Engineering with Nature Using Vegetation on Dredged Material Placement Areas

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WEDA Gulf Coast Chapter Meeting
16 November 2016
Galveston, TX

US Army Corps of Engineers
BUILDING STRONG®

- Problem
  - Potentials of DMPAs not currently harnessed nationwide
  - No guidance on DMPA post-disposal management practices
  - DMPAs are not viewed as a resource

- **Value Statement**: Providing resilient and cost effective solutions which serve ecological and engineering functions

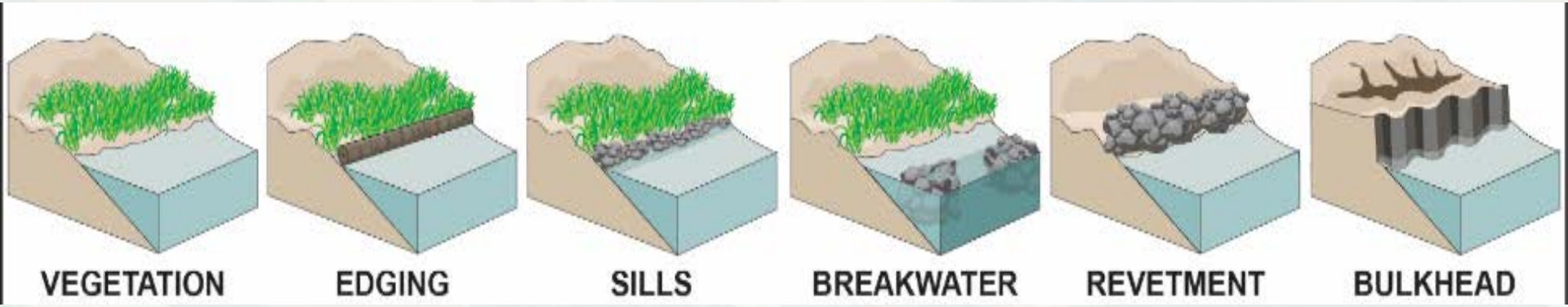
- Objective

  - Provide guidance on establishing native plant communities on DMPAs
  - Demonstration
  - Re-orientation of Corps Districts on DMPA post-operational practices

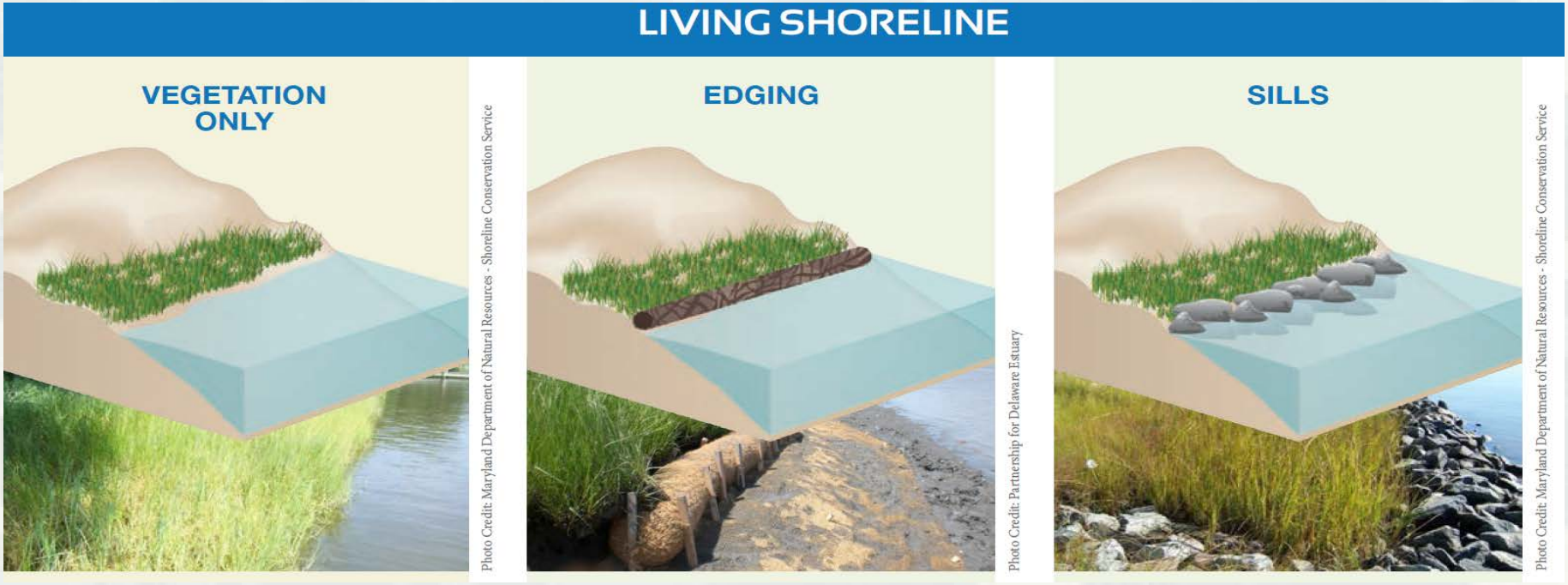
- Approach

  - Facilitate workshops
  - Publications-TN,TR, ECB, JA
  - Website Resources-Fact Sheet, Wikipedia page, presentations, and publications

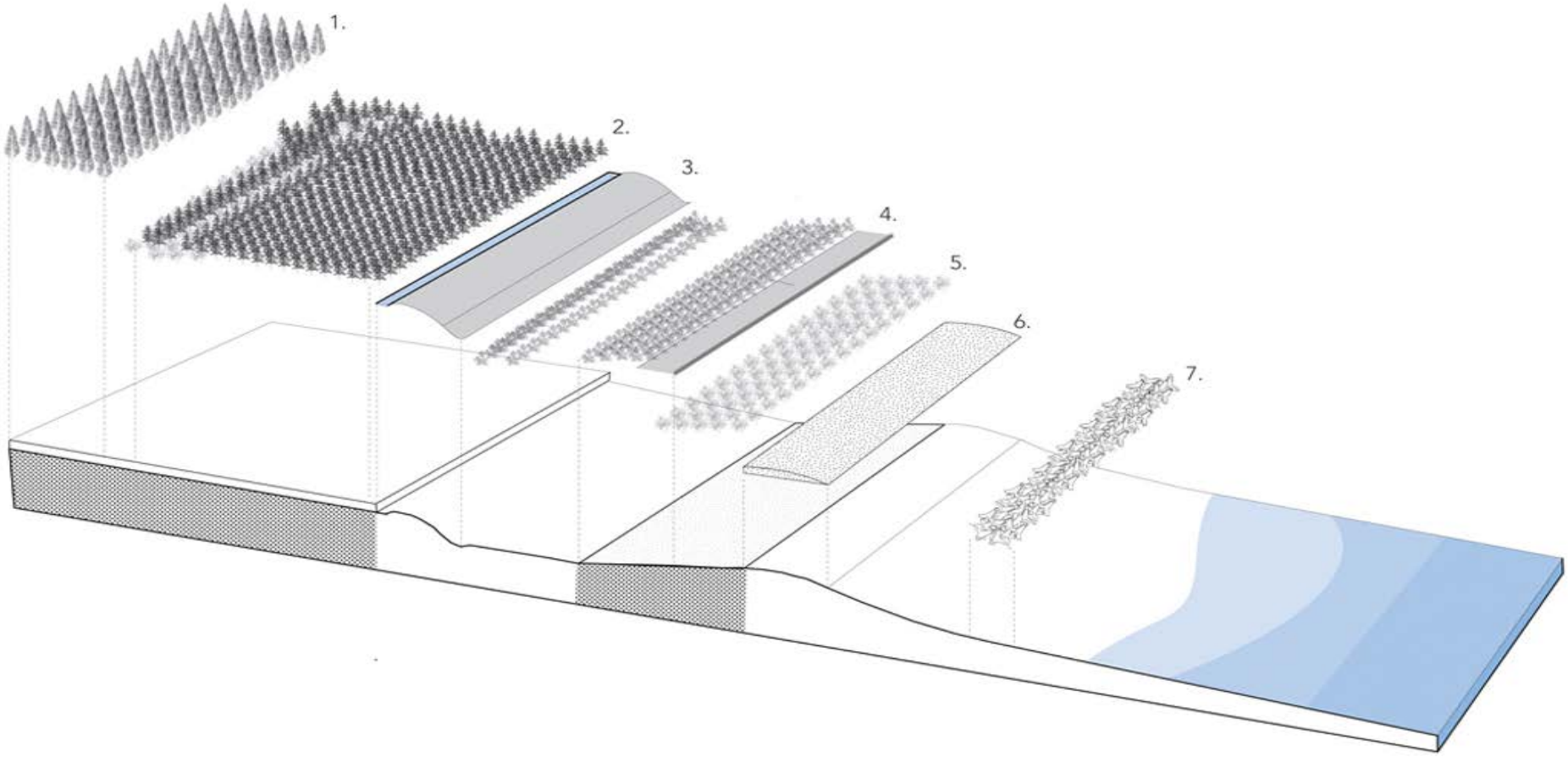
EWN-NNBF Vs Traditional Design



Graphic Credit: Brian Durham USACE ERDC; Re-drawn from SAGE 2015



EWN-NNBF Conceptual Design

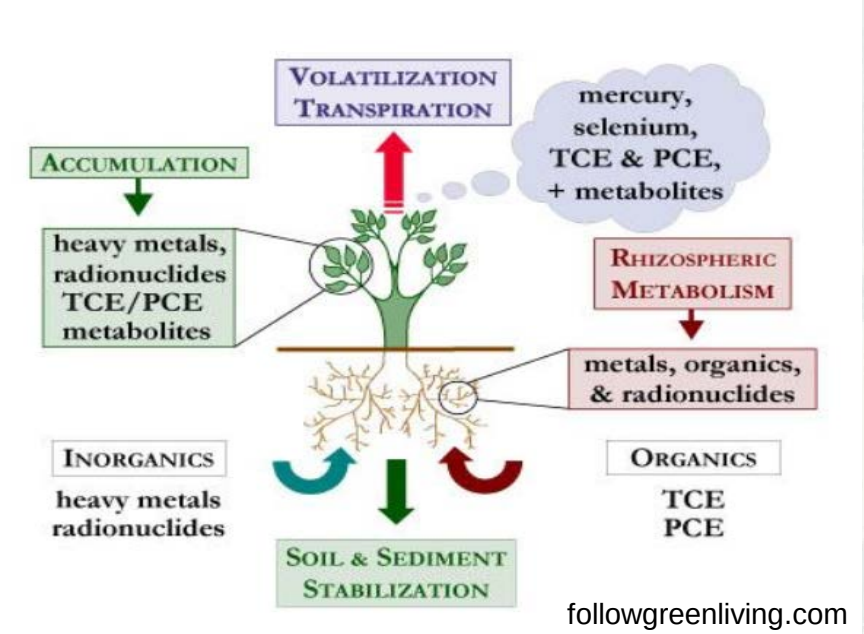


1. Upland forest
2. Lowland swamp forest
3. Resevoir and berm
4. Scrub and road
5. Rosa rugosa mix
6. Foredune
7. Rip rap


HOWARD BEACH
VERGE ENHANCEMENT
CANARSIE
VERGE ENHANCEMENT
MILL BASIN
VERGE ENHANCEMENT
ELDERS POINT
PUMPKIN PATCH
DUCK POINT
BLACK BANK
CANARSIE POL
JAMAICA BAY
MARSH ATOLL TERRACES
RULERS BAR
STONY CREEK
BLACK WALL
YELLOW BAR
RUFFLE BAR
FLOYD BENNETT
MARSH INLET
DEAD HORSE BAY
PLUMB BEACH
BIG EGG
LITTLE EGG
MARSH ATOLL TERRACE
BROAD CHANNEL
JACKSON HOLE
BROAD CREEK
EAST HIGH MEADOW
JFK AIRPORT RUNWAY
FLUSHING TUNNELS
GRASS HASSOCK
JO CO MARSH
WINHOLE
HASSOCK
SILVER HOLE
BAYSWATER
FAR ROCKAWAY
ARVERNE
HAMMELS
SEASIDE
EDGEMERE
FLUSHING TUNNELS
BELLE HARBOR
NEPONSIT
ROXBURY
BREEZY POINT
JACOB RIIS
OVERWASH PLAIN
FORT TILDEN
OVERWASH PLAIN
2011 MARSH
NEW
ATOLL TERRACE / ISLAND MOTOR
STRATEGIC PLACEMENT OF DREDGED MATERIAL
VERGE ENHANCEMENT
NATURE-BASED FEATURES - FLOOD MANAGEMENT STRUCTURES
SURFACE
TUNNEL
FLOW AND CIRCULATION
TIDAL INLETS - OVERWASH PLAINS - FLUSHING TUNNELS

Potentials of Plants

- Phytoremediation
- Erosion control-soil binders
- Dust control
- Habitat for wildlife
- Socio-economic benefits-Birdwatching opportunities
- Dewatering Applications
- Coastal Protection-Wave breakers



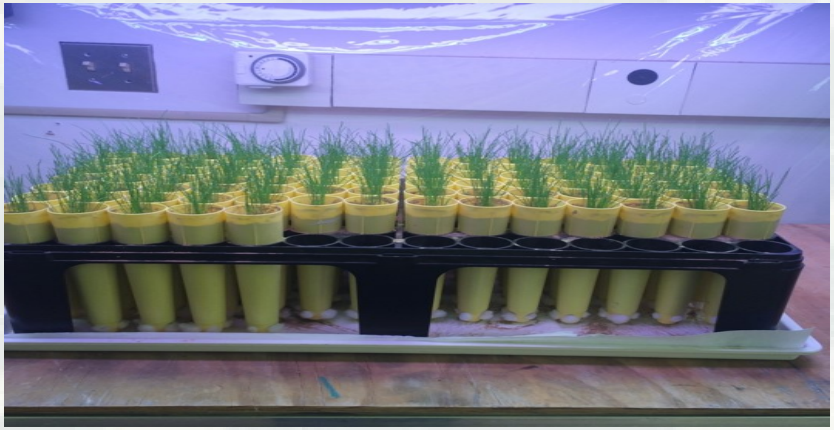


Photo Credit: Dr. Afrachanna Butler, USACE ERDC

Dewatering of Sediments - Smith et al. 2009

Ecological Engineering 35 (2009) 1523–1528

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Dewatering of contaminated sediments: Greenhouse and field studies

K.E. Smith [a,*], M.K. Banks [c], A.P. Schwab [b]

[a] Department of Math, Science and Technology, University of Minnesota-Crookston, 2900 University Ave., Crookston, MN 56716, United States
[b] Department of Agronomy, Purdue University, West Lafayette, IN 47907, United States
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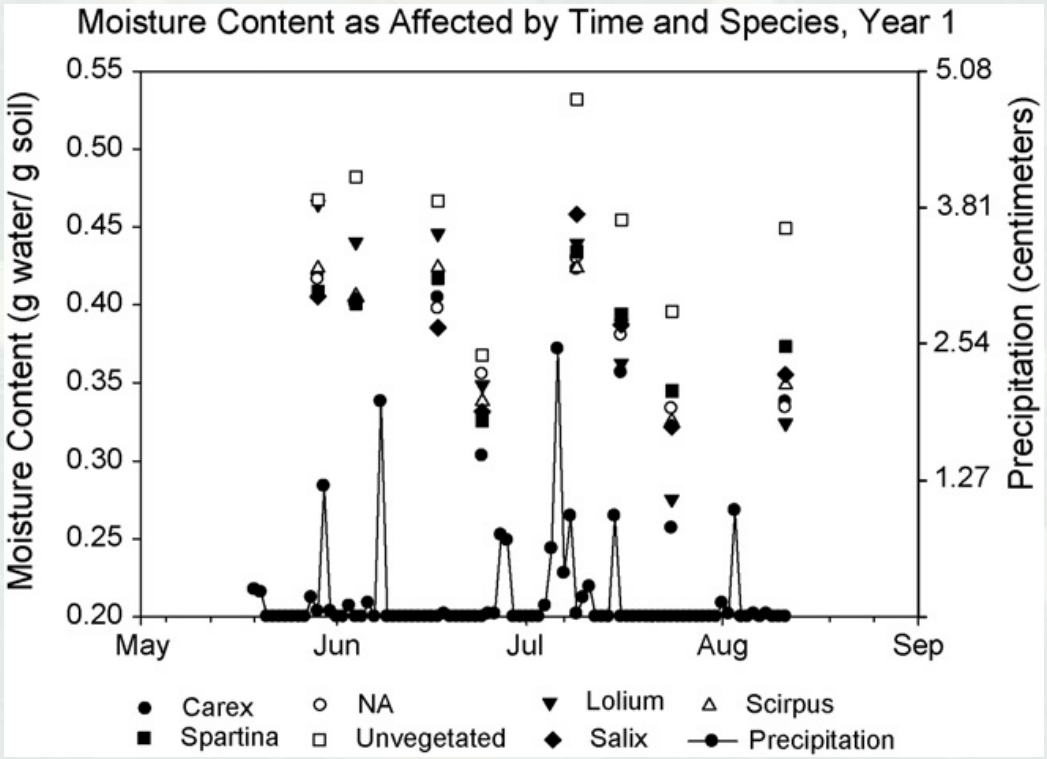


• Wave Attenuation

Coastal Engineering 58 (2011) 251–255

Contents lists available at ScienceDirect

Coastal Engineering

journal homepage: www.elsevier.com/locate/coastaleng

Short communication: Engineering properties of wetland plants with application to wave attenuation

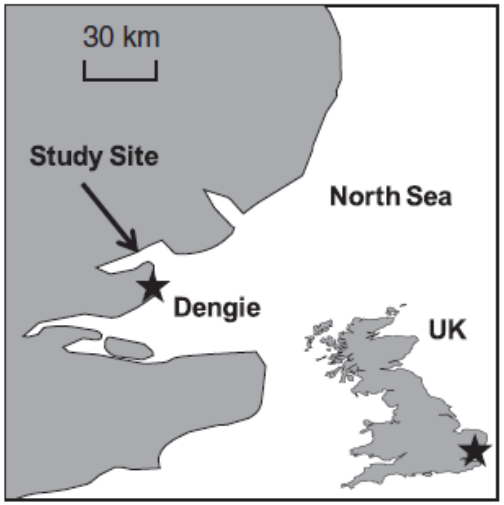
R.A. Feagin [a,b,*], J.L. Irish [c], I. Möller [b], A.M. Williams [a], R.J. Colón-Rivera [a], M.E. Mousavi [c]

[a] Spatial Sciences Laboratory, Department of Ecosystem Science & Management, Texas A&M University, College Station, TX 77845, USA
[b] Fitzwilliam College and Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, Cambridge CB2 3EN, United Kingdom
[c] Zachry Department of Civil Engineering, Texas A&M University, College Station, TX 77843, USA

- Feagin et al. 2011

Table 1. Field studies of wave attenuation over vegetation.

Reference	Transect Length (m)	Dominant Plant Species	Average Wave Reduction (% per m)
Wayne (1976)	20	*Spartina alterniflora*	3.6
	20	*Thalassia testudinum*	2.1
Knutson et al. (1982)	30	*Spartina alterniflora*	3.1
Möller et al. (1999)	180	*Limonium vulgare, Aster Tripolium, Atriplex portulacoides, Salicornia spp., Spartina spp., Suaeda maritime, Plantago maritime, Puccinellia maritima*	0.34
Möller and Spencer (2002)	163	*Aster, Suaeda, Puccinellia, Salicornia, Limonium spp.*	0.54
	10	*Aster, Suaeda, Puccinellia, Salicornia, Limonium spp.*	4.38
Cooper (2005)	300	*Puccinellia maritima, Salicorinia europaea*	0.30
	250	*Atriplex portulacoides, Spartina alterniflora*	0.26
	110	*Atriplex portulacoides, Salicorinia europaea*	0.71
Möller (2006)	10	*Spartina anglica, Salicornia spp.*	1.8
	10	*Spartina anglica, Salicornia spp.*	1.4
	10	*Salicornia spp.*	1.0
Quartel et al. (2007)	100	*Kandelia candel, Sonneratia sp., Avicennia marina*	0.74
Bradley and Houser (2009)	39	*Thalassia testudinum*	0.77
Lövstedt and Larson (2010)	over first 5-14 m of vegetation	*Phragmites australis*	4.0 – 5.0



- Anderson et al. 2011

Erosion Control

- "Coastal vegetation modify and control sedimentary dynamics in response to gradual phenomena like sea level rise" - Feagin 2009

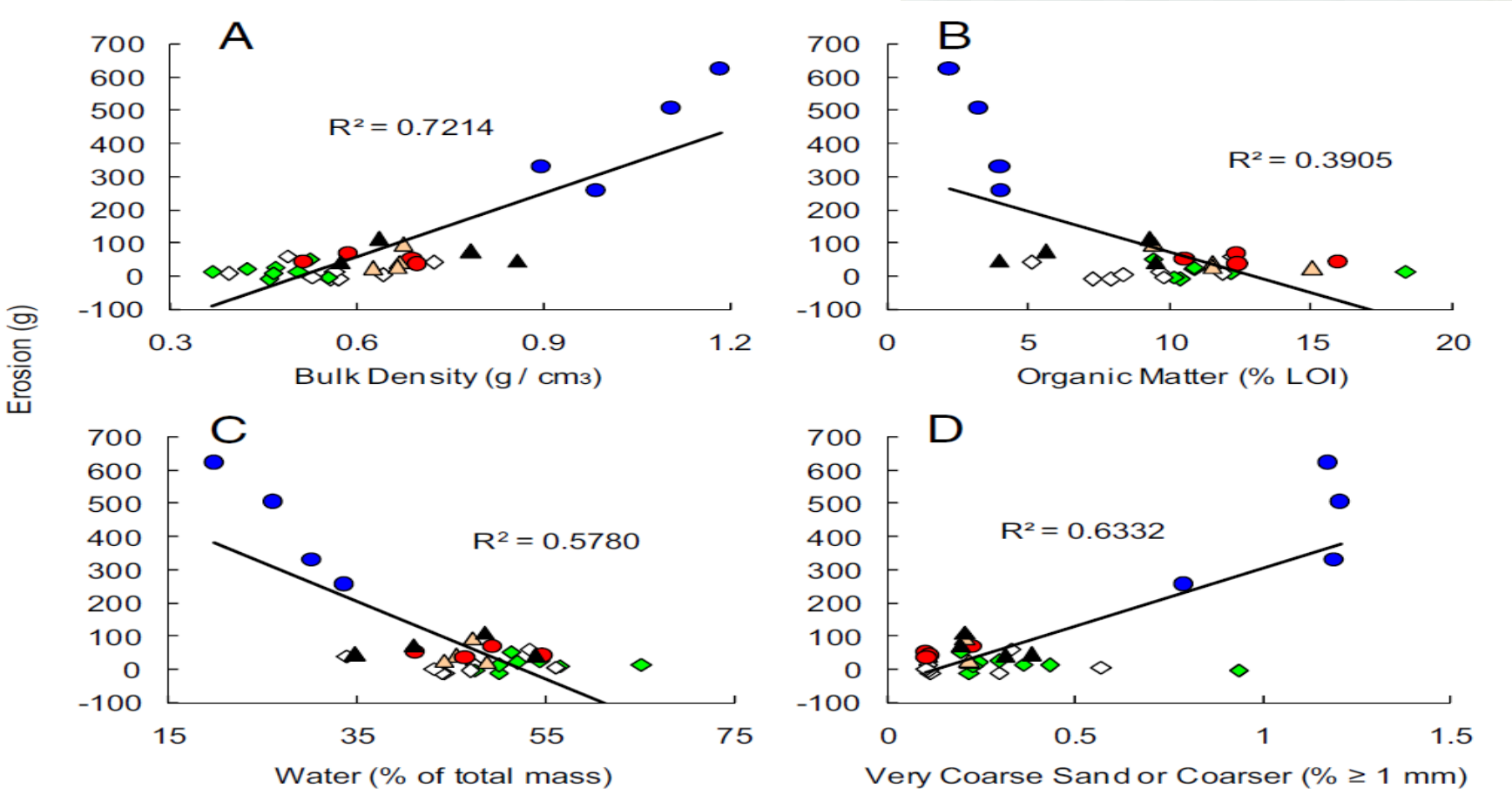
PNAS _ **June 23, 2009** _ vol. 106 _ no. 25 _ **10109–10113**

Does vegetation prevent wave erosion of salt marsh edges?

R. A. Feagin[a,b,1], S. M. Lozada-Bernard[a], T. M. Ravens[c], I. Möller[b,d], K. M. Yeager[e], and A. H. Baird[f]

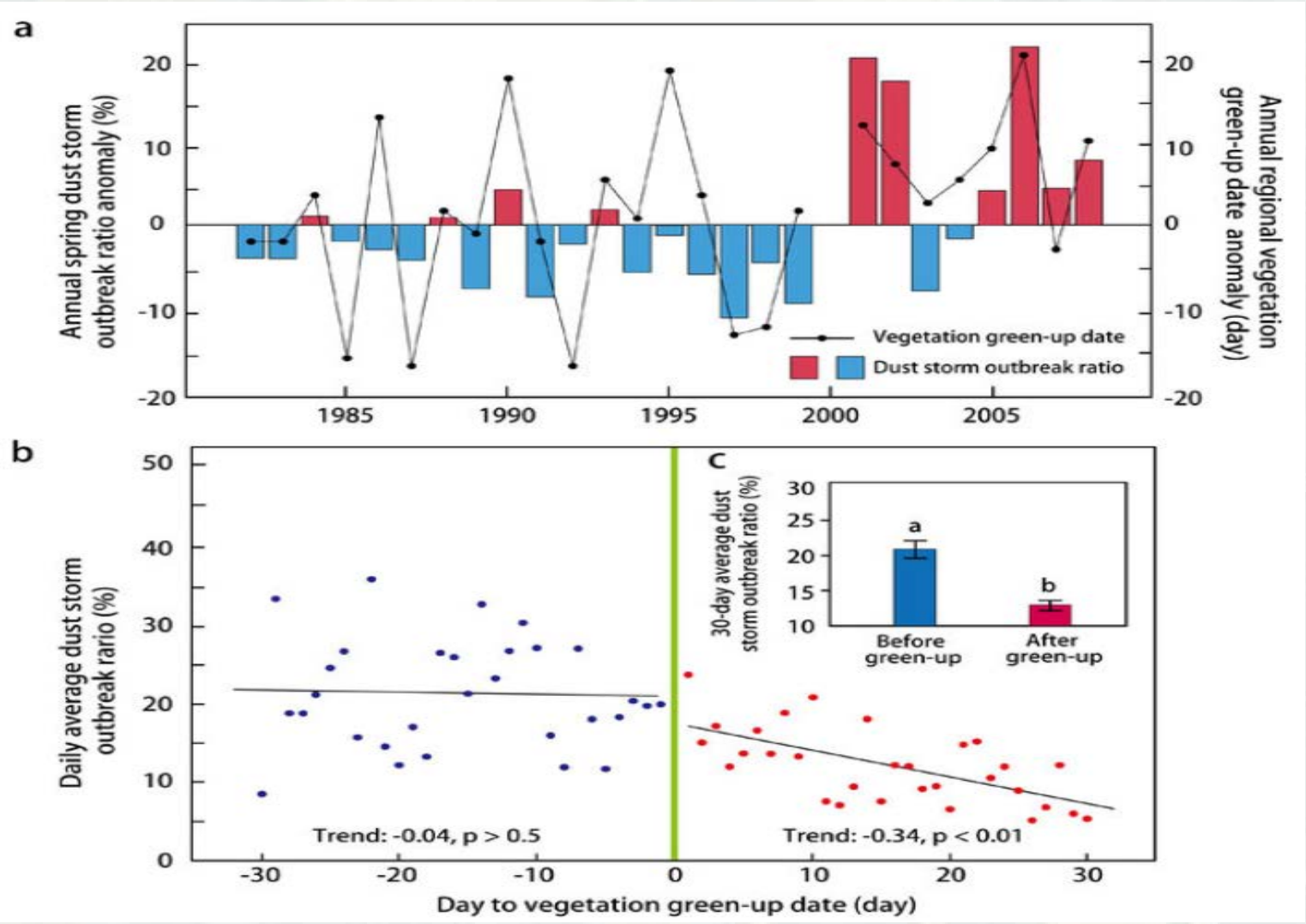
[a]Spatial Sciences Laboratory, Department of Ecosystem Science and Management, Texas A&M University, College Station, TX 77845; [b]Fitzwilliam College, University of Cambridge, Cambridge CB3 0DG United Kingdom; [c]Department of Civil Engineering, University of Alaska, Anchorage, AK 99508; [d]Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, Cambridge CB2 3EN United Kingdom; [e]Department of Marine Science, University of Southern Mississippi, Stennis Space Center, MS 39529; and [f]Australian Research Council Centre of Excellence for Coral Reef Studies, James Cook University, Townsville, Queensland 4811, Australia

Edited by David H. Thomas, American Museum of Natural History, New York, NY, and approved April 29, 2009 (received for review February 5, 2009)



- Wildlife Habitat and Bird Watching

- Dust Control

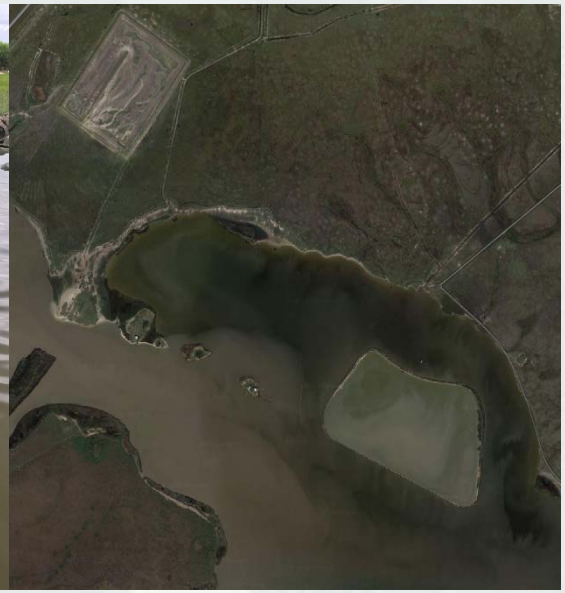


Fan et al. 2014

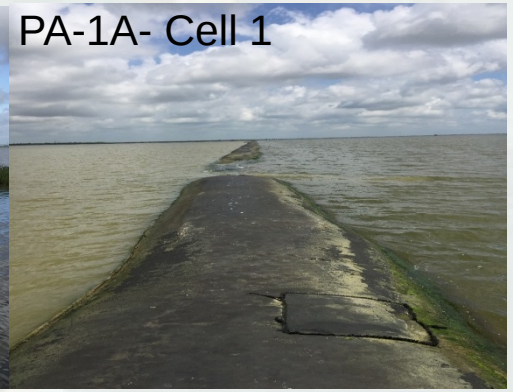
EWN Workshop in SWG

- Occurring in FY17
- Tentative Date: 13-17 March, 2017
- Proposed Dredged Material Placement Site: Beneficial Use Site 4A
- SWG Contacts: Eddie Irigoyen, Jantzen Miller, Seth Jones, and Dr. Edmond Russo





Opportunities in SWG



- Invasive plant species control
- Dyke stabilization/erosion control
- Geotube maintenance cost reduction
- Habitat creation/habitat expansion
- Dust control

Involvement in Detroit District

- Marsh Creation-Marsh Restoration

- Wet-mesic coastal savanna
- Limestone cobble shore
- Sedge meadow pocket wetlands
- Large wood debris fish habitat

- Clinton River Mouth Restoration
- Desirable Vegetation
- Sediment Characterization
- Sediment Consolidation
- Water Level Fluctuations

- In collaboration with - Texas A&M University – Dr. Rusty Feagin, Coastal Ecology and Spatial Sciences Lab

We can quantify:

- Shoreline erosion (using millimeter resolution TLS LIDAR)
- Incident waves (using ultrasonic sensors)
- Currents (using doppler sensors)
- Bathymetry (using survey-grade GPS)

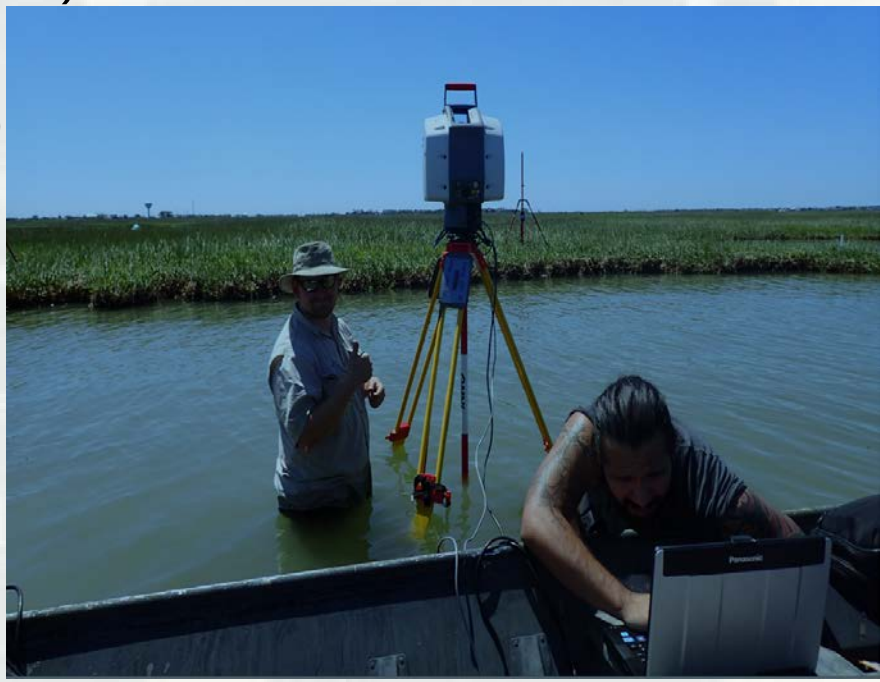
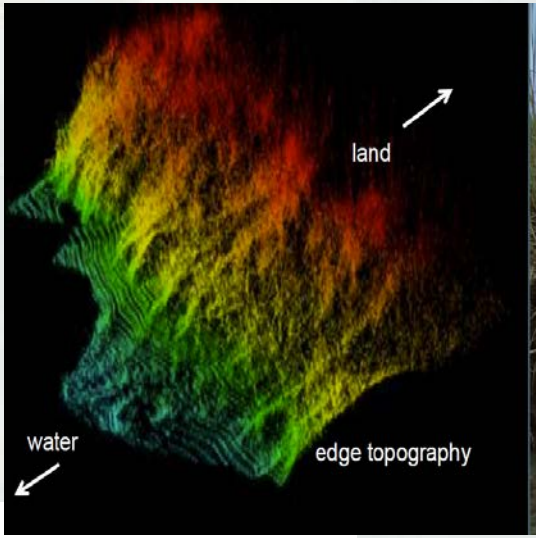


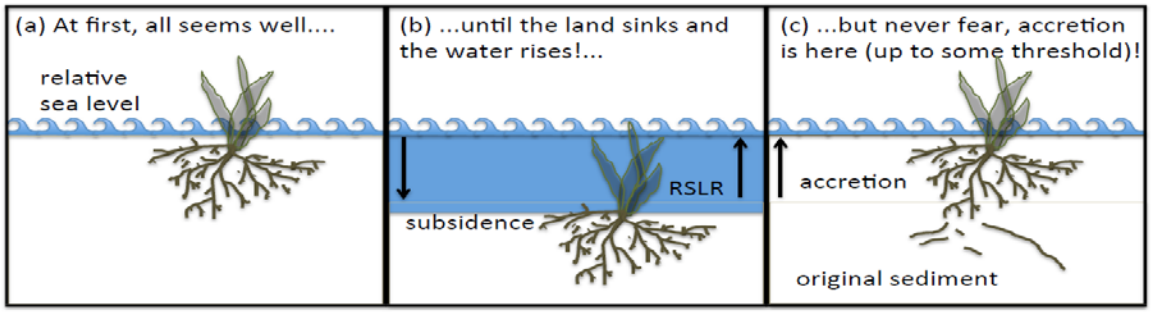
Photo credit: Dr. Rusty Feagin, Texas A&M University

Additional Capabilities

- Sediment parameters (bulk density, organic matter, grain size, porosity, shear, among others)
- Plant parameters (stem diameter, flexibility, root biomass, aboveground biomass; drag, lift)



....in marshes...



Conceptual model of coupled RSLR-accretion process. Relative wetland surface elevation with respect to water level drives the vertical accretion process. Orson et al. 1998 said this process is coupled at decadal scales; Feagin et al. 2013 found similar.

- Uprooting forces and moments due to plant canopy interaction with flow
- Plant-mediated accretion of sediments
- Topography

Photo and graphic credit: Dr. Rusty Feagin, Texas A&M University

Team Members

Tosin Sekoni - Research Ecologist - Principle Investigator
Jacob Berkowitz - Research Soil Scientist
Susan Bailey - Research Engineer - Dredging Focus
Scott Bourne - Research Physical Scientist - GIS
Kevin Philley - Research Botanist
Brian Durham - Research Biologist - Biotechnical Planting

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