A Survey of Techniques to Increase Plant and Animal Diversity in Coastal Dune Restoration

Barrier Island Dynamics, Restoration and Beach Mice

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Debbie Miller, Mack Thetford, Lyn Branch, Gabriel Campbell, Hannah Hunsberger, Margo Stoddard, Elliot Wilkinson, Natalie Hooton, Alex Pries, Sarah Lumban-Tobing, Jennifer Dupree, Kathryn Smith, Ashlynn Smith, Sean Claypool, Lesley Atwood, Mica Schneider, Lisa Yager

University of Florida Departments of Wildlife Ecology and Conservation and Environmental Horticulture
COLLABORATORS

- National Park Service
  Gulf Islands National Seashore
- US Fish and Wildlife Service
- Florida Fish and Wildlife Conservation Commission
- Eglin Air Force Base
- Northwest Florida DEP (restoration division)
- NOAA
- Gulf of Mexico Foundation
- USDA National Institute of Food and Agriculture
Dune Restoration and Enhancement for the Florida Panhandle

Authors and Contributing Editors:
Dr. Debbie Miller, Professor, Wildlife Ecology and Conservation Department, West Florida Research and Education Center; UF/IFAS
Dr. Mack Thetford, Associate professor, Environmental Horticulture Department, West Florida Research and Education Center; UF/IFAS
Christina Verlinde, Florida Sea Grant Extension Agent, Santa Rosa County Extension; UF/IFAS

Authors:
Gabriel Campbell, Graduate Research Assistant, West Florida Research and Education Center; UF/IFAS
Ashlynn Smith, Graduate Research Assistant, West Florida Research and Education Center; UF/IFAS
The purpose of this manual is

- to provide an overview of the Florida Panhandle coastal dune systems
- to provide information on coastal dune restoration and restoration enhancement activities developed through implementation of research and monitoring activities for this region of the northern Gulf of Mexico.
- to provide a common resource for homeowners, local government officials, land managers, nurserymen, and individuals responsible for designing, contracting or monitoring of restoration projects.
- to provide propagation and production information for key plant species useful in dune restoration.
Where is this work taking place?
Impacts of Hurricanes Erin and Opal!
Research questions?

Habitat Loss
Dunes
Vegetation
Beach Mice
Turtles
Where Sea Turtles are not a concern—What orientation works best?

Bay side

Gulf Side

Straight (Conventional)

Straight-Perpendicular

Oblique
When to plant Sea Oats and Bitter Panicum? Fall or Spring?

Sea Oats
*Uniola paniculata*

Bitter Panicum
*Panicum amarum*

What Materials to use?

Wood Fence

Geojute

Straight fence and other configurations work equally well (1996-1999); Geojute failed after 1.5 yrs.
Survival

<table>
<thead>
<tr>
<th>Season of planting</th>
<th>Sea Oats</th>
<th>Bitter Panicum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>73%</td>
<td>63%</td>
</tr>
<tr>
<td>Spring</td>
<td>80%</td>
<td>82%</td>
</tr>
</tbody>
</table>

Survival the same but plants grew bigger the first growing season when planted in the Spring!

What does blowing sand do to Sea Oats survival?

<table>
<thead>
<tr>
<th>Survival</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>54</td>
<td>63</td>
</tr>
<tr>
<td>More Wind</td>
<td>31</td>
<td>43</td>
</tr>
<tr>
<td>Less Wind</td>
<td>77</td>
<td>83</td>
</tr>
</tbody>
</table>

Want to Plant Diversity of Species

When should we plant bluestem?

Does burial influence Survival?

For Coastal bluestem plant in Summer only. June and August. June is best for survival and growth

Wind uprooting bluestem is a major problem

Potential Novel Restoration Approach
Dune building with Sea Oats Rhizomes

Can uprooted Sea oats be replanted to restore dunes?

How long can uprooted sea oats survive?

Reburied Sea Oats  YES!

- Uprooted Sea Oats fragments can be reburied
  - Soil moisture is the most important factor for replanted Sea Oats survival
- Can’t wait too long – after 3 days success declines.
- Still grow after 5 days exposure - With rain and watering

Restoration After Hurricanes Ivan and Dennis

Considerations for beach mice and other wildlife species
Plant re-establishment?
Dune redevelopment?
Habitat restoration for beach mice?

When, where and how to plant a diversity of herbaceous and woody species?

Miller et al. 2001. Coastal Resch. 17(4):936-948
Raymer et al. 2008 Hortotechnology 18(3)372-378
Threats to beach mice and beach habitat: Direct

- Hurricanes
- Fragmented habitat – Creates Barriers
- Restoration can address fragmentation

Coastal development
Beach Mouse Use of Altered Landscape
How important is secondary dune habitat for beach mice?

Patch characteristics and landscape context: what specific variables predicted occupancy of Frontal Dunes?

- Distance to nearest occupied dune
- Dune height
- Percent cover of woody vegetation, distance to nearest occupied dune

Pre-Ivan


Post-Ivan

% cover woody vegetation*

*Vegetation not measured pre-hurricane
Patch characteristics and landscape context:

What variables predict occupancy of Scrub Dunes?

Dune area

Habitat within 200 m

% cover woody vegetation

Key habitat variables

Patch characteristics and landscape context influence occupancy

Frontal dunes

- Distance to nearest occupied dune
- Dune height

Scrub dunes

- Habitat within 200 m
- Dune area
- % cover woody vegetation

Habitat variables that predict occupancy did not change with hurricane in scrub.
Conclusions and Conservation Implications

• Scrub habitat is
  • less prone to damage by tropical storms than frontal dunes
  • critical as refugia for beach mice

• Beach mice selectively use secondary dunes and wetland margins for foraging and nesting

• Protection of a diversity of habitats is necessary if conservation of beach mice and their habitat is a concern

• Vegetation cover is consistently one of the most important factors noted in each study

Multiple publications authored by Miller, Branch, Pries, Wilkerson and Stoddard
Conservation implications

Dune restoration efforts for mice should:
1. Facilitate connectivity by minimizing distance between dunes
2. Incorporate woody vegetation
3. Enhance features that promote dune stability (e.g., dune height)
1. Facilitate Connectivity

Revegetate sand gaps with a diversity of plant species and monitor mouse use.
2. Incorporate woody vegetation
3. Enhance features that promote dune stability (dune height)

What are questions related to plant re-establishment and dune redevelopment?

When, where and how to plant herbaceous and woody species?

Miller et al. 2001. Coastal Research. 17(4):936-948
Raymer et al. 2008 HortTechnology 18(3)372-378
How far from the gulf before you can plant woody species?

- Wax myrtle
- Inkberry
- Beach rosemary

Does Size of Pot or Dimension of Pot Matter?

Inkberry
- Standard 1 gallon
- Treepot 3 gallon

Yaupon
- Standard 1 gallon
- Treepot 1 gallon
How far from the Gulf?

- At least 400 ft
- With 2 small dunes (1-3 ft) between plants and Gulf
- 50% or greater survival

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Ceratiola Survival (%)</th>
<th>Morella Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months after planting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>7 a</td>
<td>0 a</td>
</tr>
<tr>
<td>124</td>
<td>50 b</td>
<td>45 b</td>
</tr>
<tr>
<td>170</td>
<td>87 c</td>
<td>50 b</td>
</tr>
<tr>
<td>200</td>
<td>90 c</td>
<td>65 b</td>
</tr>
<tr>
<td>15 months after planting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>0 a</td>
<td>0 a</td>
</tr>
<tr>
<td>124</td>
<td>30 a</td>
<td>40 b</td>
</tr>
<tr>
<td>170</td>
<td>67 c</td>
<td>50 b</td>
</tr>
<tr>
<td>200</td>
<td>90 d</td>
<td>65 b</td>
</tr>
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</table>
Pot Size and Type

- Does pot size matter for inkberry? **YES**
  - Inkberry survived greater windspeed, salt spray and lower soil moisture found nearer to gulf when grown in 3 gal treepot containers

- Does pot size matter for bluestem? **NO**
What about Landscape Context and Pot Size?

Swale Ridge

Swale Depression

Thetford, M., D.L. Miller, L.W. Atwood and B.O. Ballard. 2015. Microsite and rooting depth are more important than water-holding gel on establishment of restoration plantings of Ilex vomitoria on barrier islands in the Gulf of Mexico. Native Plants Journal. Volume 16(2):77-86.

Survival
- 30% swale ridge
- 66% swale depression
- 32% standard gal pot
- 65% treepot gal pot

2 yrs. After establishment

What about Hydrogels?
Survival on swale ridges did not improve with addition of hydrogel but height was increased in swale depressions for 1 year.
Effectiveness of polyacrylamide gel?

No significant difference!
Be careful of initial foliar assessments of survival!

Observed survival of *Quercus geminata* planted in vegetated areas of the maritime forest of Santa Rosa Island
What Planting Patterns may facilitate increased diversity and dune height

Competition study
- bluestem and beach elder growth reduced when planted as neighbors with sea oats;
- effect on sea oats is neutral

Planting Patterns – 2 separate planting zone experiments

• 3 species combinations
  – Sea oats, Beach elder, Maritime bluestem

• 4 species combinations
  – Sea oats, Beach elder, Maritime bluestem and Bitter panicum
Planting in zones

- Each species planted in blocks of 36 plants; 18” spacing
- After 2 years best coverage, sand accumulation - PPPP, PUSI, UPSI, IPUS, and UUUU

P = Bitter Panicum
S = Maritime Bluestem
U = Sea Oats
I = Beach Elder

looked at treatments with ±45% survival, ≥45% foliar cover when foliar cover of the four zones are added together and >15 cm of sand accumulation.
But do the beach mice use the restored areas?

Compared beach mice use of:
1. open sand gaps
2. natural dunes
3. restoration plots

Observations:
• Use of natural dunes highest
• Patterns of use are similar with new moon and full moon
• Restoration plots may be corridors that facilitate movement
Restoration plots may be corridors that facilitate movement of beach mice

Margo A. Stoddard, Deborah L. Miller, Mack Thetford, and Lyn C. Branch,
If you build it, will they come? Use of restored beach dunes by Beach mice. In Preparation
Novel approaches to enhance restoration? Is there a benefit of applying an artificial wrack?

One of Six Replicate Sites

3.96 m (13 ft)

21.34 meters (70 feet)

No Mulch, *U. paniculata*

Mulch, *U. paniculata*
Sea Oats Aboveground Biomass

Aboveground Biomass (g)

4 Months AP  6 Months AP  Change

Mulch

No Mulch

*=Mulch and No mulch statistically different
Mean Biomass Weight (g) 2 years post planting

Mean Inflorescence Weight (g) 2 years post planting

2 yrs post planting

Mulch  No Mulch
Need to Repeat Mulch Experiment Nearer to the Gulf
Propagation, production and planting information for 28 plant species
# Propagation, Production and Establishment of 10 Native Wildflower Species

Sandy Wilson, Mack Thetford, Hector Perez and graduate students

<table>
<thead>
<tr>
<th>Scientific Name:</th>
<th>Common Name:</th>
<th>Family:</th>
<th>Native Habitat:</th>
<th>FL Zone:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balduina angustifolia</td>
<td>Coastalplain Honeycomb-Head; Yellow Buttons</td>
<td>Asteraceae</td>
<td>Sandhills, Scrub, Dunes</td>
<td>8A - 10B</td>
</tr>
<tr>
<td>Callisia ornata</td>
<td>Florida Scrub Roseling</td>
<td>Commelinaceae</td>
<td>Sandhills and Scrub</td>
<td>8B - 10B</td>
</tr>
<tr>
<td>Chrysoma pauciflosculosa</td>
<td>Woody Goldenrod</td>
<td>Asteraceae</td>
<td>Coastal dunes, Sandhills and Scrub</td>
<td>8A - 8B</td>
</tr>
<tr>
<td>Dalea feayi</td>
<td>Feay’s Prairieclover</td>
<td>Fabaceae</td>
<td>Sandhills and Scrub</td>
<td>8B - 10B</td>
</tr>
<tr>
<td>Dalea pinnata var. pinnata</td>
<td>Summer Farewell</td>
<td>Fabaceae</td>
<td>Sandhills and Scrub</td>
<td>8A - 9B</td>
</tr>
</tbody>
</table>

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<th>Family:</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Heliotropium curassavicum</td>
<td>Seaside Heliotrope</td>
<td>Boraginaceae</td>
<td>Dunes</td>
<td>8B - 11</td>
</tr>
<tr>
<td>Licania michauxii</td>
<td>Gopher-Apple</td>
<td>Chrysobalanaceae</td>
<td>Sandhills</td>
<td>8A - 11</td>
</tr>
<tr>
<td>Polygonella macrophylla</td>
<td>Large-Leaved Jointweed</td>
<td>Polygonaceae</td>
<td>Coastal dunes and Scrub</td>
<td>8A - 8B</td>
</tr>
<tr>
<td>Polygonella polygama</td>
<td>Jointweed; October Flower</td>
<td>Polygonaceae</td>
<td>Coastal dunes and Scrub</td>
<td>8A - 10B</td>
</tr>
<tr>
<td>Polygonella robusta</td>
<td>Largeflower Jointweed</td>
<td>Polygonaceae</td>
<td>Sandhills and Scrub</td>
<td>8B - 10A</td>
</tr>
</tbody>
</table>
Propagation and Outplanting

- Chrysopsis godfreyi godfreyi  
  Godfrey’s golden aster
- Chrysopsis godfreyi viridis  
  Godfrey’s golden aster
- Chrysopsis gossypina cruiseana  
  Cruises Golden aster
- Oenothera humifusa  
  Seabeach evening primrose
- Smilax auriculata  
  Greenbriar
- Physalis angustifolia  
  Ground Cherry
- Chrysoma pauciflosculosa  
  Woody Goldenrod
- Licania michauxii  
  Gopher Apple
- Balduina angustifolia  
  Coastalplain honeycombhead
- Asclepias humistrata  
  Sandhill Milkweed
**Hesperapis oraria**
Balduina Bee

- Solitary
- Ground nesting
- Single floral host

- What is the distribution of bee and plant?
- What is the effect of *B. angustifolia* density, patch size, and flower density on bee presence?
- What is the effect of landscape context on *B. angustifolia* and bee presence?
Opportunities for Continued Collaboration?

• Operational-scale implementation of research results
  – Planting zone combinations
  – Surrogate wrack at planting

• Propagation and outplanting of additional species of interest.
  • *Balduina angustifolia* – *Coastalplain honeycombhead*
    – enhanced bee foraging habitat?
  • *Asclepias humistrata* - *Sandhill Milkweed*
    – enhanced Monarch Butterfly habitat?
Research Direction

• Propagation, production and outplanting
  – Sandhill Milkweed (*Asclepias humistrata*)

• Mulch or fertilization at planting
  – Ground Cherry (*Physalis angustifolia*)
  – Golden Asters (*Chrysopsis sp*)

• Seed germination requirements
  – Sand Frost Weed (*Crocanthemum arenicola*)

• Development of project monitoring and evaluation criteria for coastal restoration projects.
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- Gabriel Campbell, Graduate Research Assistant, West Florida Research and Education Center; UF/IFAS
- Ashlynn Smith, Graduate Research Assistant, West Florida Research and Education Center; UF/IFAS

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