"Estimating wave tolerance of *S. alterniflora* in coastal Alabama"

Rebecca M. Roland and Scott L. Douglass

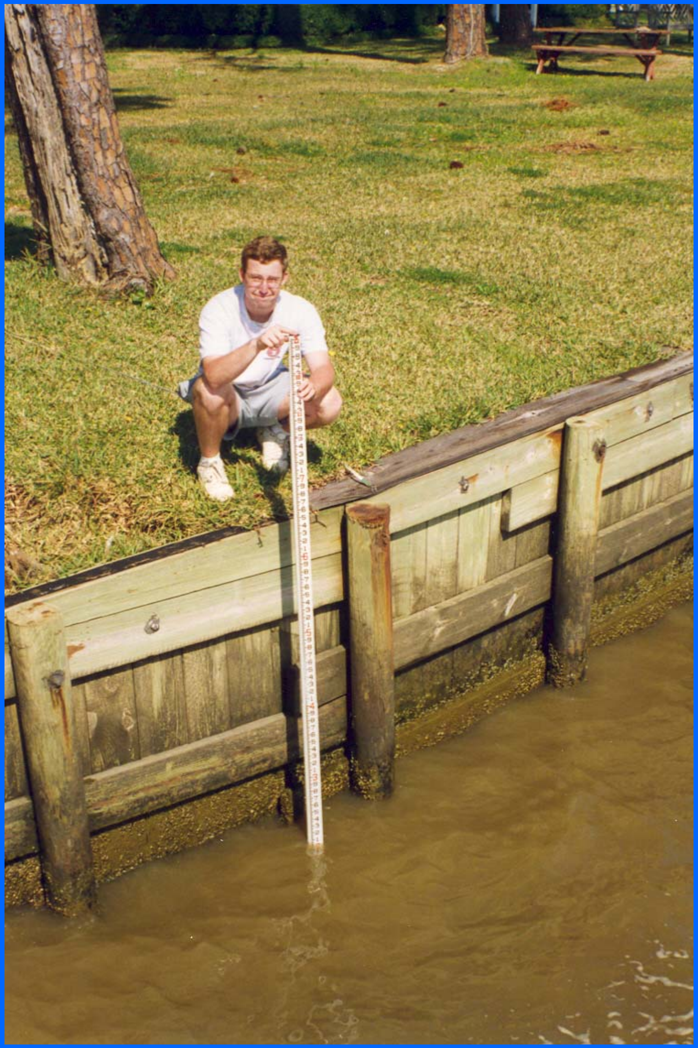
Alabama Center for Estuarine Studies
Dauphin Island, AL: Jan 27, 2004

“Natural” shorelines of Alabama bays

Pelican Point

Daphne Bayfront Park

But much of the bay shoreline is armored



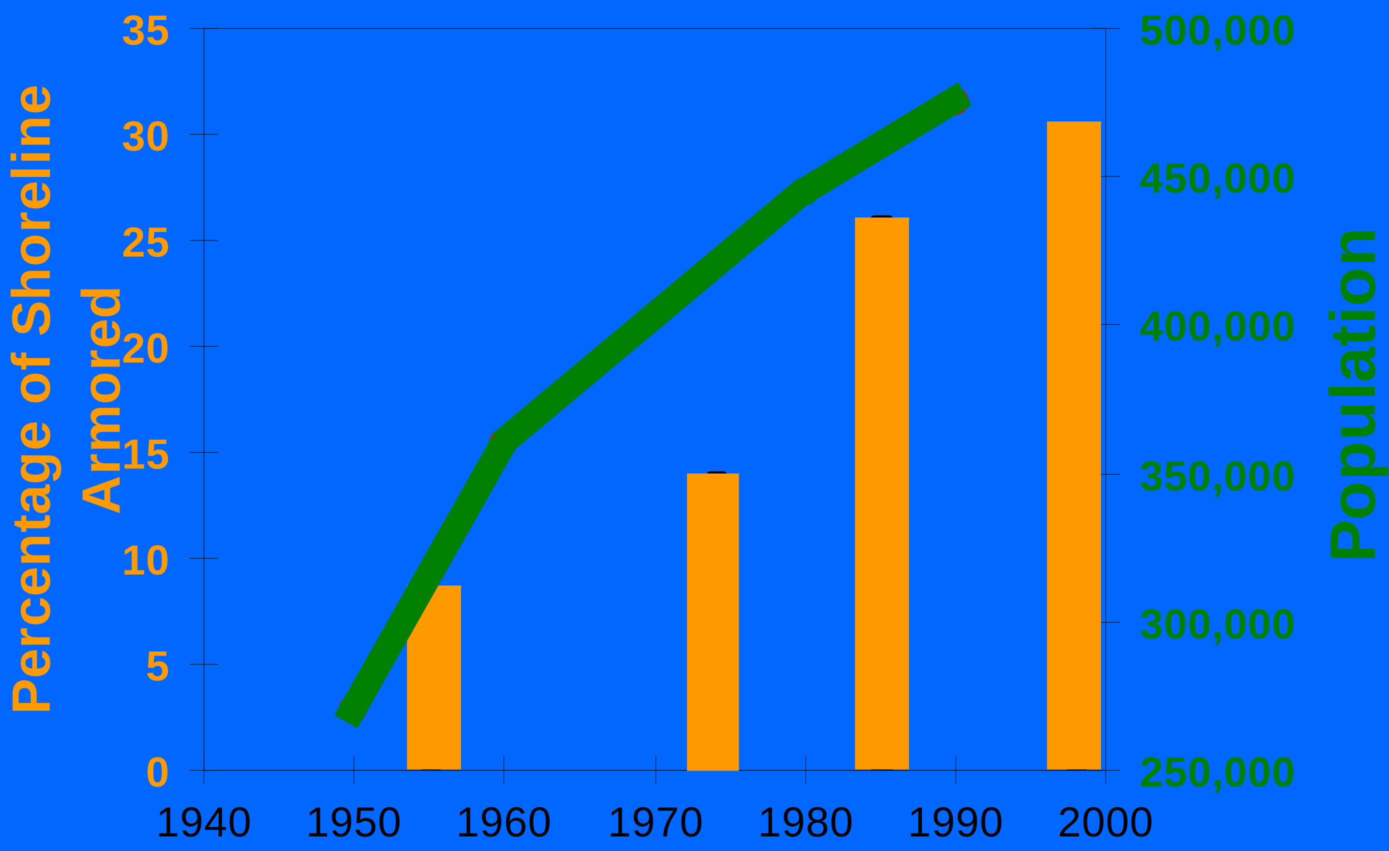
1/3rd of the bay is armored (1997)

•Most common armoring: vertical bulkhead(71%)

Douglass and Pickel (1999)

- Loss of intertidal area (10-20 ac)*
- Loss of intertidal shoreline (4-8 mi)*

*Douglass and Pickel 1999



Armoring has increased with population

Douglass and Pickel (1999)

IMPLICATIONS?

"The tide don't go out no more!"

Is this the fate of our urban estuaries?

Are there alternatives to bulkheads...?

Are there alternatives to bulkheads that will protect the upland and provide more of the ecological and sociological function of the natural shorelines?

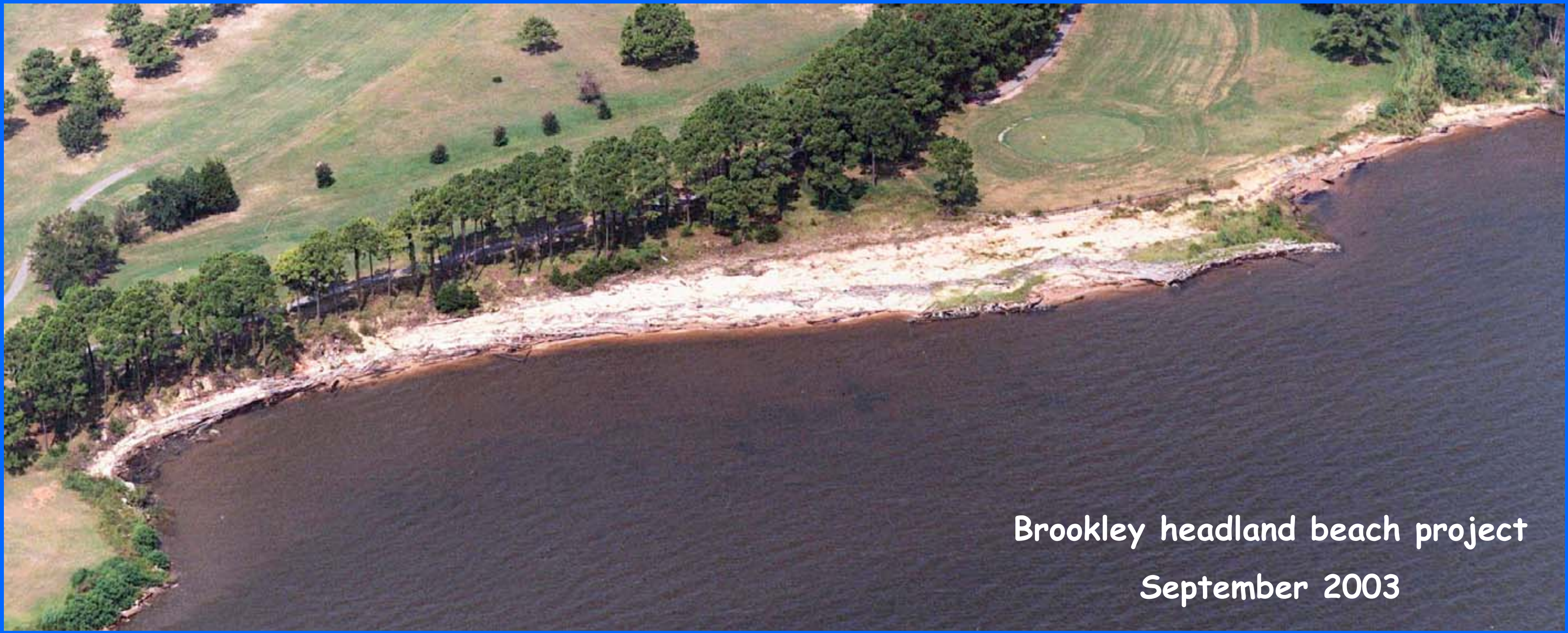
Can we emulate more “natural” shorelines in constructed alternatives to bulkheads?

Demonstration project of an alternative to bulkheads on bay shorelines

Brookley headland beach project - 2000

- built Aug 1998
- two low elevation rock headland breakwaters
- 3000 m^3 sand fill
- survived Hurricane Georges Sept. 1998

Demonstration project of an alternative to bulkheads on bay shorelines



- stabilized 200 m of eroding bay shoreline
- more natural shoreline than a bulkhead

a sandy beach as an alternative to a bulkhead

Marriott's Grand Hotel Resort, Mobile Bay, Point Clear, Alabama

Beach nourishment - Grand Hotel, Point Clear

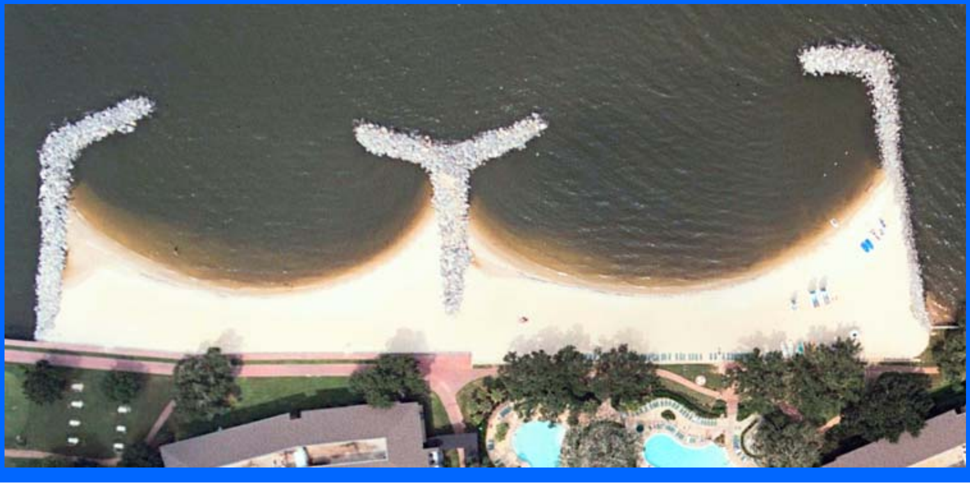
- **built 2001**
- **3 rock headland breakwaters**
- **6000 m^3 sand fill**
- **Extended in 2003 (lengthened breakwaters and added sand)**

(three weeks after initial 2001 construction)

construction
2001

one year later
2002

after extension
2003



Beach constructed in front of bulkhead/seawall

1998

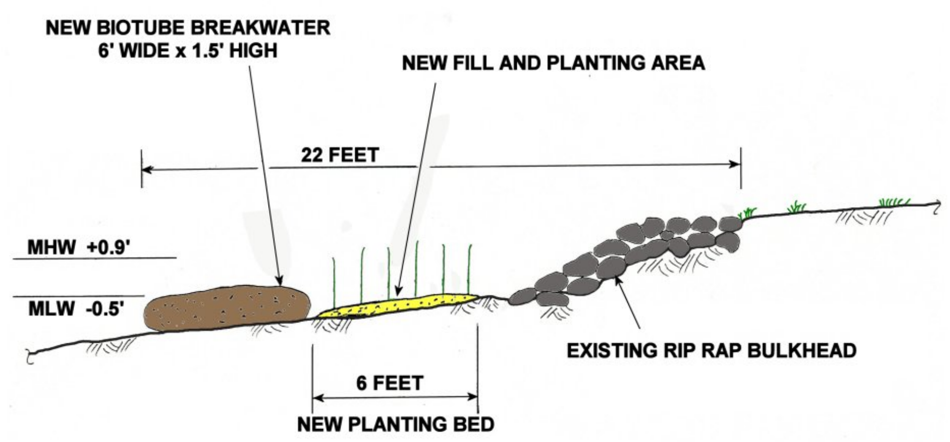
2003

Marriott's Grand Hotel Resort, Mobile Bay, Point Clear, Alabama

Can we emulate <u>these</u> “natural” shorelines in constructed alternatives to bulkheads?

Daphne Bayfront Park

Original questions driving this ACES research:



PLANTING BEHIND A BIOTUBE BREAKWATER

- Can breakwaters be used to reduce wave energy to levels that allow wetland development?

- and if so,…

 how low can you go?

How much wave energy can *S. alterniflora* tolerate?

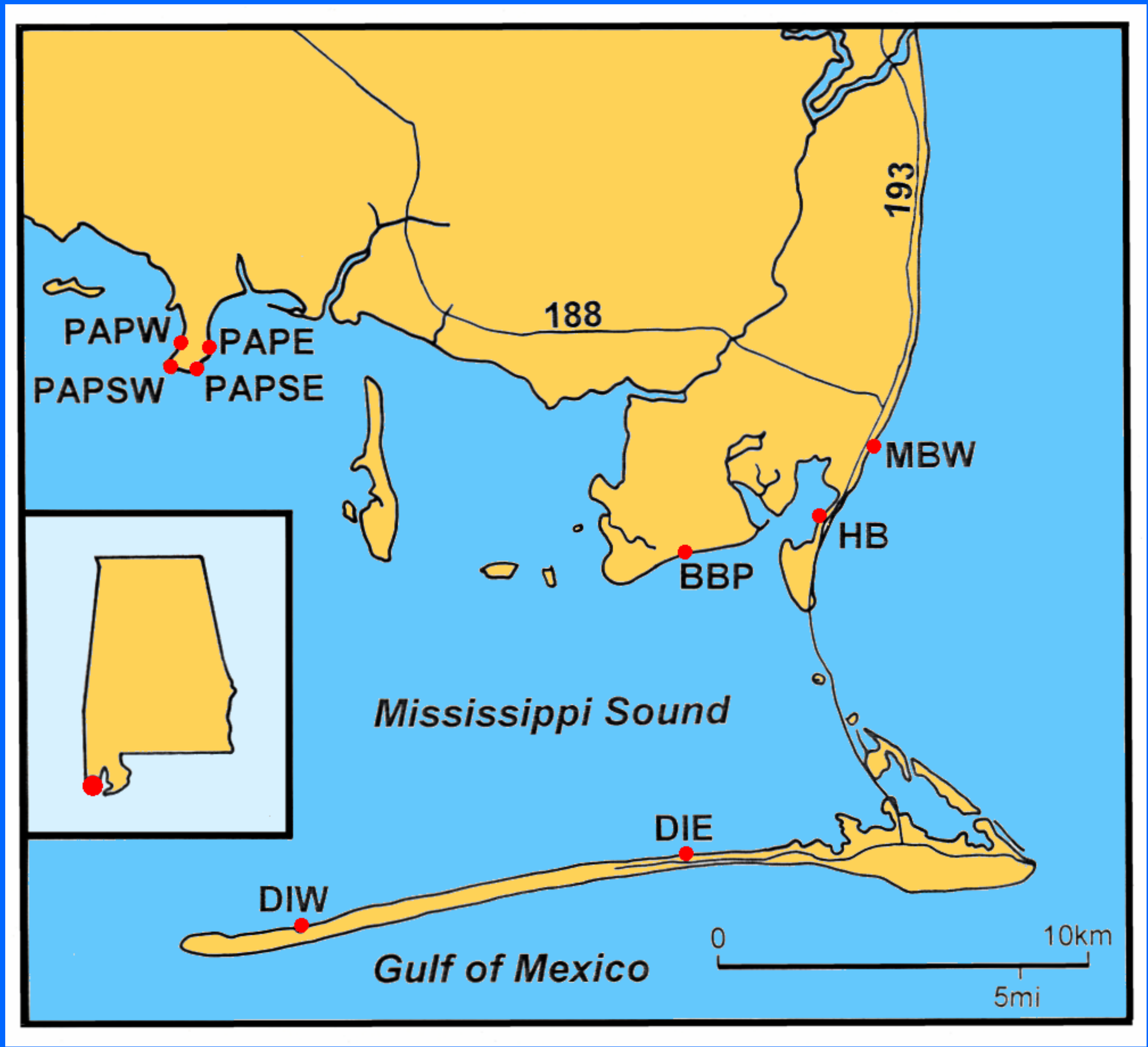
Research by others

What is the limiting wave climate for wetlands?

1. **Keddy (1982) - "exposure index"**
2. **Knutson (1981) - "cumulative score"**

two weaknesses with both

9 study sites in coastal Alabama



Wetland Sites

Heron Bay (HB)

Barry/Baron Point (BBP)

Point aux Pines East
(PAPE)

Similar to PAPW

Non-wetland Sites

Mobile Bay West
(MBW)

Dauphin Island East
(DIE)

Dauphin Island West
(DIW)

Eroding-wetland Sites

Point aux Pines

Southwest (PAPSW)

Point aux Pines

Southeast (PAPSE)

Methods

- **Surface elevation, vegetation, and sediment data collected at each site**

- **wave climate estimated for each site by <u>hindcasting</u>**

Wave Model

- **Shallow water modeling equations recommended by the Army Corps of Engineers, Shore Protection Manual (1984) were used to hindcast waves:**

$$gH/U^* = \frac{0.283 \tanh\left(0.530\,(gd/U^*)^{3/4}\right) \tanh\left(0.00565\,(gF/U^*)^{1/2}\right)}{\tanh\left(0.530(gd/U^*)^{3/4}\right)}$$

$$U^* = (0.17U^{1.23})^2$$

where H=wave height, F=fetch, d=average water depth, U*=an adjusted wind speed.

- **Equivalent to Hasselmann's JONSWAP model in deepwater**

Input to wave model

- Fetch (F) = distance over which waves can propagate
- d = average high tide water depth
- U = windspeed

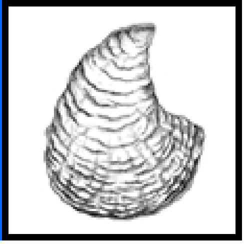
Wind Data

- Wind records were collected from NOAA's web site for the Dauphin Island Buoy from 1987 to 2000

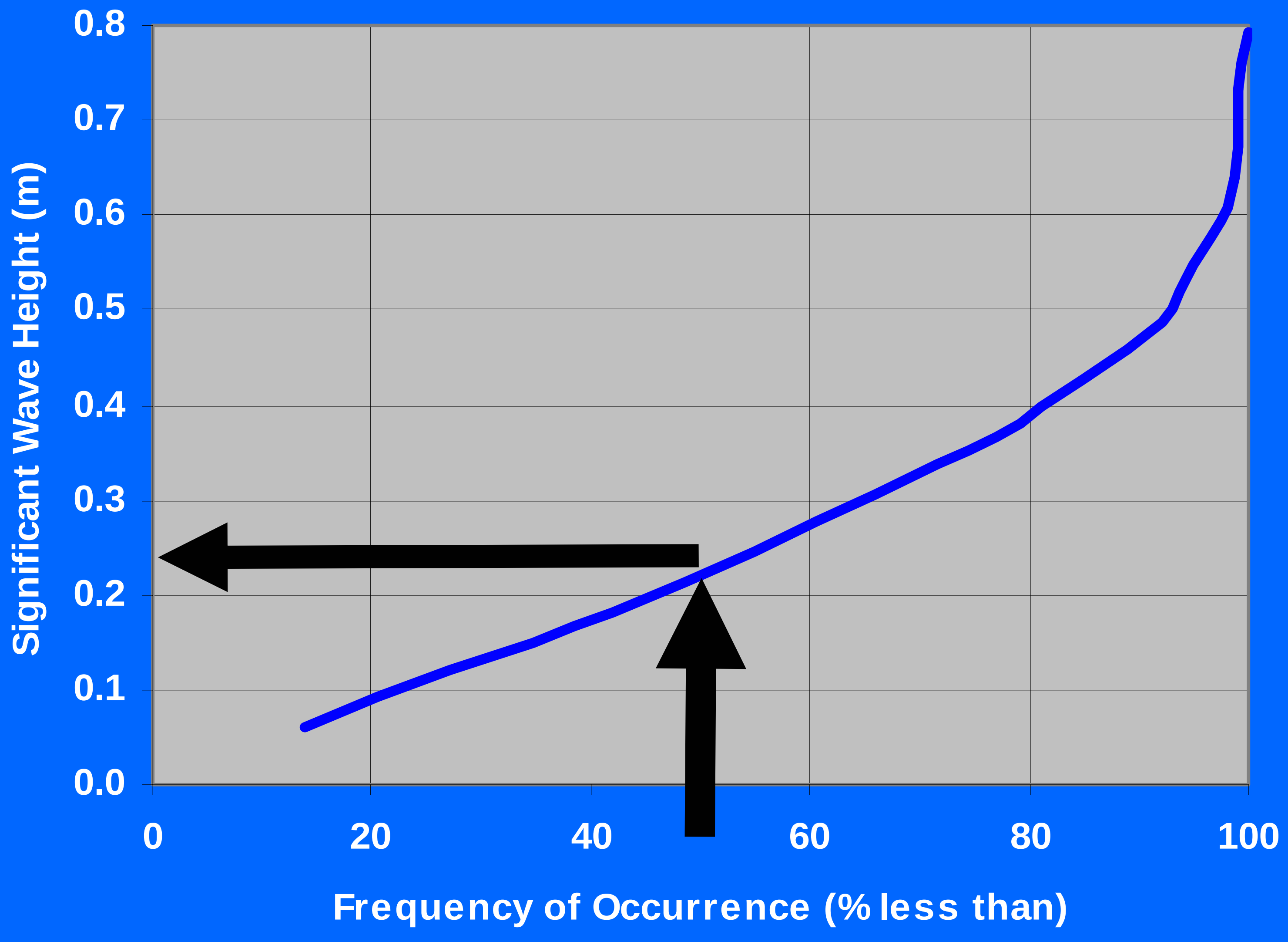
- Hourly records were separated into ten degree wind direction bins and 1 m/s windspeed bins

Wave Height Frequency Distributions

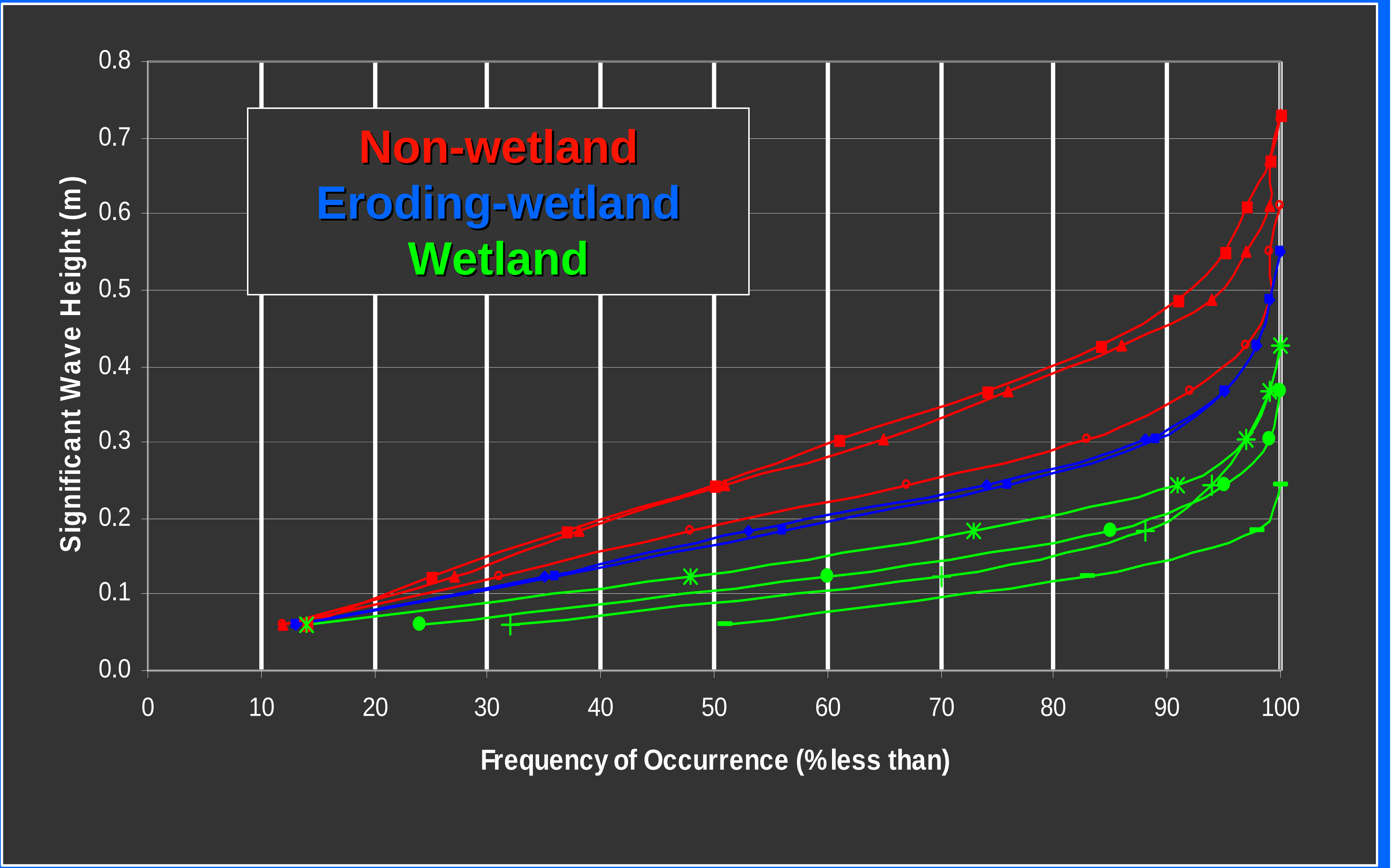
- **Wave height frequencies were estimated by finding the percentage of time each wave height occurred**
  - **Calculated the wave height at each site for each wind direction and speed combination**
  - **Tallied all wave heights to determine frequency of occurrence of wave height at each site**



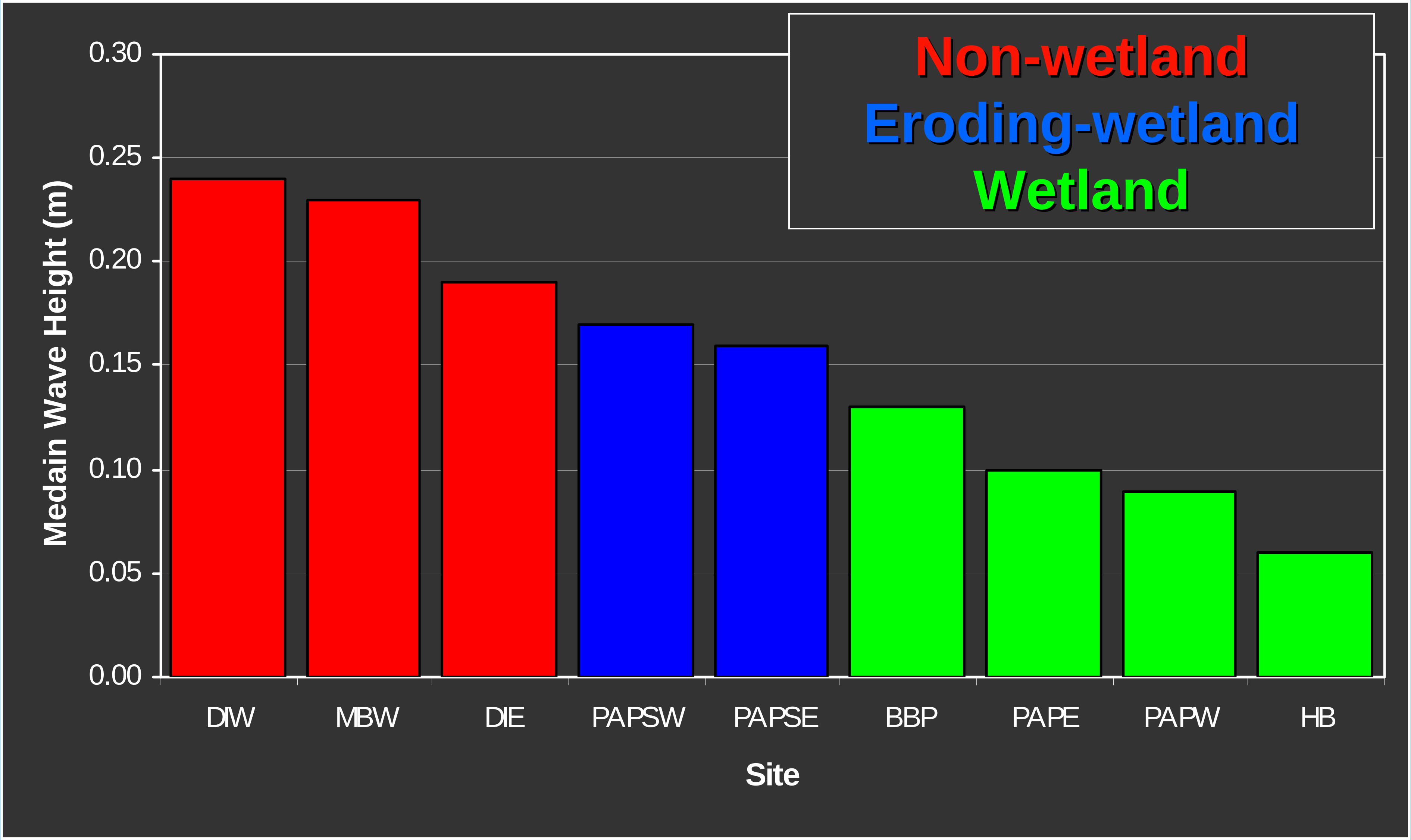
Wave climate results - example



Results - wave climate estimates



Results - hindcast median wave heights



Results

The upper limit of wave energy for salt marsh existence:

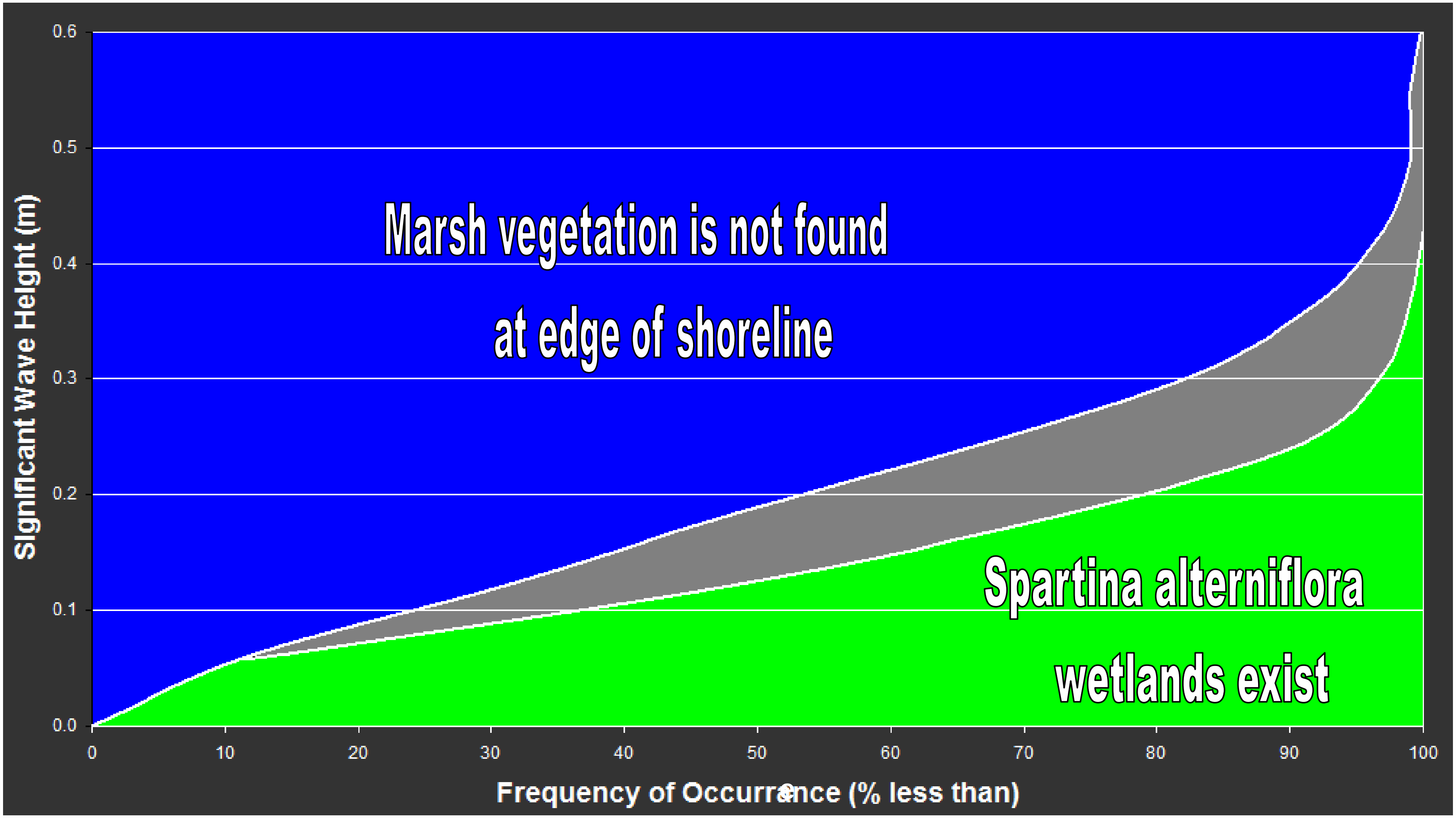
- a median (H_{50}) H = 0.13 m

- a corresponding H_{80} = 0.25 m

Sites with less wave energy had vegetation along the shoreline.

after Roland and Douglass 2003

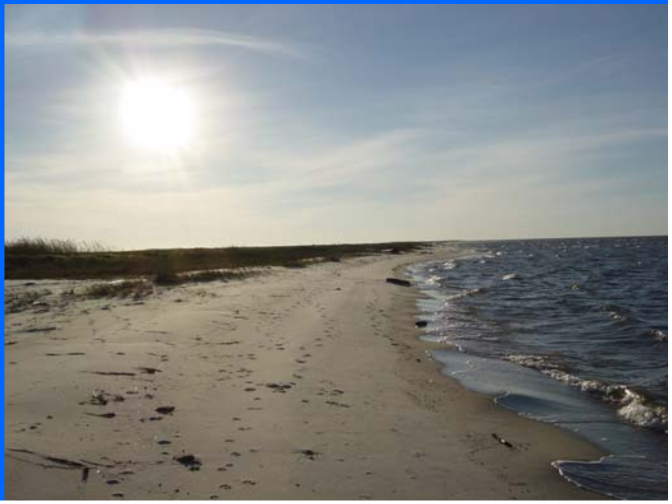
Results - summary



after Roland and Douglass 2003

Conclusions

•Site-specific estimates of wave climate, based on wind-wave hindcasting, showed skill in segregating sites with wetlands along shorelines from those without wetlands



Conclusions

•For the sites in this study, ***S. alterniflora*** **exists at locations where the long-term median significant wave height was estimated by hindcasting as less than**

H = 0.13 m

Conclusions

- Compared to other, existing methods used to evaluate wetland wave climate (i.e. Keddy's and Knutson's methods), wind-wave hindcasting appears to provide several advantages:
  - Better correlations
  - Physically meaningful measure (H)
  - Can be used for engineering guidance

Conclusions

- First time that a critical level of wave energy for wetlands has been quantified in terms of wave height

???

Publications/presentations resulting from this research

- Roland, R.M. 2003 "Wave climate evaluation for *Spartina alterniflora* existence in coastal Alabama, masters thesis, Department of Marine Sciences, University of South Alabama, Mobile, AL, May 2003.

- Douglass, S.L., Roland, R.M. and Stout, J. 2003 "Bulkheads on Urban Estuarine Shorelines on the Gulf Coast," presentation at 17th Biennial conference of the Estuarine Research Federation, Seattle, WA.

- Roland, R.M. and Douglass, S.L. 2004 "Wave tolerance of *Spartina alterniflora* in coastal Alabama," accepted for publication in the *Journal of Coastal Research*.

Acknowledgements

- This research was supported by the Alabama Center for Estuarine Studies

  (EPA STAR program EPA-R-827072-01-1)

- Significant discussions and technical input from

  – J. Stout, Q. Chen, and D. Haywick, University of South Alabama

  – J. Davis and D. Shafer, Corps of Engineers