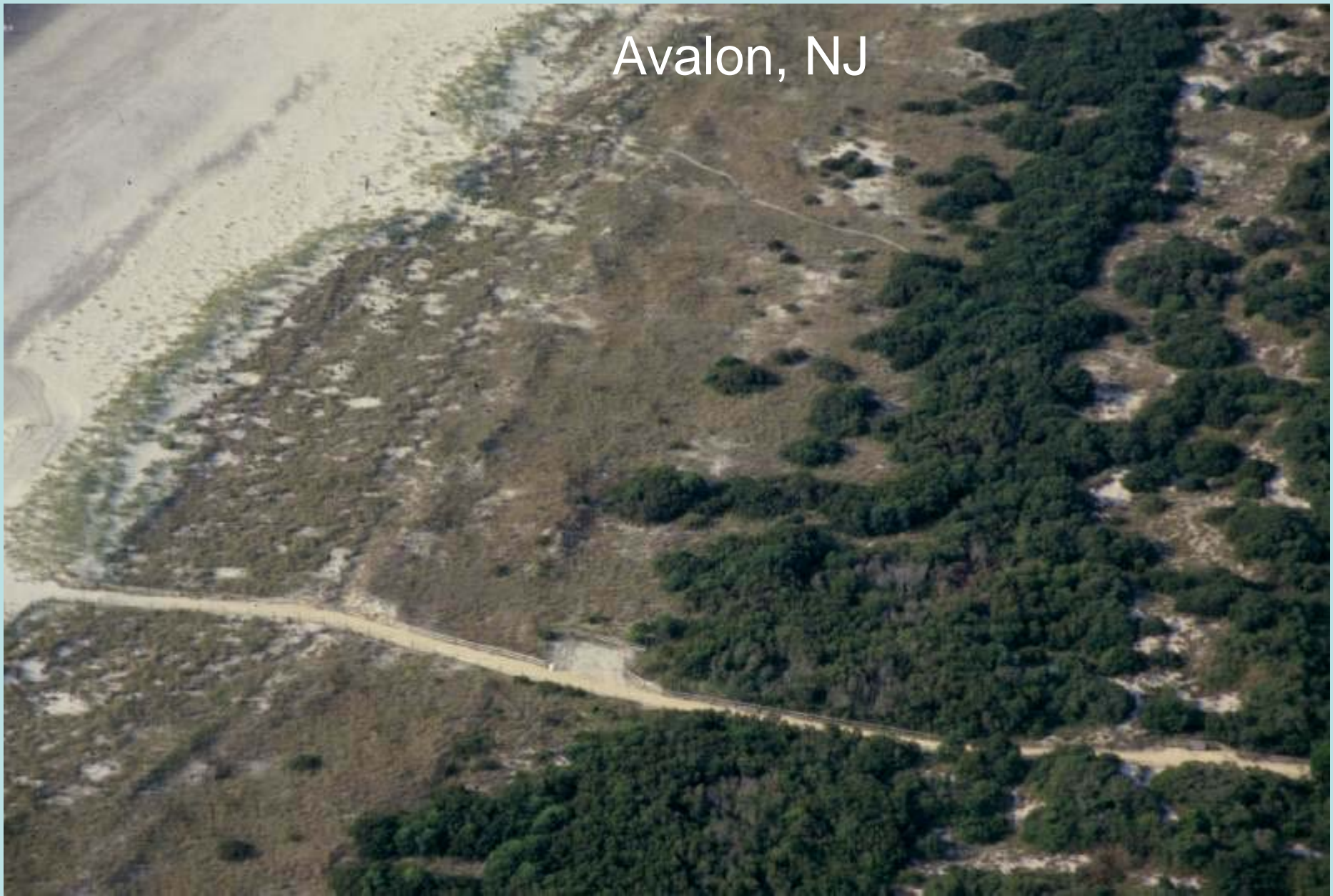
Piping plover <http://mikilo.image.pbbase.com>

Planting for Dune Stabilization

- Different plant species thrive in different parts of the dune



Avalon, NJ



Vegetation Diversity

Back Dune



Primary Dune

- American beach grass (*Ammophila breviligulata*) can grow further forward than most other species. However, it needs active sand accretion; it loses vigor when not growing on the foredune.
- Most commercially available beachgrass is the 'Cape' variety. Origin: Cape Cod. Some availability: Bogue (NC) Germplasm
- Caution: Do not use Great Lakes ecotypes on Atlantic Coast and vice versa.



Assessing Beachgrass Quality

- Growth of bare root beach grass is not dependent on presence of roots, but rather on the “node” or growing point located at the bottom of the plant.
- When you squeeze bottom of culm, it should be hard, not soft.
- A hard stem indicates sufficient energy stored to allow growth
- Spindly or soft stems should be discarded or combined with a good stem in a common planting hole.



When and How to Plant

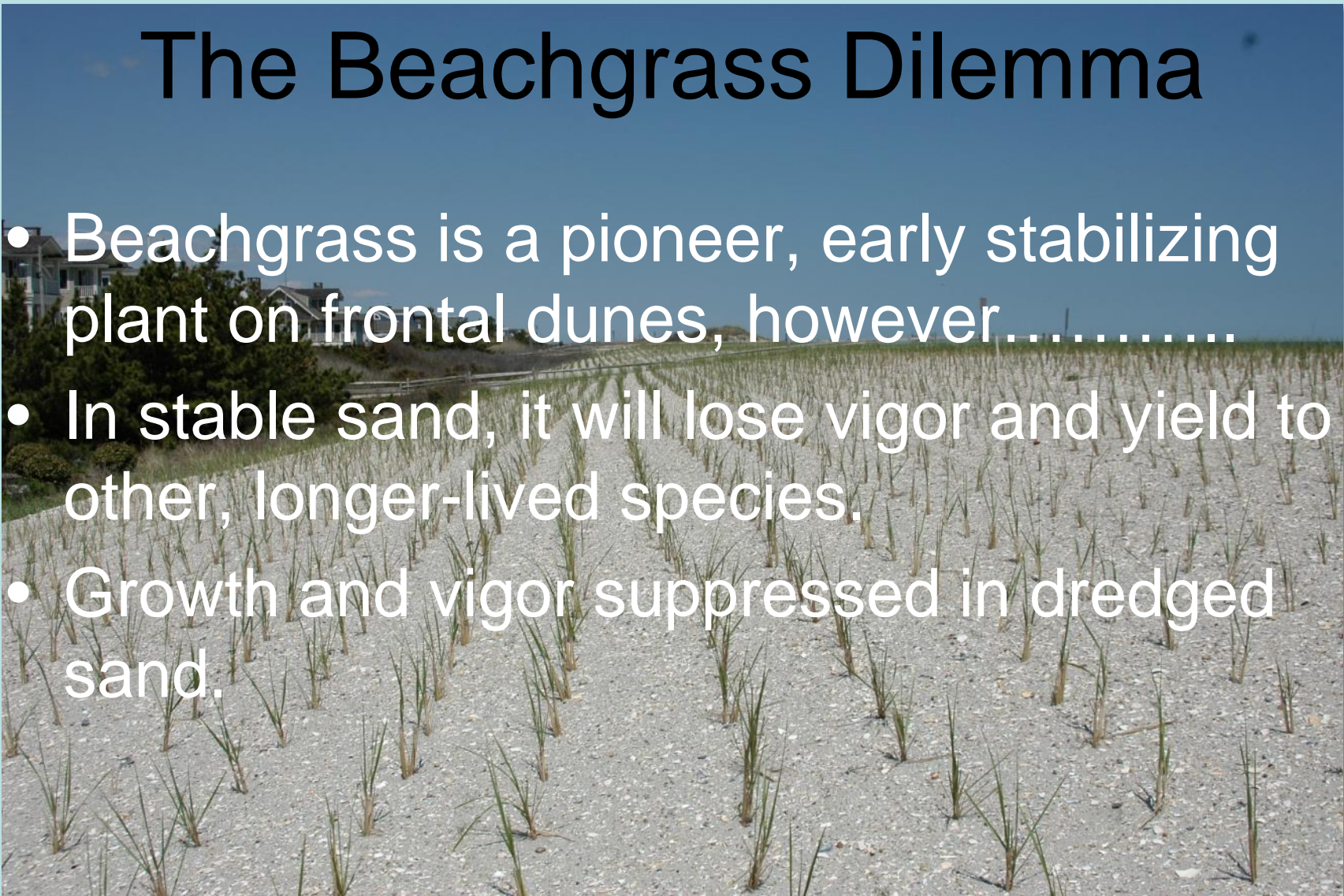
- Best time to plant bare root plants is while they are dormant (winter and early spring)
- If planting later in growing season use **plugs** not bare root plants
- Beach grass should be planted so 2/3 of stem is in sand.
- Planting 2 stems/hole is sufficient
- Plantings should be irregularly spaced and offset from one another not in straight rows
- Plants should be about 12-36 inches apart depending on.....?





The Beachgrass Dilemma

- Beachgrass is a pioneer, early stabilizing plant on frontal dunes, however.....
- In stable sand, it will lose vigor and yield to other, longer-lived species.
- Growth and vigor suppressed in dredged sand.







A Beachgrass Monoculture









Remove thatch by raking or with FIRE!



Primary Dune

- Bitter panicgrass (*Panicum amarum*)
 - Establish vegetatively, slow to spread. Seed viability low. Longer lived than beachgrass.
- **Commercially available bitter panicgrass**
 - ‘Northpa’ variety. Adaptation: Mid-Atlantic
 - ‘Southpa’-South Atlantic/Eastern Gulf Coast
 - ‘Fourchon’-Western Gulf Coast



Primary Dune

Sea Oats (*Uniola paniculata*)-cold tolerant germplasm being tested for MD, DE, southern NJ.

-production of local ecotypes- NC, FL

Caminada-local ecotype, western Gulf coast



Saltmeadow Cordgrass (*Spartina patens*)

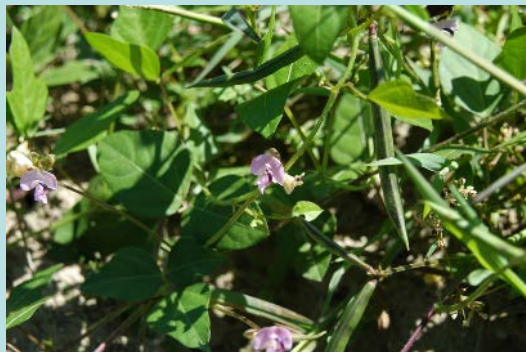


Saltmeadow cordgrass on dune



Secondary Dune

- High diversity leads to high resilience
- Secondary dunes can support more species, so in a healthy dune there should be a diverse mix of native species e.g.
 - Saltmeadow cordgrass (*Spartina patens*)
 - Coastal panicgrass (*Panicum amarum* var. *amarulum*)
 - Coastal little bluestem (*Schizachyrium littorale*)
 - Seaside goldenrod (*Solidago sempervirens*)
 - Trailing wild bean (*Strophostyles helvola*)
 - Beach pea (*Lathyrus japonicus*)



Dune Seeding Technology- 1990's



Coastal panicgrass seeded in back dune-first growing season. Now specified by ACOE in many projects.

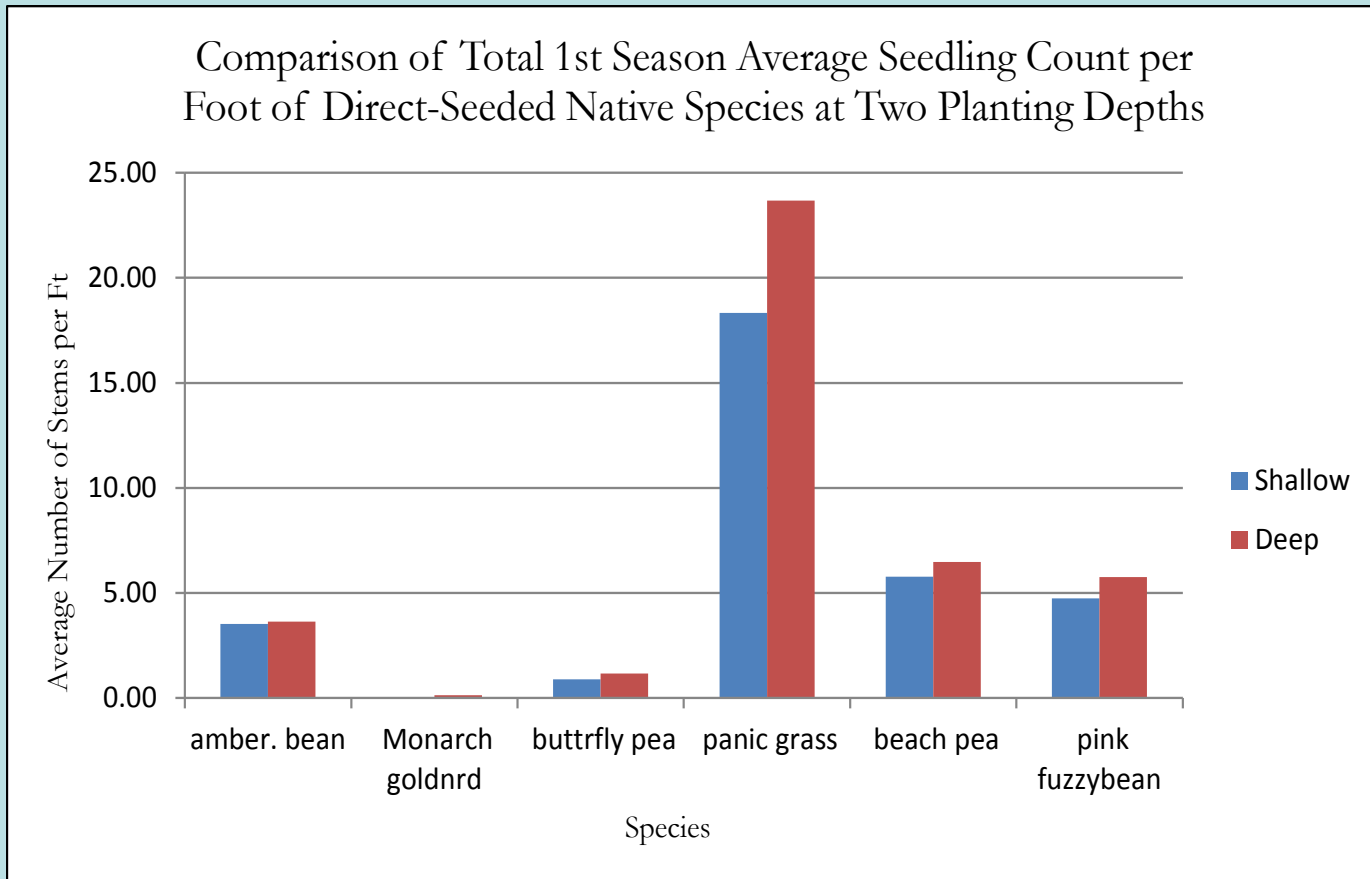
Cape May PMC-Dune Seeding Trials



- Beach pea
- Trailing wild bean (annual)
- Coastal panicgrass
- Seaside goldenrod



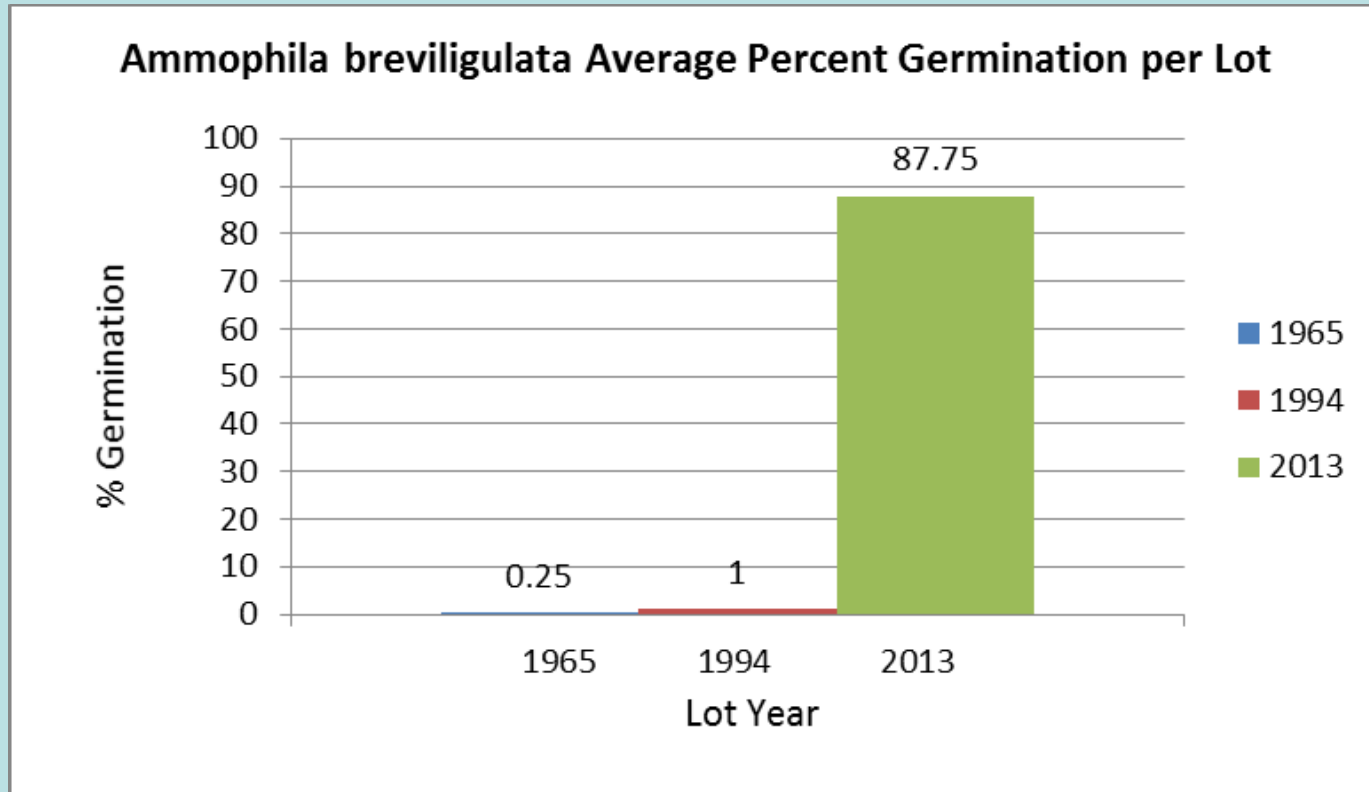
Dune Seeding Trials



Seaside Goldenrod



Beachgrass Seed Germination



Seed production highly variable by year/population.
Generally beachgrass seed germination rates are below 15%

Dune Seeding Species

Herbaceous

- **GRASSES**

- American beachgrass (*Ammophila breviligulata*)
- Bitter Panicgrass (*Panicum amarum*)
- Coastal Panicgrass (*Panicum amarulum*)*
- Coastal Little Bluestem (*Schizachyrium littorale*)*
- Southeastern Wildrye (*Elymus glabraflorus*)*
- Sea Oats (*Uniola paniculata*)*

- **LEGUMINOUS FORBS**

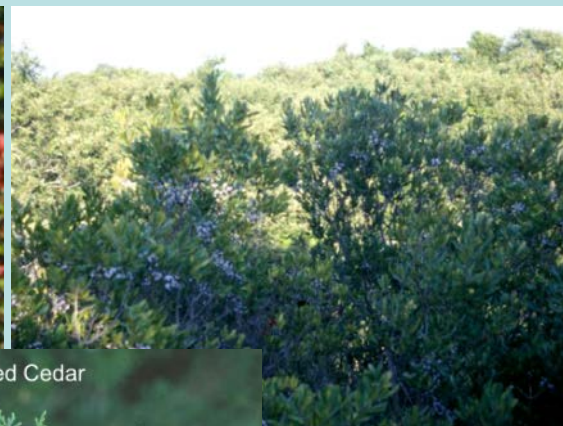
- Partridge pea (*Chamaecrista fasciculata*)*
- Spurred Butterfly Pea (*Centrosema virginianum*)*
- Beach Pea (*Lathyrus japonicas*)*
- Trailing Fuzzy Bean (*Strophostyles helvola*)*

- Seaside Goldenrod (*Solidago sempervirens*)*
- Seabeach Evening Primrose (*Onoethera humifusa*)
- Camphorweed (*Heterotheca subaxillaris*)
- Prickly pear cactus (*Opuntia humifusa*)*

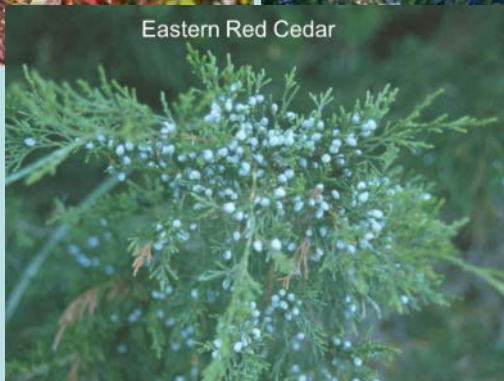
* Current direct seeding trials

Dune Seeding/Planting Woody Species

- Groundsel (*Baccharis halimifolia*)
- Bayberry (*Morella pensylvanica*)*
- Virginia Creeper (*Parthenocissus quinquefolia*)
- Beach Plum (*Prunus maritima*)*
- Dwarf Sumac (*Rhus coccifolia*)
- Eastern Red Cedar (*Juniperus virginiana*)



Eastern Red Cedar



Amendments

- Small amounts of slow release or organic fertilizer in each hole when planting
 - Old protocols suggested broadcast fertilization of beach grasses, but this leads to water pollution, and is no longer acceptable
- Adding organic materials such as compost or seaweed can improve water holding, but these materials should also be mixed in with sand to prevent water barrier forming between them and plants



Nodulation on Wild Bean

Root nodulation



Beachgrass/wildbean pots



Amendments

- Terra-sorb is a water absorbing gel that helps maintain water absorption to roots during dry periods.
- Mycorrhizal fungi promote plant vigor, add disease resistance, and can increase survival.
- The jury is still out on the effectiveness of the commercially available mycorrhizal inoculant, but if budget can sustain an extra \$0.05/ plant, it can't hurt.



So What Did We Learn from Sandy?

- Piles of unconsolidated sand, no matter how tall, provide little or no long term storm protection.



Dunes in Brick, New Jersey (credit: CBS 2)

Dunes in Brick, New Jersey (credit: APP)

How Do Plants Fortify Dunes?

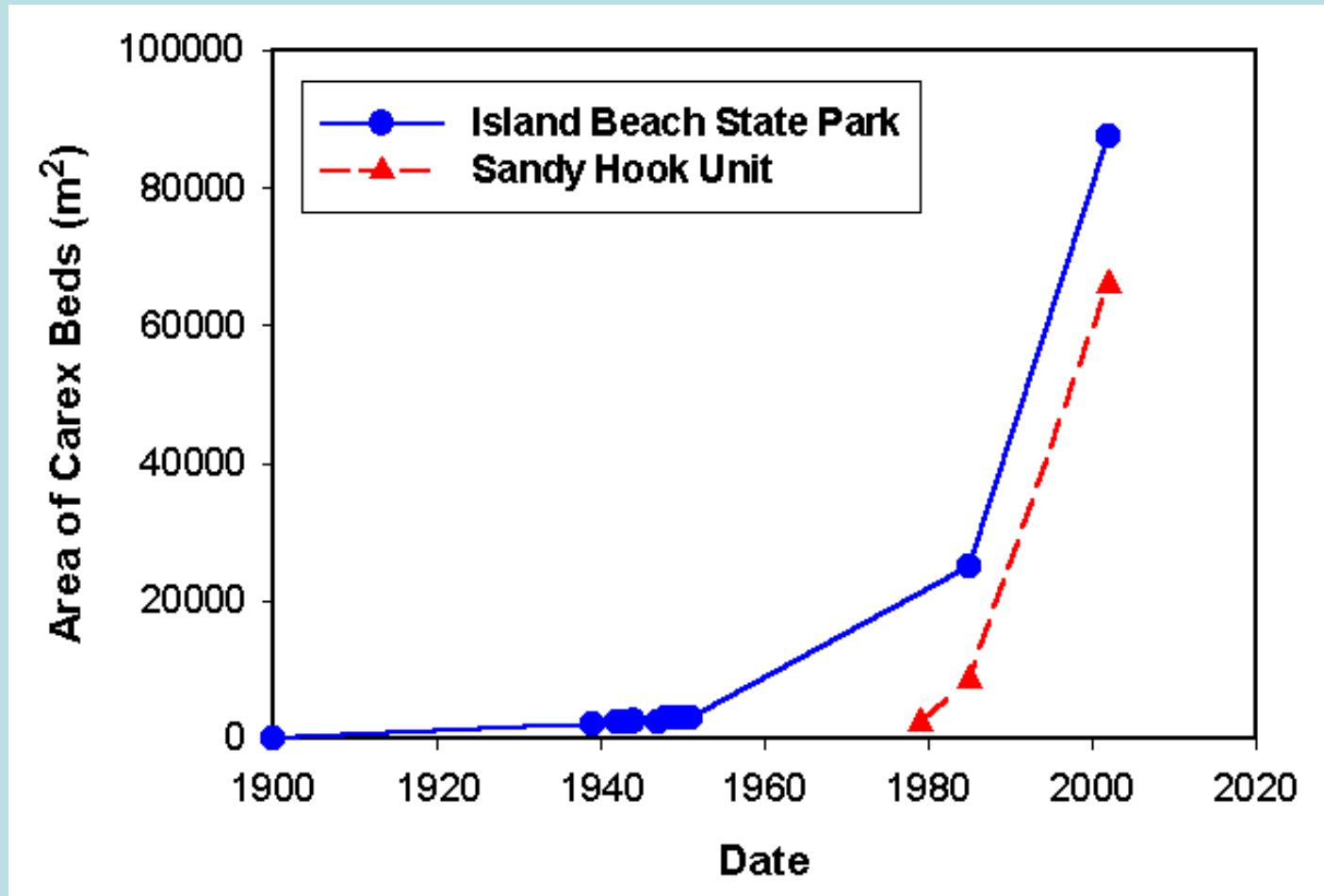
- Plants not only catch sand like a fence, they also keep sand in place.
- Their roots and underground stems spread below the sand surface, stabilizing the dune. Roots have **tensile** strength.
- And as the sand builds up, the plants grow with it, instead of being buried like a fence, but the roots stay buried. **Plant roots increase mechanical strength of the sand.**



Dune With *Carex*: Note Loss of Native Plants and Open Spaces



Carex kobomugi Invasion of New Jersey's Coastal Dunes



- Species thrives in disturbed habitats
- Sandy may thus accelerate its spread within NJ dunes

Asiatic Sand Sedge



Serrated Leaf Edges



Male Releasing Pollen



Female Dropping Seeds

Desirable Dune Vegetation

- Some diversity, height structure and open space.



Impact of Changed Plant Density

- Reduced abundance of endangered species due to competition and habitat loss



Seabeach amaranth



Beach tiger beetle
<http://collections2.eeb.uconn.edu>

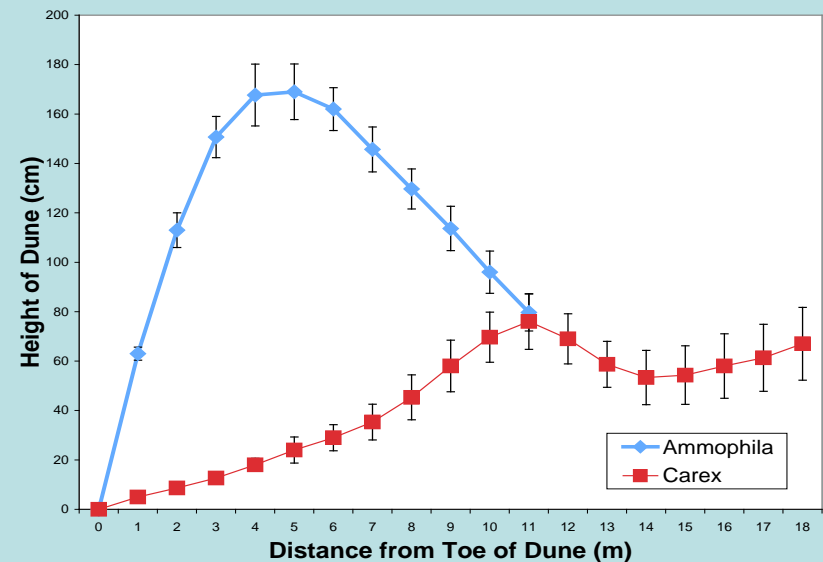


Piping plover

http://www.birdcapemay.org/blog/uploaded_images/DSC_0012-788159.jpg

Impact of Changed Plant Morphology

- *Carex* is shorter than *Ammophila*, so it catches less sand
- Result: Accreting dunes stabilized by *Carex* have lower profile
- Lowered dune profile increases chance dune overtopped by storms, flooding communities behind



Invasive Dune Plants to Avoid

- Blue Lyme Grass (*Elymus arenarius*)
- European beachgrass (*Ammophila arenaria*)
- Northern Sea oats (*Chasmanthium latifolium*)
- Japanese Black Pine (*Pinus thunbergii*)
- Rugosa Rose (*Rosa rugosa*)



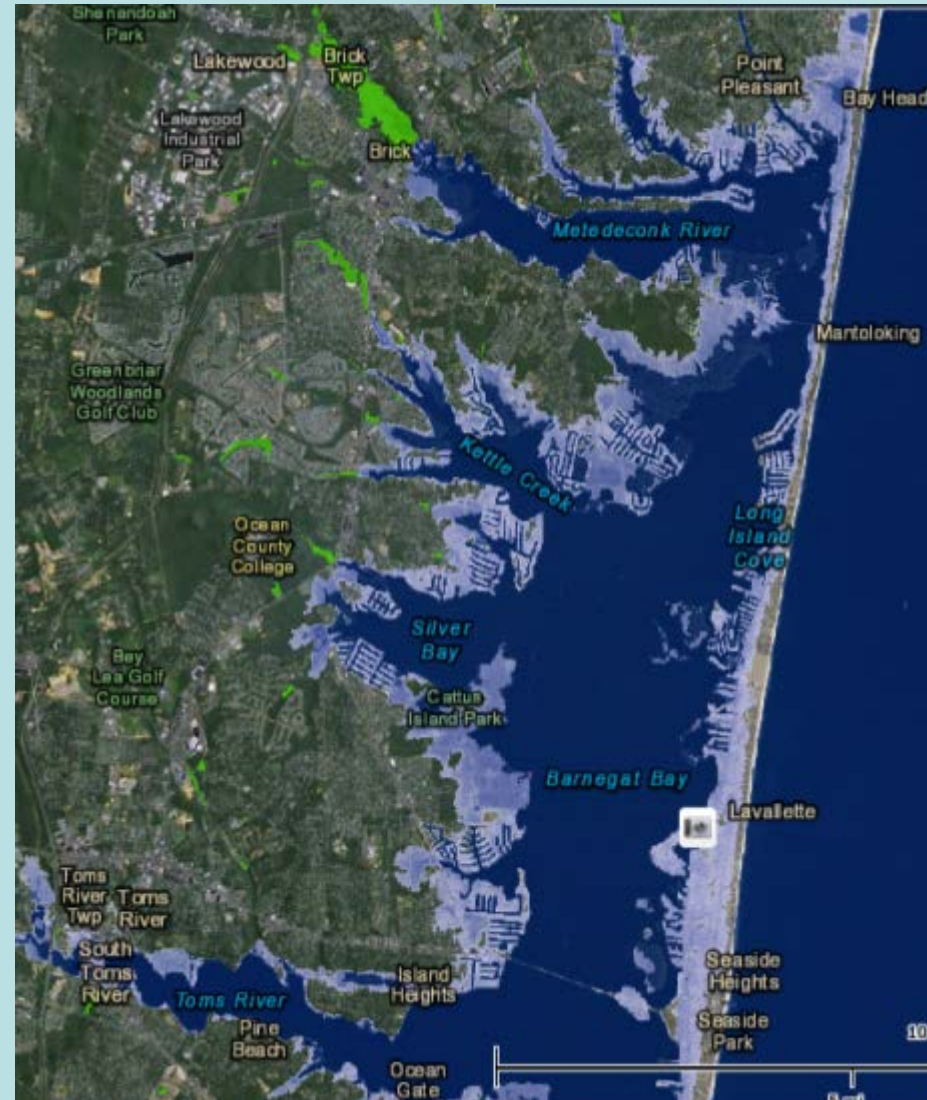
Future Approaches

Dune Planting Techniques

- Facilitate the production and use of local ecotypes of beachgrass
Slaymaker & Peek, *“Genetic Structure of Native and Restored Populations of Am. Beachgrass”* 2013. (William Paterson Univ.)
- Incorporate bitter panicgrass and possibly sea oats to complement beachgrass for frontal dunes in the northern Mid-Atlantic.
- Develop improved mycorrhizal fungi inoculation strategies for dune plantings.
- Advance dune seeding techniques for multiple species to diversify plantings. (grasses, wildflowers and shrubs)
- Improve commercial seed/plant availability of a diversity species. (i.e. beach pea, trailing wild bean, sea beach primrose, seaside goldenrod, coastal little bluestem, beach heather)

What's Next?-Tidal Marsh Restoration

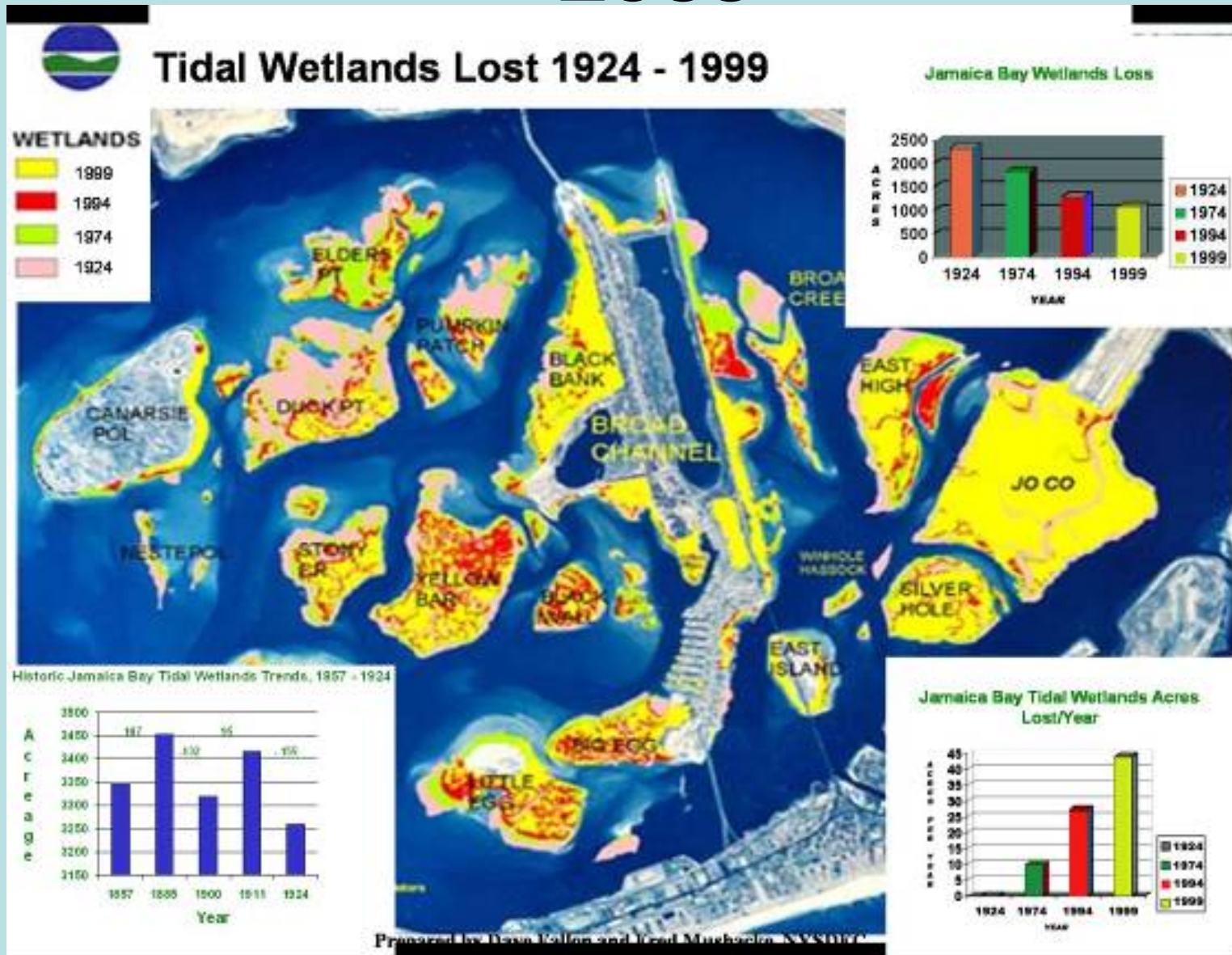
- East and Gulf coasts are more vulnerable to sea level rise than West coast.
- While natural habitats may protect some areas, unless helped along by engineers, sea level rise will overwhelm those habitats in others
- Probably need a variety of strategies, including both habitat enhancement and engineered solutions



Jamaica Bay, New York ACOE-Marsh Restoration



Jamaica Bay Islands Wetland Loss



Dredged sand pumped and graded





Graded area before
seeding/planting

Seed Ripeness

Five to six weeks from flowering to seed maturity



Seed Harvest- Sickles/Machetes



Equipment Settings for Cleaning Seed of Smooth Cordgrass (*Spartina alterniflora*).

William Skaradek, and Noel Murray USDA-NRCS Cape May Plant Materials Center

Melissa Alvarez US Army Corp of Engineers NY District

Abstract

The purpose of this project was to determine the most efficient and yet affordable process by which to clean seed of smooth cordgrass.

Smooth cordgrass is a dominant warm season grass occupying the inter-tidal zone of estuarine plant communities. Large scale harvesting, processing and cleaning of *Spartina* seed has been limited to hand processes to ensure high levels of viable seed harvested.

*The USDA NRCS Cape May Plant Materials Center is the first known facility to utilize an agricultural combine for large scale seed cleaning equipment that resulted in hundreds of pounds of viable seed. This information will serve to advance the cost effectiveness of large scale estuary conservation.

Materials and Methods:

Building for after ripening of seed, combine, 62-D three Screen separator, germplasm storage at 1-2 Celsius, and 25 ppt salt water.



Photo to the left illustrates hand sickle harvest of seed heads from the wild. The entire seed harvesting process can be accessed by requesting a copy of:

Interagency Publication: MP-NJPMC-0501
Planning Considerations for Collecting Seed of Smooth Cordgrass *Spartina alterniflora* (L.) in the Mid-Atlantic.

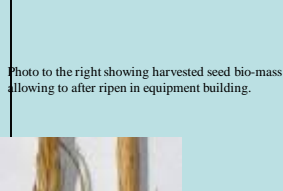


Photo to the right showing harvested seed bio-mass allowing to after ripen in equipment building.



Photo to the left shows a "green" seed head on the left requiring after ripening until it finishes and turns tan like the one on the right.



Photo above shows PMC combine that was used



From left to right: Seed flowing from combine bin to cans; 62D three screen separator; staff bagging clean seed.



Photo above shows clean healthy seed extracted from 25 ppt salt water and stored in cold storage at 1-2 degrees C.

Results and Discussion:

Though many settings combine settings were experimented with the following settings yielded the cleanest and least damaged seed.

Fan Speed:	9
Cylinder Speed:	7
Concave:	12
Air Inlet:	Full-Open
Adjustable Sieves:	15 mm

The 62-D three screen separator performed best at the following settings:

Hopper Roller Opening:	2/3rd Open
Air Deflector Board:	1/4" Open
Fan Speed:	900 RPM
Top Screen:	#24
Middle Screen:	Slotted 6/64th by 3/4"
Bottom Screen:	1/25th covered with paper.
Adjustable Speed:	1/2 Turn open
Seed Discharge Door:	Closed
Top and Bottom Fan Balancer:	Air Flow Ribbon Balanced

Summary:

Cost effective seed cleaning of the coastal halophyte smooth cordgrass can be accomplished. Due to the purchase costs associated with the machinery mentioned, a propagator will need to carefully examine available labor rates, the quantity of seed that will be processed and the cost of equipping their operation with similar machinery.

Equipment Manufacturer Disclaimer:

Mention of trade and company names does not imply any guarantee, warranty or endorsement by the USDA Natural Resources Conservation Service and does not imply its approval to the exclusion of other products that are also suitable.

Seed Storage

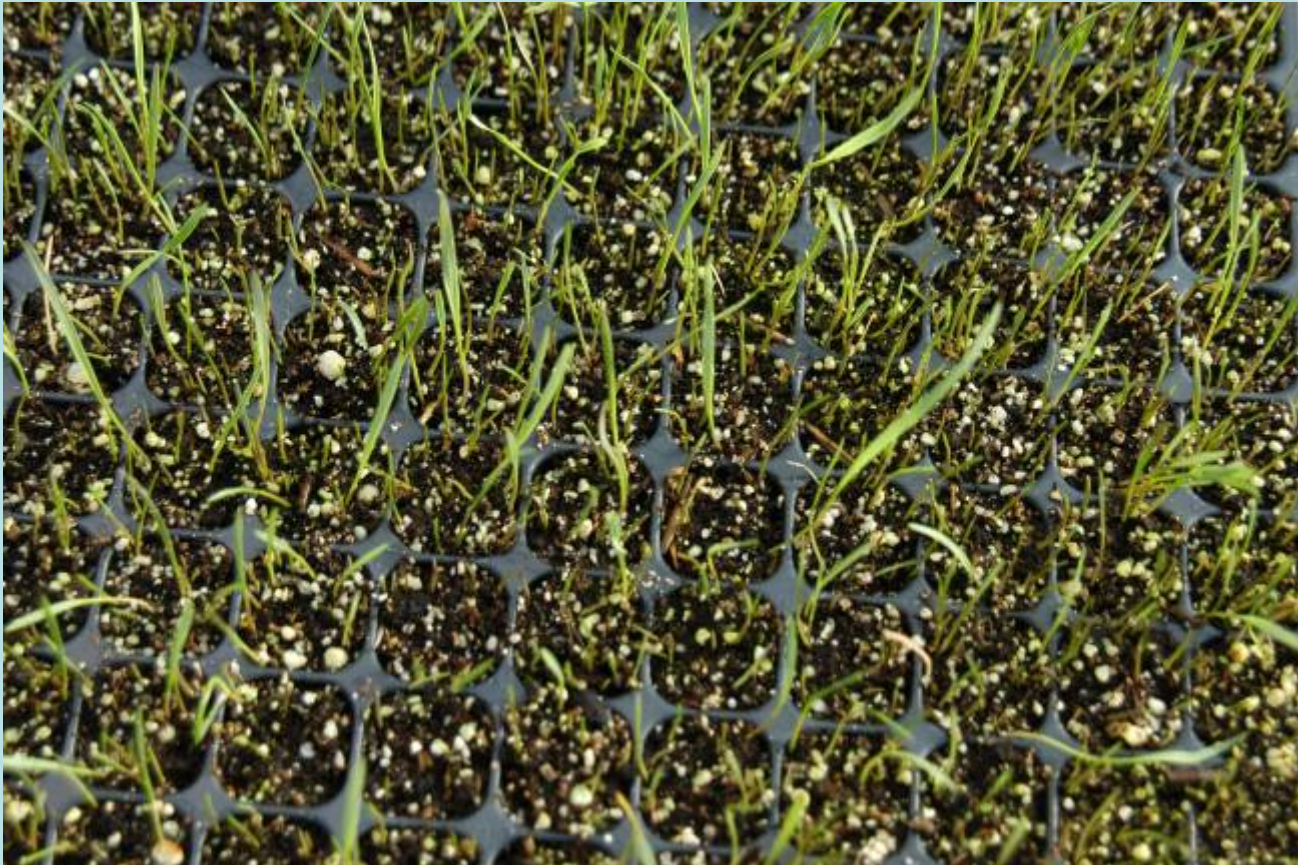
Salt Water: 25 ppt. flushed every ten days.
¼ cup Clorox per 25 gallons.



Seed Storage: 38 degrees F.



Seeding tray germination



Plant Propagation

Takes 3-4 mo. from seed germination to marketable plant.



Direct Seeding Technology for Marsh Establishment



Jamaica Bay Seeding Low Energy Site



Seeding vs Vegetative Planting

- Advantages of Seeding
 - -reduced planting costs, more mechanized
 - -Cover more area less time
 - -Seed is cheaper than plugs.

Seeding vs Vegetative Planting

- Advantages of plugs
 - -quick stabilization under high energy. Used quart sized pots in highest energy shoreline fringe
 - -Resistant to waterfowl “plucking” if planted by end of June-early July.

Plug Planting-Season 1 vs Season 2



Plant Propagation



7.5" deep plugs produced.
Cost was \$0.70/plug.

Quart pots produced at
\$ 2.50/container

1.5 foot spacing:

Plugs- \$20,328/ac.

Qt. Pots- \$72,600/ac.

Drill Seeding-\$4,356.00/ac.

@ 10 Pure live seeds/sq.ft.



Seeding *Spartina alterniflora* (smooth cordgrass)

- Very limited trials done on seeding *Spartina alterniflora*
 - North Carolina State-Drs. Woodhouse, Seneca, and Broome (1970's)
 - Galveston Bay mud flats-surface broadcast seeding with airboats (1990's)
 - Louisiana State University-Work with improved seeding genotypes.

Challenges with seeding *Spartina alterniflora*

- Wild harvest by hand at **optimum** time.
- Low natural germination percentage (10-40%).
- Cold, wet storage requirements.
- Difficulty getting seed to flow through a seeder/seed drill since seed is wet.
- Proper depth of seeding to prevent seed movement/washing away.

Direct seeding for Tidal Marsh Restoration



Use of a seed carrier is necessary:

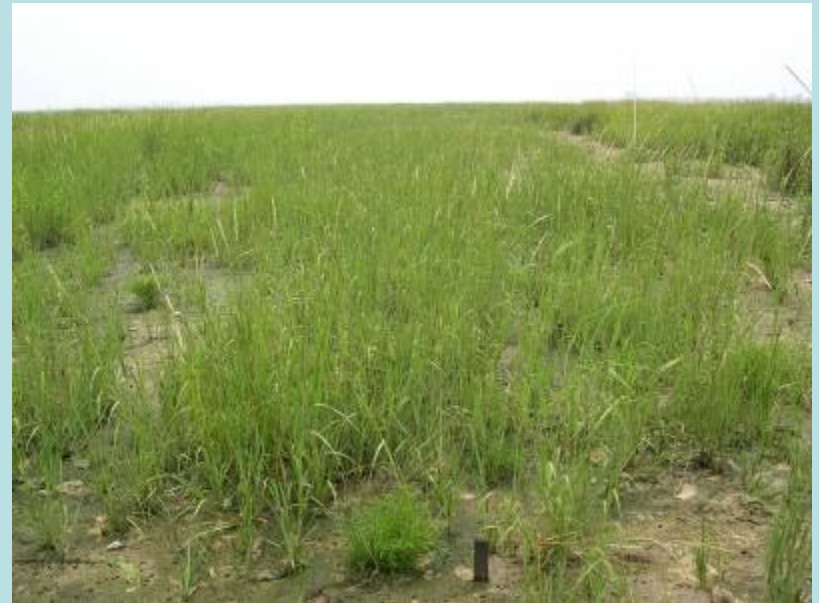
We chose **non-clumping cat litter**.

Low Energy Site-Seeding

Sept. 07



July 08



High Energy site conditions

- 25 foot planted buffer of quart pots - *Spartina alterniflora*.
- Planting in Median tidal range elevation.



High Energy Site Seeding

September 07



July 08



July 2008 Stem Counts

Treatment	Average # Stems/lin. foot (line transect-across plot)				Average
	Rep 1	Rep. 2	Rep. 3	Rep. 4	
Low Energy	1.1	0.90	0.68	0.87	0.88
Low Energy (control)	0.30	0.70	0.18	0.07	0.31
High Energy	0	0.13	0.01	0.16	0.07
High Energy (control)	0	0	0	0.05	0.01

Seed Drill Preparation/Calibration



ACOE-Yellow Bar Project Jamaica Bay, NY



* Breaks in fencing - February 18, 2013

Jamaica Bay-Yellow Bar Island



Spartina alterniflora seeding

First growing season



Conclusions

- **High quality seed**, properly stored and handled is necessary for seeding success.
- Direct seeding is a viable option in lower energy environments, in the upper $\frac{1}{2}$ of the tidal range in coarse-textured (sand) dredge materials. Seeding depth-1.5 inches.
- In higher energy sites, plant a shoreline fringe buffer of at least 50 foot with vegetative material. (upper $\frac{1}{3}$ of tidal range)
- Drill seeding in high organic (muck) soils would be difficult and may yield different results. (broadcast may work?)

BMP's for Coastal Resilience

Climate Change

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

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

High Tide Germplasm switchgrass





Chesapeake Bay - March 6, 2006 - MODIS/MODIS/SeaWiFS

High Tide Germplasm switchgrass

- Stabilizing scoured bank on Sedge Island (Dredge Containment Facility) on back bay behind Stone Harbor.
- Salinity-25 ppt



Native Warm Season Grasses

- Substitute for beachgrass above mean high tide on bay sites.
- Tolerate periods of drought as well as flooding.
- Deep root system allows for soil/bank reinforcement



Switchgrass roots

Aerenchyma roots



Freshwater Cordgrass (*Spartina pectinata*)



Cape May Plant Center

-Long Island population



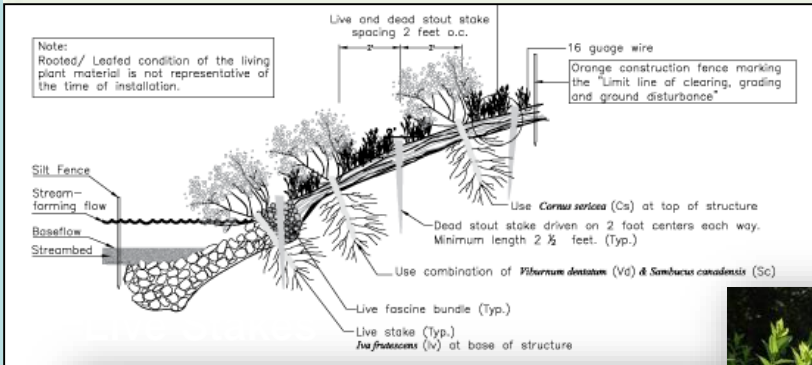
Giant Cordgrass (*Spartina cynosuroides*)



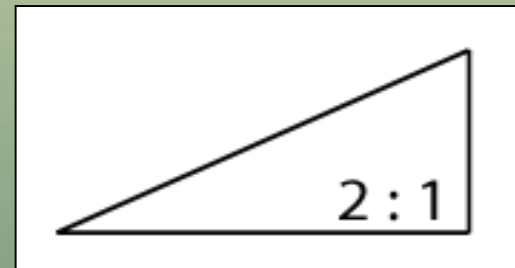
Chesapeake Bay population

Soil Bioengineering: Using Plants in a Structural Function

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



Brushmattress Installation



Soil Bioengineering



Future Planting Approaches

- Living Shoreline Applications
 - Advance living shoreline techniques through the development of seeding/integrated planting techniques.
 - Selection/testing of woody plant species for soil bioengineering applications in brackish/saline water. (Groundsel-*Baccharis* , Marsh elder- *Iva*)
 - Screening shoreline species for salt water adaptation/tolerances.
 - Test under-utilized plants for shorelines, e.g. eastern gamagrass, prairie cordgrass, switchgrass.

Value-Added Conservation Plants

- Beach Plum-fruit is used for jams, wine, salad dressing, and can be direct marketed.
- Seashore Mallow- marginal, salt affected cropland/riparian buffers
- Salt meadow cordgrass-marginal cropland/buffers harvested for salt hay.

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/Production Guidelines** provided by the Plant Materials Centers and plant specialists.
- **Technical Support/Marketing Assistance** provided by the Plant Materials Program through fact sheets, brochures, plant source directories, etc.

Our goal is to support the development
of an integrated system
for a sustainable Beach Plum Industry
in Southern New Jersey.



*THE CAPE MAY COUNTY
BEACH PLUM ASSOCIATION*

cmcbeachplum@comcast.net
cmcbeachplum.com

A NEW JERSEY NON-PROFIT
BUSINESS ENTITY

The Beach Plum grows in a tree-like form upwards of 10 feet





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



Value added beach plum products

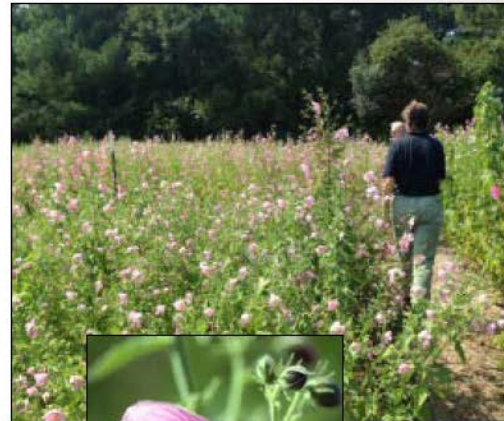


Specialty Crop

University of Delaware

Seashore Mallow

- Dr. Jack Gallagher and the halophyte research lab
- Extension, nonprofit collaboration
- Native to the US East and Gulf Coasts
- Non-invasive
- Perennial (10 years)
- Drought-tolerant and water log-tolerant
- No known diseases
- Ecosystem services identified
 - Roots absorb nutrients, suppresses spread of *phrag*, air and water filtration, food source for pollinators, carbon sequestration



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. For harvest, use an upright variety: 'Flageo'

NRCS-Plant Materials Centers doing coastal work

- Cape May, NJ*
- Golden Meadow, LA *
- Nacogdoches, TX
- Coffeeville, MS
- Brooksville, FL
- Rose Lake, MI

*primary function

Internet Resources

- USDA-NRCS Plant Materials Program-Coastal and Shoreline Webpage: <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/plantmaterials/technical/publications/?cid=stelprdb1044304>
- Cape May Plant Materials Center: <http://plant-materials.nrcs.usda.gov/njpmmc/>

Dune it Right FAQ website

- **Superstorm Sandy-Rapid Response**

- Dune It Right FAQ: Dr. Louise Wootton:

http://gcuonline.georgian.edu/wootton_l/restoration.htm

- NJ Sea Grant-Comprehensive Dune Stabilization Manual will be electronically available in a few months.
 - Update of the 1992 USDA-SCS. “*Restoration of Sand Dunes along the Mid-Atlantic Coast*”. Hamer, Belcher and Miller.

Questions?