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

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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:

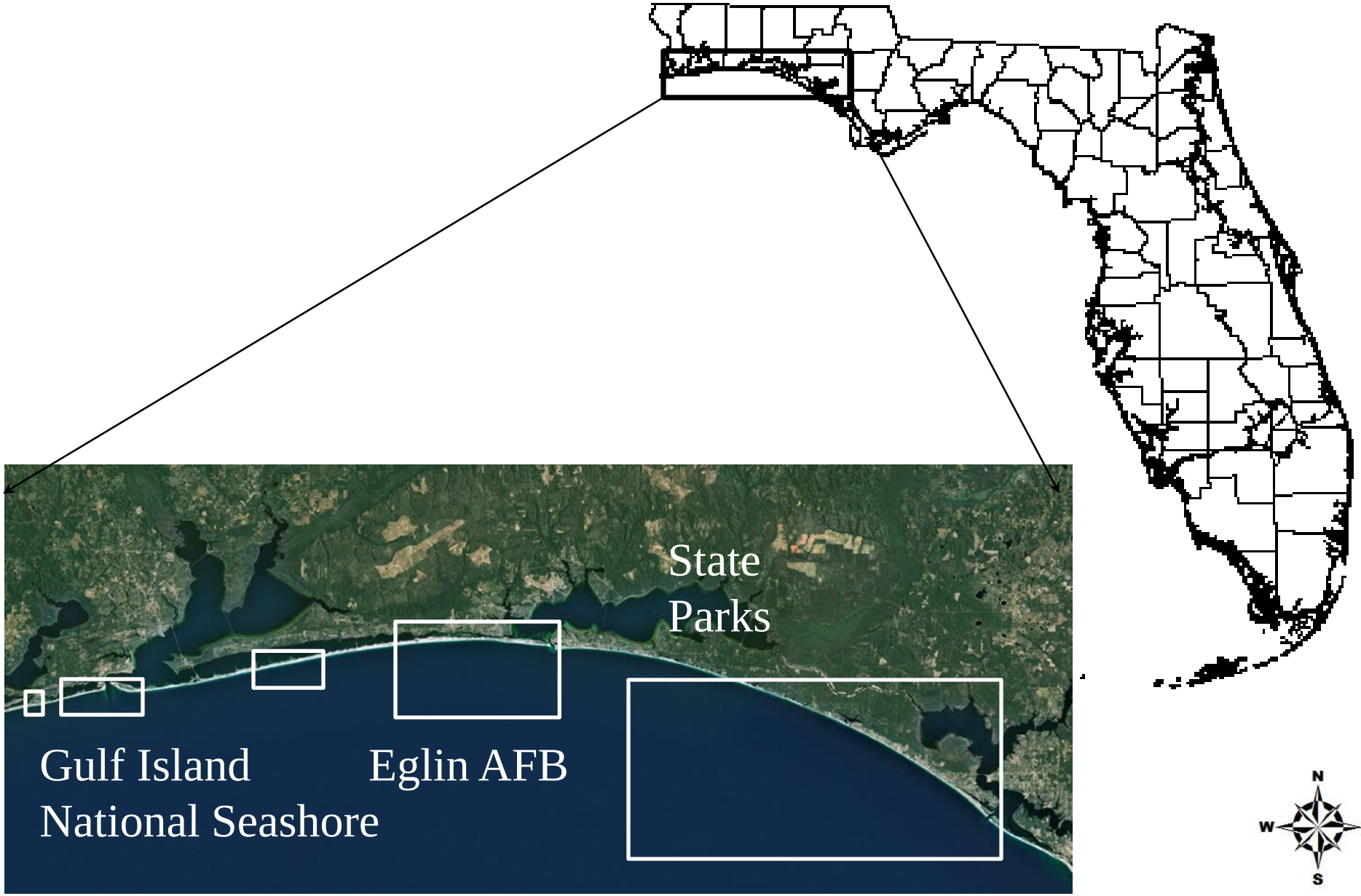
Gabriel Campbell, Graduate Research Assistant, West Florida Research and Education Center; UF/IFAS

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 ?

<u>Habitat Loss</u>

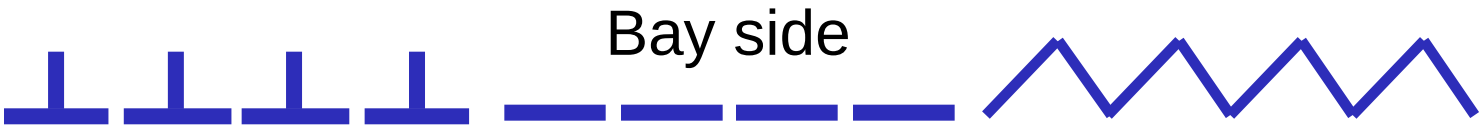
Dunes

Vegetation

Beach Mice

Turtles

Where Sea Turtles are not a concern– What orientation works best ?



Straight (*Conventional*)

Straight-Perpendicular

Oblique

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

Sea Oats
Uniola paniculata

Bitter Panicum
Panicum amarum

D.L. Miller, M. Thetford and L. Yager 2001. J. Coastal Research pp. 359-369

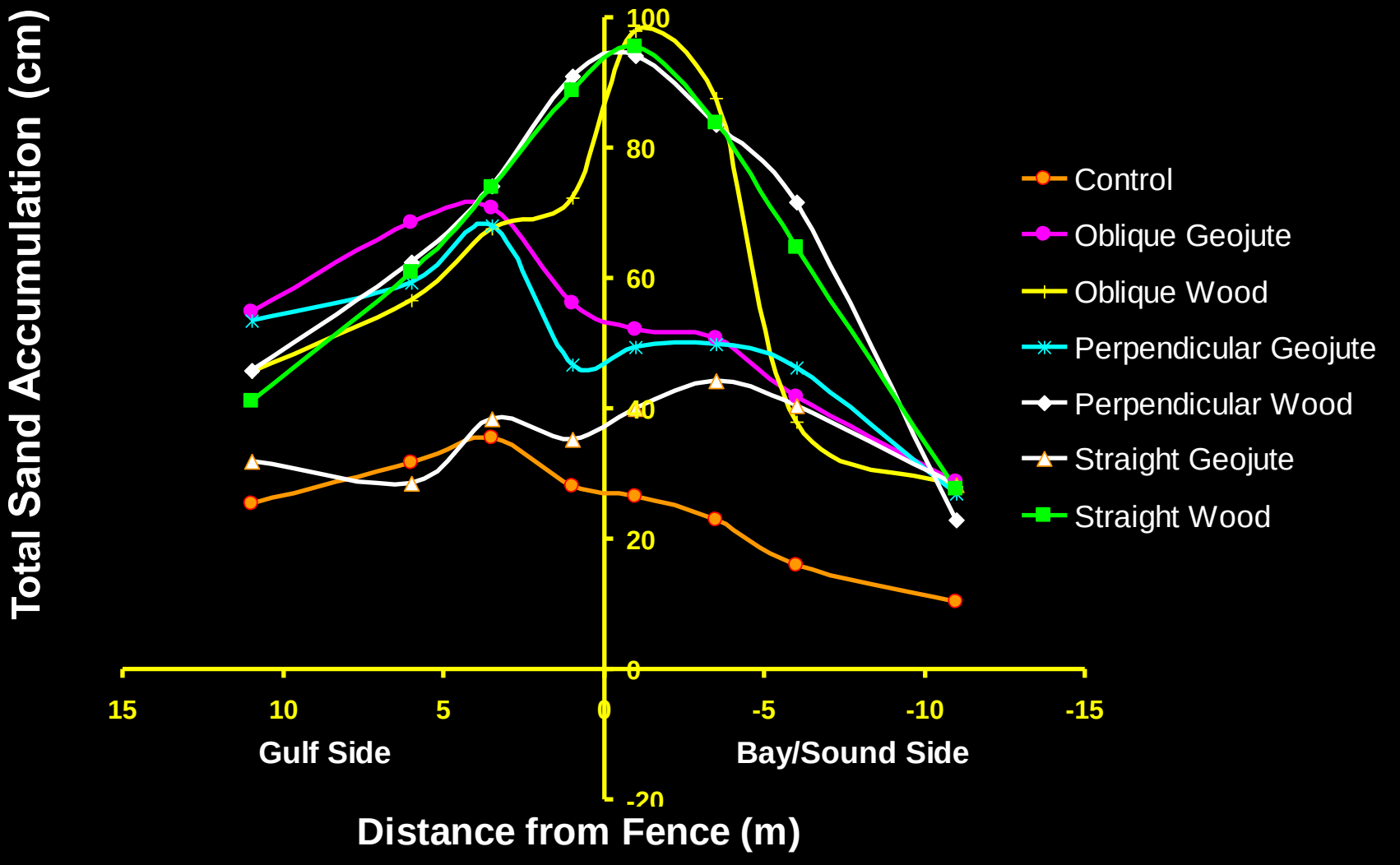
What Materials to use?

Wood Fence

Geojute

D.L. Miller, M. Thetford and L. Yager 2001. J. Coastal Rsch pp. 359-369

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



Survival

Season of planting	Sea Oats	Bitter Panicum
Fall	73%	63%
Spring	80%	82%

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

D.L. Miller, M. Thetford and L. Yager 2001. J. Coastal Research pp. 359-369


Dune Restoration
Experiment
Do Not Disturb

What does blowing sand do to Sea Oats survival?

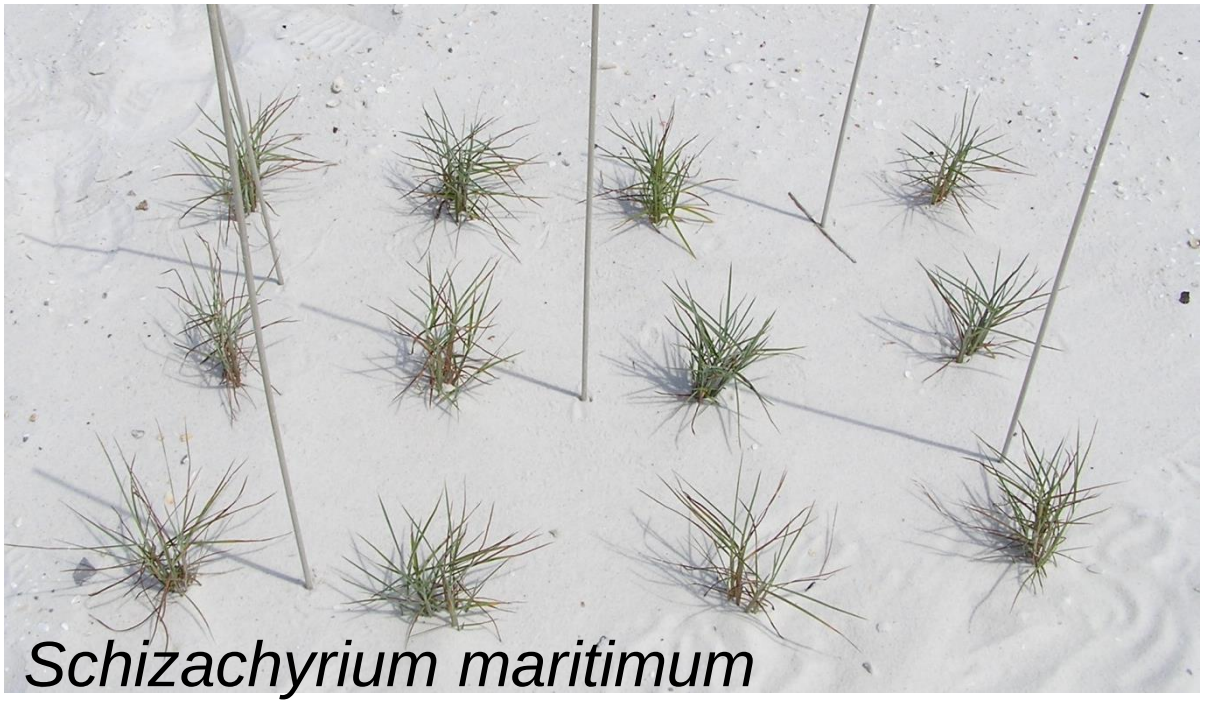
Survival	Fall	Spring
Overall	54	63
More Wind	31	43
Less Wind	77	83

D.L. Miller, M. Thetford and L. Yager 2001. J. Coastal Research pp. 359-369

Want to Plant Diversity of Species

When should we plant bluestem?

Does burial influence Survival ?



Schizachyrium maritimum
Coastal bluestem

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

Wind uprooting bluestem is a major problem

D.L. Miller, M. Thetford, J. Dupree**, L. Atwood. 2014. Influence of seasonal changes and shifting substrate on survival of restoration plantings of *Schizachyrium maritimum* (Gulf Bluestem) on Santa Rosa Island, Florida. Journal of Coastal Research. 30(2): 237-247. Doi: http://dx.doi.org/10.2112/jcoastres-d-13-00031.1

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 ?

D.L. Miller, et al. 2003.. Restoration Ecology Vol 11 pp. 359-369

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

D.L. Miller, et al. 2003.. Restoration Ecology Vol 11 pp. 359-369

Ivan Sept. 15 2005

Dennis July 10 2006

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 Rsch. 17(4):936-948
Raymer et al. 2008 Hortechnology 18(3)372-378

Threats to beach mice and beach habitat: Direct

Hurricanes

Coastal development

Fragmented habitat – Creates Barriers

Restoration can address fragmentation

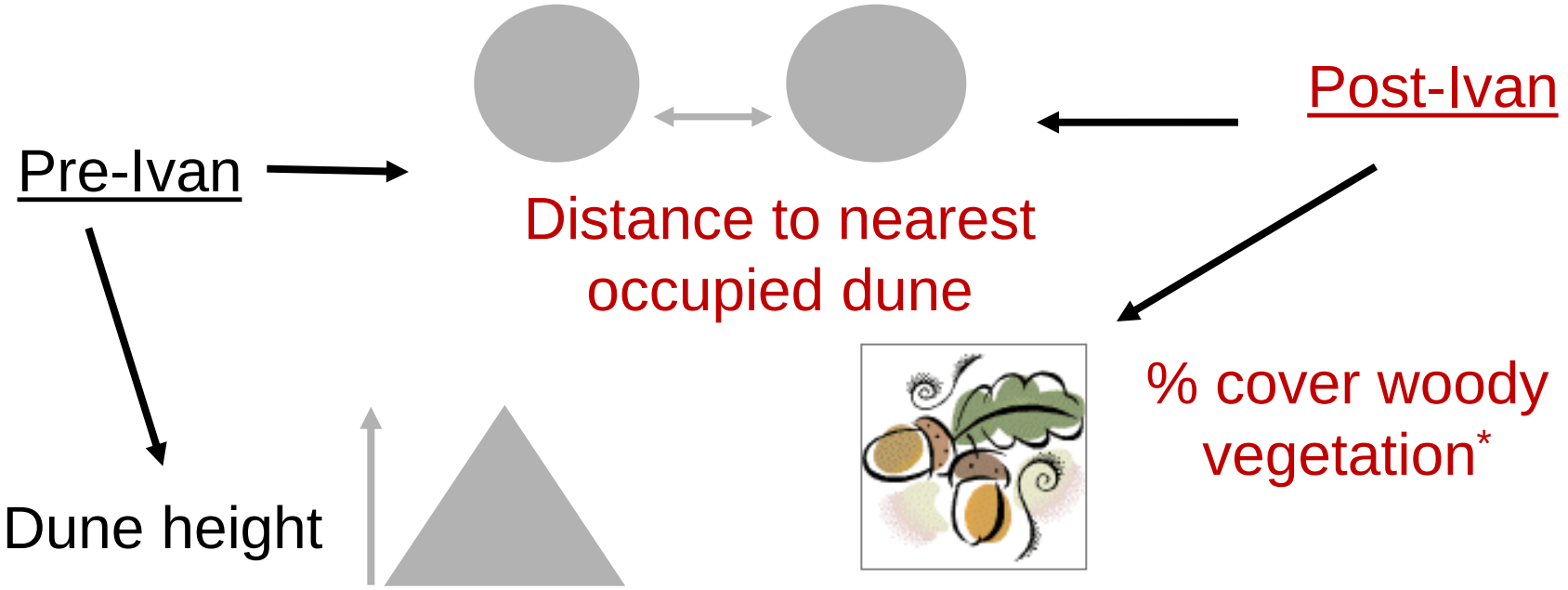
Beach Mouse Use of Altered Landscape

How important is secondary dune habitat for beach mice?

Pries et al. 2009. J. Mammology 90(4): 841-850.
Pries et al. 2008. J. Coastal Reseaerch 24(3): 168-173

Patch characteristics and landscape context:

what specific variables predicted occupancy of Frontal Dunes?

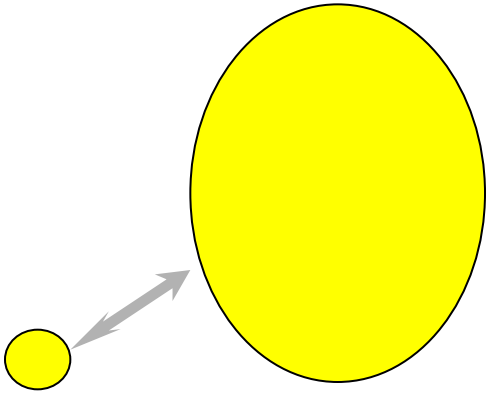


*Vegetation not measured pre-hurricane

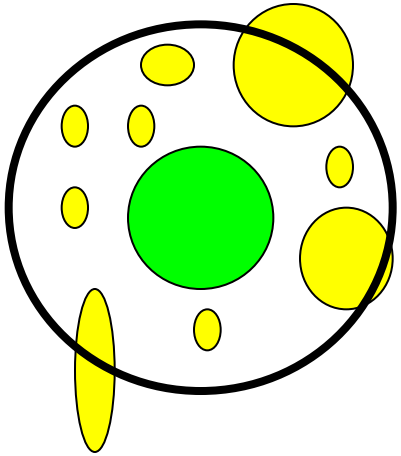
Pries et al. 2009. J. Mammology 90(4): 841-850.

Patch characteristics and landscape context:

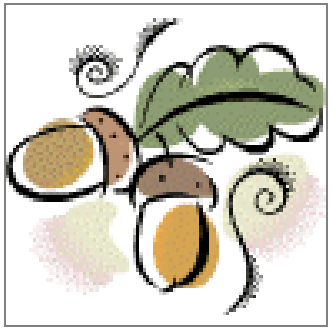
What variables predict occupancy of Scrub Dunes?



Dune area



Habitat within 200 m

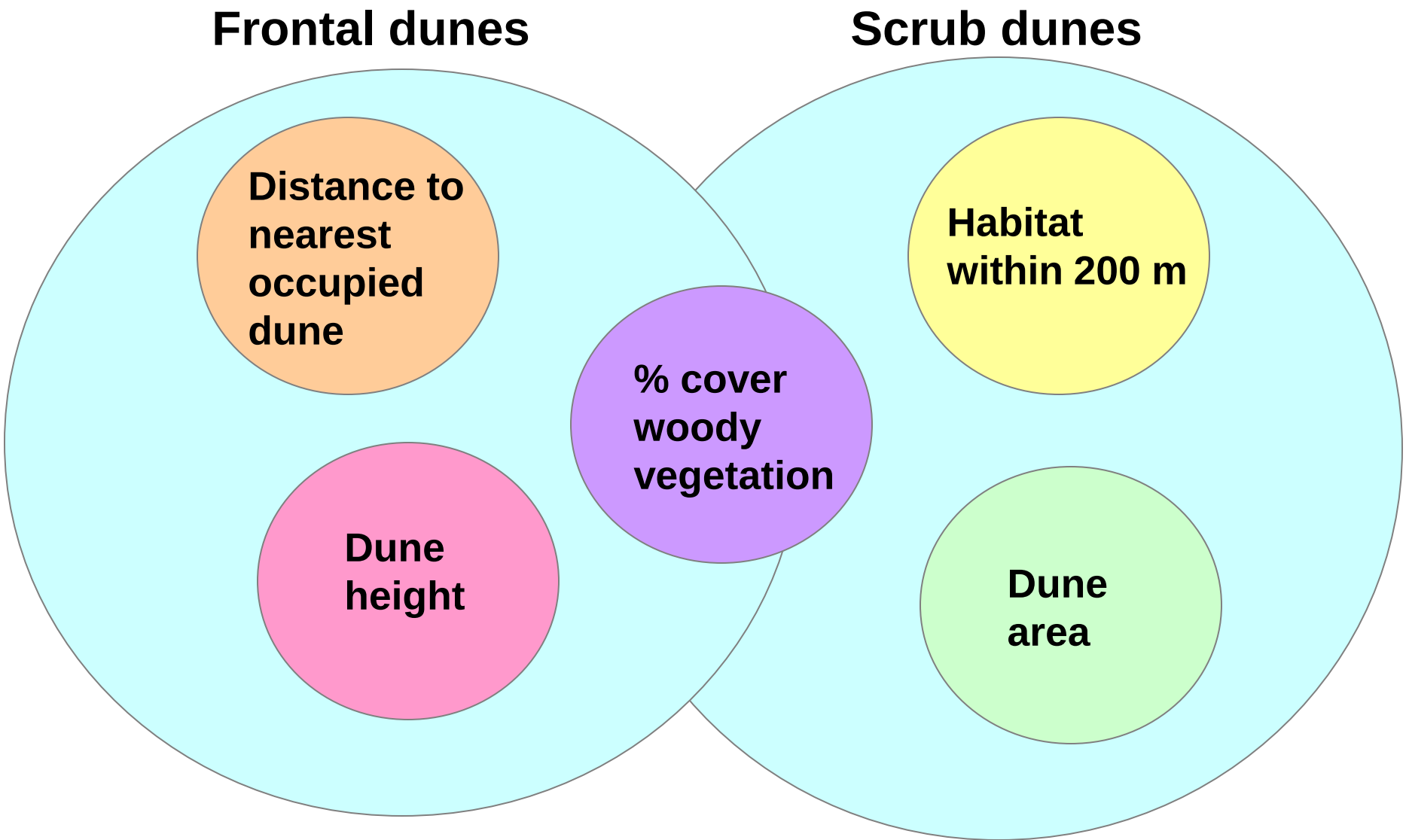


% cover woody vegetation

Pries et al. 2009. J. Mammology 90(4): 841-850.

Key habitat variables

Patch characteristics and landscape context influence occupancy



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)

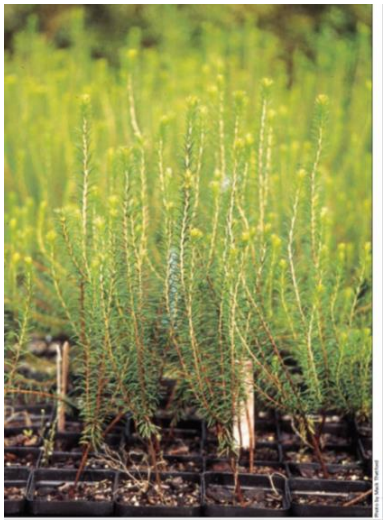
What are questions related to plant re-establishment and dune redevelopment?

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

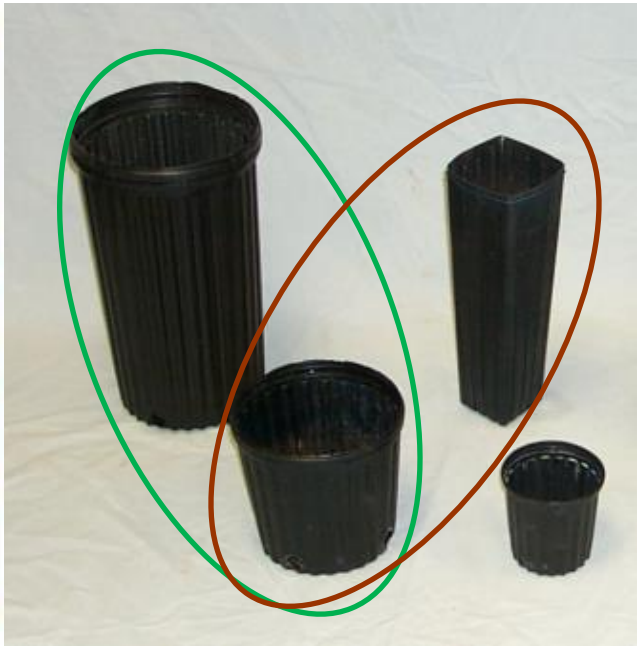
How far from the gulf before you can plant woody species?

- Wax myrtle
- Inkberry
- Beach rosemary



Miller, D.L., M Thetford and Schneider M. 2008. Distance from the Gulf Influences Survival and Growth of Three Barrier Island Dune Plants. Journal of Coastal Research. 24(3): 261-266.

Does Size of Pot or Dimension of Pot Matter?

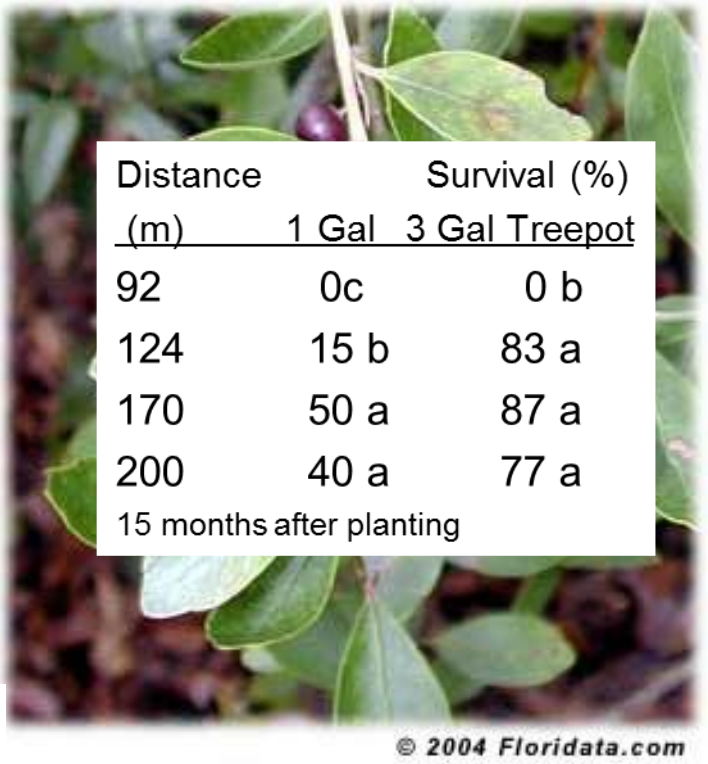


Inkberry
- Standard 1 gallon
- Treepot 3 gallon

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



Distance (m)	Survival (%) 1 Gal	3 Gal Treepot
92	0c	0 b
124	15 b	83 a
170	50 a	87 a
200	40 a	77 a

15 months after planting

Distance (m)	Survival (%) Ceratiola	Morella
6 months after planting		
92	7 a	0 a
124	50 b	45 b
170	87 c	50 b
200	90 c	65 b
15 months after planting		
92	0 a	0 a
124	30 a	40 b
170	67 c	50 b
200	90 d	65 b

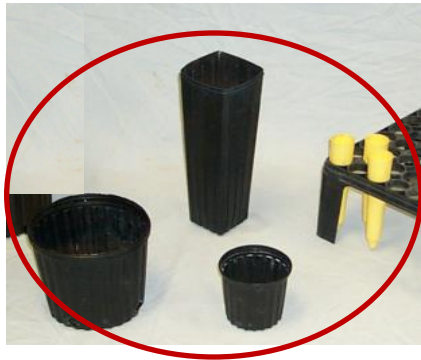
Pot Size and Type

- 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

Distance (m)	Survival (%) 1 Gal	3 Gal Treepot
92	0c	0 b
124	15 b	83 a
170	50 a	87 a
200	40 a	77 a

15 months after planting



Survival

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

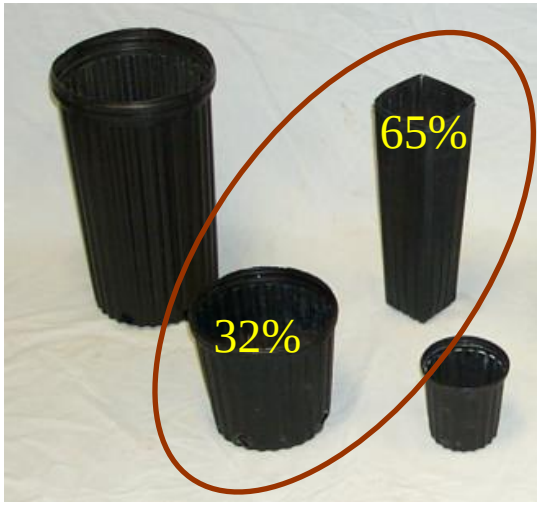
2 yrs. After establishment

What about Hydrogels?

Survival on swale ridges did not improve with addition of hydrogel but height was increased in swale depressions for 1 year.

Swale Ridge

Swale Depression



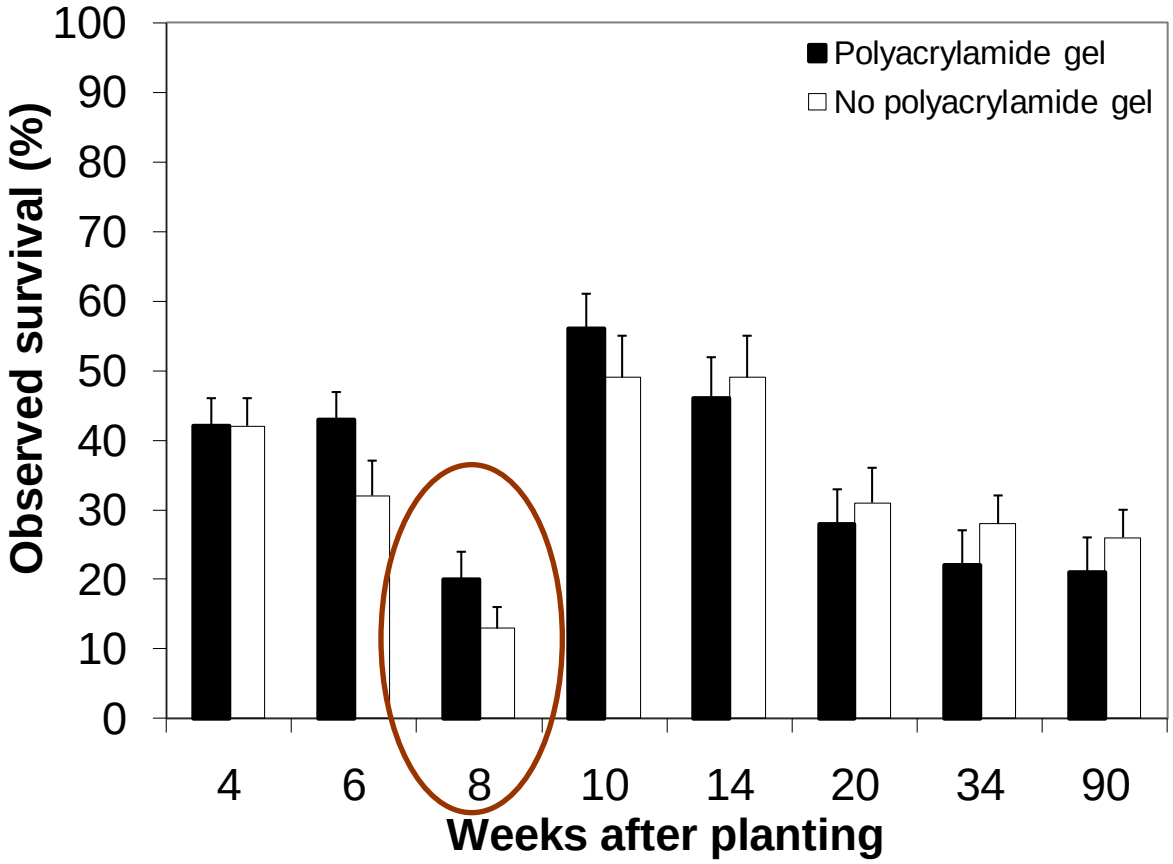
Thetford, M., D.L. Miller, L.W. Atwood and B.O. Ballard. 2015. Microsite and rooting depth are more important than water-holding gel on establishment of restoration plantings of Ilex vomitoria on barrier islands in the Gulf of Mexico. Native Plants Journal. Volume 16(2):77-86.

Effectiveness of polyacrlyamide 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

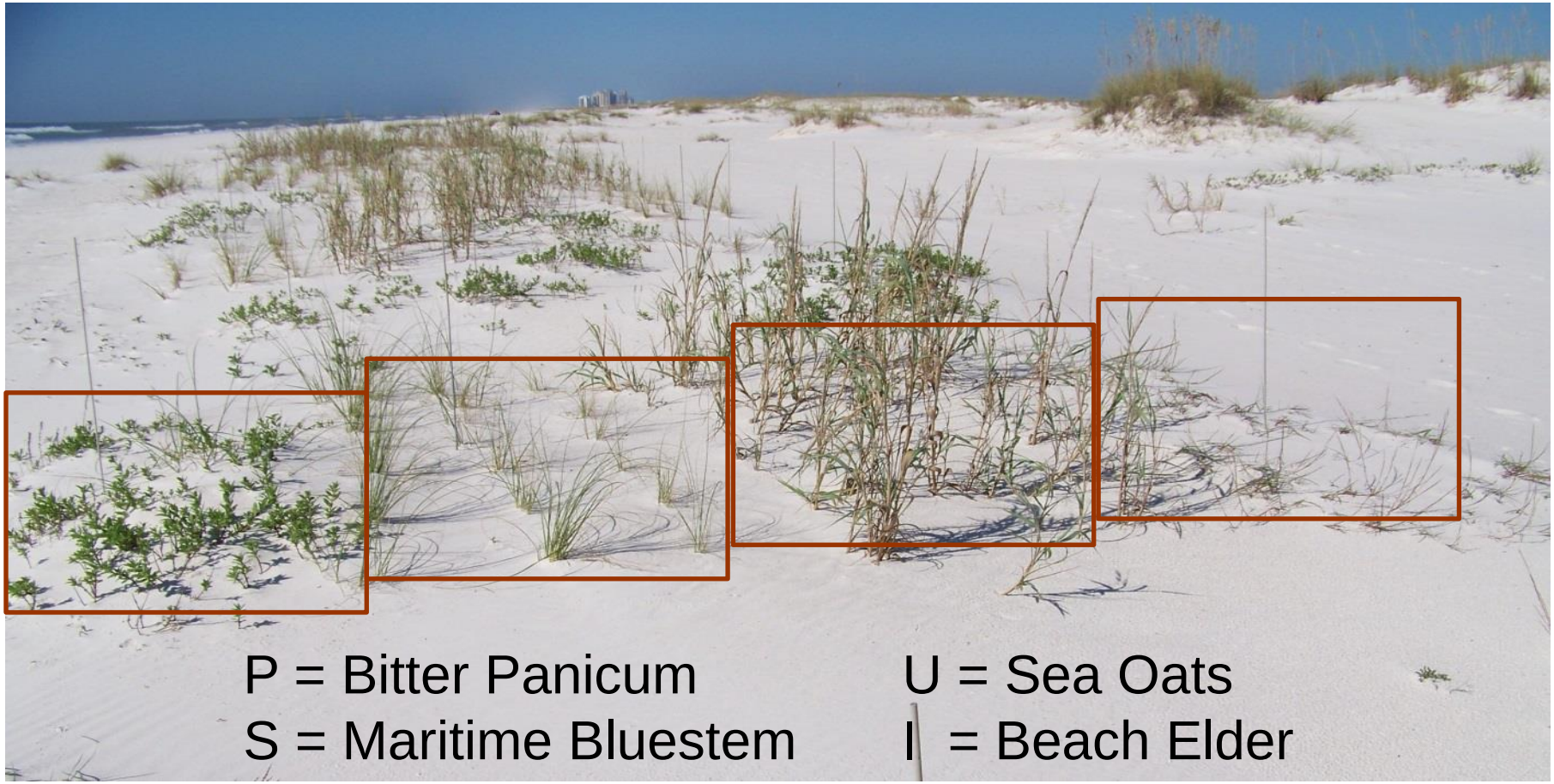
- bluestem and beach elder growth reduced when planted as neighbors with sea oats;
- effect on sea oats is neutral

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



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?

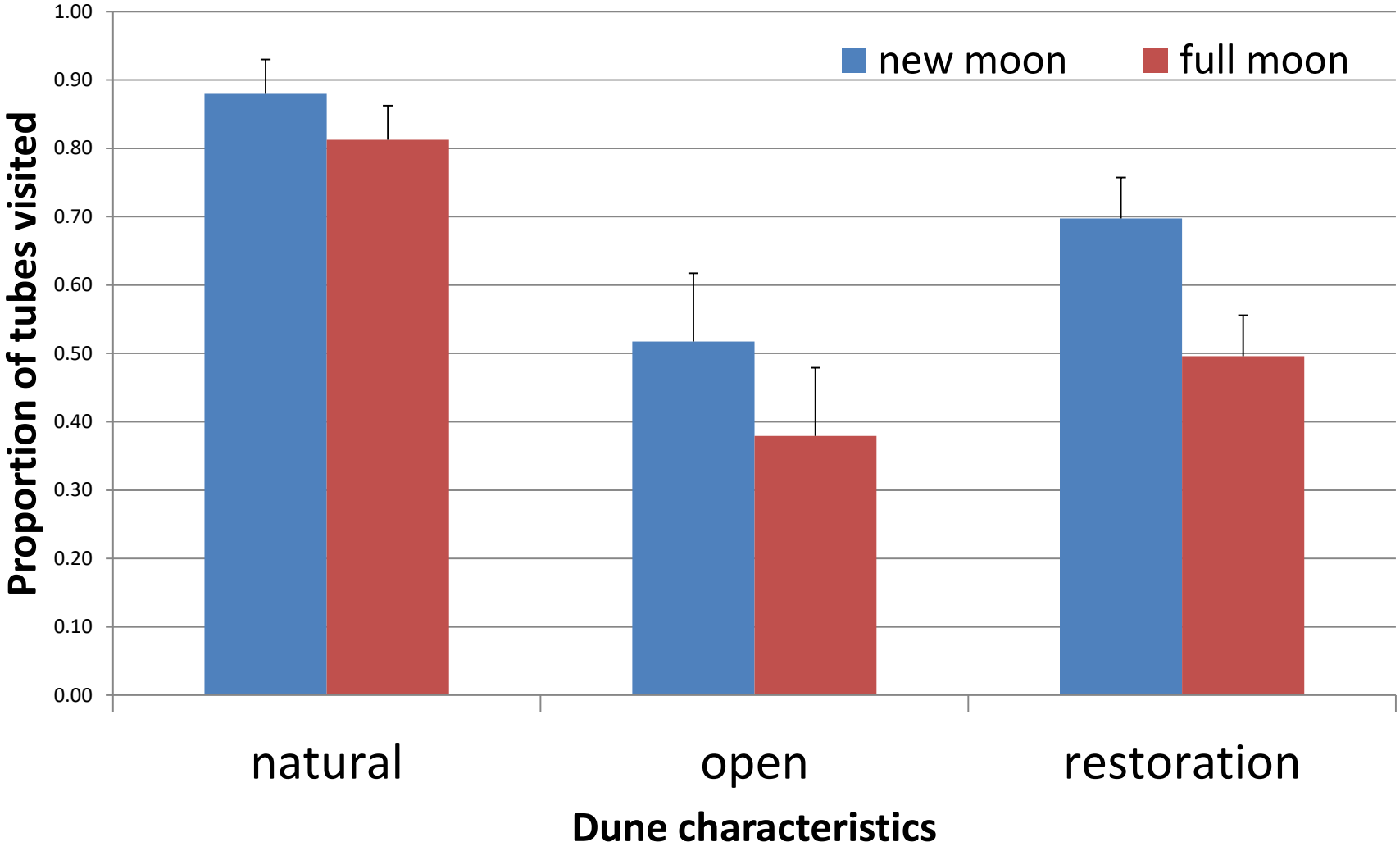
Compared beach mice use of:

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

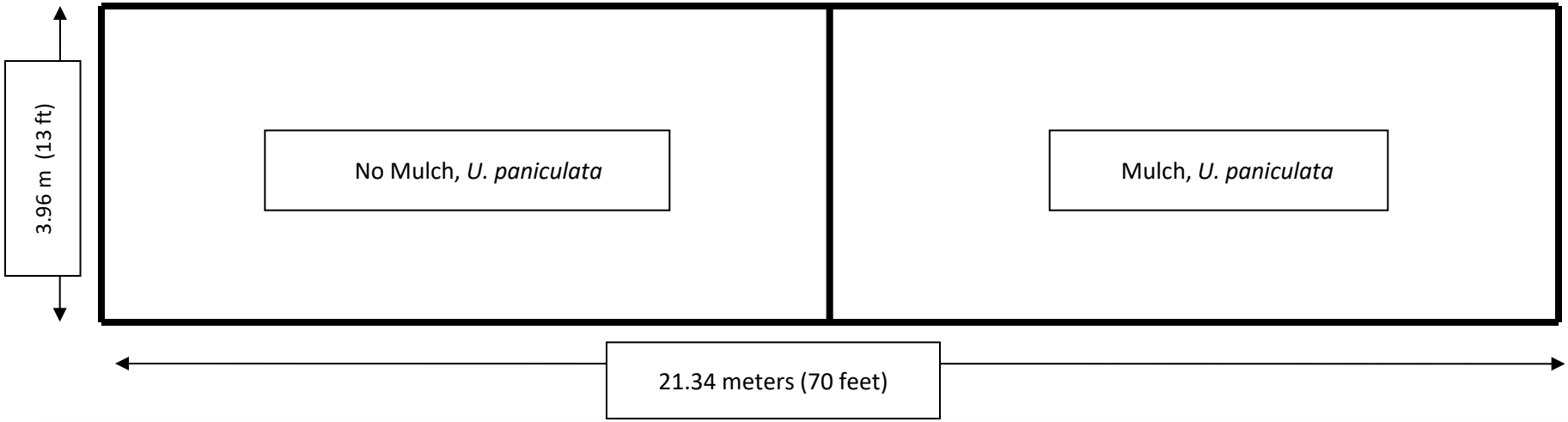
Restoration plots may be corridors that facilitate movement of beach mice



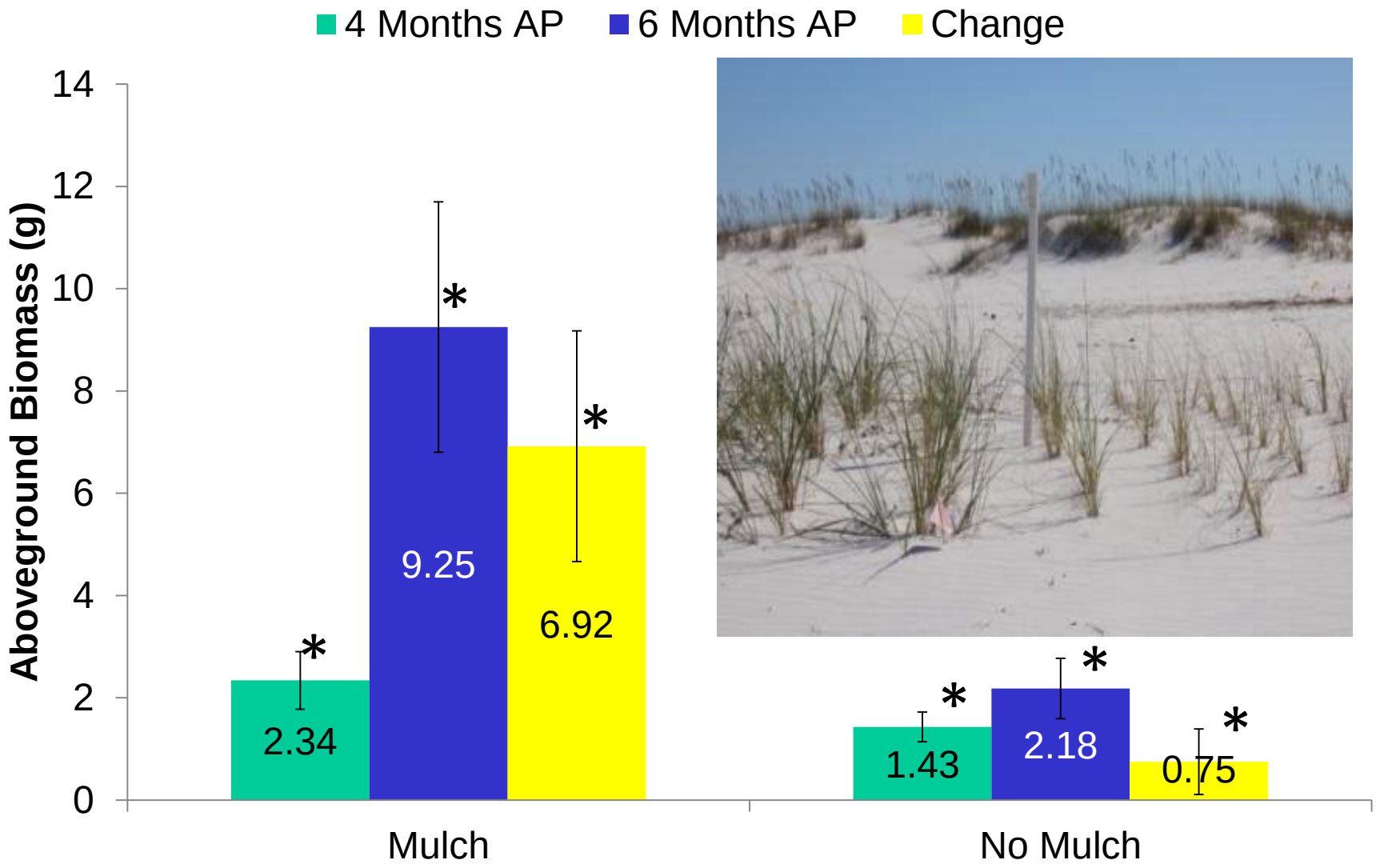
Margo A. Stoddard, Deborah L. Miller, Mack Thetford, and Lyn C. Branch,
If you build it, will they come? Use of restored beach dunes by Beach mice. In Preparation

Novel approaches to enhance restoration?
Is there a benefit of applying an artificial wrack?

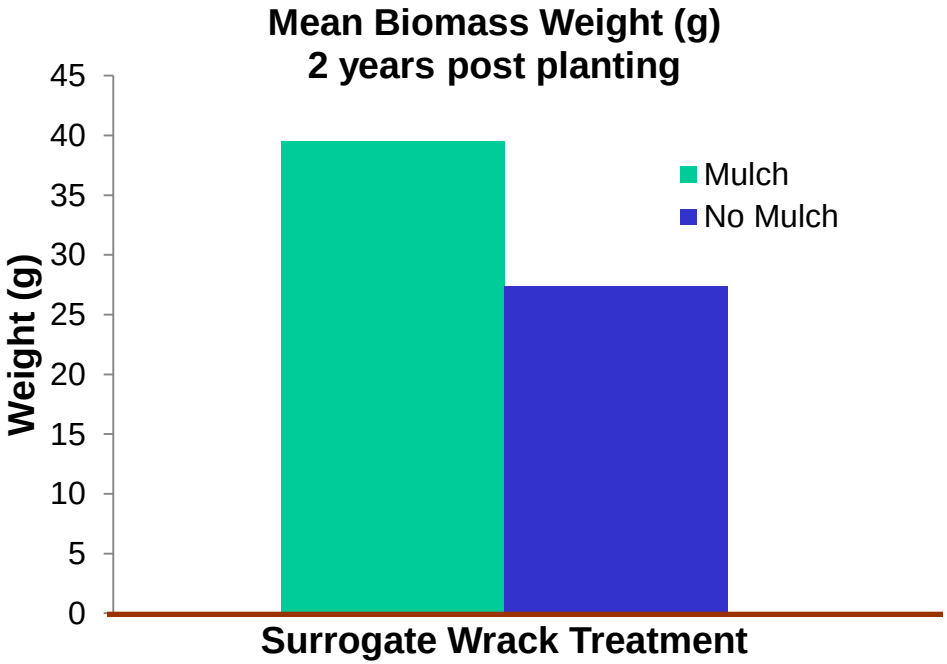
One of Six Replicate Sites

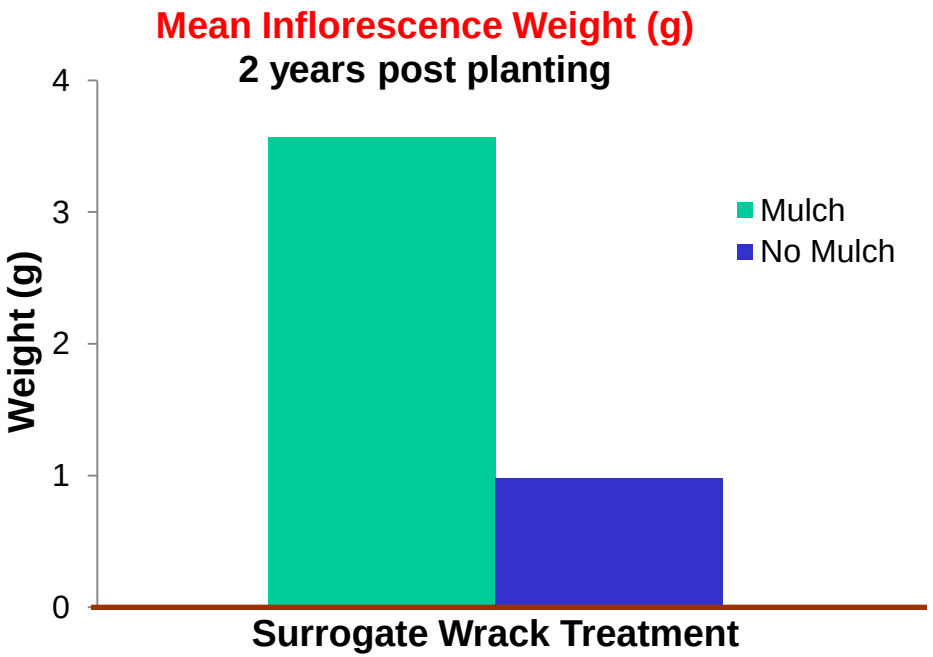


Sea Oats Aboveground Biomass

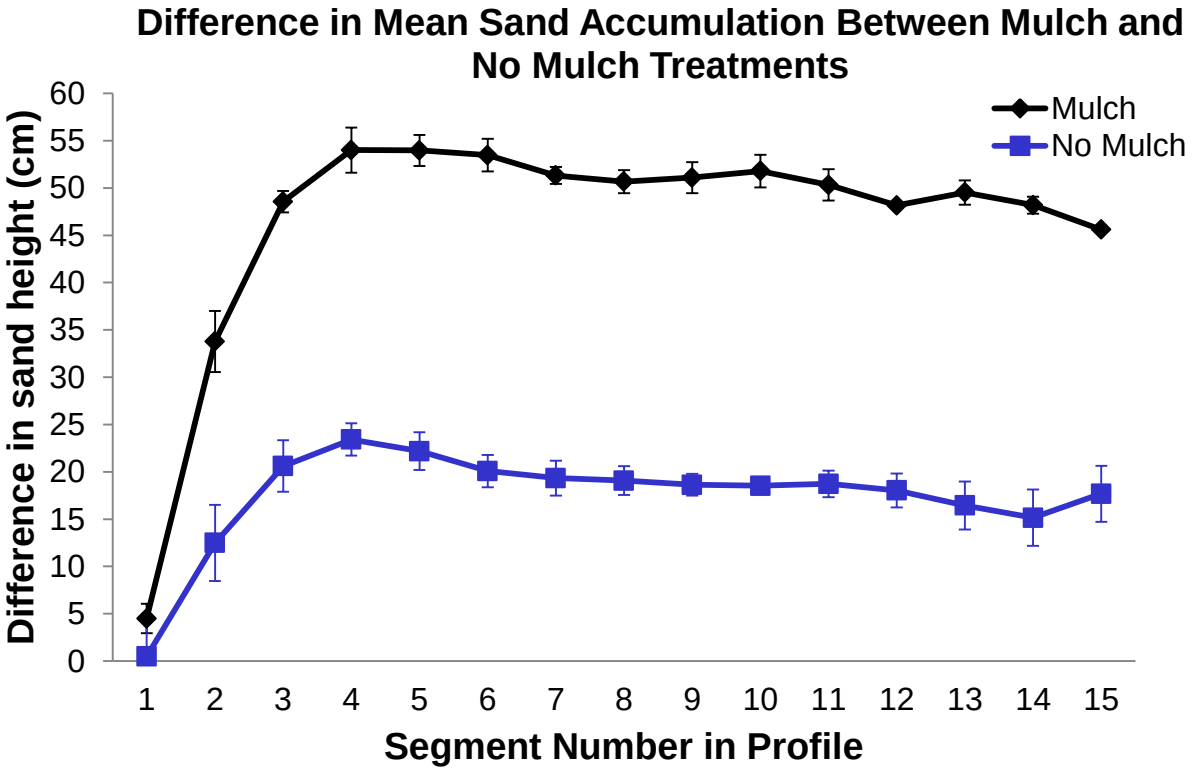


*=Mulch and No mulch statistically different


Mean Biomass Weight (g)
2 years post planting
45
40
35
30
25
20
15
10
5
0
Weight (g)
Mulch
No Mulch
Surrogate Wrack Treatment

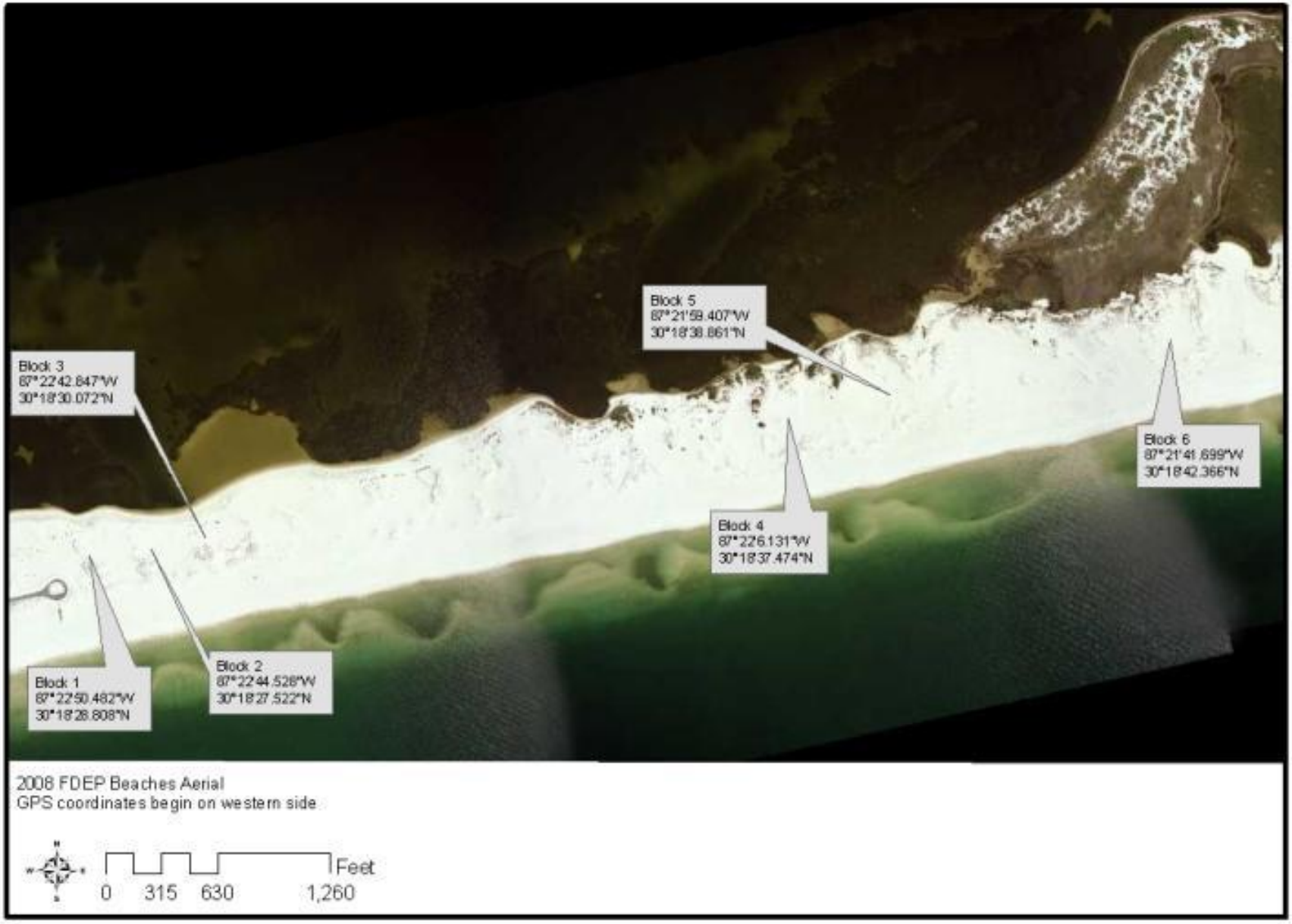

Mean Inflorescence Weight (g)
2 years post planting
4
3
2
1
0
Weight (g)
Mulch
No Mulch
Surrogate Wrack Treatment


2 yrs post planting
Mulch
No Mulch



Natalie Hooton, D.L. Miller, M. Thetford and B.S. Claypool. 2014. Survival and growth of planted Uniola paniculata and dune building using surrogate wrack on Perdido Key Florida, U.S.A. 22(5):710-707.

Need to Repeat Mulch Experiment Nearer to the Gulf



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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

					
Scientific Name:	*Balduina angustifolia*	*Callisia ornata*	*Chrysoma pauciflosculosa*	*Dalea feayi*	*Dalea pinnata* var. *pinnata*
Common Name:	Coastalplain Honeycomb-Head; Yellow Buttons	Florida Scrub Roseling	Woody Goldenrod	Feay's Prairieclover	Summer Farewell
Family:	Asteraceae	Commelinaceae	Asteraceae	Fabaceae	Fabaceae
Native Habitat:	Sandhills, Scrub, Dunes	Sandhills and Scrub	Coastal dunes, Sandhills and Scrub	Sandhills and Scrub	Sandhills and Scrub
FL Zone:	8A – 10B	8B – 10B	8A – 8B	8B – 10B	8A – 9B
					
Scientific Name:	*Heliotropium curassavicum*	*Licania michauxii*	*Polygonella macrophylla*	*Polygonella polygama*	*Polygonella robusta*
Common Name:	Seaside Heliotrope	Gopher-Apple	Large-Leaved Jointweed	Jointweed; October Flower	Largeflower Jointweed
Family:	Boraginaceae	Chrysobalanaceae	Polygonaceae	Polygonaceae	Polygonaceae
Native Habitat:	Dunes	Sandhills	Coastal dunes and Scrub	Coastal dunes and Scrub	Sandhills and Scrub
FL Zone:	8B - 11	8A - 11	8A – 8B	8A – 10B	8B – 10A

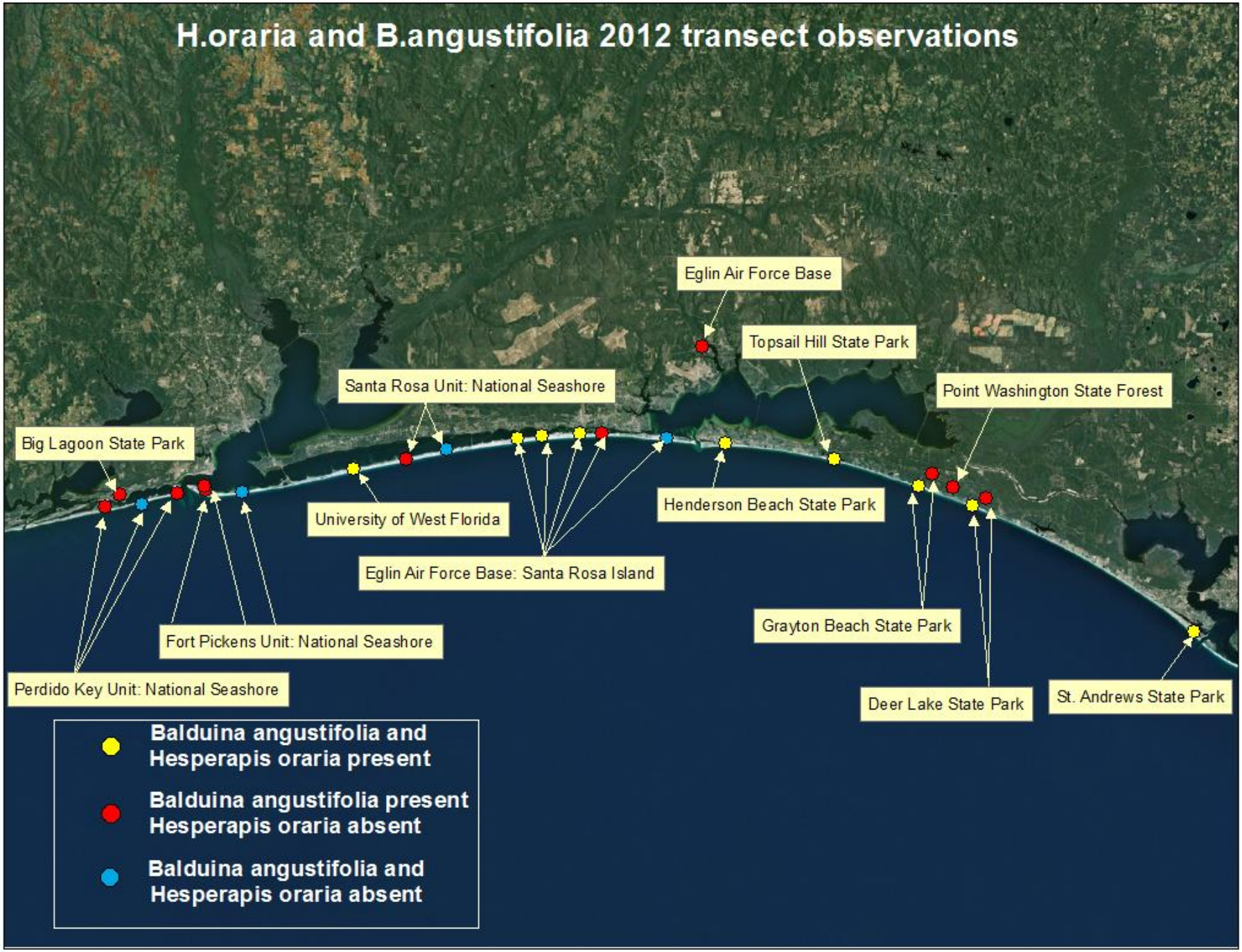
Propagation and Outplanting

- *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 ?


H.oraria and B.angustifolia 2012 transect observations
Eglin Air Force Base
Topsail Hill State Park
Point Washington State Forest
Santa Rosa Unit: National Seashore
Big Lagoon State Park
University of West Florida
Henderson Beach State Park
Eglin Air Force Base: Santa Rosa Island
Grayton Beach State Park
Fort Pickens Unit: National Seashore
Perdido Key Unit: National Seashore
Deer Lake State Park
St. Andrews State Park
Balduina angustifolia and Hesperapis oraria present
Balduina angustifolia present Hesperapis oraria absent
Balduina angustifolia and Hesperapis oraria absent

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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