The Association of State Wetland Managers Presents:

Improving Wetland Restoration Success
2014 — 2015 Webinar Series

Atlantic Coast Coastal Marshes & Mangrove Restoration

Presenters: Roy R. "Robin" Lewis, III, John Teal, James Turek and Joseph Shisler

Moderators: Jeanne Christie & Marla Stelk

Funded by EPA Wetland Program Development Grant 83541601

If you have any technical difficulties during the webinar you can send us a question in the webinar question box or call Laura at (207) 892-3399 during the webinar.

HAVING TROUBLE WITH THE SOFTWARE?

Don't Panic -
we've got it covered!

Check your email from this morning:

1. You were sent a link to instructions for how to use the Go To Webinar software.
2. You were also sent a PDF of today's presentation. This means you can watch the PDF on your own while you listen to the audio portion of the presentation by dialing in on the phone number provided to you in your email.

AGENDA

- **Welcome and Introductions** (5 minutes)
- **Restoration Webinar Schedule & Future Recordings** (5 minutes)
- **Atlantic Coast Coastal Marshes & Mangroves Restoration** (60 minutes)
- **Question & Answer** (15)
- **Wrap up** (5 minutes)

WEBINAR MODERATORS

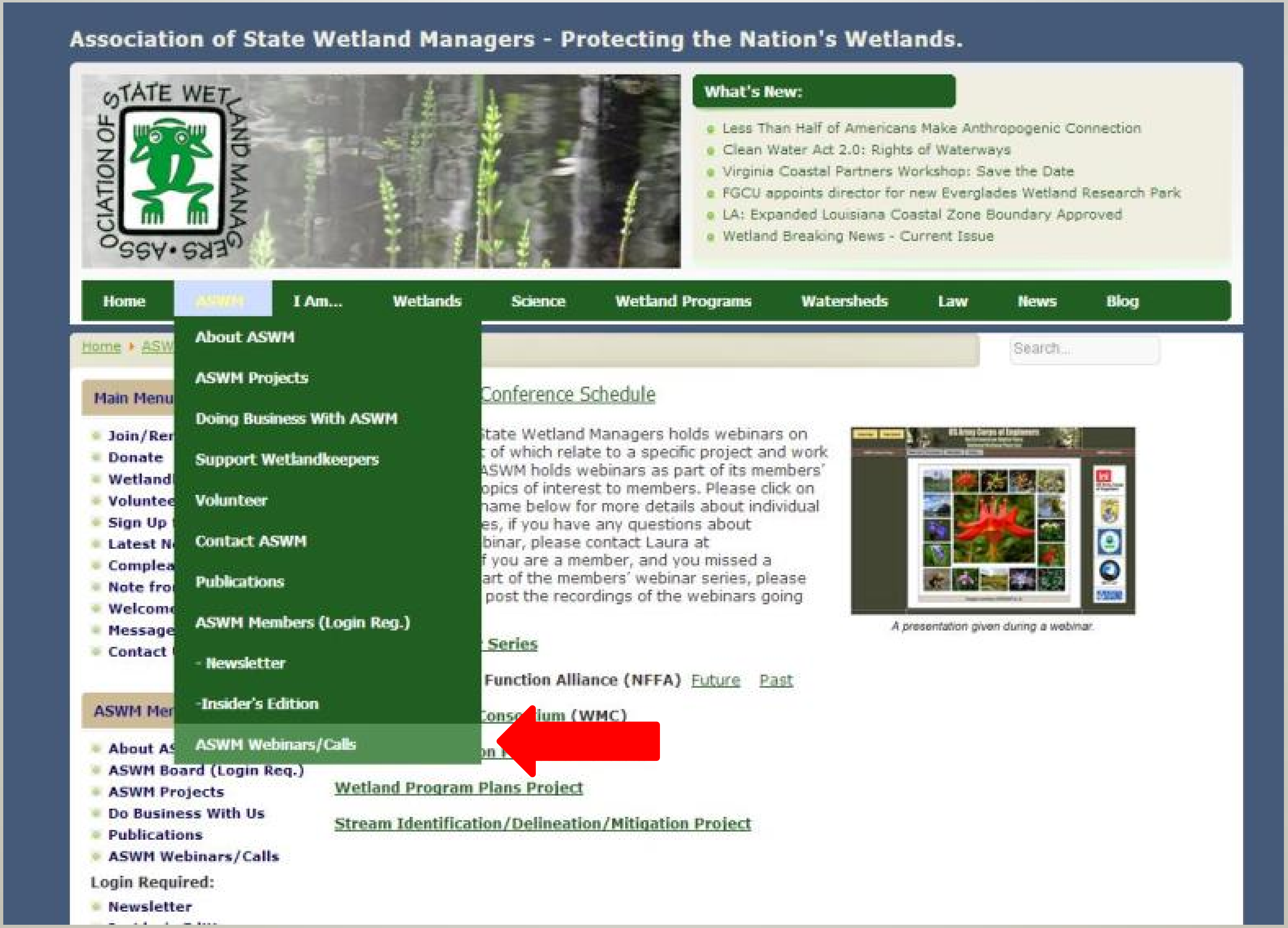
Jeanne Christie,
Executive Director

Marla Stelk,
Policy Analyst

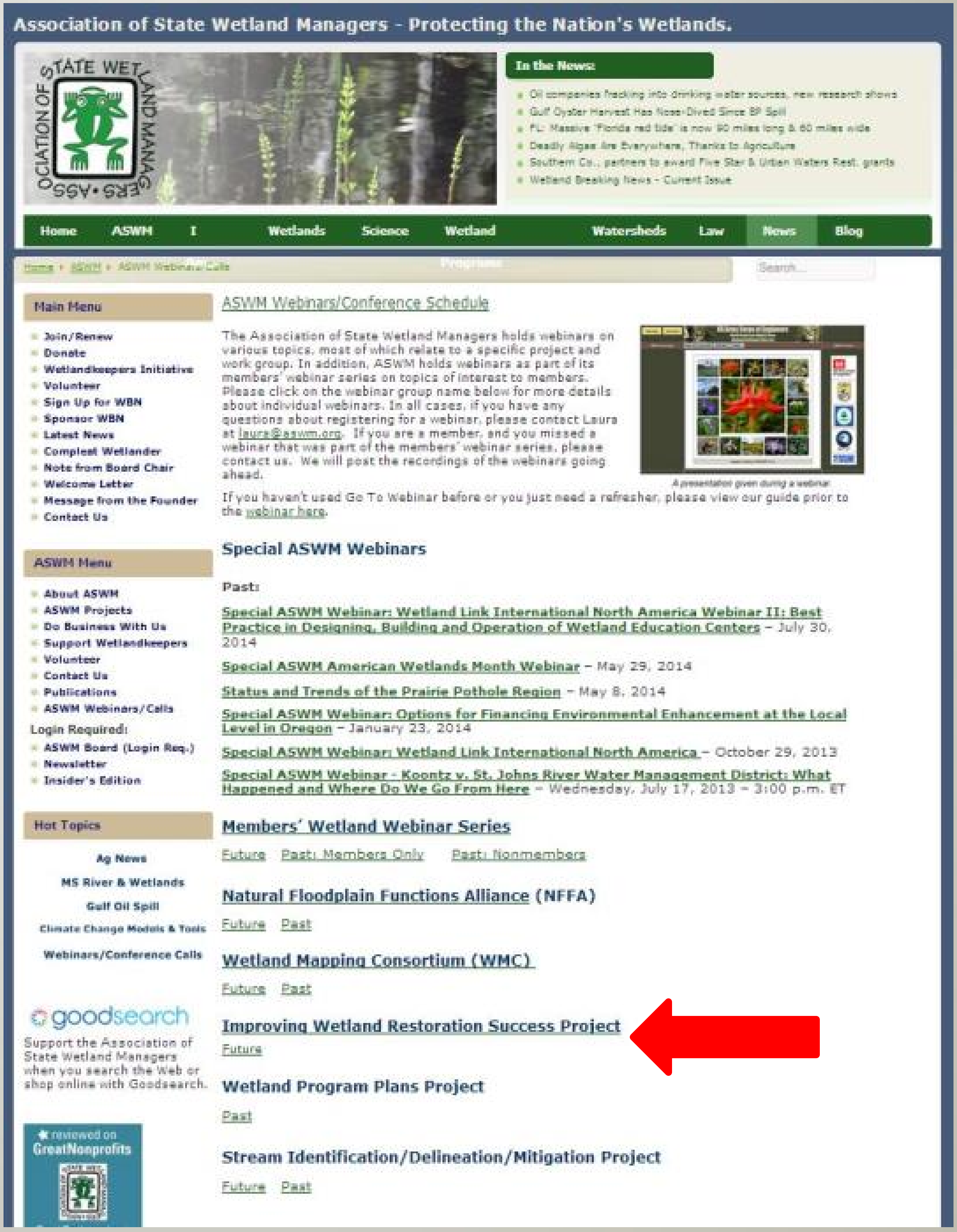
WETLAND RESTORATION PROJECTS

- Convened interdisciplinary workgroup of 25 experts
- Developing monthly webinar series to run through September 2015
- Developing a white paper based on webinars and participant feedback
- To be continued through 2016 in an effort to pursue strategies that:
  - Maximize outcomes for watershed management
    - Ecosystem benefits
    - Climate change
  - Improve permit applications and review
  - Develop a national strategy for improving wetland restoration success

WEBINAR SCHEDULE & RECORDINGS



WEBINAR SCHEDULE & RECORDINGS



FUTURE SCHEDULE - 2015

- **Tuesday, January 20, 3:00pm eastern:**
  - **Temperate & Tropical/Subtropical Seagrass Restoration**

    Presented by:

    Robin Lewis, Lewis Environmental Services, Inc. & Coastal Resource Group, Inc. and,

    Mark Fonseca, CSA Ocean Sciences
- **Tuesday, February 17, 3:00pm eastern:**
  - **Playa & Rainwater Basin Restoration**

    Presented by:

    Richard Weber, NRCS Wetland Team and,

    Ted LaGrange, Nebraska Game & Parks Commission

FOR FULL SCHEDULE, GO TO: http://aswm.org/aswm/6774-future-webinars-improving-wetland-restoration-success-project

PRESENTERS

Roy R. "Robin" Lewis, III
President & Wetland Scientist
Lewis Environmental Services, Inc. & Coastal Resource Group, Inc.

John Teal
Ecologist
Woods Hole Oceanographic Institution (Scientist Emeritus)

James Turek
Restoration Ecologist
NOAA Fisheries Restoration Center

Joseph Shisler
Principal Ecologist
ARCADIS

A "COOKBOOK" APPROACH TO WETLAND RESTORATION WON'T WORK

There are too many variables.

- *Ingredients are always different*
- *Reason for 'cooking' varies*
- *Recipe isn't always correct*
- *Inexperienced cooks*
- *Cooking time varies*
- *Poor inspection when "cooking"*
- *Additional ingredients may be needed*
- *Is it really done?*

WE NEED TO UNDERSTAND THE PLANNING PROCESS AND VARIABLES FROM SITE TO SITE THAT MUST BE STUDIED, UNDERSTOOD AND ADDRESSED

Atlantic Coast Coastal Marshes & Mangrove Restoration…

Subtitle:
Restoration and Creation of Atlantic Coast Tidal Marshes and Mangrove Forests: It Looks Easy But It is Not!

By Robin Lewis, John Teal, James Turek and Joseph Shisler

Photo credit: Delaware Dept. of Natural Resources & Environmental Control

Atlantic Coast Estuarine Intertidal Emergent Wetlands, Marshes and Mangroves

Emergent, regularly flooded, mixohaline

Emergent and scrub-shrub, irregularly flooded, mixohaline

Probability of Success

…high

Estuarine marshes

Coastal marshes

Mangrove forests

Freshwater marshes

Freshwater forests

Groundwater/Seepage Slope Wetlands

Seagrass Meadows (SAV)

…low

From Lewis 2011


THE UNITED STATES OF AMERICA
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B 57066618 A
B 57066605 A
THE UNITED STATES OF
STATES OF AMERICA
B 57066620 A
THE UNITED S
B 57066613 A
THE UNITED STATES
B 57066616 A
THE UNITED STATES OF AMERICA
B 57066611 A
B 57066615 A

Probability of Success

…high

Estuarine marshes

Coastal marshes

Mangrove forests

Freshwater marshes

Freshwater forests

Groundwater/Seepage Slope Wetlands

>$ 10X-20X

Seagrass Meadows (SAV)

…low

Lessons Learned From 40 Years of Successful Ecological Mangrove Restoration (EMR)

Roy R. "Robin" Lewis III, MA, PWS

President

Coastal Resources Group, Inc. [501(c)(3)]

Salt Springs, Florida, USA

BLUE FORESTS

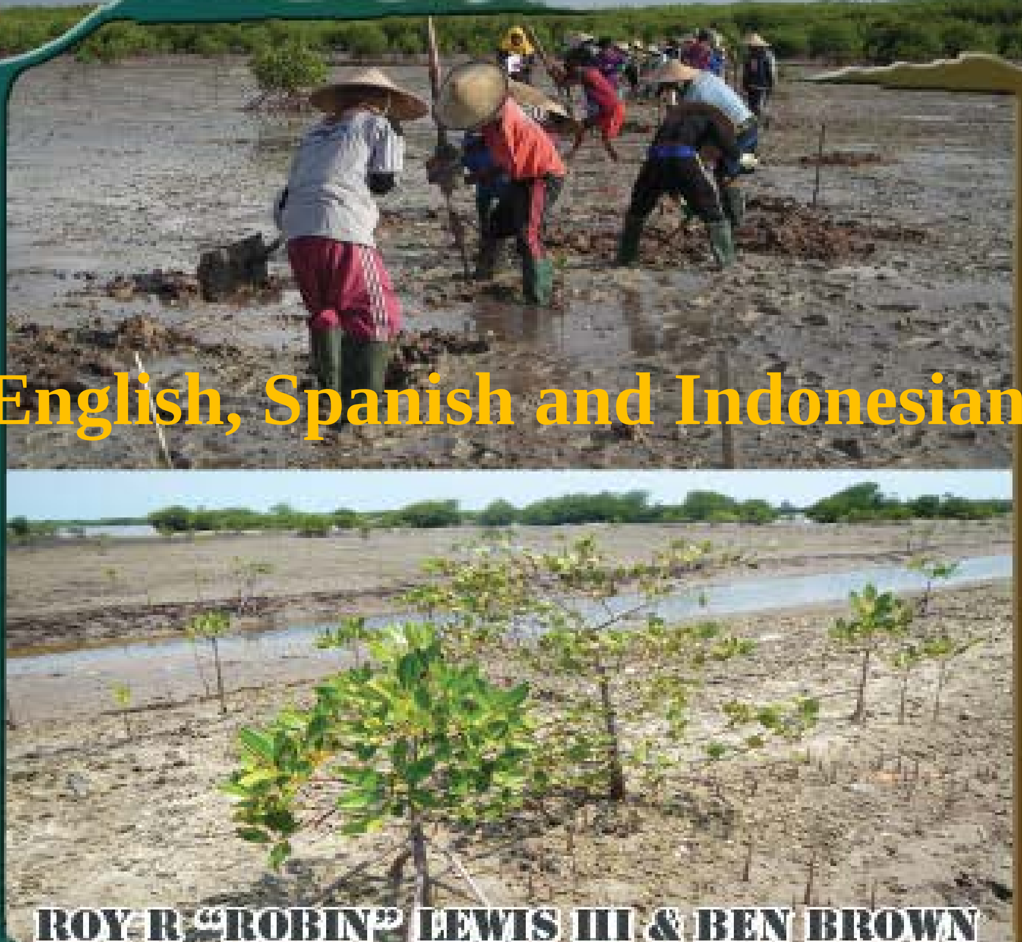
Oxfam

Canadian International Development Agency

DEC 9, 2014

"Ecological Mangrove Restoration (EMR): Hydrologic Restoration is Critical, Planting Mangroves is Not"

ECOLOGICAL MANGROVE REHABILITATION



English, Spanish and Indonesian

ROY R "ROBIN" LEWIS III & BEN BROWN

A FIELD MANUAL FOR PRACTITIONERS

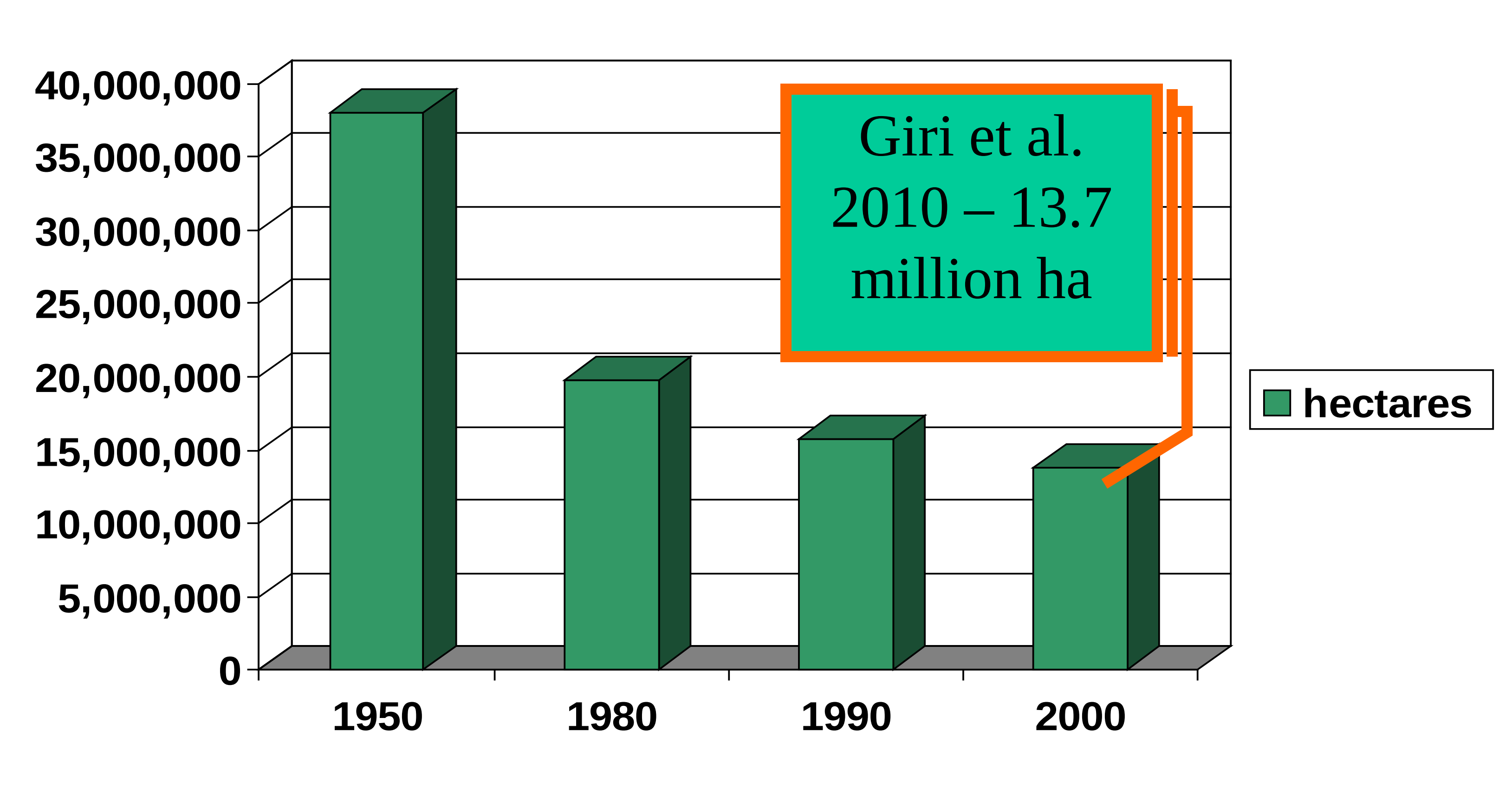
ECOLOGICAL MANGROVE REHABILITATION
A FIELD MANUAL FOR PRACTITIONERS

114 Free .pdf Files

WWW.COASTALRESOURCESGROUP.COM
WWW.MANGROVERESTORATION.COM
WWW.MARCOMANGROVES.COM
LESRRL3@GMAIL.COM

Rookery Bay Fruit Farm Creek USA Proposed Restoration Site – January 21, 2011 (www.marcomangroves.com)

Area of Mangroves Worldwide



CURRENT RATE OF LOSS = 150,000 HA (370,000 AC)/YR

ALTERNATIVE APPROACHES TO MANGROVE RESTORATION

Ecological Mangrove Restoration (EMR) versus Planting Only

(Brown and Lewis 2006, Brown et al. 2014, Lewis 2000, 2005, 2009, Lewis and Brown 2014)

1. Understand Autecology and Community Ecology
2. Understand Normal Hydrology of Mangroves
3. Assess Modifications to Hydrology or Added Stress?
4. Select the Restoration Site
5. Restore or Create Normal Hydrology, or Remove or Reduce Stress
6. Plant Mangroves Only As Needed

SUCCESS !

1. Build a Nursery, Grow Mangrove Seedlings and Plant Mangroves

(GARDENING)

FAILURE**#!!*

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Mangrove replanting project a bust

Only 9 percent of seedlings placed around Naples Bay since 2000 have survived

By ERIC STAATS
emstaats@naplesnews.com

A pilot project to replant mangroves along Naples Bay has not had much more success than Mother Nature.

Crews from the Conservancy of Southwest Florida planted 1,114 red and white mangrove seedlings at various spots around Naples Bay in two planting cycles between 2000 and 2002.

Of those, only 95 red mangrove seedlings have survived, or about 9 percent, according to monitoring results reported in a December 2005 report to the U.S. Fish and Wildlife Service.

The Fish and Wildlife Service awarded the Conservancy a $25,000 grant in 2000 to conduct the pilot project.

The results illustrate the high hurdles scientists will have to jump to regrow mangroves as part of a larger effort to restore Naples Bay.

It will take more than a green thumb.

Conservancy researchers have estimated that Naples Bay has lost some 70 percent of its mangrove forest to development. Mangrove loss has dealt a significant blow to the bay's ecosystem.

Fish find meals and hide from predators among mangrove roots. The roots keep water clean by holding sediment. Migratory birds roost in mangrove branches. When mangrove leaves fall and rot, they become food for organisms at the base of the food chain.

A healthy mangrove forest can produce millions of floating seeds each year, and a small percentage of them find a place where they can grow on their own, said wetlands scientist and mangrove expert Roy "Robin" Lewis III, president of Lewis Environmental Services in Salt Springs, Fla.

If mangroves have not moved into an area, the problem could be with the site, not necessarily the planter, he said.

On Naples Bay, water along most seawalls is too deep for mangroves to grow, and riprap is placed at too steep an angle in many places.

The solution: Either don't plant mangroves where they won't grow or find ways to revamp the shoreline, Lewis said.

"It doesn't mean you can't correct it," Lewis said.

Restoration also will depend on quelling homeowners' fears that water views and mangroves are not mutually exclusive.

Homeowners volunteered to allow mangroves to be planted on the edge of their lots as part of the pilot project.

Besides inhospitable shoreline structure, boat wakes slamming the shoreline also contributed to mangrove seedlings' failure, according to the Conservancy report.

An unexpected freeze in late December 2000 took a toll on the first planting cycle, according to the report.

Vandalism or honest mistakes by ill-informed gardeners were other problems, according to the report. The report theorizes that misguided shoreline fishermen pulled out seedlings at Bayview Park.

"It's not an easy thing," said Brad Rieck, a Fish and Wildlife Service biologist in the agency's project planning division in Vero Beach.

"You just don't walk up and down the shoreline, plant propagules at the mean high water line, walk away and a couple years later have a nice stand of mangroves."

Although most of the seedlings didn't make it, crews did what they could to give them a leg up when they were planted.

Workers collected about 2,750 mangrove seeds and propagules and cultivated them in a nursery the Conservancy set up.

About 18 percent of the white mangrove seeds and 72 percent of the red mangrove propagules germinated and grew roots for replanting, according to the report.

Monitoring after the planting showed a survival rate of 19 percent for the first cycle and 71 percent in the second cycle, according to the report.

The report attributes the difference to more mature seedlings planted in the second cycle.

In both planting cycles, some of the mangroves were planted inside plastic tubes and the rest were planted directly into riprap.

In the second planting cycle, the root systems of half of the mangroves seedlings were wrapped in cheesecloth filled with soil and then wedged into riprap, packed with more soil and supported with bamboo stakes.

Unwrapped seedlings had a survival rate of 69 percent compared with an 81 percent survival rate of wrapped seedlings, according to the report.

Seedlings planted in riprap had a 56 percent survival rate compared with 36 percent surviving in plastic tubes along seawalls, according to the report.

By the end of the monitoring period in November 2005, though, the overall survival rate had dropped to 9 percent.

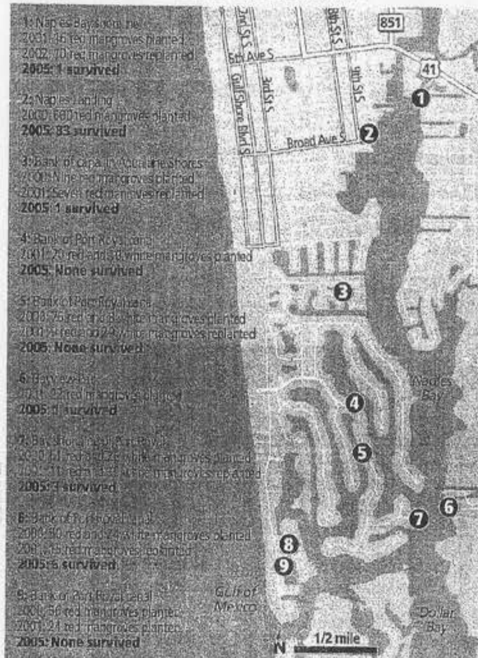
Conservancy biologist Kathy Worley said the results should not discourage future plantings, but the problems that kept mangroves from growing should be fixed first.

"We're not saying it can't be done; it can," she said.

■ Conservancy of Southwest Florida biologist Kathy Worley said the results should not discourage future plantings, but the problems that kept mangroves from growing should be fixed first.

Trouble with mangroves

Less than 10 percent of the mangrove seedlings the Conservancy of Southwest Florida planted along Naples Bay have survived, according to a Conservancy report. The report cites problems with vandalism, water depths and boat wakes. Some 70 percent of the bay's original mangroves have been destroyed by development.



Source: Conservancy of Southwest Florida

Chad Yoder/Staff

NAPLES DAILY NEWS
NAPLES
DAILY - 63,000
Jan 20, 2006

Figure 2. Some examples of the less successful mangrove enhancement initiatives in the Philippines, mainly planting *Rhizophora* at the seafronts: (a) under a prolonged period of immersion, *Rhizophora* seedlings planted at the lower intertidal zone may "drown," causing massive mortalities in Tayabas Bay (16, pers. obs.); (b and e) macroalgae and other debris may cause defoliation of the broad-leafed *Rhizophora*; (c and g) planting between pneumatophores (c) of *Sonneratia* and aided by bamboo stakes (g) did not prevent many *Rhizophora* seedlings from dying (g; i.e., <50 of the ~1000 seedlings planted survived; Agdangan, Quezon); (d and h) part of 10-ha mangrove plantation (carbon-sink) effort in which *Rhizophora* seedlings mostly (i.e., >95% of the seedlings within sampling plots) died after only about 9 months, apparently because of the mechanical stress of wave action and substrate erosion; and (f) seedling stems serving as substrates for oyster colonization.

From Sampson and Rollon 2008

20 Year Failed Effort To Restore Mangroves In The Philippines, USD$ 17.6 Million Spent for 44,000 Ha of Plantings

Figure 2. Some examples c ... ing *Rhizophora* at the
seafronts: (a) under a prolc ... nay "drown," causing
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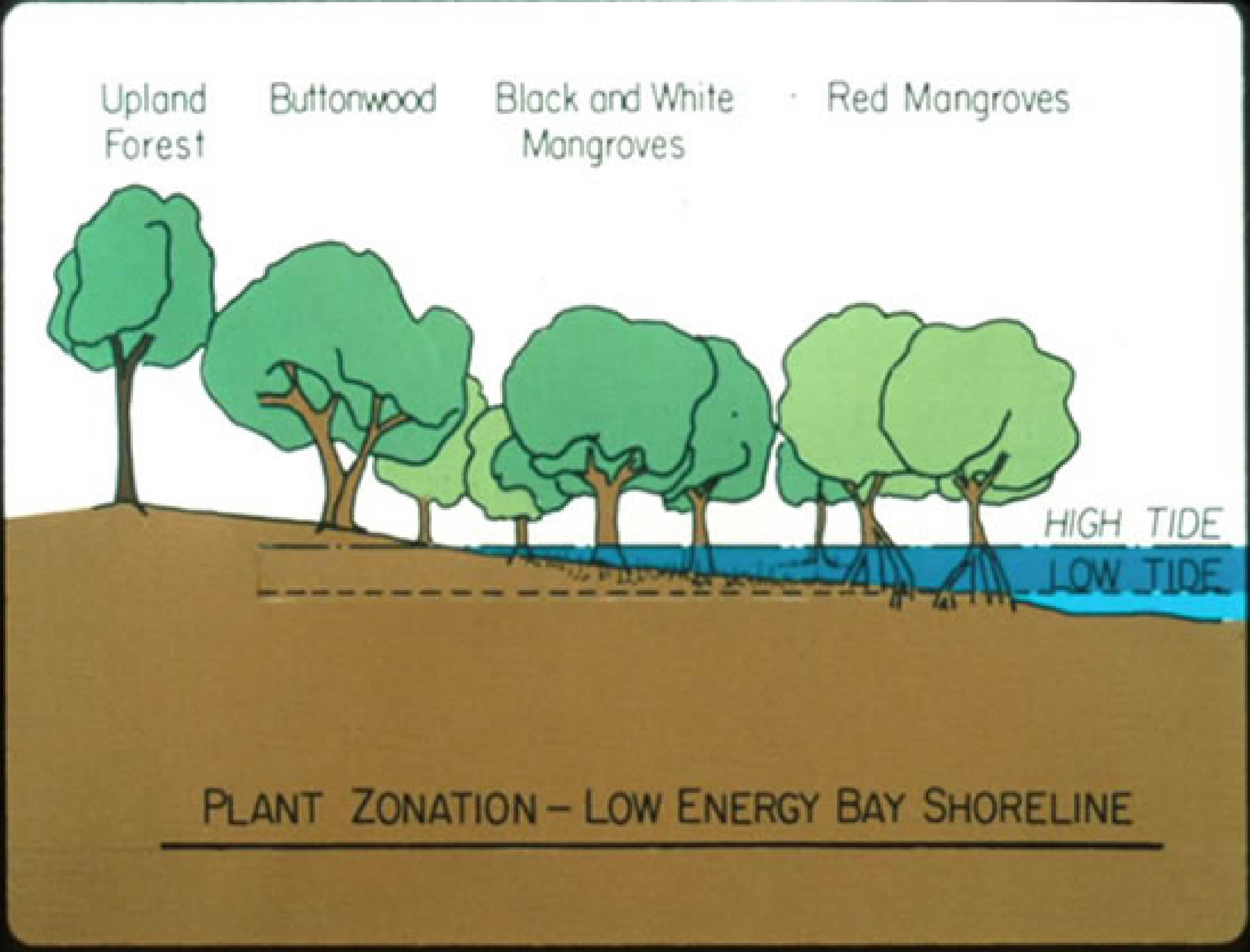

Upland Forest
Buttonwood
Black and White Mangroves
Red Mangroves
HIGH TIDE
LOW TIDE
PLANT ZONATION – LOW ENERGY BAY SHORELINE

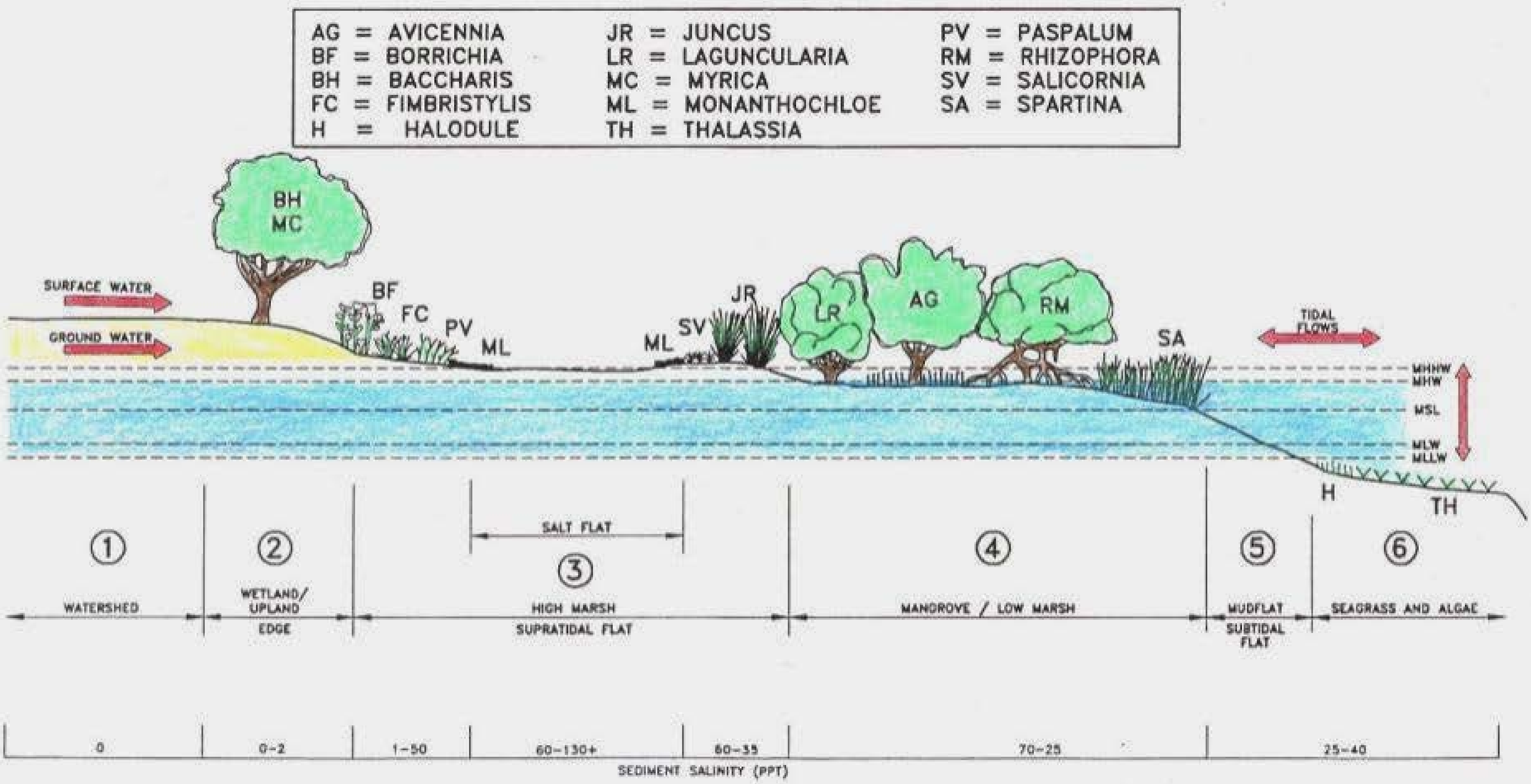
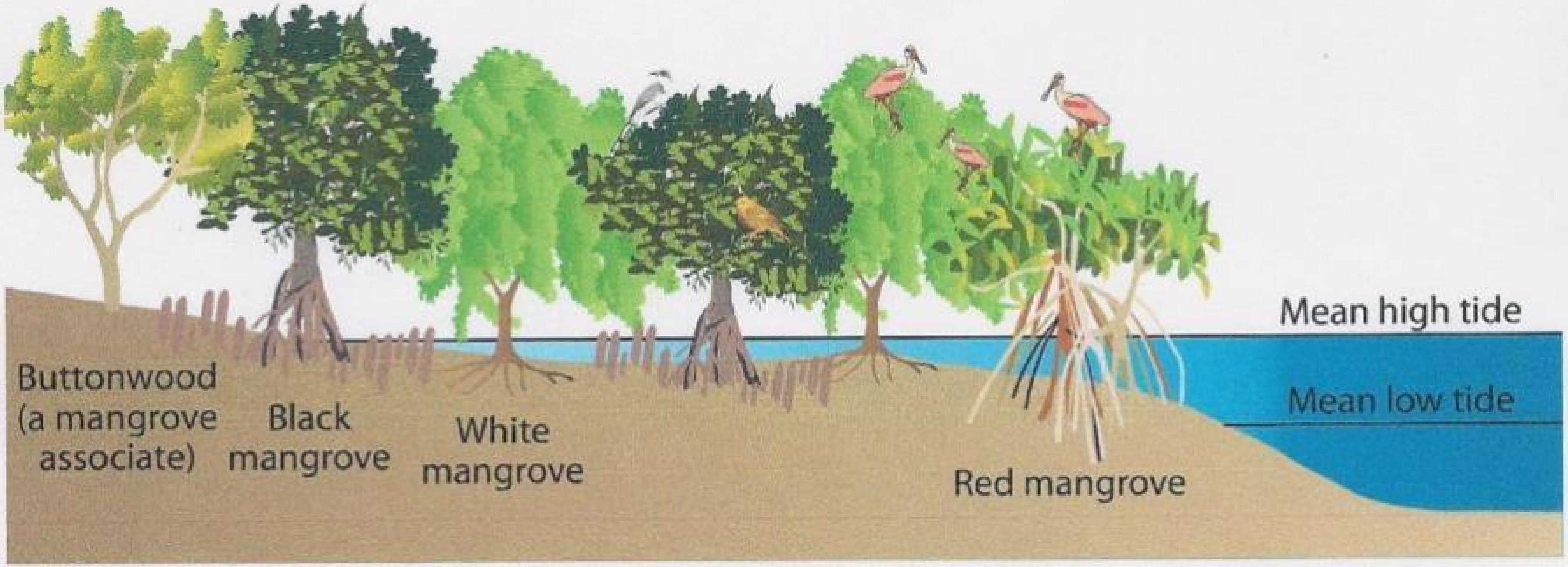


Figure 1. Schematic diagram of the six components of the tropical coastal shelf ecosystem (modified from Crewz and Lewis 1991).

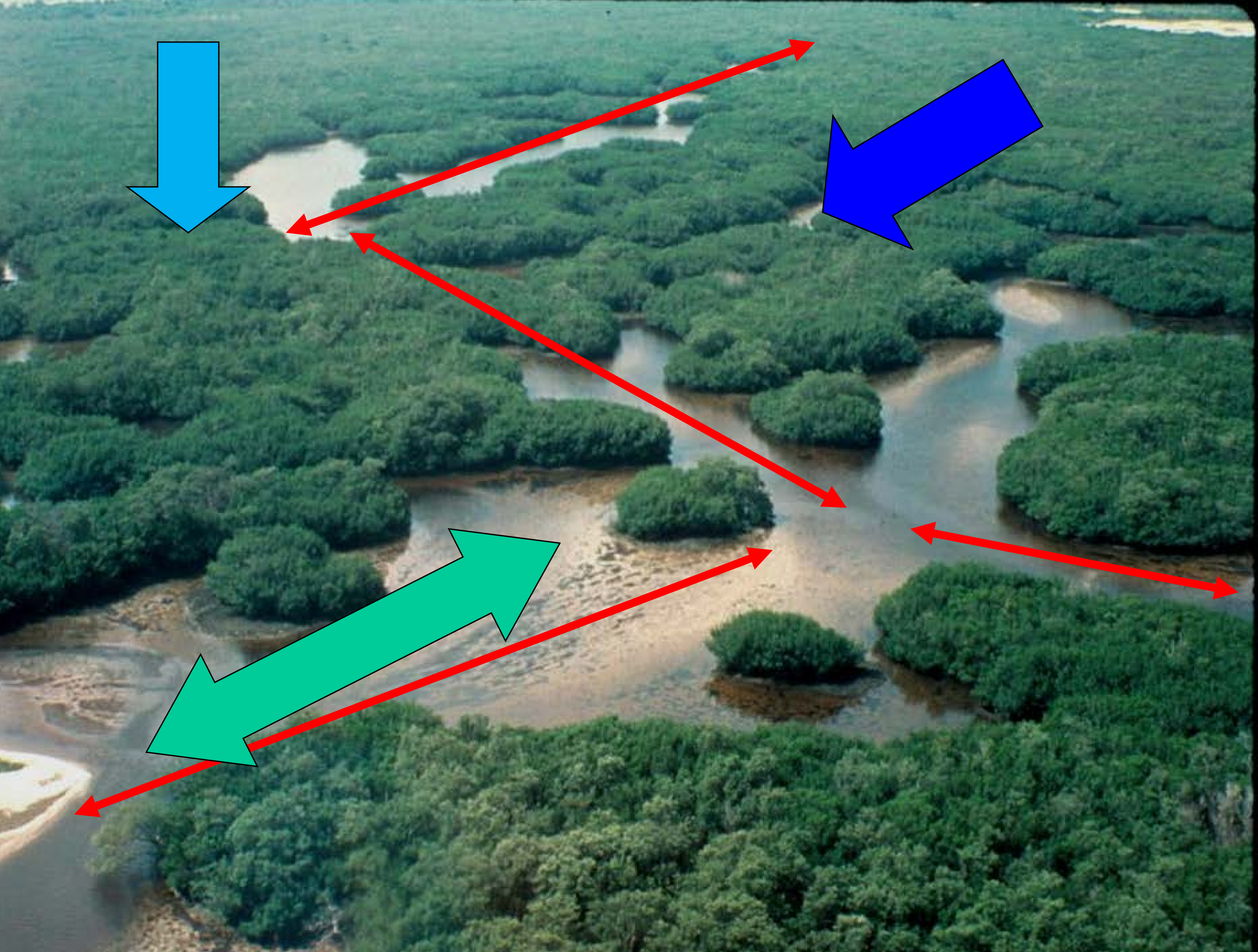
Crewz and Lewis 1991

Mangrove Zonation in South Florida from Kruczynski and Fletcher 2012



The three dominant mangrove species found in south Florida are the red, black, and white mangrove. Buttonwood is a mangrove associate that is often found at the landward margin of mangrove communities.

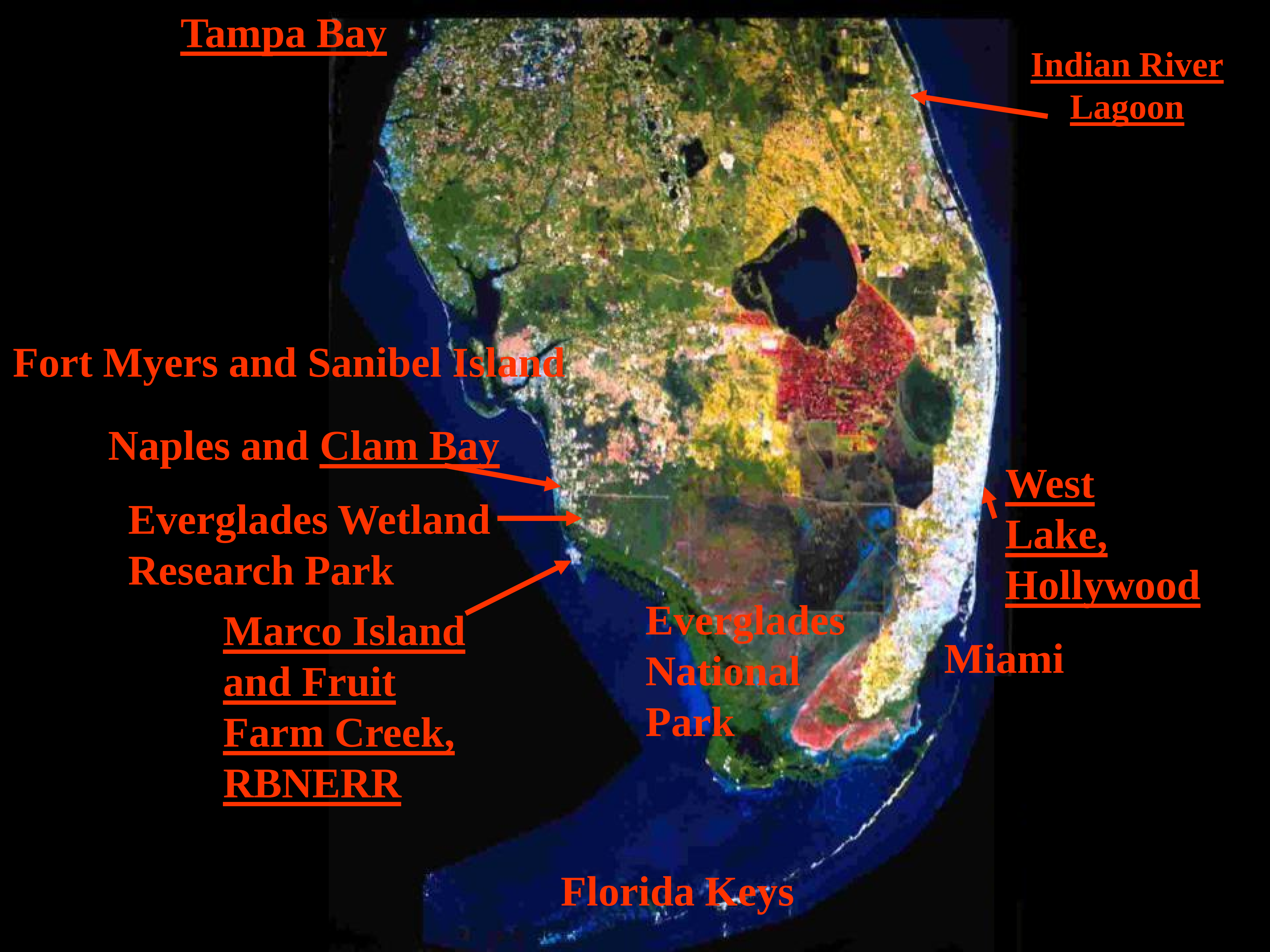

ECOHYDROLOGY



Duration of Flooding as a % of the Tide Cycle?

View of the same part of an inner forest at high tide (*top*) and at low tide (*below*). It is assumed that both regular tidal fluctuations and extraordinary flooding events are vital for mangrove habitats as they wash out or dilute excessive salts, organic debris and toxic substances in the upper soil surface. If inundations are absent for long periods the soil gradually dries out. Then the mangrove area may be colonised by other halophytes that find the conditions favourable.

Duration of Drying as a % of the Tide Cycle?


Tampa Bay
Indian River Lagoon
Fort Myers and Sanibel Island
Naples and Clam Bay
Everglades Wetland Research Park
West Lake, Hollywood
Marco Island and Fruit Farm Creek, RBNERR
Everglades National Park
Miami
Florida Keys

West Lake Mangrove Restoration Project, Ft. Lauderdale, FL, USA, <u>500 ha</u> of hydrologic and major excavation methods of restoration, cost USD$6 million (1990 costs) and the design and development of the $1 million Anne Kolb Mangrove Park and Environmental Education Center (Lewis 1990)

80 ha of Excavation of Dredged Material Deposits (Spoil) to Restore Mangroves, 420 ha of Hydrologic Restoration Through Channel Restoration


1989

Time Zero – July 1989


Time Zero + 27 Months

Time Zero + 78 months- January 1996

March 5, 1997 (Time Zero + 128 months or 10.7 years)

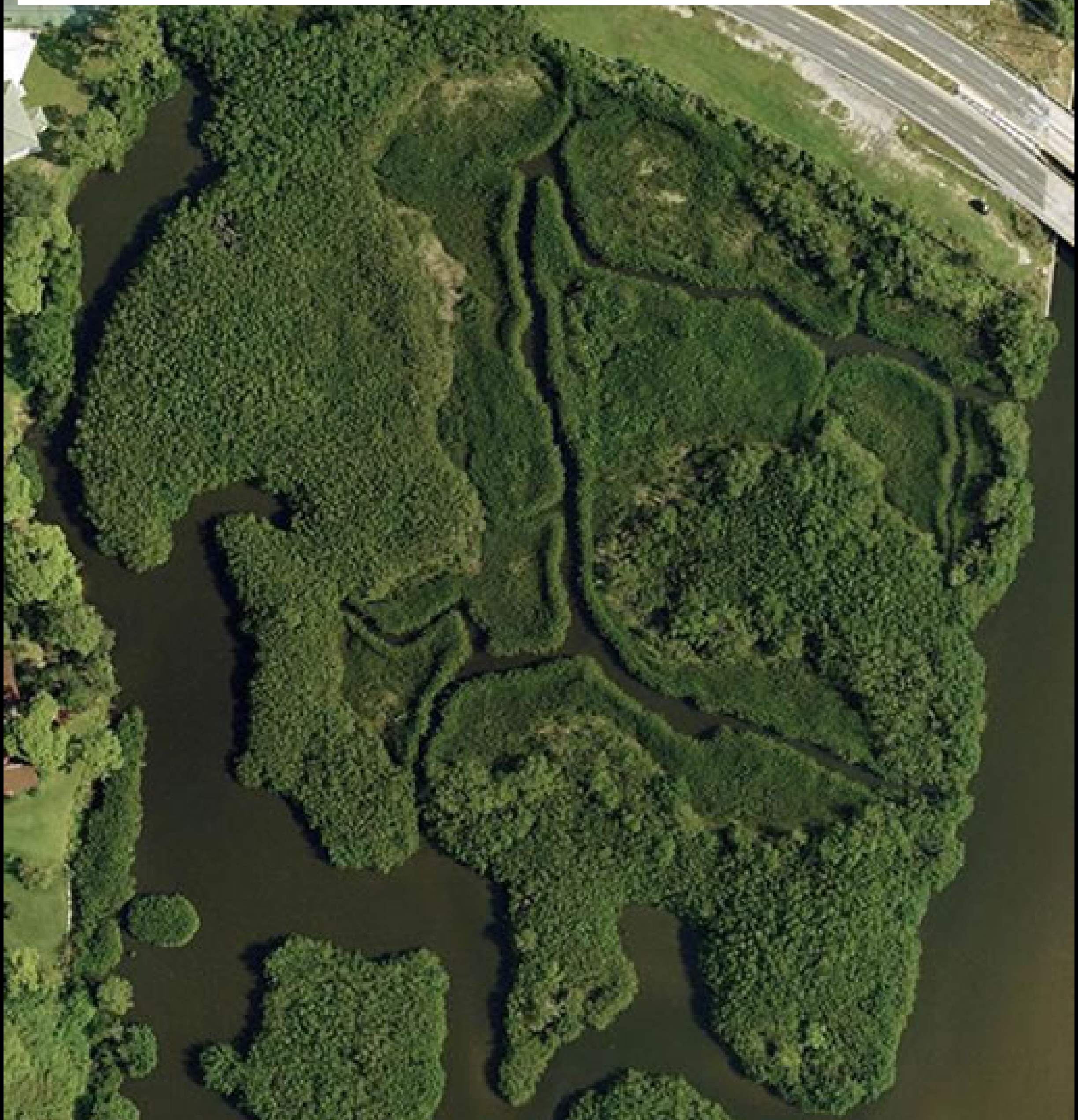
Largest Successful Mangrove Restoration Project in the Americas = Indian River Lagoon, Florida, USA (Brockmeyer et al. 1997, and Rey et al 2012) – 12,605 ha (31,134 ac) over 25 years

Impounded Mangroves – Indian River, FL, USA

Time 0 - 1990

Time 0 + 15 Years - May 6, 2005

Cross Bayou, Pinellas County, Florida, USA, October 7, 2003




Cross Bayou Site June 9, 1999 Under Construction

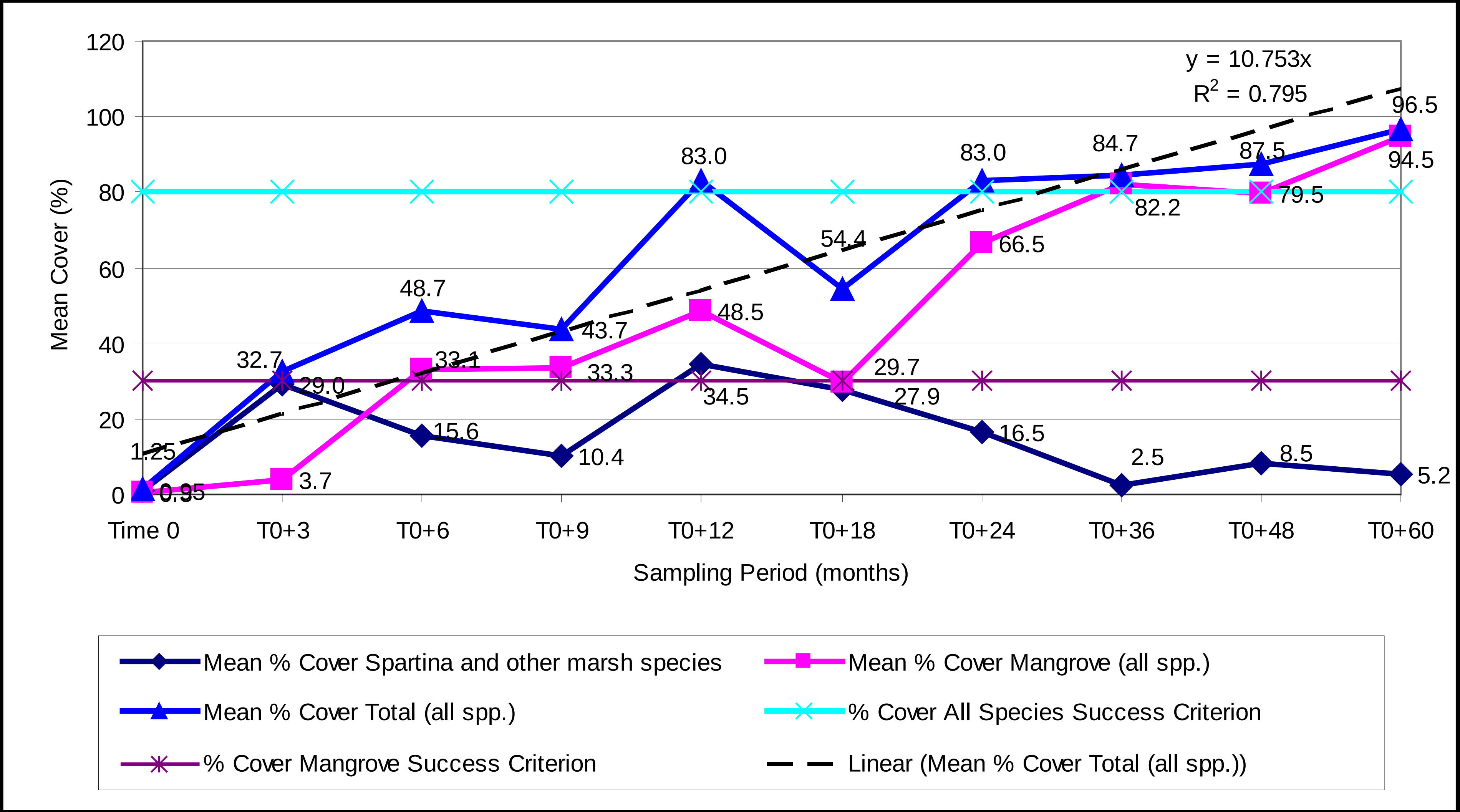
Cross Bayou Site September 4, 1999 Time Zero

Cross Bayou Site October 1, 2000 Time Zero Plus 13 Months

Cross Bayou September 3, 2002 Time Zero Plus 36 Months


Cross Bayou Site October 1, 2004
Time Zero Plus 60 Months

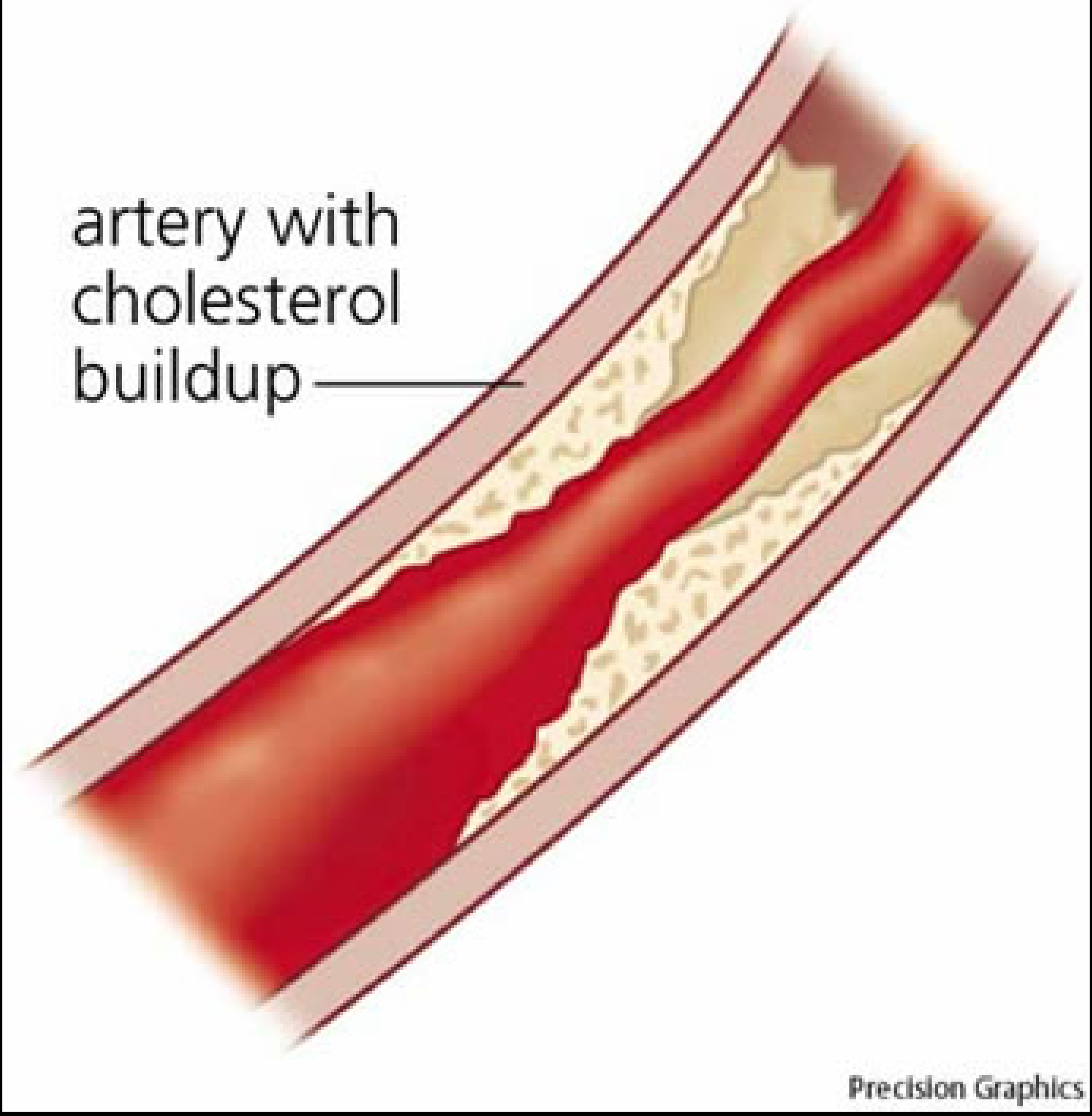
Mean % Cover – All Species



From Lewis et al 2005

10 AUG 94

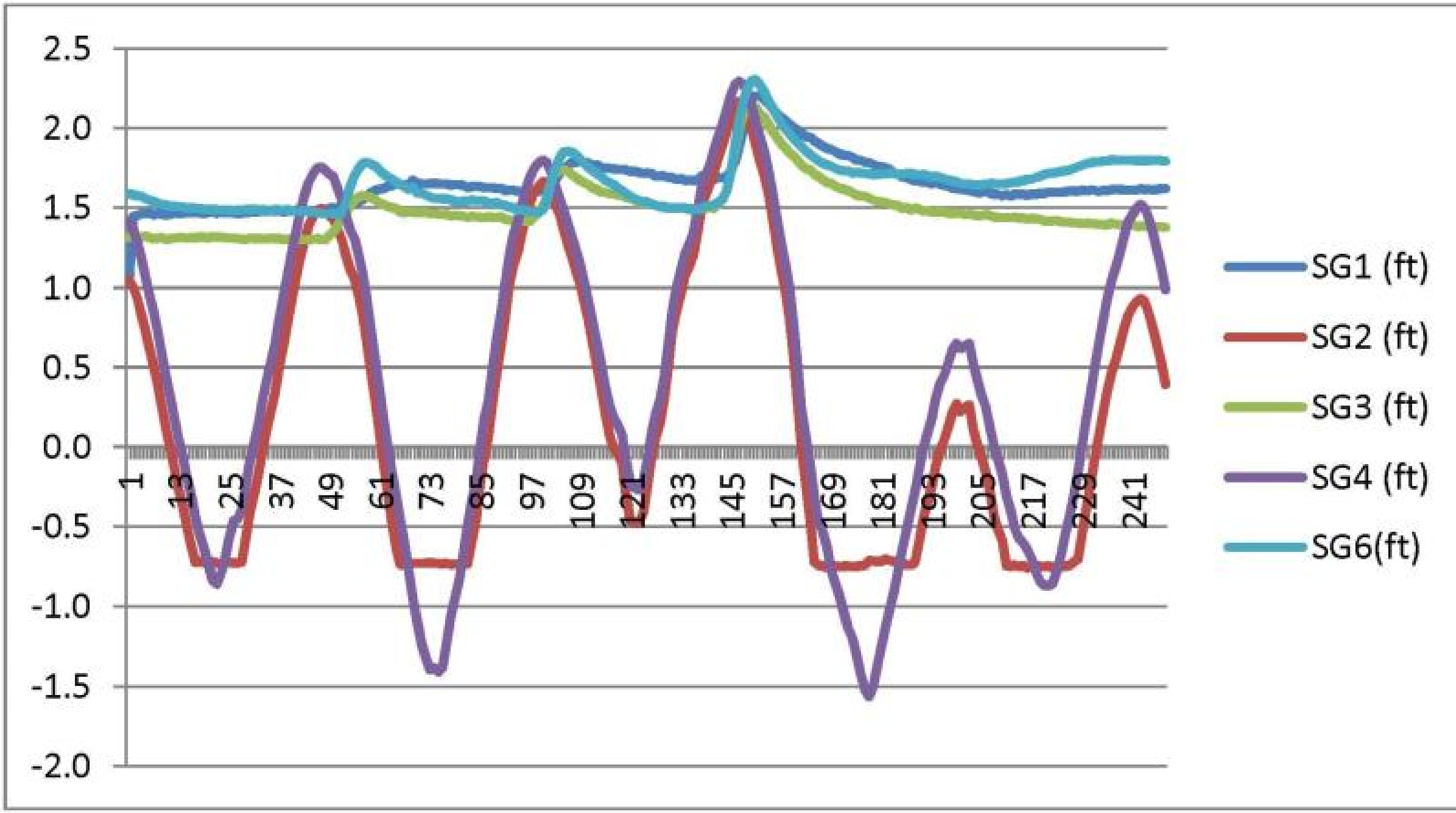
This is the result of a “mangrove heart attack” !


artery with
cholesterol
buildup
Precision Graphics

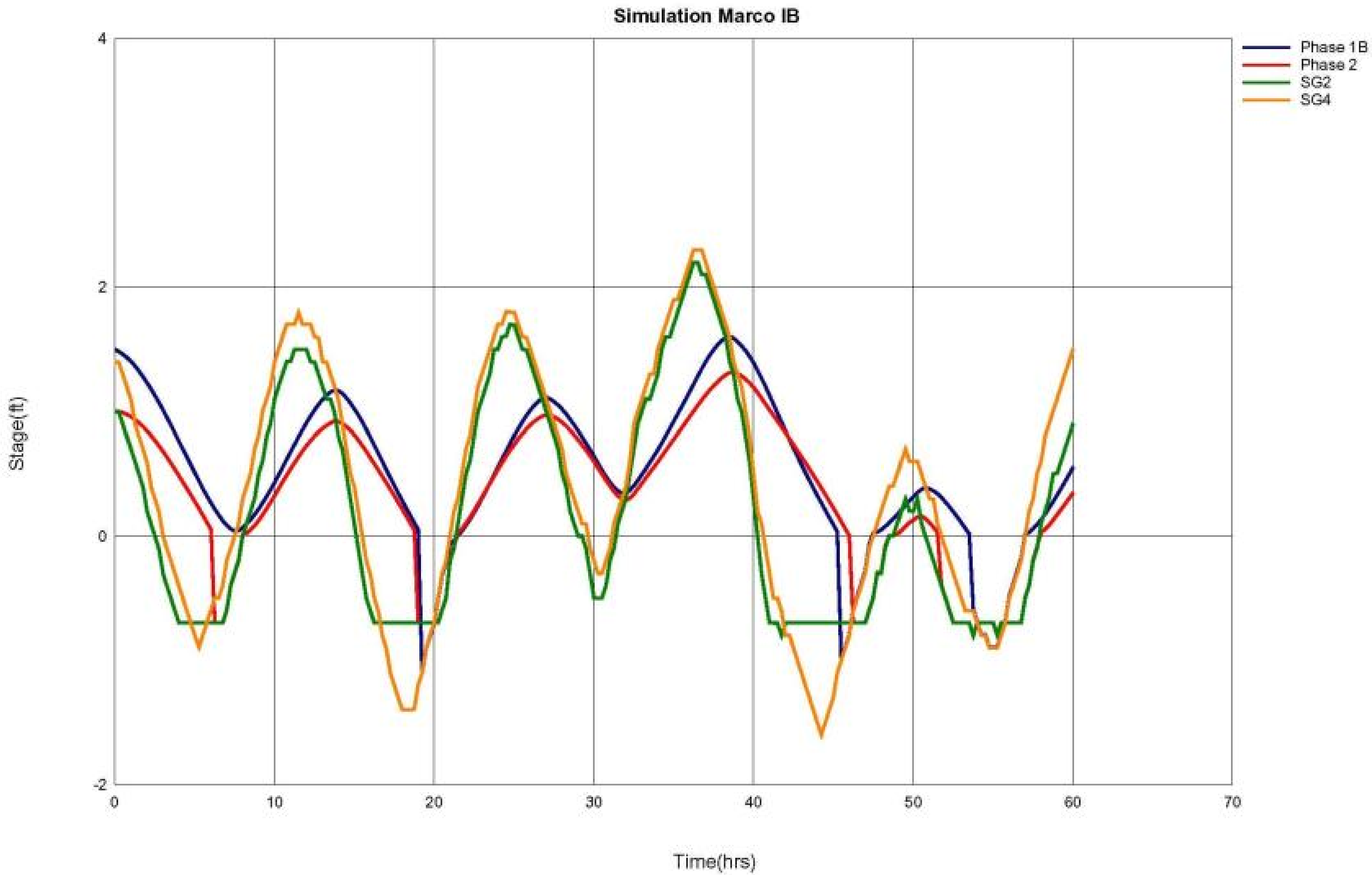
Rookery Bay Fruit Farm Creek Proposed Restoration Site – January 21, 2011

HOBO Water Level Logger
(1" X 6 ")
www.onsetcomp.com

TIDE (FT NAVD 88) vs TIME (HOURS)



Phase 1B (SG4) - 1 x 48" Culverts (proposed)
Phase 1B (SG4) - 1 x 60" Culvert (existing)
Phase 2 (SG2) - 3 x 48" Culverts (proposed)



WWW.COASTALRESOURCESGROUP.COM

WWW.MANGROVERESTORATION.COM

WWW.MARCOMANGROVES.COM

LESRRL3@GMAIL.COM

Coastal restoration example from Estuarine Enhancement Project

John Teal

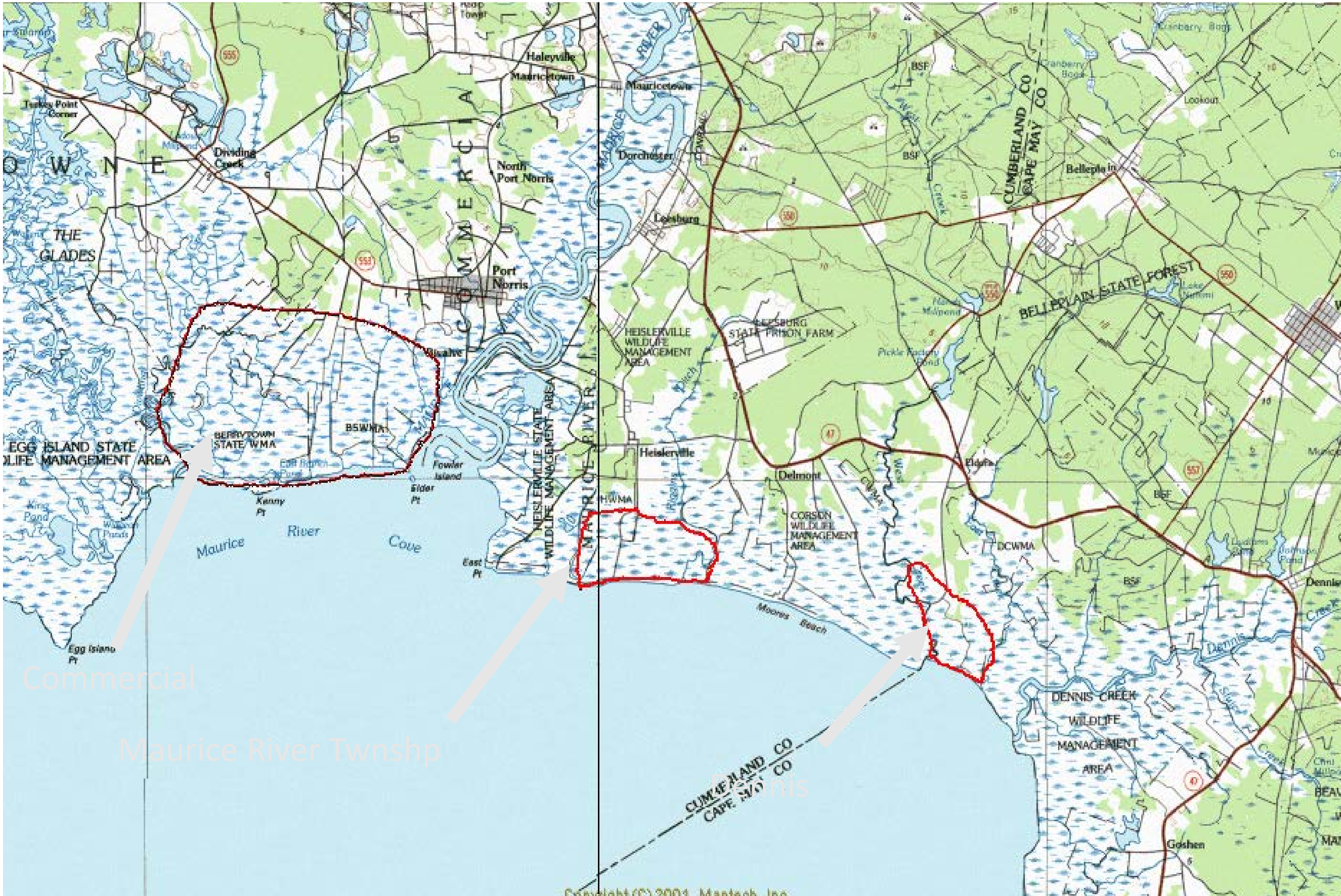
Scientist Emeritus

Woods Hole Oceanographic Inst.

Delaware Bay sites of Estuarine Enhancement Project of Public Service Enterprise Group

Teal will discuss the red sites (salt marsh, former salt hay farms). He will focus on design, engineering, and construction related to circulation goals and the adaptive management used to help achieve the goals.

Salt Hay Farms, Delaware Bay, New Jersey



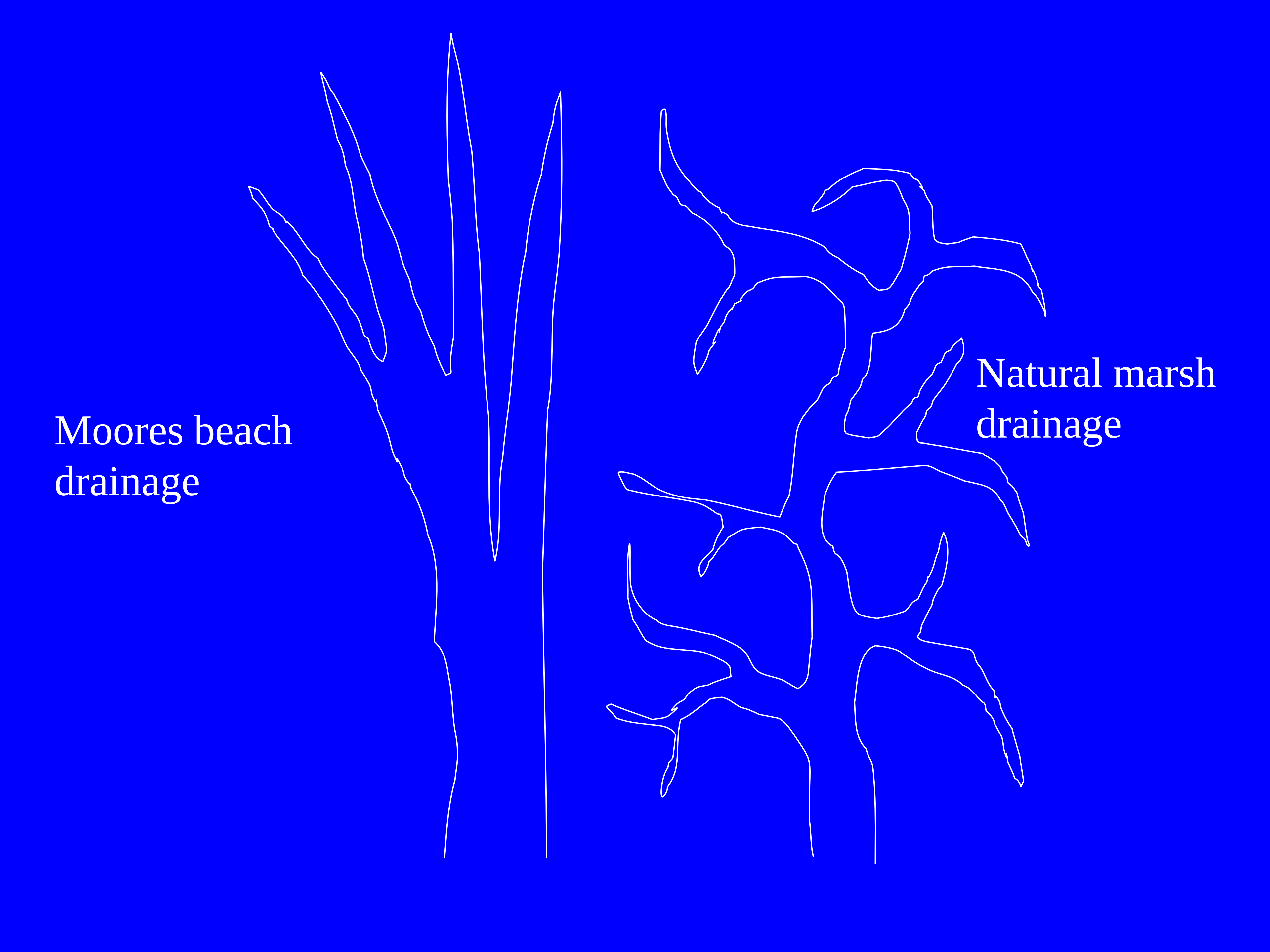

Salt hay farm, firm enough for cars to drive on and brackish enough for *Phragmites* to colonize

Mad Horse Creek

Unmodified salt marsh with natural drainage system

Moores Beach

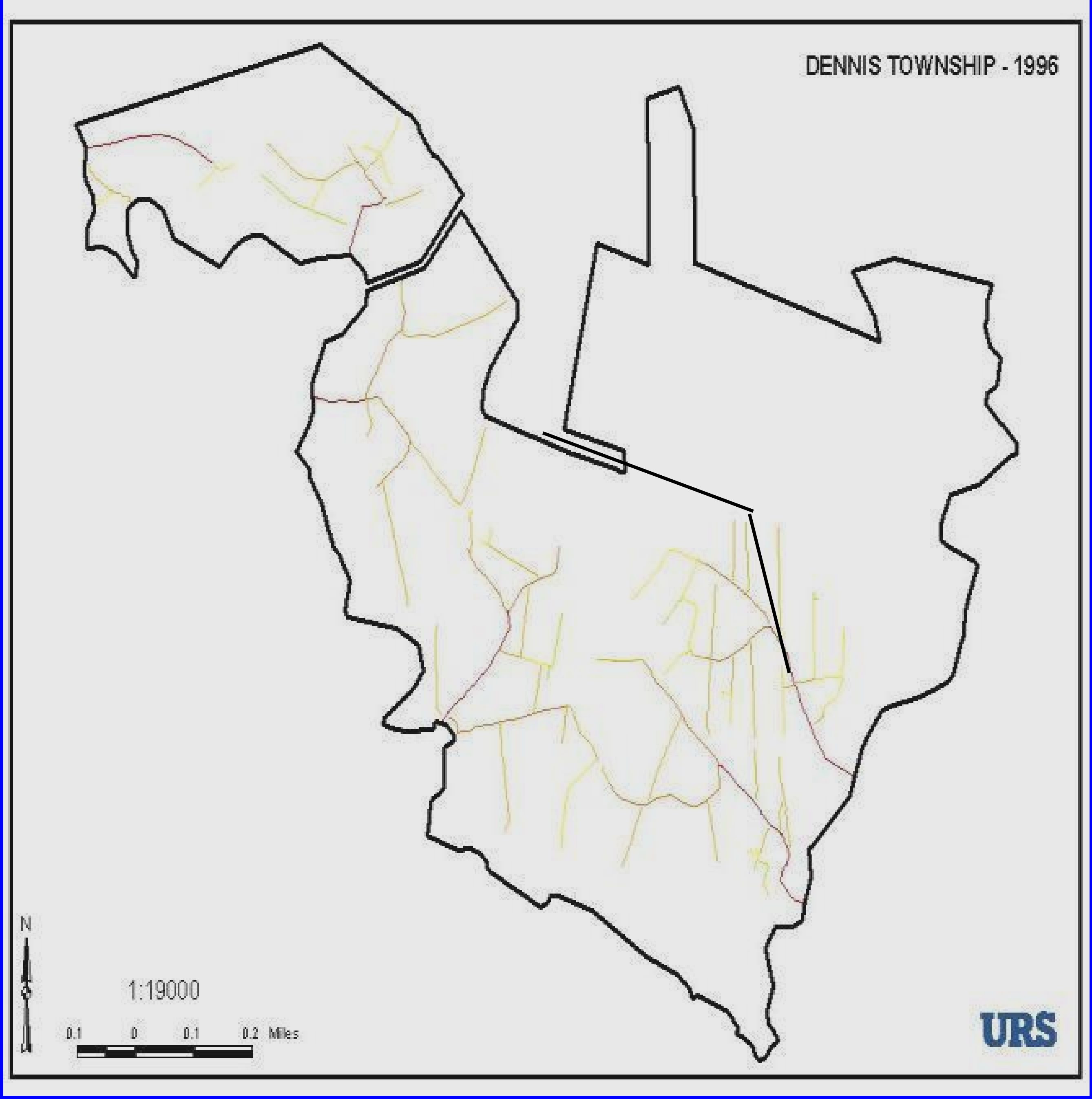
old salt hay farm, the dike opened by a storm decades before


Moores beach drainage
Natural marsh drainage

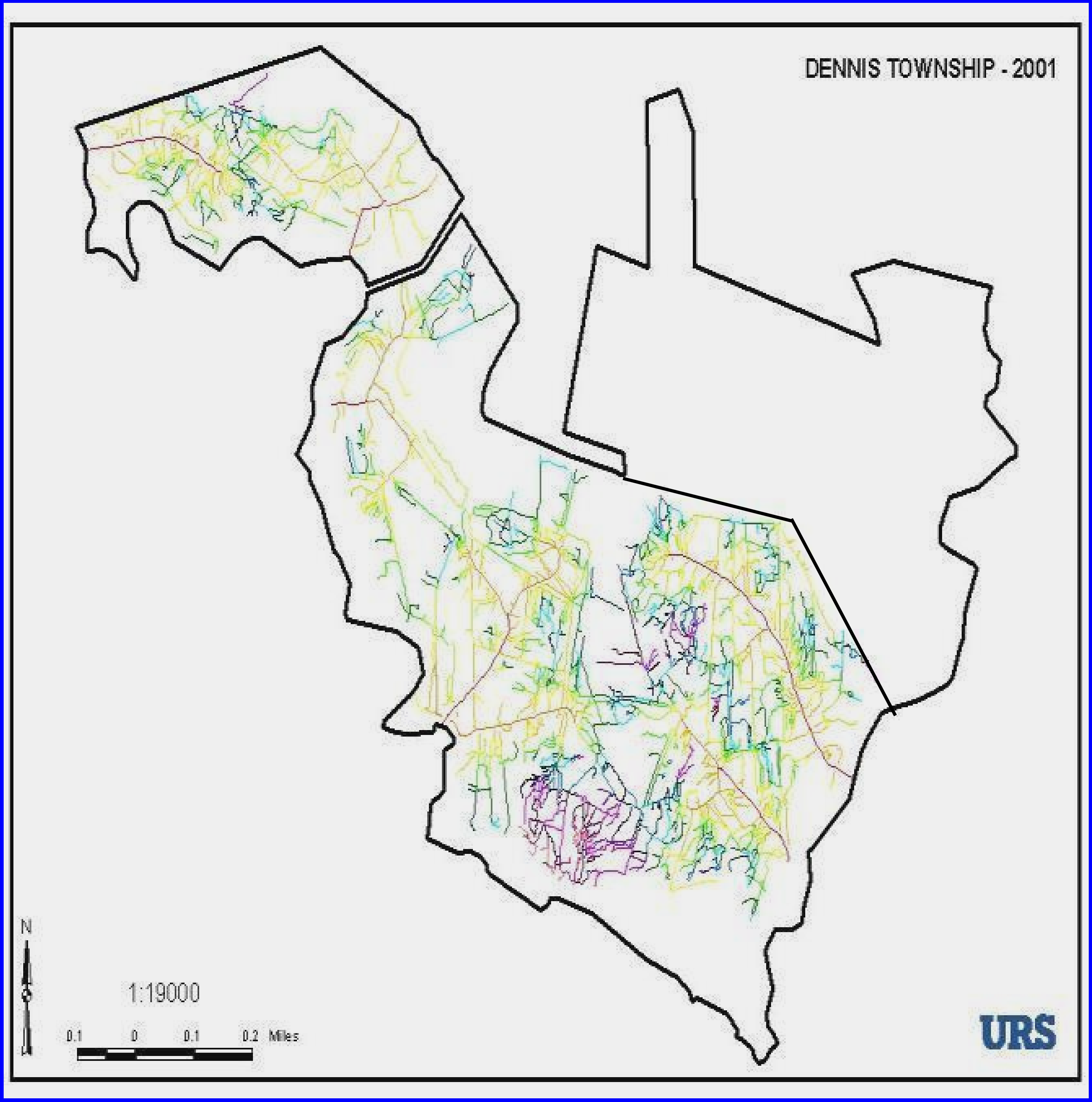
Functioning salt hay farm before restoration

Salt hay farm just after dikes were breached

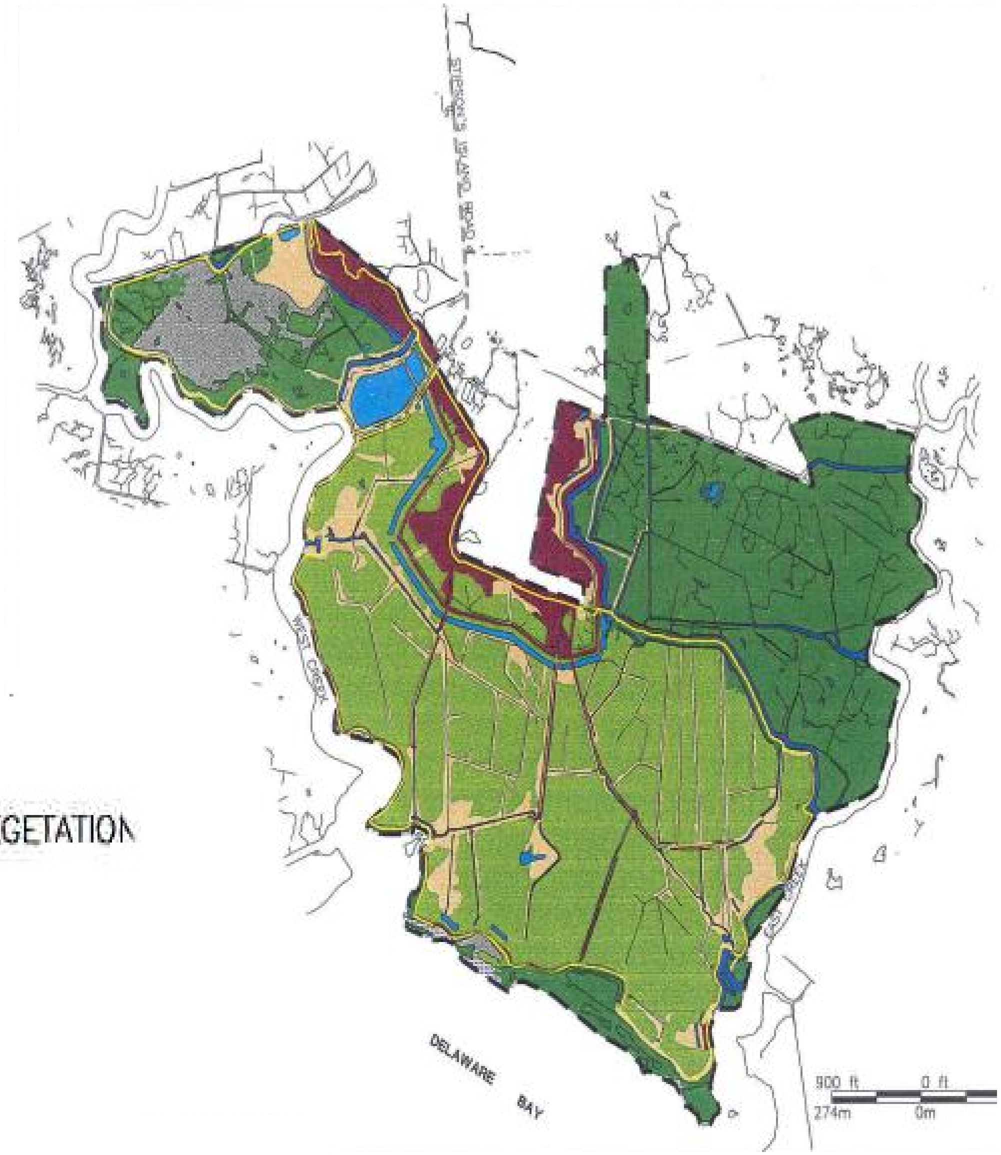
Initial dredged channels (brown) and farm drainage channels (yellow)



Natural marsh channel development after five years



1995

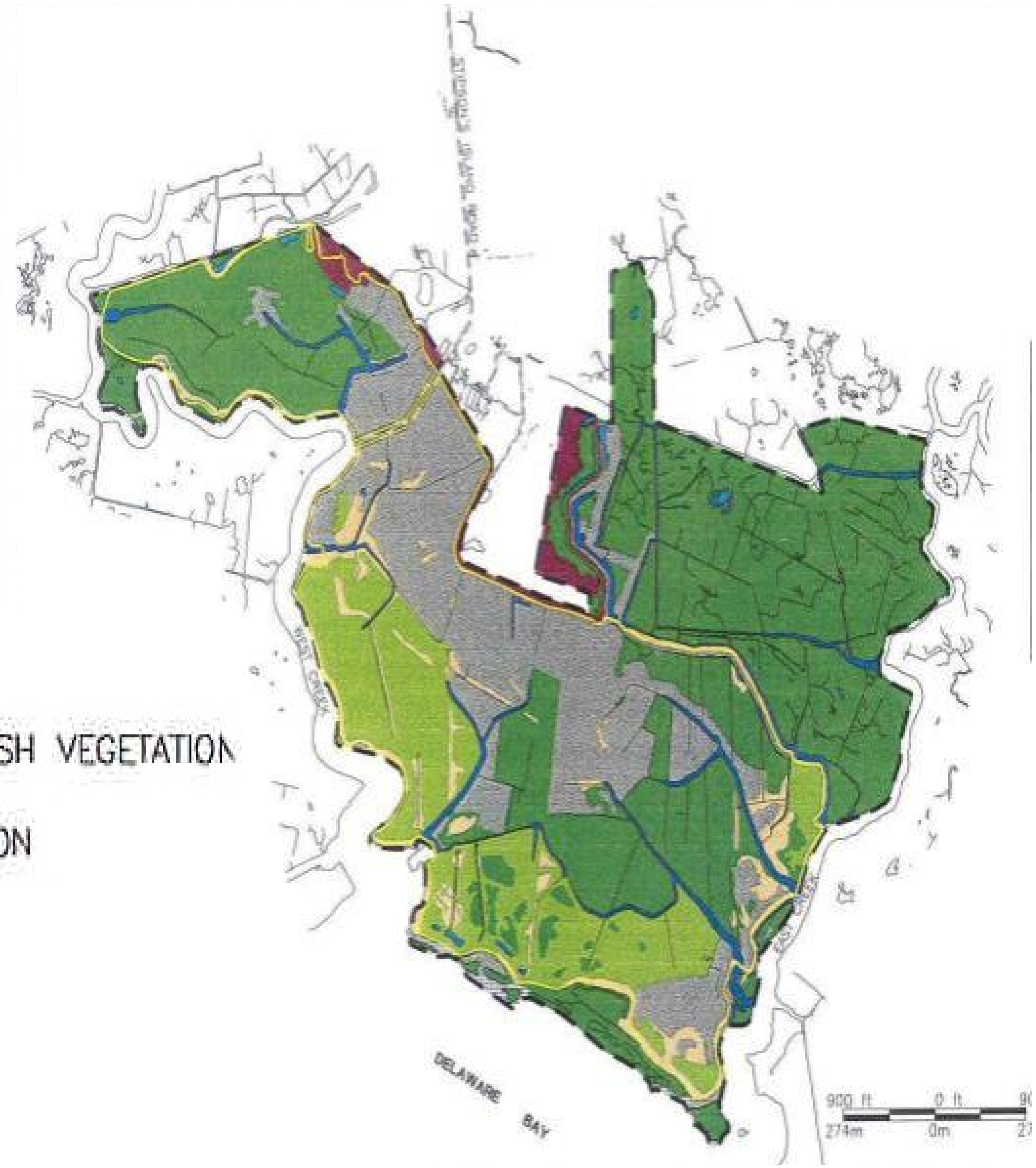


VEGETATIVE COVER CATERGORIES

- *Spartina*/OTHER DESIRABLE MARSH VEGETATION
- SALT HAY FARM
- *Phragmites* DOMINATED VEGETATION
- NON-VEGETATED MARSH PLAIN
- PONDED WATER
- CHANNEL
- OPEN WATER
- UPLAND/DEVELOPED LAND

Naturally seeded *Spartina alterniflora* in first spring after opening dikes

1996



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1999

VEGETATIVE COVER CATERGORIES

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2001

VEGETATIVE COVER CATERGORIES

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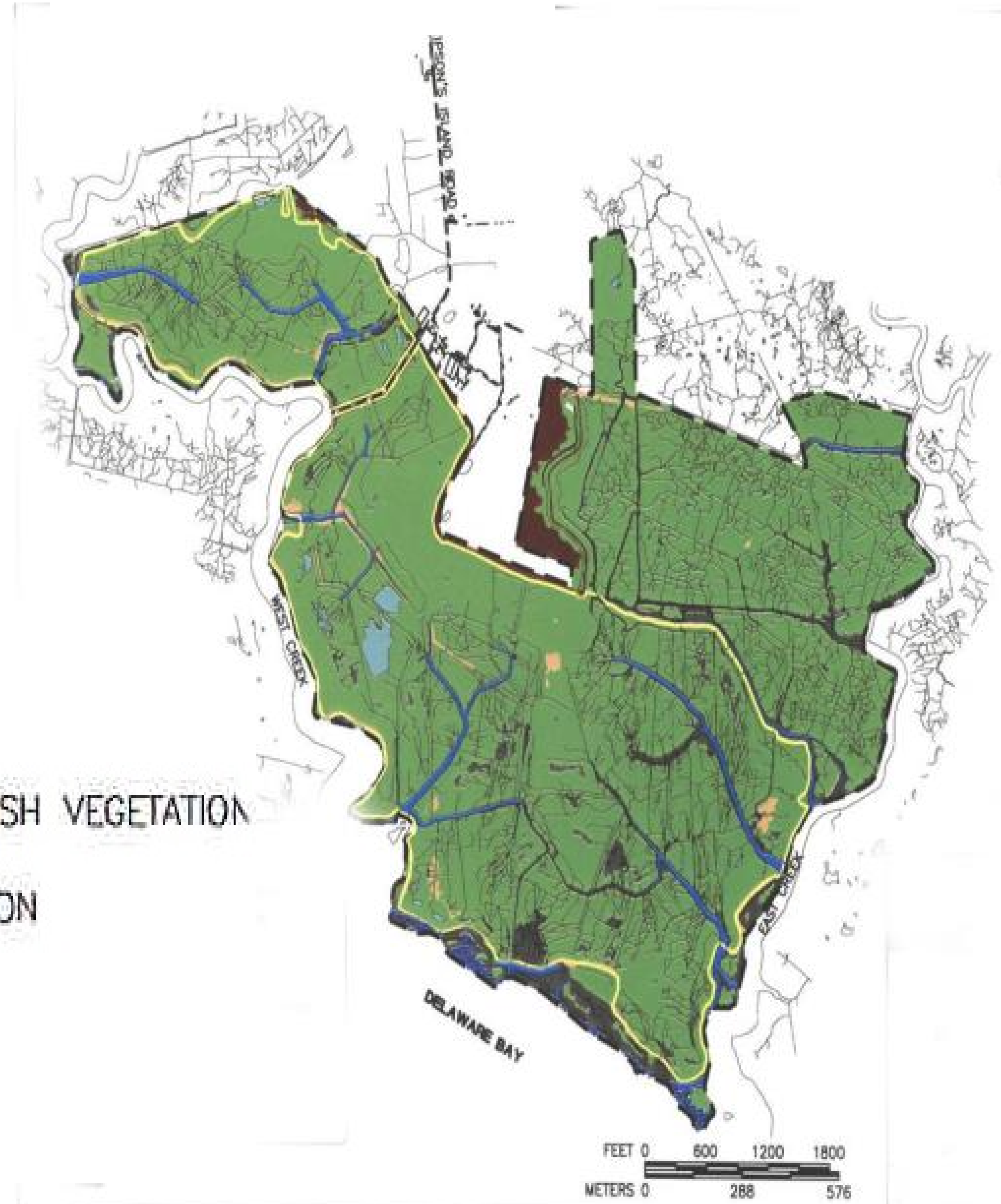
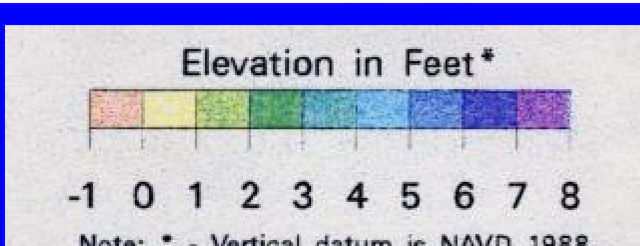
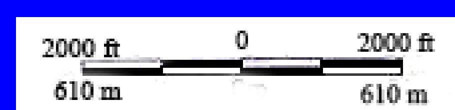
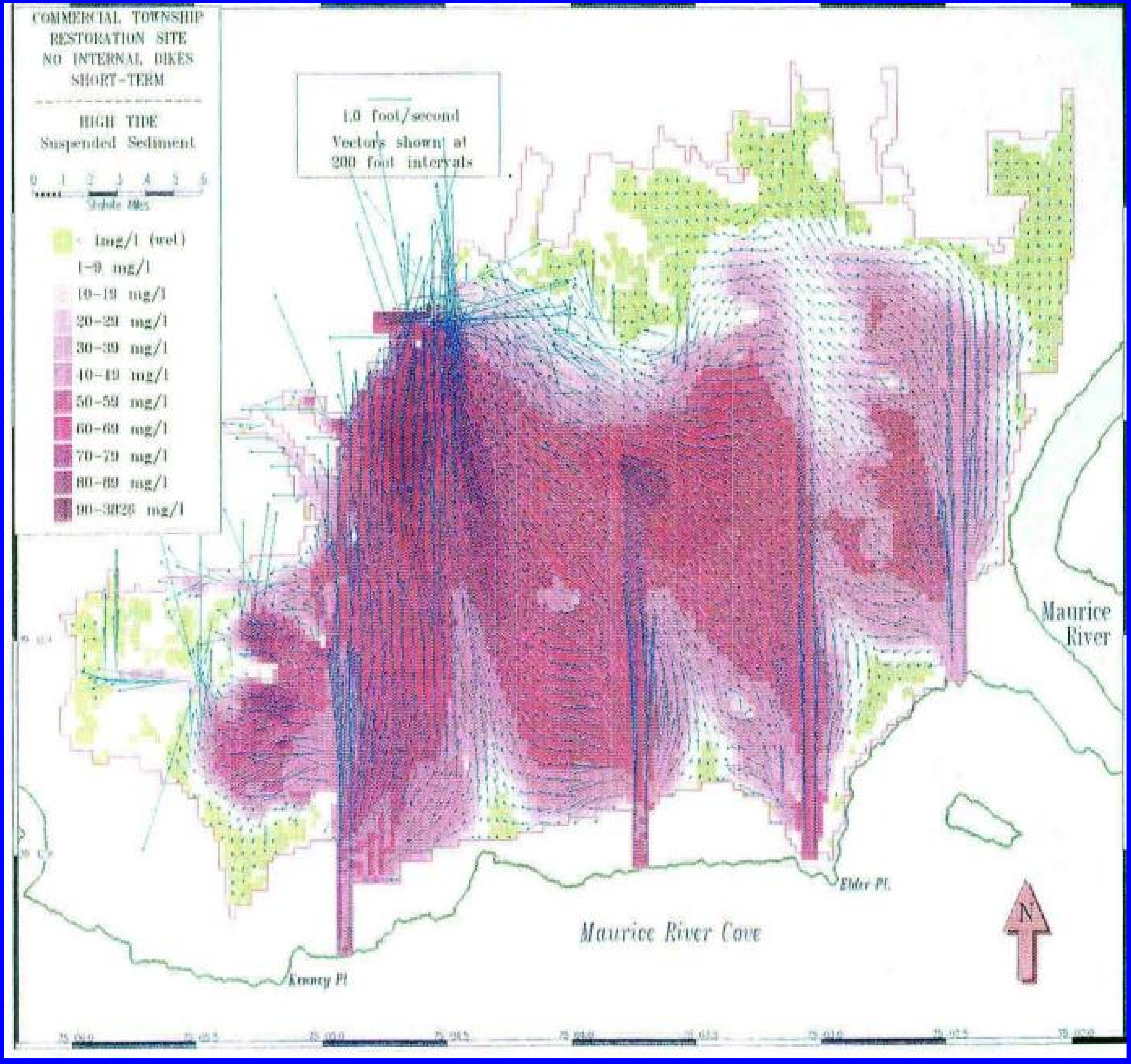


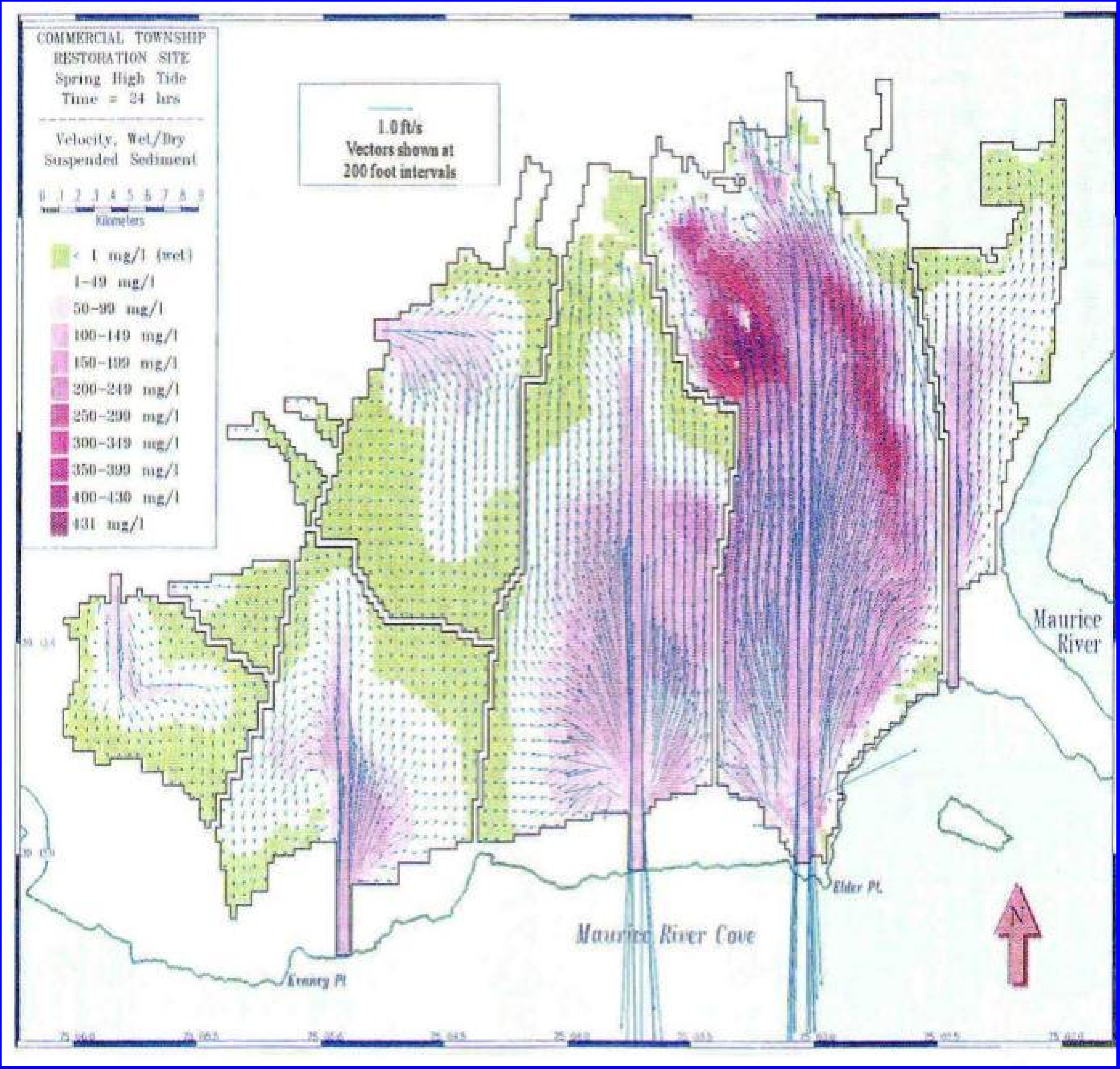
Can’t tell restored from natural


DOWNE TOWNSHIP
COMMERCIAL TOWNSHIP
DELAWARE BAY

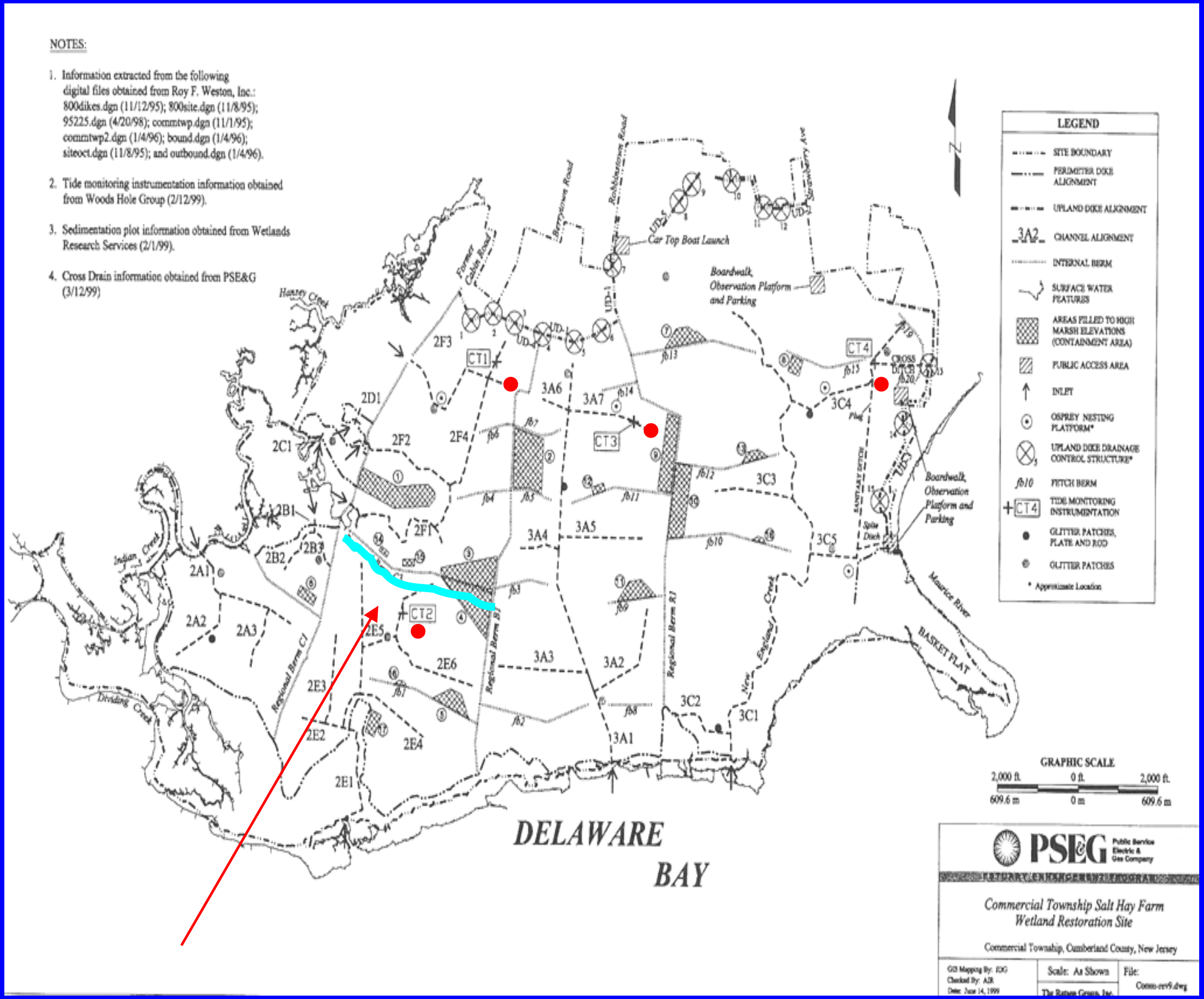

Elevation in Feet*
-1 0 1 2 3 4 5 6 7 8
Note: * - Vertical datum is NAVD 1988


2000 ft
0
2000 ft
610 m
610 m

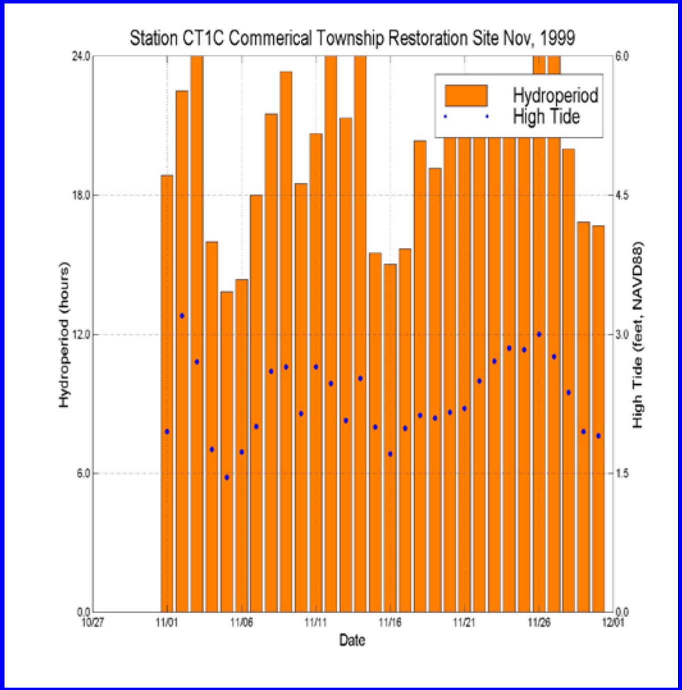

COMMERCIAL TOWNSHIP
RESTORATION SITE
NO INTERNAL DIKES
SHORT-TERM
HIGH TIDE
Suspended Sediment
< 1mg/l (wet)
1-9 mg/l
10-19 mg/l
20-29 mg/l
30-39 mg/l
40-49 mg/l
50-59 mg/l
60-69 mg/l
70-79 mg/l
80-89 mg/l
90-3826 mg/l
1.0 foot/second
Vectors shown at
200 foot intervals
Maurice River
Maurice River Cove
Elder Pt.
Kenney Pt.
N

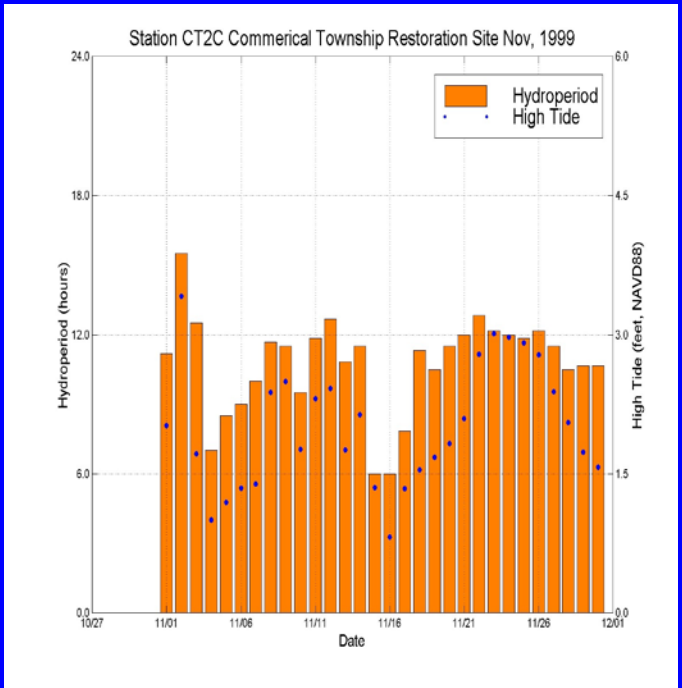

COMMERCIAL TOWNSHIP
RESTORATION SITE
Spring High Tide
Time = 24 hrs
Velocity, Wet/Dry
Suspended Sediment
0 1 2 3 4 5 6 7 8 9
Kilometers
< 1 mg/l (wet)
1-49 mg/l
50-99 mg/l
100-149 mg/l
150-199 mg/l
200-249 mg/l
250-299 mg/l
300-349 mg/l
350-399 mg/l
400-430 mg/l
431 mg/l
1.0 ft/s
Vectors shown at
200 foot intervals
Maurice
River
Elder Pt.
Maurice River Cove
Kenney Pt


DOWNE TOWNSHIP
COMMERCIAL TOWNSHIP
PORT NORRIS
MAURICE
RIVER
TOWNSHIP
DELAWARE BAY



- **Regional Berm 3C**
  - Berm separates Region 2F and Region 2E
  - Berm has been repaired/rebuilt three times since completion of construction
  - New breaches developed in late fall 1999
  - Observations indicate that latest breach may be improving drainage in Region 2F





Site Regions 2F and 2E

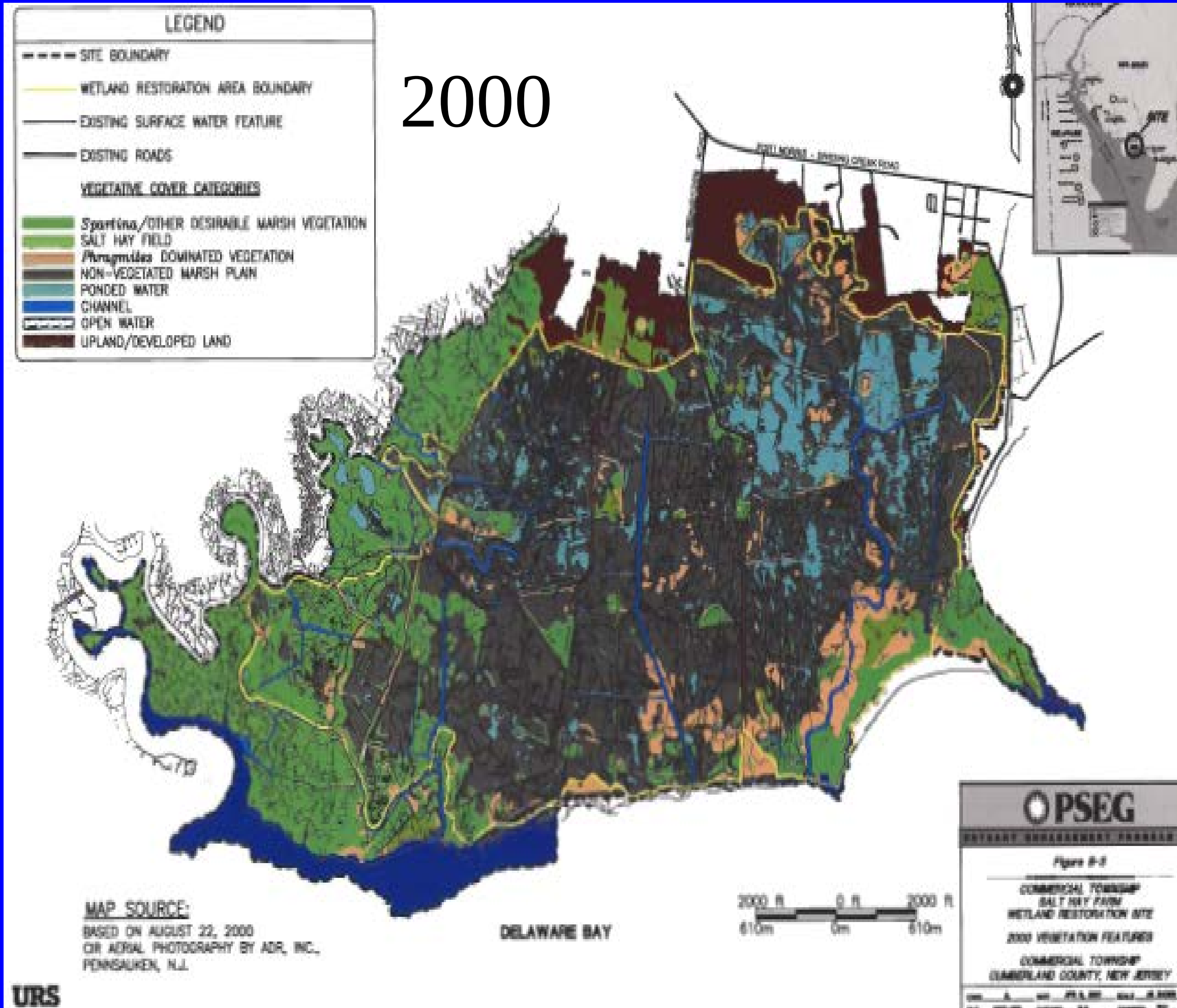
Tidal Analysis

Regional Berm 3C breach –
Looking from Region 2E toward 2F

Regional Berm 3C breach –
Looking from Region 2F toward 2E

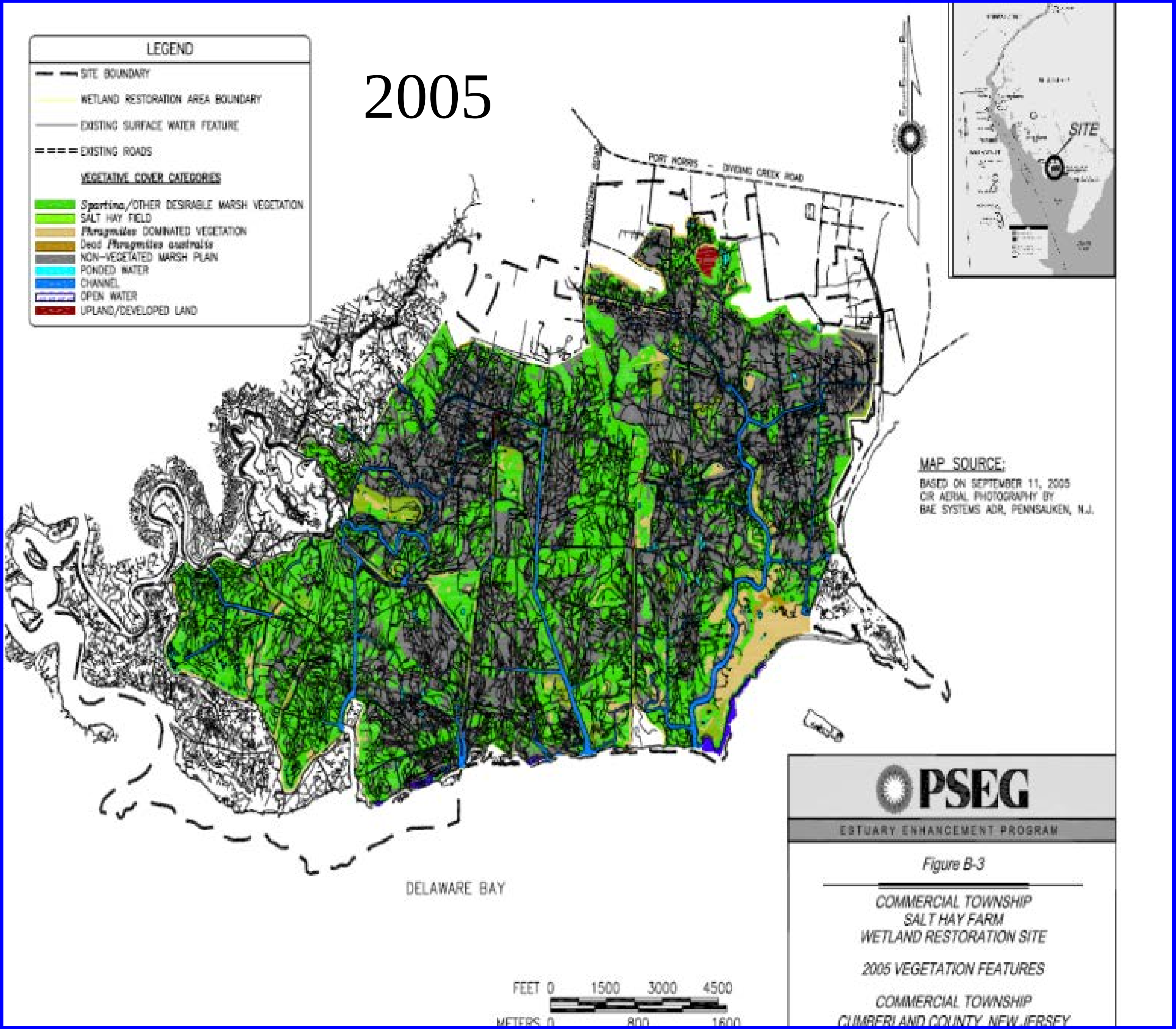

7/5/2010
Image USDA Farm Service Agency
Image © 2014 DigitalGlobe
Google earth

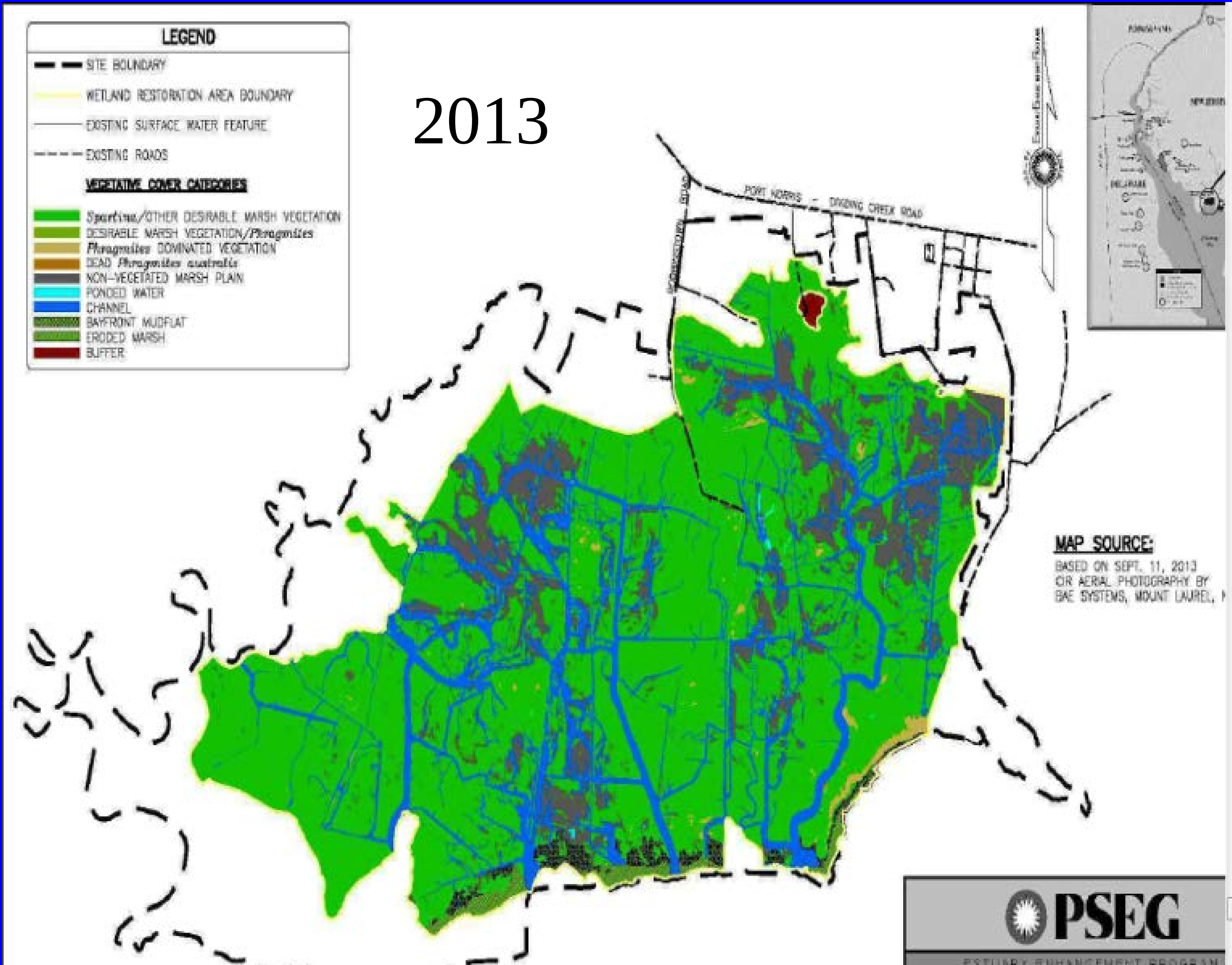
2000



LEGEND
SITE BOUNDARY
WETLAND RESTORATION AREA BOUNDARY
EXISTING SURFACE WATER FEATURE
EXISTING ROADS
VEGETATIVE COVER CATEGORIES
Spartina/OTHER DESIRABLE MARSH VEGETATION
SALT HAY FIELD
Phragmites DOMINATED VEGETATION
NON-VEGETATED MARSH PLAIN
PONDED WATER
CHANNEL
OPEN WATER
UPLAND/DEVELOPED LAND
MAP SOURCE:
BASED ON AUGUST 22, 2000
CIR AERIAL PHOTOGRAPHY BY ADR, INC.,
PENNSAUKEN, N.J.
DELAWARE BAY
2000 ft 0 ft 2000 ft
610m 0m 610m
PSEG
COMMERCIAL TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY
URS

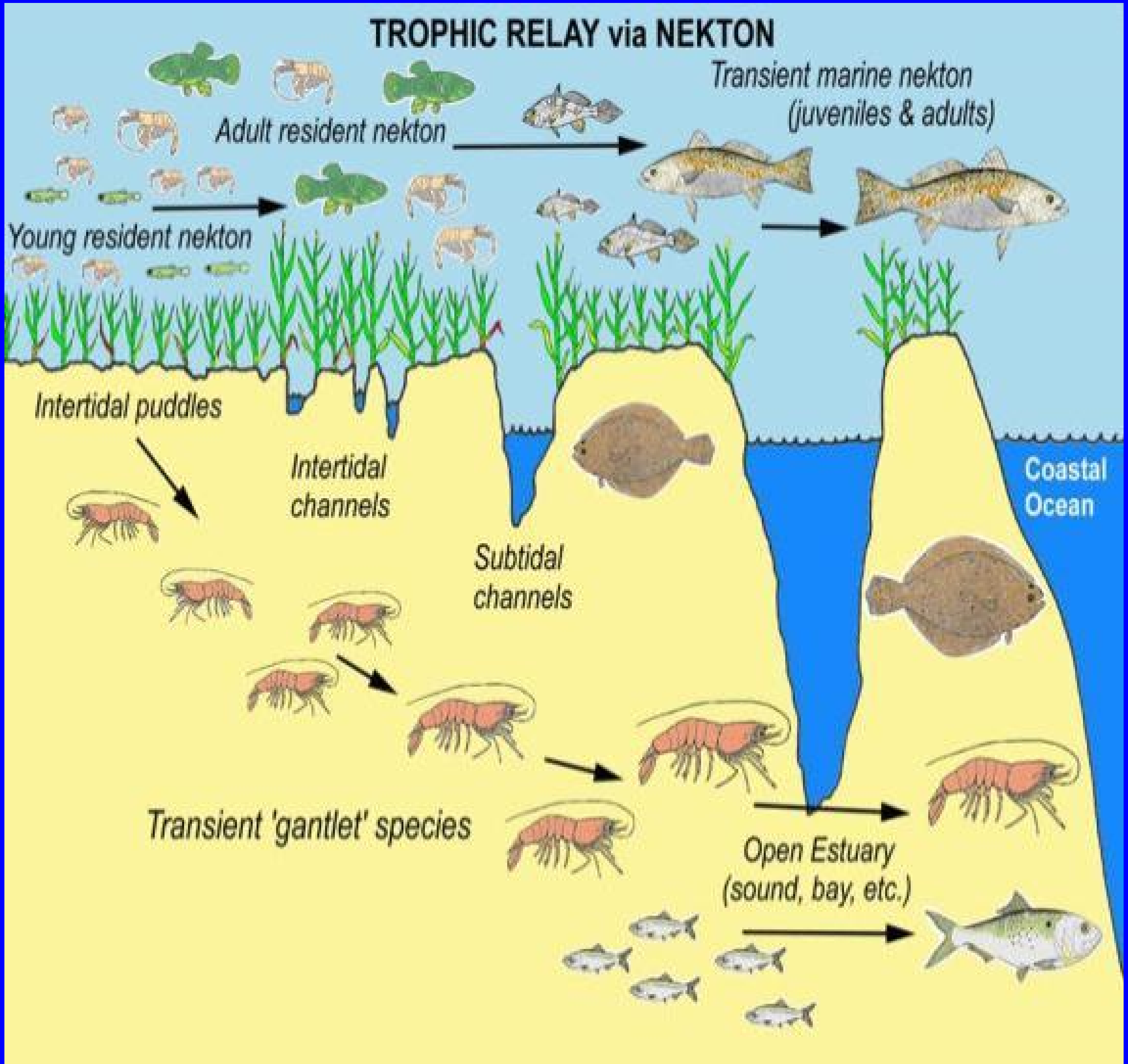
2005


LEGEND
SITE BOUNDARY
WETLAND RESTORATION AREA BOUNDARY
EXISTING SURFACE WATER FEATURE
EXISTING ROADS
VEGETATIVE COVER CATEGORIES
Spartina/OTHER DESIRABLE MARSH VEGETATION
SALT HAY FIELD
Phragmites DOMINATED VEGETATION
Dead Phragmites australis
NON-VEGETATED MARSH PLAIN
PONDED WATER
CHANNEL
OPEN WATER
UPLAND/DEVELOPED LAND
PORT NORRIS – DIVIDING CREEK ROAD
SITE
MAP SOURCE:
BASED ON SEPTEMBER 11, 2005
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS ADR, PENNSAUKEN, N.J.
DELAWARE BAY
FEET 0 1500 3000 4500
METERS 0 800 1600
PSEG
ESTUARY ENHANCEMENT PROGRAM
Figure B-3
COMMERCIAL TOWNSHIP
SALT HAY FARM
WETLAND RESTORATION SITE
2005 VEGETATION FEATURES
COMMERCIAL TOWNSHIP
CUMBERLAND COUNTY, NEW JERSEY

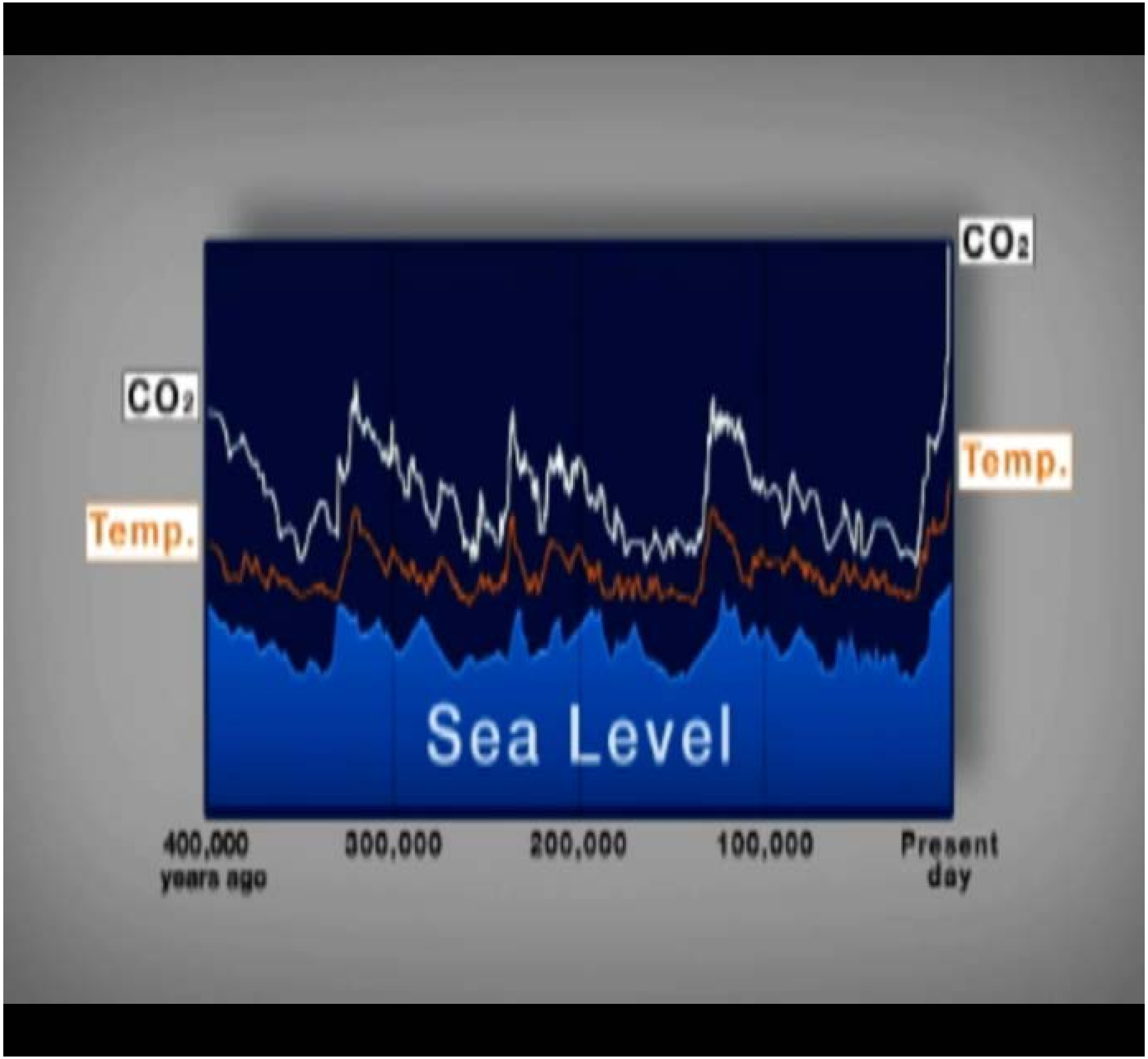

2013
LEGEND
SITE BOUNDARY
WETLAND RESTORATION AREA BOUNDARY
EXISTING SURFACE WATER FEATURE
EXISTING ROADS
VEGETATIVE COVER CATEGORIES
Spartina/OTHER DESIRABLE MARSH VEGETATION
DESIRABLE MARSH VEGETATION/Phragmites
Phragmites DOMINATED VEGETATION
DEAD Phragmites australis
NON-VEGETATED MARSH PLAIN
PONDED WATER
CHANNEL
BAYFRONT MUDFLAT
ERODED MARSH
BUFFER
PORT NORRIS - DIVIDING CREEK ROAD
MAP SOURCE:
BASED ON SEPT. 11, 2013
CIR AERIAL PHOTOGRAPHY BY
BAE SYSTEMS, MOUNT LAUREL,
PSEG
ESTUARY ENHANCEMENT PROGRAM

Fundulus heteroclitus

Life styles of the rich and mobile



Ron Kneib, U. Ga.



CO_2
CO_2
Temp.
Temp.
Sea Level
400,000
years ago
300,000
200,000
100,000
Present
day

Delaware Bay drowned forest

Reference site

http://www.pseg.com/info/environment/pdf/scientific_publications.pdf

Tidal Marsh Restoration in the Northeast: Past Experiences, Future Challenges

James Turek
NOAA Restoration Center, Narragansett, RI

Association of State Wetland Managers
Tidal Wetlands Restoration Webinar
December 9, 2014

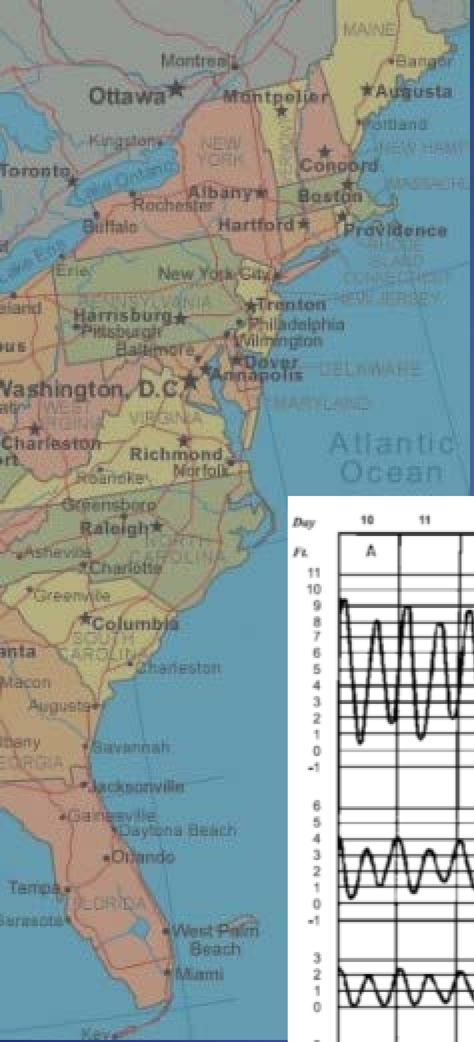
Atlantic Coast Tidal Marshes in the Northeast

More expansive, contiguous tidal wetland area and individual wetland size in the Coastal Plain in contrast with the glaciated Northeast

State	Total (AC)	Size Range (AC)	Mean Size (AC)	SD (AC)	Database, Source
Connecticut	14,122	0.1-1,211	27.0	97.1	NWI, 2010, K. O'Brien
Rhode Island	3,069	0.03-114	3.4	8.5	RIGIS, 2003, P. August
Maryland, Chesapeake Bay	189,519	0.03-14,969	23.4		NWI, 2010, M. Canick
Virginia, Chesapeake Bay	88,322	0.04-1,787	8.6		NWI, 2010, M. Canick

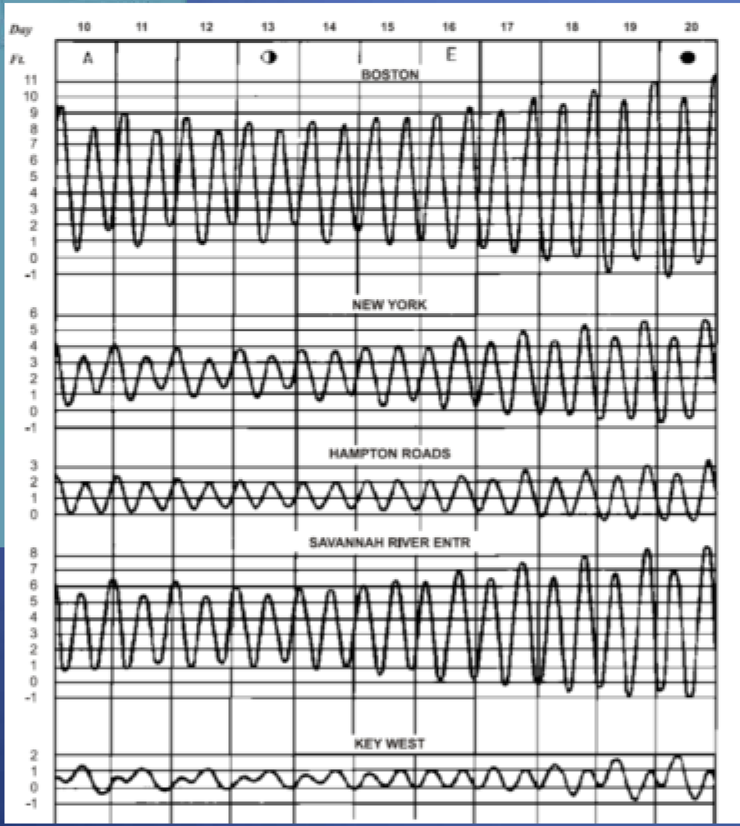
Photos: C. Mason

Understanding **hydrology** affecting project site **hydraulics** is key to restoration design

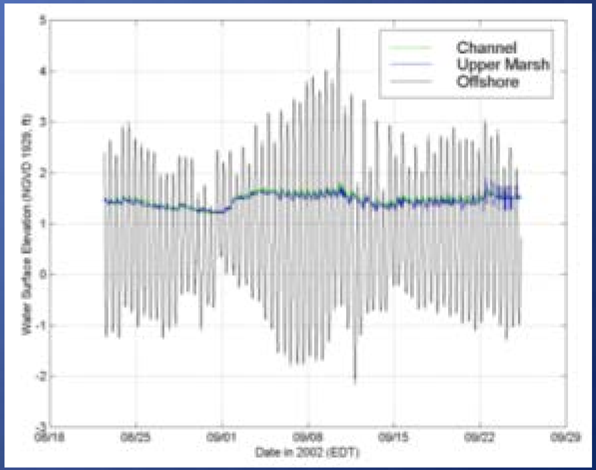


NOAA Tides and Currents:
http://www.co-ops.nos.noaa.gov

- Lunar and latitudinal effects on tides; local coastal conditions (e.g., narrow inlets, shallow waters) and weather conditions (e.g., barometric pressure, wind) also affect tidal hydraulics
- Assess local marsh hydraulics



Source: NOAA COOPS, 2001

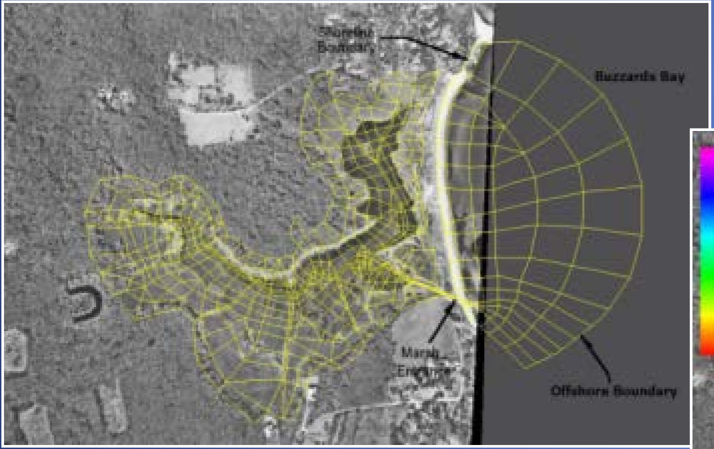


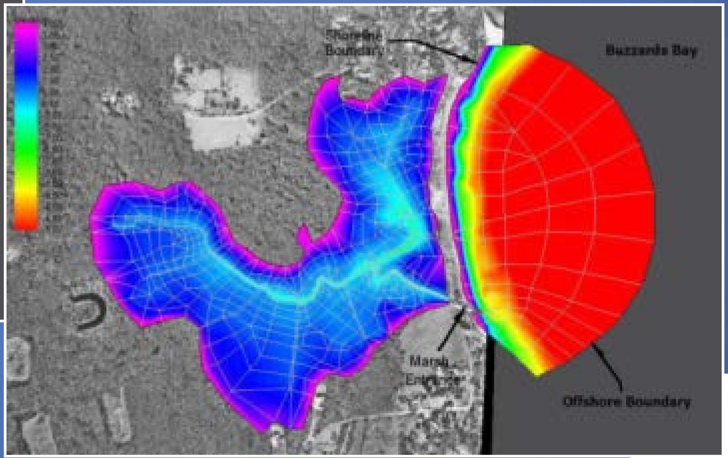
Source: EA, 2004

Elevational mapping of project site and other contributing features to create accurate Digital Elevation Model (DEM)

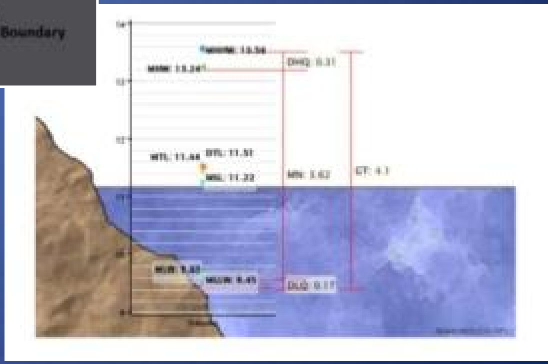
- Conventional topographic and bathymetric field survey (e.g., DGPS)
- Aerial photogrammetry
- LiDAR (Light detection and ranging)

Hydraulic Model: Use of tidal data and DEM
(e.g., MacBroom and Schiff, 2012)





Model figure sources: EA, 2004



NOAA tidal datums:
http://www.coops.nos.noaa.gov/stations.html?tpe=Datums

NOAA transform vertical data including orthometric datums (NAD88, NGVD29): http://vdatum.noaa.gov/

NOAA RC Northeast Tidal Marsh Restoration Projects

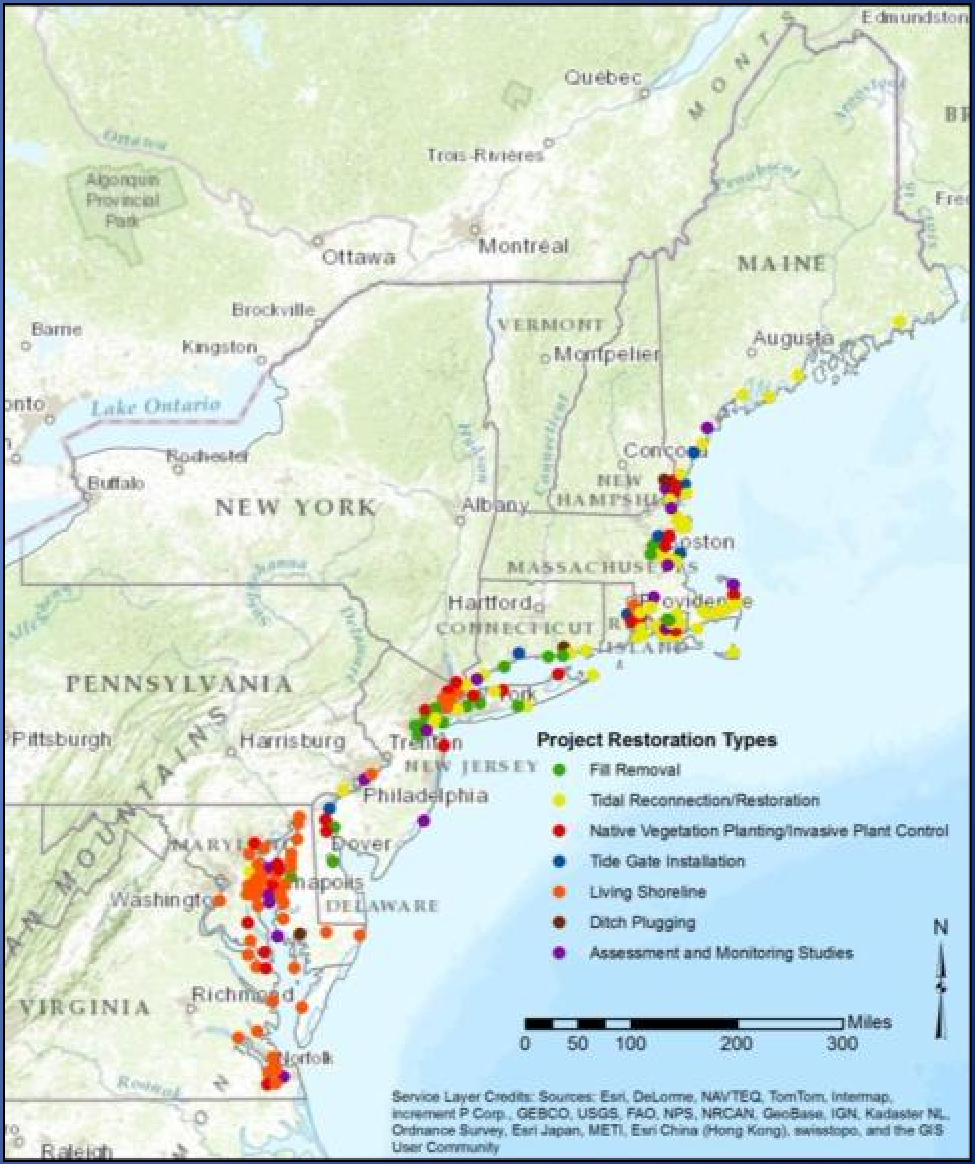
Project Type:

Fill removal	20 (10.0%)
Tidal hydrology reconnection	60 (29.9%)
Plant community management	27 (13.4%)
Tide gate	6 (3.0%)
Living shoreline	63 (31.3%)
Ditch plugging	3 (1.5%)
Assessment/studies	22 (10.9%)

Total Projects: **201**

Total Acres: **4,000.5**

http://www.habitat.noaa.gov/



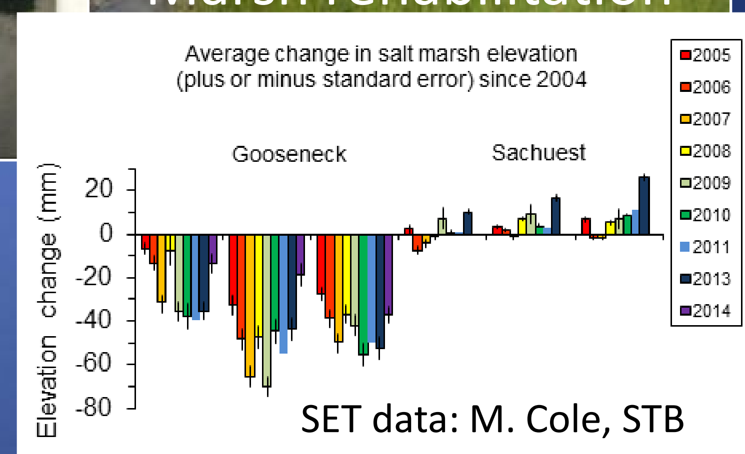
Map prepared by R. King, NOAA

Tidal Reconnection

Gooseneck Cove, Newport, RI

Substrate degradation, see: Ainsfield et al., 1999)

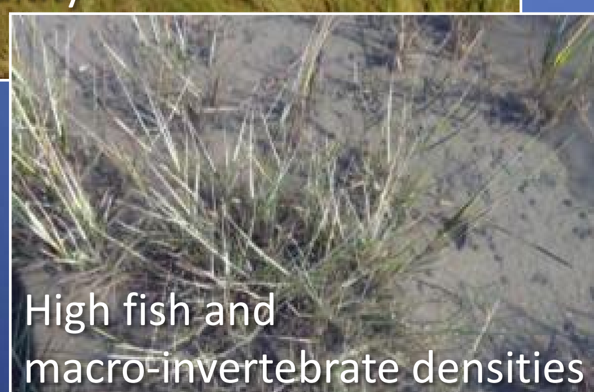
Gooseneck Cove Construction, 2009



Restored Hydrology, Ecological Changes
Padanaram Marsh, Dartmouth, MA

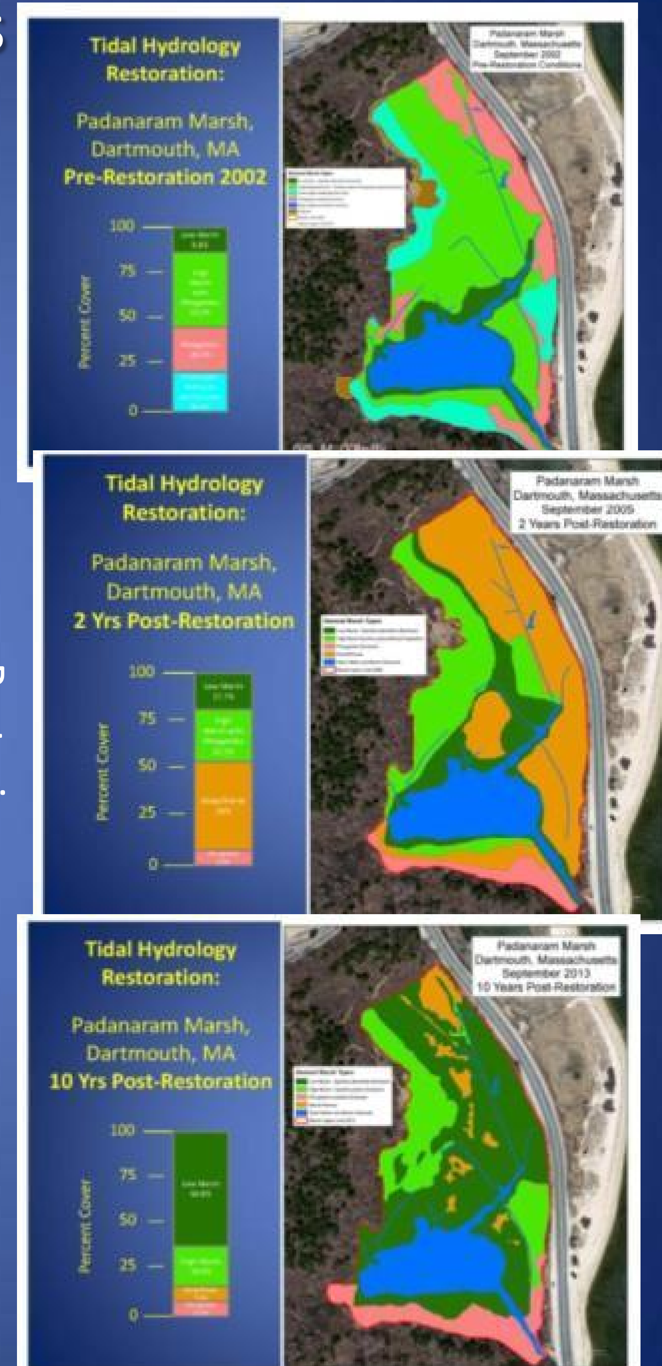
Phragmites australis community

Restoring *Spartina alterniflora* community



High fish and macro-invertebrate densities

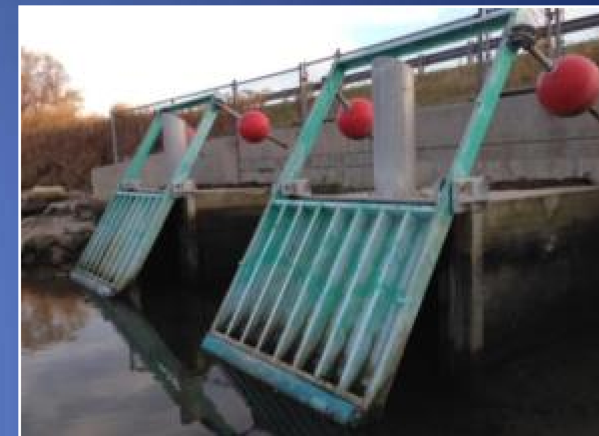
Restoring



Tidal Reconnection Challenges

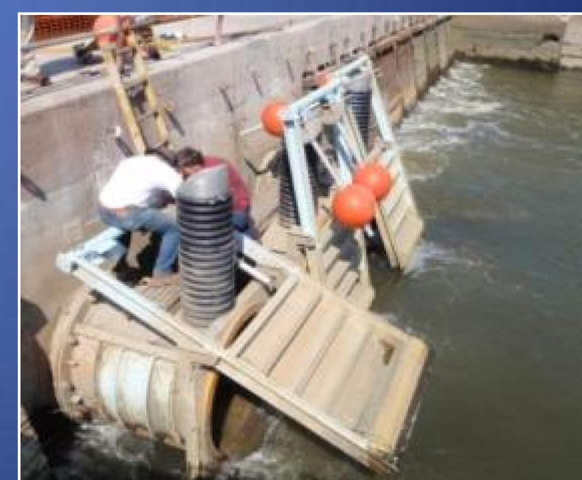
Beachfront channel and channel migration

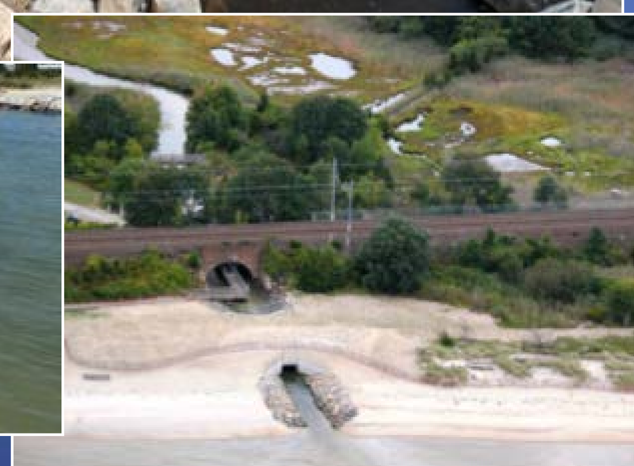
Bordering low-lying development



Low-level groin and apron protection at beachfront

Self-regulating tide gates





Fill Removal

Fill or soil removal projects (Marsh restoration or creation)

Evaluate cost/benefit of fill removal

Take into account predicted SLR rates for setting excavation depth (e.g., NOAA SLR planning document, 2011)

http://www.habitat.noaa.gov/pdf/slr_workshop_report_december_2011.pdf

Target reuse of non-contaminated soils (e.g., restoring elevation capital of nearby degraded peat-dominated marshes)

Volunteer marsh planting

Spartina community 1-yr later

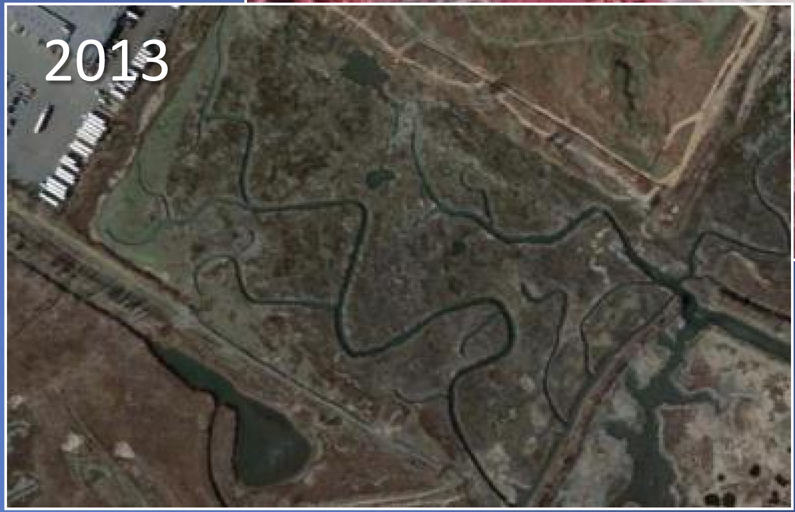
Hempstead Harbor Park, North Hempstead, NY

McKinney NWR, GMU, Stamford, CT

Site conditions, May 2008

Creek formation

2006



2013

Channel evolution and design: Myrick and Leopold, 1963, PWA, 1995, Zeff, 1999, Williams et al., 2002

Excavated plain, channel, June 2006

Site conditions, June 2012

Restoration development: Craft et al., 1999, 2003; Warren et al., 2002

Declining Health of Northeast Marshes

Marsh Health Symptoms

See: DeLaune et al., 1994; Davey et al., 2011; Deegan et al., 2012; Wigand et al., 2014

Thin-Layer Spraying

Thin-Layer Sediment Slurry Placement, Gulf of Mexico

Cahoon and Cowan, 1988; DeLaune et al., 1990; Ford et al., 1999

Slocum et al. 2005: intermediate (5-12 cm) soil placement depth resulted in greatest plant vigor over 7-yr period by increasing elevation and bulk density; results: >plant cover, <hydrogen sulfides (mineral soil Fe/Mn precipitating hydrogen sulfide), plus shorter-term ($\leq$3 yrs) nutrient and mineral enrichment benefit

Option of thin-layer slurry placement using pipes to carry slurry into marsh interior, as opposed to slurry spraying with limited spray distance

Source: USACE ERDC/EL TN-07-1, December 2007

Thin-Layer Sediment Spraying: Big Egg Marsh Pilot Project, Jamaica Bay, NY

2-acre marsh restoration using spraying technique after Ford et al. (1999)

Up to 1.6 ft (0.48 m) gain in marsh plain elevation

Dredged sediment source too near pilot site

Photos: D. Cahoon, USGS

Thin-Layer Sediment Spraying: Pepper Creek Marsh, Dagsboro, DE (DNREC, CIB, 2013)

Sediments dredged from nearby navigational channel

Slurry with 85-90% water; spray rate of 3,000 gal/minute

Flexible piping and pivoting spray head nozzle on mini barge to access marsh

Maximum 6-inch initial placement depth

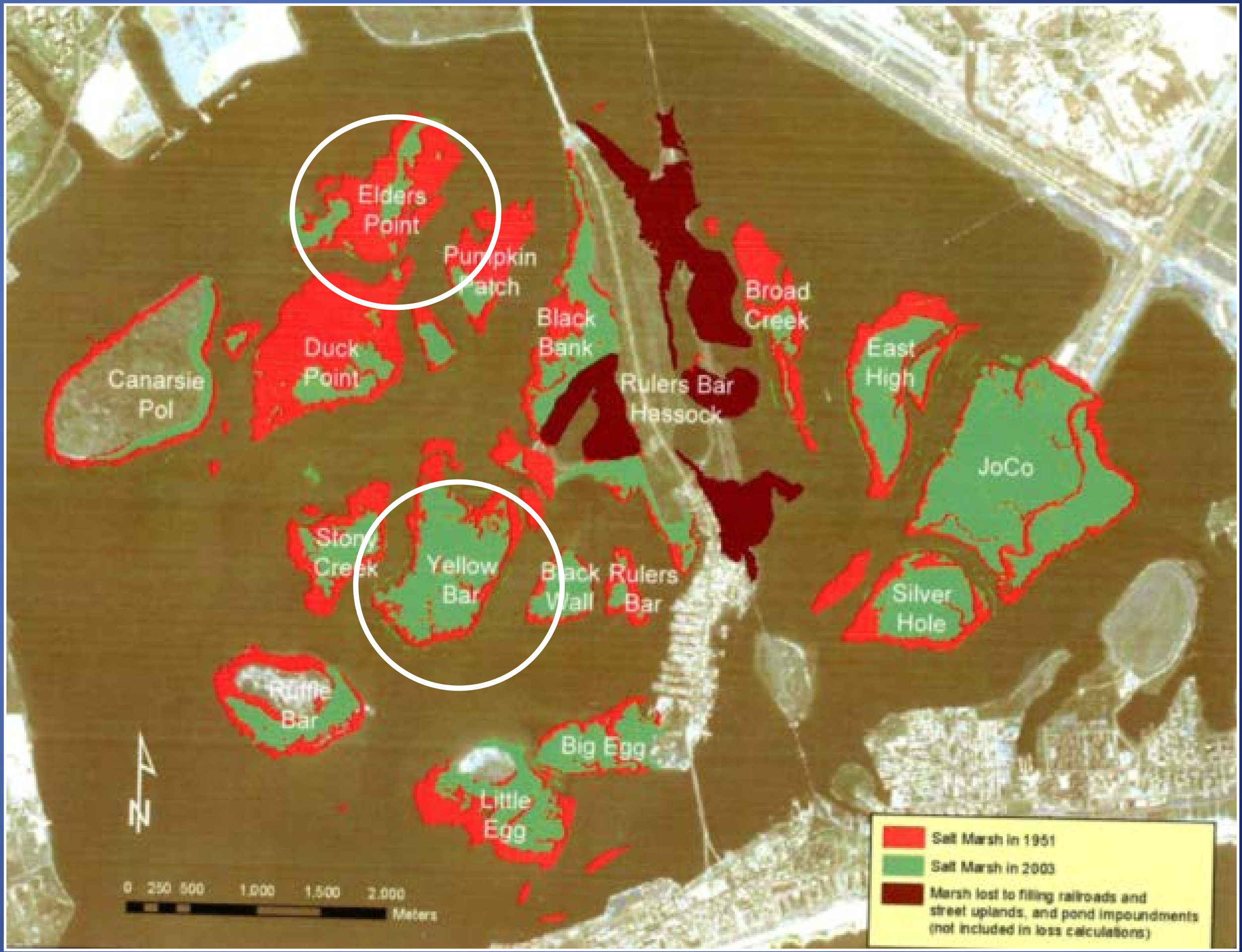
Photos: DNREC, May 2013

Fill Placement

Jamaica Bay Marsh Islands, Gateway National Recreational Area, NY

26 mi^2 bay

Marsh loss rate of 47 ac/yr (1994-1999)



Source: Christiano and Mellander, USPS, GNRA

Jamaica Bay, NY Wetland Restoration: Fill Placement (ACE)

Site	Area (AC)	Soil Volume (CY)	Calc Fill Depth (FT)	Project Cost	Cost/Acre
Elders East (2006)	43	249,000	3.6	$12.9M	$300,967
Elders West (2010)	40	302,000	4.7	$17.2M	$430,000
Yellow Bar (2012)	45.5	375,000	5.1	$19.6M	$431,711
Black Wall (2013)	20.5	155,000	4.7	$2.1M	$102,439
Rulers Bar (2013)	9.8	95,000	6.0	$1.3M	$133,775
	158.8	1,176,000		$53.1M	

Jamaica Bay, Elders East (2006) and Elders West (2010)

Photos: Galvin Brothers, Inc.
U.S. Army Corps of Engineers

Jamaica Bay, Elders Point East: Fill placement, 2006

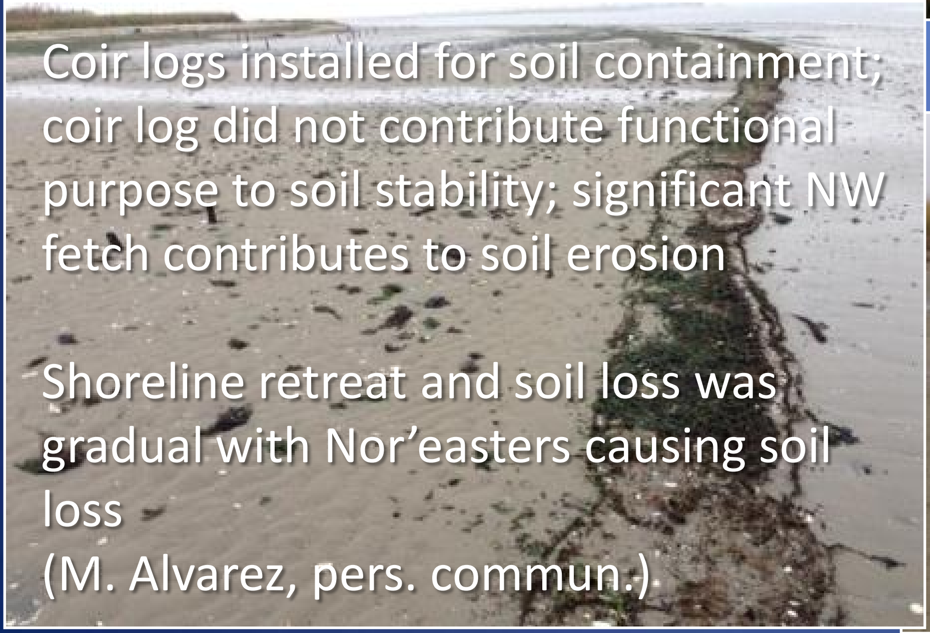
2-4 ft depth of compacted fill

High density of plantings (1.5-ft oc)

High percent plant cover achieved

Seven marsh plant species present

Site conditions, November 2014



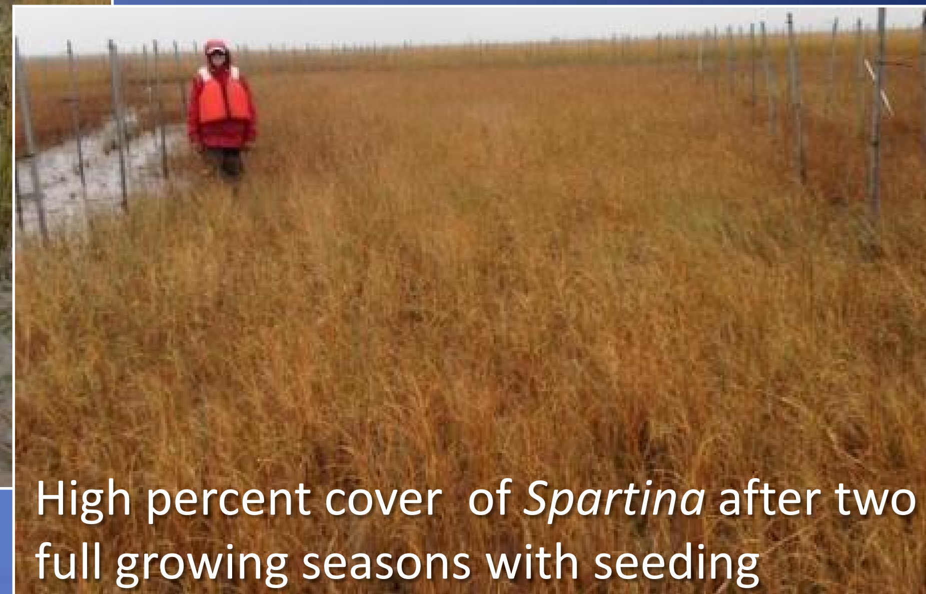
Coir logs installed for soil containment; coir log did not contribute functional purpose to soil stability; significant NW fetch contributes to soil erosion

Shoreline retreat and soil loss was gradual with Nor'easters causing soil loss
(M. Alvarez, pers. commun.)

Tidal channel constructed with natural bed adjustment

Jamaica Bay, Yellow Bar: Fill placement 2012

Seeding tracks, high seed germination rate



High percent cover of *Spartina* after two full growing seasons with seeding

Site conditions, November 2014

Marsh plug transplants (3+-ft dimension) installed along shorefront; good resiliency even with Storm Sandy

Soil overwash along high-energy marsh shorefront

Jamaica Bay, Yellow Bar

High estuarine nutrient loading

High abundance and cover of sea lettuce(*Ulva lactuca*)

Waterfowl foraging, localized effects

USACE and NPS site information:

http://www.nan.usace.army.mil/Missions/CivilWorks/ProjectsinNewYork/EldersPointJamaicaBaySaltMarshIslands.aspx

http://www.nan.usace.army.mil/Portals/37/docs/civilworks/projects/ny/ecor/JamBay/restoration.pdf

www.nature.nps.gov/ParkScience - Volume 27(3): 34-41

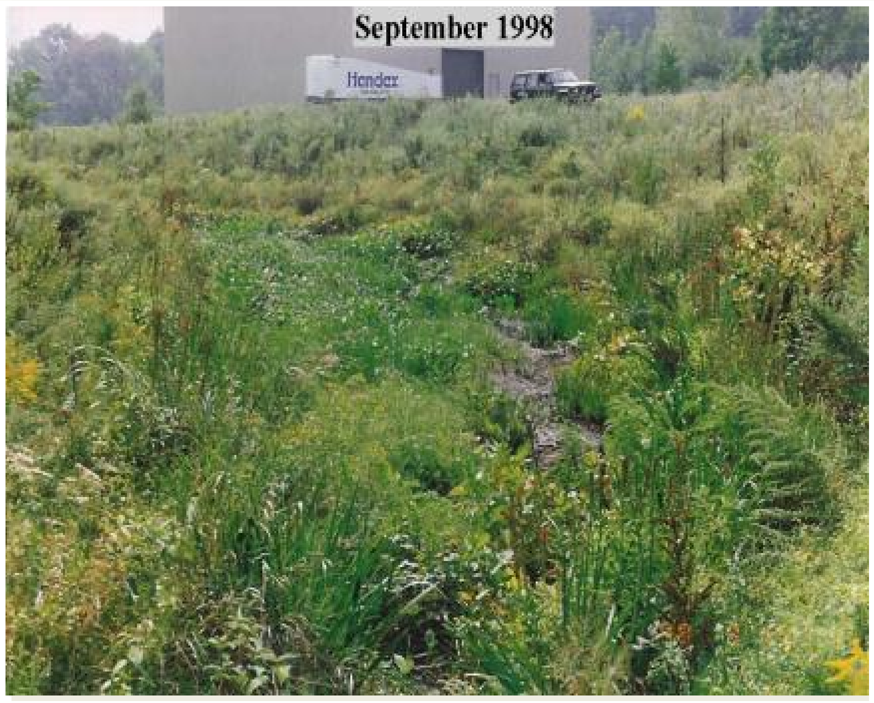
Salt Marsh Restoration - Considerations

Agenda

- Introduction
- General Considerations
- Issues
- Questions

Definitions

- Creation: The conversion of a persistent upland or shallow water area into a wetland by human activity (NRC 2001)



Definitions

- Restoration: The return of a wetland from a disturbed or altered condition by human activity to a previously existing condition (NRC 1992)

Can we restore wetlands?

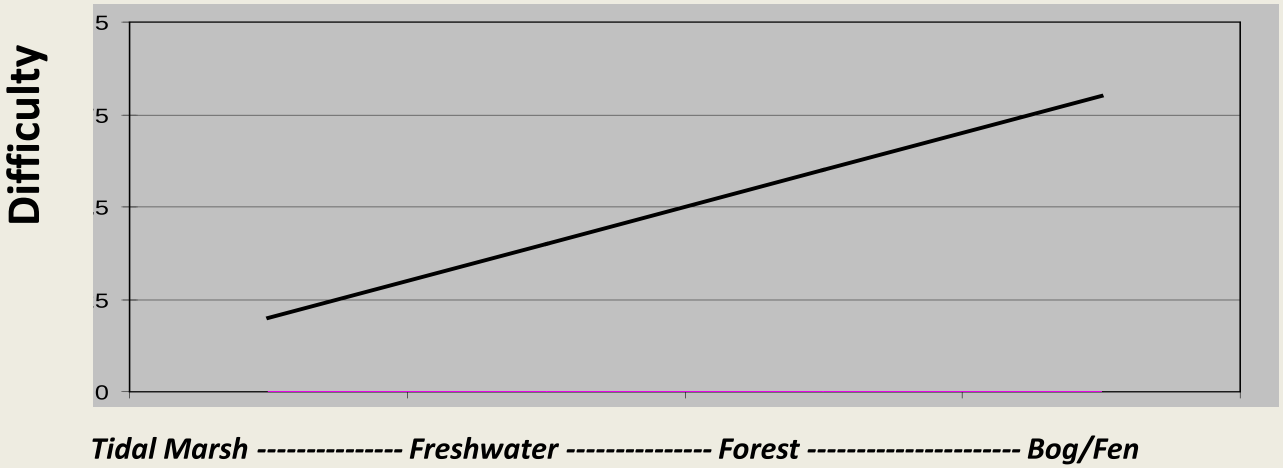
- A lot of yeas and nays
- Publications go both ways
- Key to success is understanding the complexity and functions of the wetland system to be created or restored
- Public outreach and perception - Key

Main Factors to Consider

- What habitat are we going to build?
- Location within the watershed
- Ecology and Engineering
- Pest species
- Impacts of storms and sea level rise

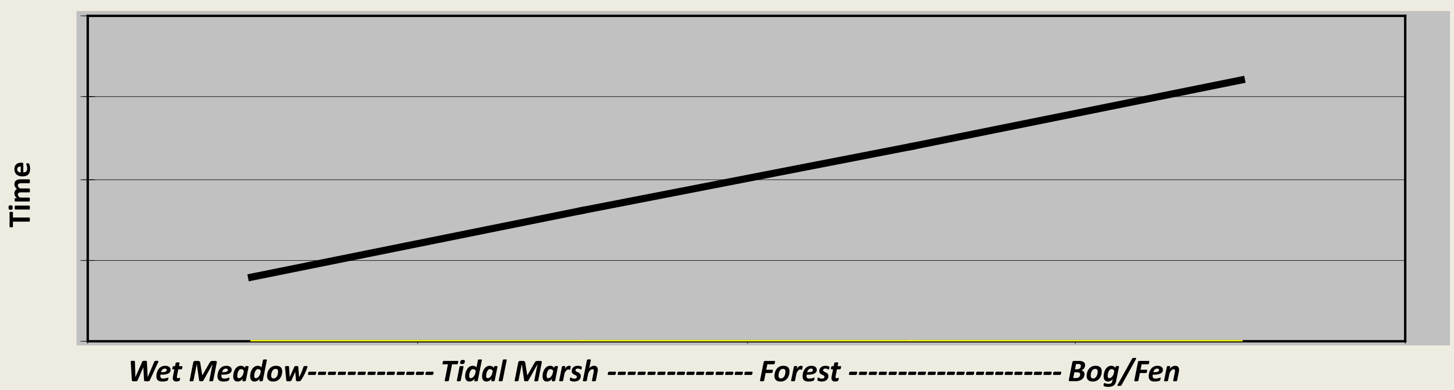
Site Location

Effort vs. Habitat Type

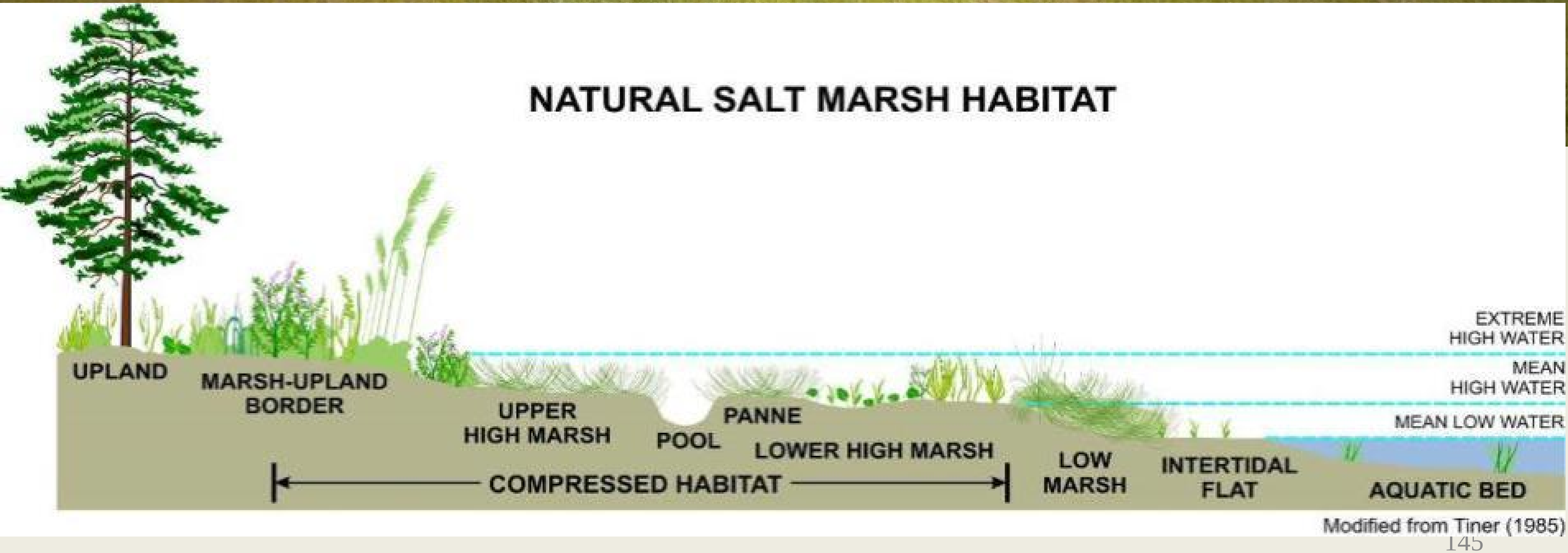


Timeframe

Time vs. Habitat Type



Natural Salt Marsh is an Objective



Two Approaches

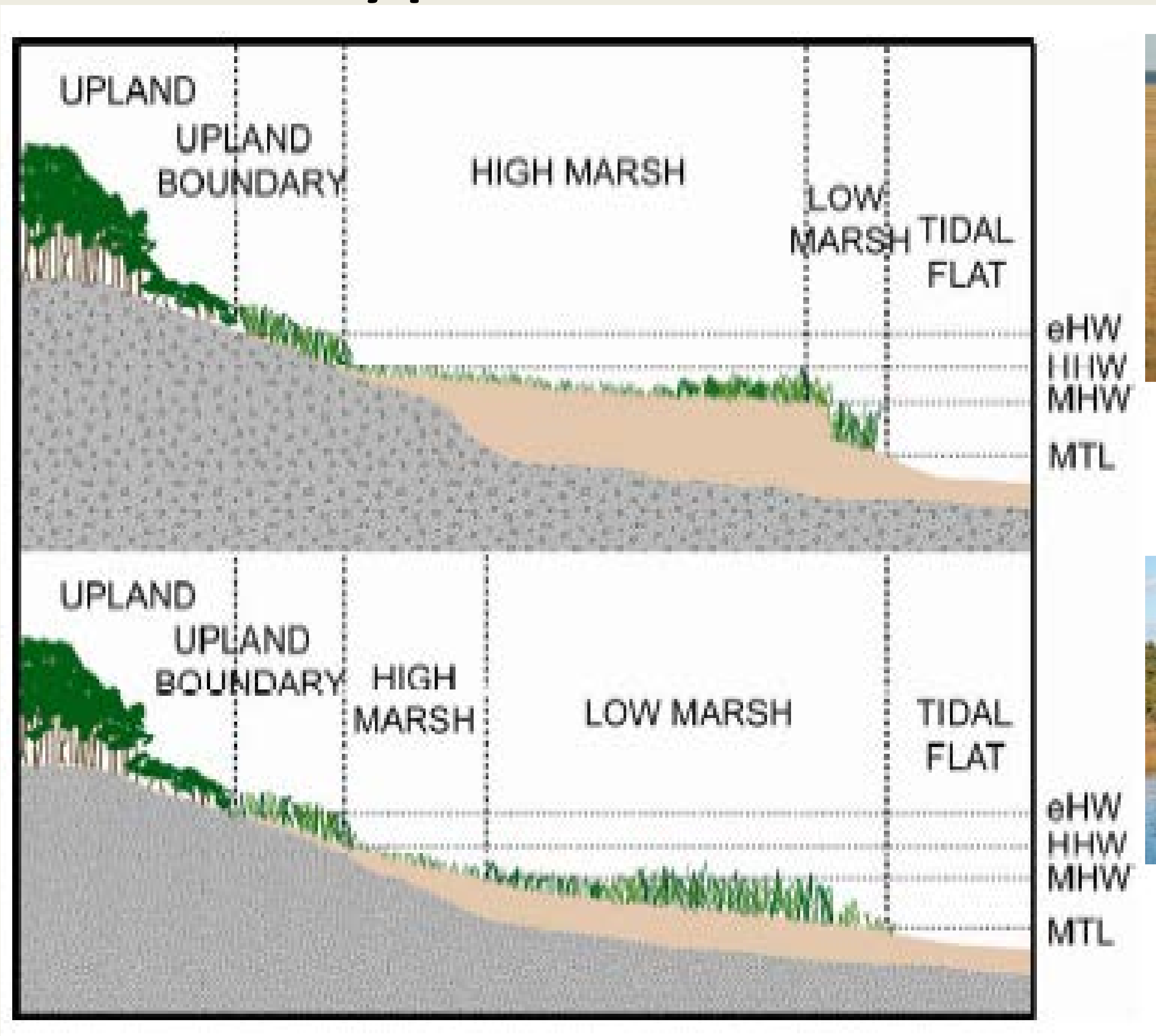
- "Cookbook"
  - Generalizations
  - Broad concepts
  - Canned plans and specifications
  - General species lists
  - Data may not be applicable

- "Site-specific"
  - Location-specific conditions (hydraulics, sediment, physical)
  - Ecological benchmarks
  - Species composition
  - Timeframe

What Information Do We Need to Get Started?

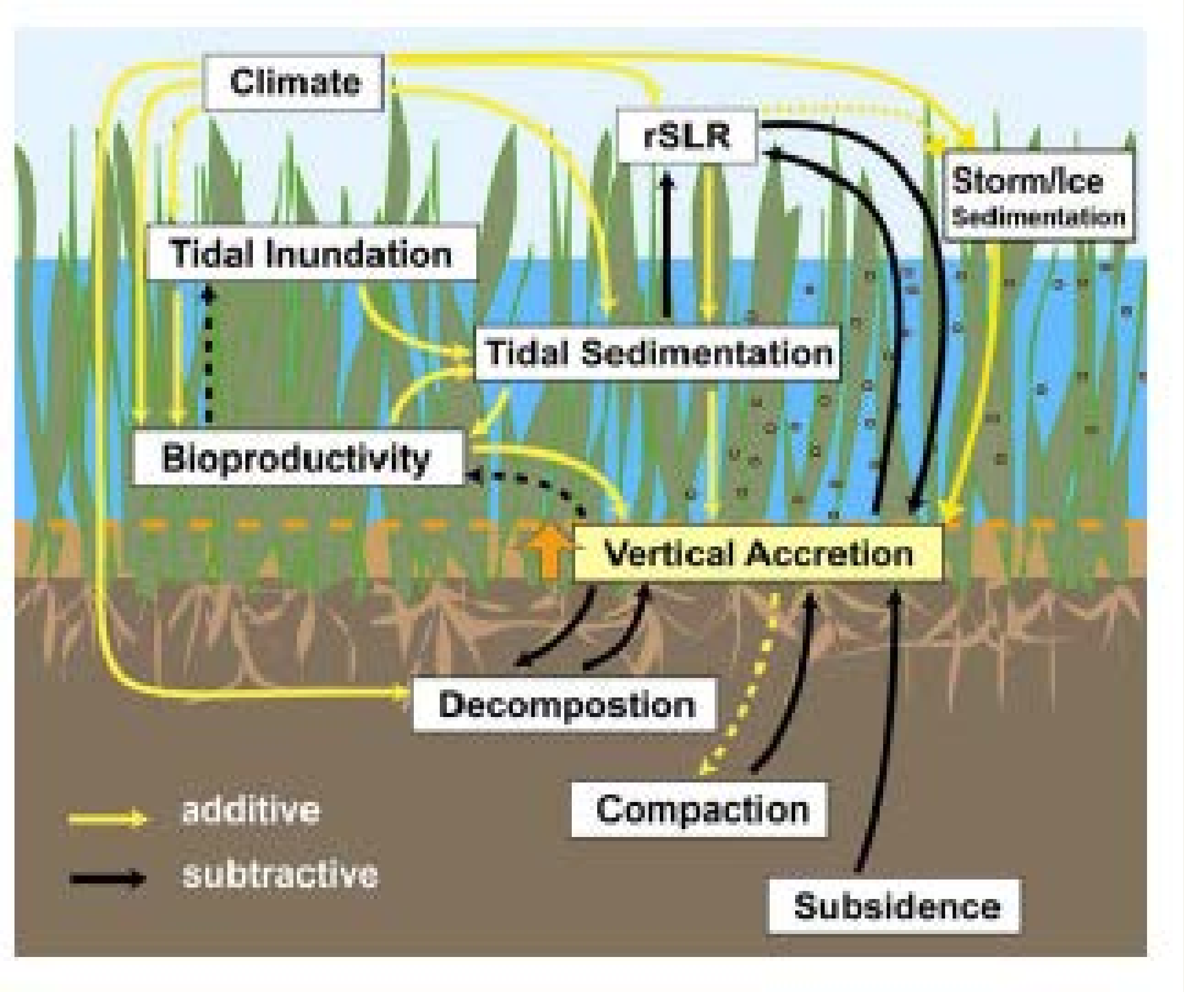
- Know the constraints
- Can we modify constraints to meet restoration goals?
- Benchmark local reference wetlands

Types of salt marshes



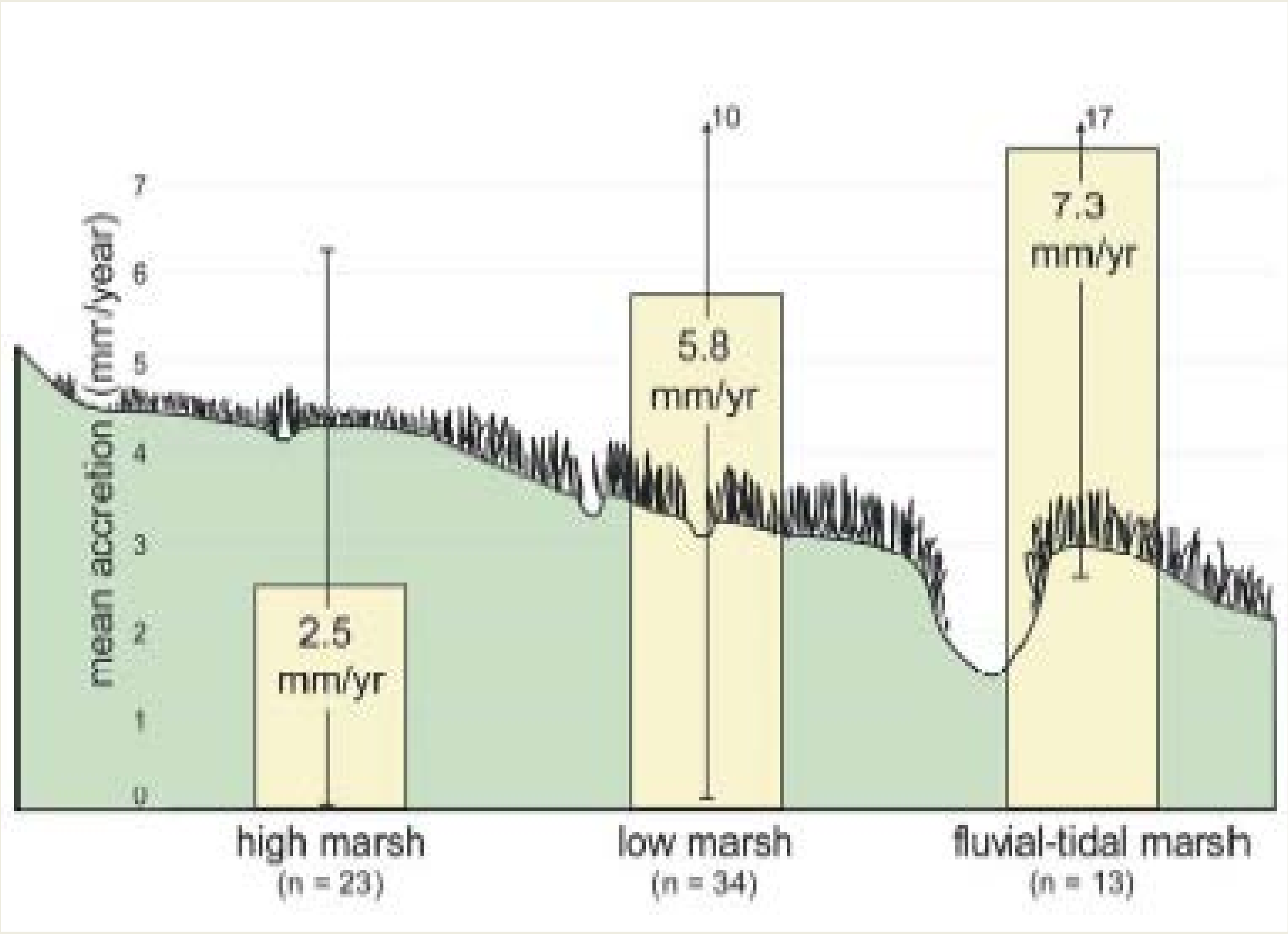
Argow 2006

Major Factors affecting marsh elevation



Argow 2006

Rates of Vertical Accretion

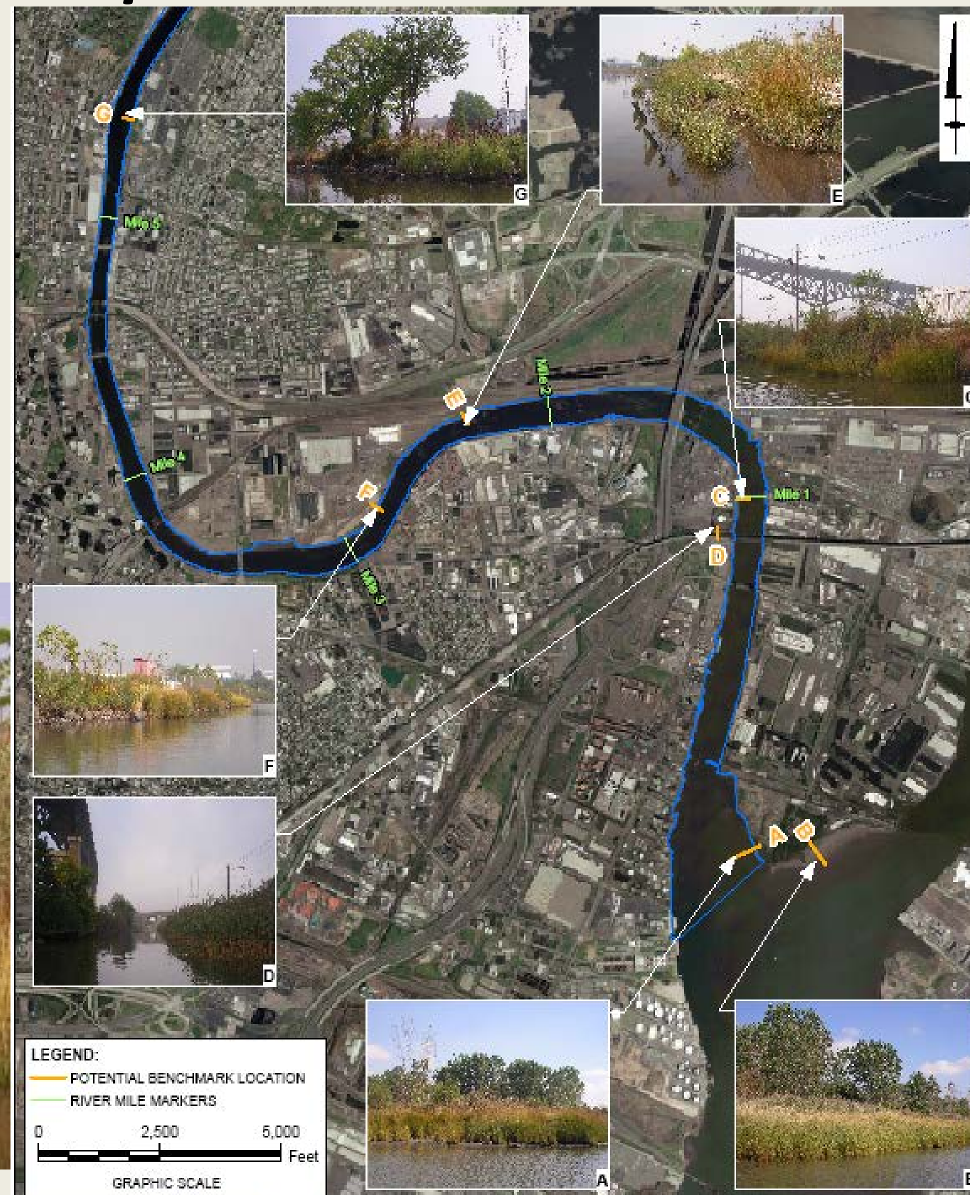


Argow 2006

What is an ecological benchmark?

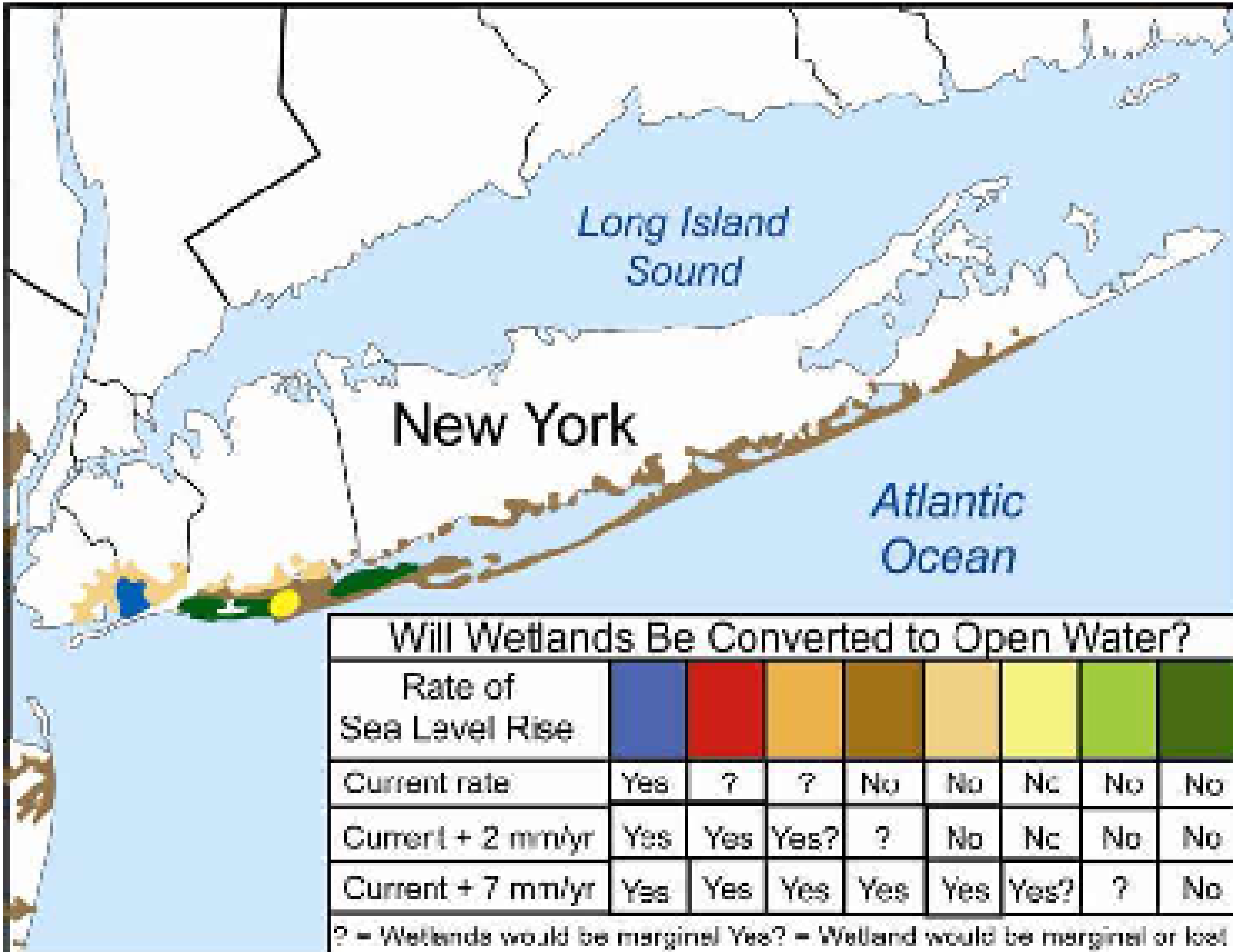
Where is *Spartina*?

- Upper limit at about river mile 2.7
- Habitat conditions are a factor



Local Wetland Restoration Effort – Why did it Fail?

- Located above elevation benchmarks for *S. alterniflora* in system
- Constraints from outside impacts
  - Geese
  - Floatables
  - Ice
- Requires extensive engineering
  to overcome constraints



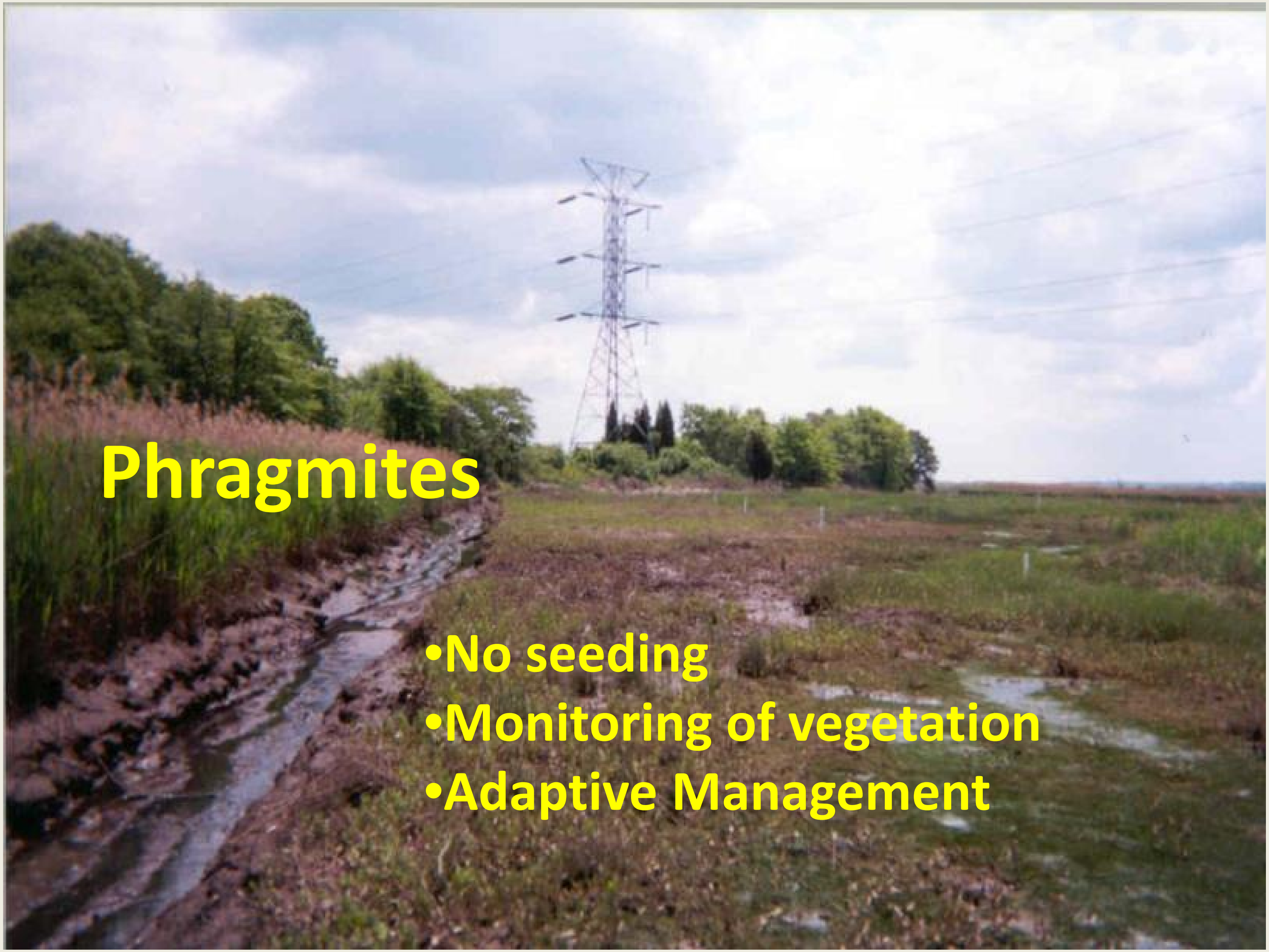
Reed et al. 2006





Phragmites
1997

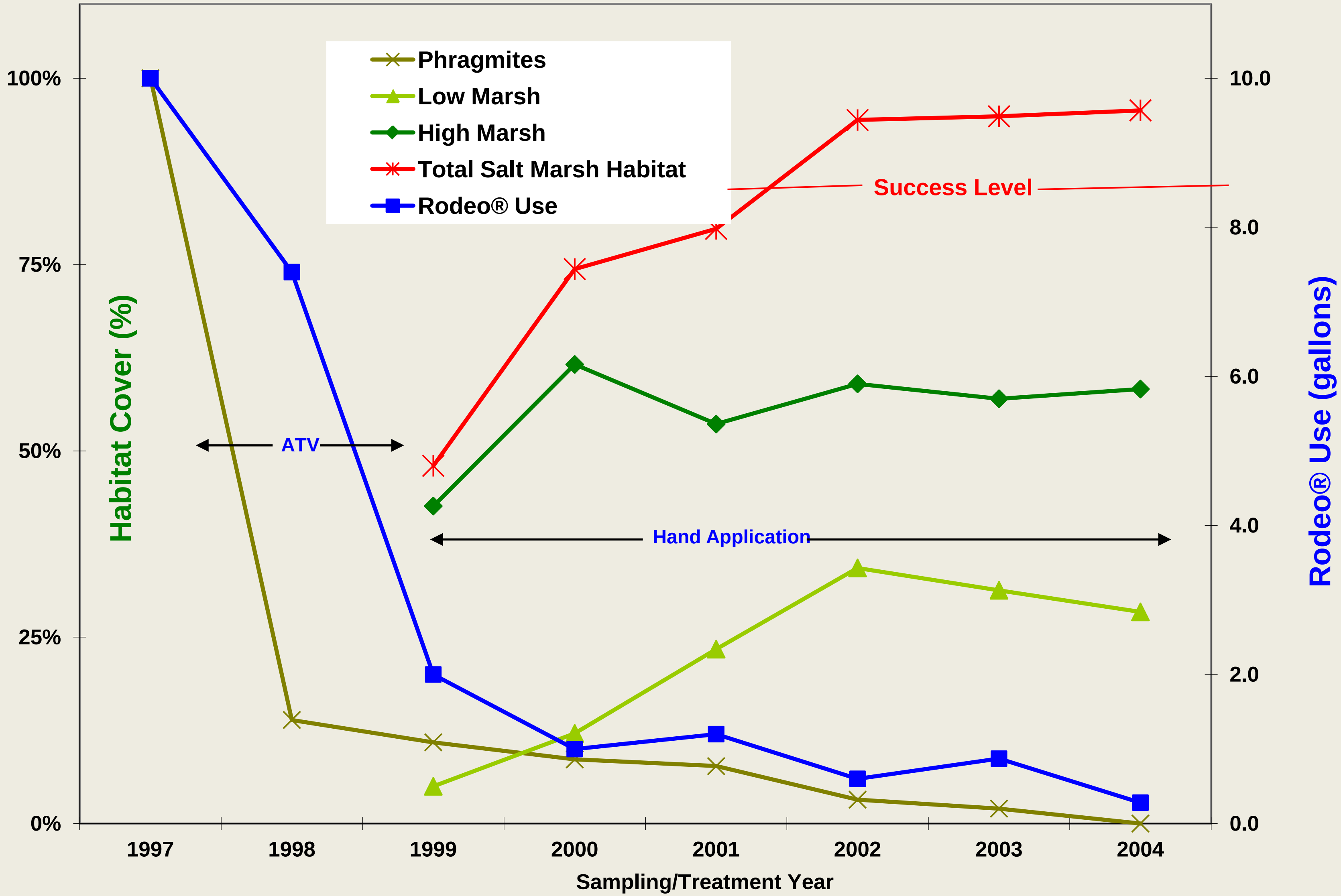

Phragmites
9 23 '97


Phragmites
•No seeding
•Monitoring of vegetation
•Adaptive Management


Phragmites


Phragmites

$10K vs $250K to $400K per ac



Shisler & Hallinger 2007

Take Home Messages…

- All wetlands are not the same
- Different classes of wetlands perform different functions
- Wetlands are resilient ecosystems
- Successful restoration of wetlands requires:
  - Use of reference systems, including clear articulation of performance goals (e.g., project targets and standards)
  - Design/build approach
  - Adaptive Management
  - Stakeholder commitment to site and program over time
  - Public outreach and participation

“Environmentalists changed the word *jungle* to *rain forest*, because no one would give money to save a jungle. Same with *swamps* and *wetlands.*”

Carlin 1997

Lewis' Top Five Recommendations

Cause of Failure	Recommendation	Details
1.Mangrove restoration designed incorrectly	Better training	Provide training for wetland professionals including consultants, regulators and monitoring and enforcement personnel who deal with mangrove restoration issues
2. Use of Inadequate baseline and target restored hydrology and topographic data	Establish current hydrology and conceptual target hydrology by using a reference condition in a nearby mangrove forest	Monitor surface and ground water hydrology at a reference site as well as the proposed restoration site. during normal seasonal rainfall, tidal, etc. conditions; Establish current frequency and duration of flooding,
3. Lack of consideration of the historical context and previously published work on success.	Republish Kusler and Kentula (1989) (the USEPA version) with added notes from the authors or substitutes to bring them up to date. Make freely available.	Simply providing a bibliography is not enough. Wetland professionals and regulators are busy people. It is often difficult or impossible for them to access good free science. This would start to overcome that impediment. Use of the website www.mangroverestoration.com as a starting point is recommended
4.Inadequate respect for the experience of current professionals with proven track records.	Provide a method for precertification by regulatory agencies and requirements for applicants to use trained professionals in mangrove design.	In consultation with federal, state and local wetland planning, and design and permitting agencies, develop approved lists of mangrove design and construction professionals who have proven track records of successful restoration and monitoring, and recommend their use.
5. Beef up compliance monitoring and enforcement activities to stop repeated errors in design with distribution of "lessons learned."	Document current mangrove restoration and creation efforts on the regional level to keep professionals apprised on progress in more successful mangrove restoration and creation efforts.	Current progress towards improving the practice of successful mangrove restoration and creation is hampered by the lack of freely availability documentation on who, what and where are the successful projects being done, and what monitoring and reporting is available for professionals to review and learn about these efforts and improve their practices.

John Teal's Recommendations

Cause of Failure	Recommendation	Selected Measures
Not having complete tidal flows	Have good hydrology data and modeling	
Too rigidly following initial model results	Carefully consider monitoring observations	Let system develop on its own as long as that fits into final goals

Turek's Recommendations

Causes of Failures/Challenges	Reasons and Recommendations	Details
Tidal reconnection lacks sufficient hydrology for restoring native marsh plant community	Culvert size and/or invert elevation are key factors in tidal hydrology reconnection; complete thorough and iterative upfront model analysis needed	Upfront site feasibility site (FS) needs to include water surface elevation (WSE) survey with dataloggers installed within the restricted site and the contributing hydrology of the unrestricted estuary. Data needs to be tied into tidal datum, plus accurate project site topography and bathymetry digital elevation needed for creating DEM.
Poor site drainage during ebb tide cycles	Marsh substrate elevations are too low relative to the restored tidal hydrology	Need water surface elevation (WSE) survey for at least one complete lunar cycle for proposed restoration site; multiple WSE dataloggers needed for site, especially for tidal reconnection sites. Sediment/soil placement and substrate elevations need to account for dewatering, settling and compaction of placed materials.
Property owners abutting project site concerned restoration will impact their properties	Increased regular flood and storm tides may increase land flooding or alter tidal inlet	Thorough assessment needed during FS especially adequate survey data for DEM and hydraulic modeling proposed tidal reconnections. Early-phase project consensus-building and community outreach is essential to project understanding and support/acceptance.
Unanticipated costs and inadequate project funds available for the project	Take into account all work tasks during all project phases including in-water construction.	Need to account for all project phases: upfront assessment includes adequate base mapping and modeling, complete alternatives analysis, and regulatory permitting including EFH assessment and consultation with NMFS. Construction costs for in-water work are higher than on-land work as specialty equipment is needed. Post-project monitoring is essential to evaluating project including SETs to assess marsh elevational capital.

Shisler's Top Five Recommendations

Cause of Failure	Recommendation	Details
1. Salt marsh restoration or creation is designed incorrectly	An understanding of the system and what is expected to be there when completed. This has to be from both the literature and field experience	Use of ecological benchmarks from adjacent wetlands to assist in the wetland restoration. An understanding of the salt marshes ecology and factors affecting the system. A background in the literature and how the system function. All wetlands are not the same.
2. Over design the wetland restoration or creation project.	Allow the natural process assist in the development of the wetland.	Need to have an understanding of the wetland ecology and how the system changes with location and time.
3. The wetland does not meet goals	Adaptive management during the restoration time until the project meets goals.	It is important for yearly evaluation and implementing corrective actions (adaptive management) during the development of the project to insure that goals will be met. The potential problems can be determine in the design phase and how they will be corrected.
4.Not meeting goals because there is a change in personnel from the design to project completion.	The same personnel should be in charge of the project from design to the project meets its goals.	The design personnel should have identified potential issues and problems with the project and how to correct them. When there is a change in personnel they usually are not aware of problems.
5. Beef up compliance monitoring and enforcement activities to stop repeated errors in design with distribution of "lessons learned."	Document current restoration and creation efforts on the regional level to keep professionals apprised on progress in more successful restoration and creation efforts.	Current progress towards improving the practice of successful restoration and creation is hampered by the lack of freely availability documentation on who, what and where are the successful projects being done, and what monitoring and reporting is available for professionals to review and learn about these efforts and improve their practices. There is a need to evaluated projects that are 20+ years to assess how they are functioning and identify

Questions?

Robin Lewis lesrrl3@gmail.com
352-546-4842

John Teal teal.john@comcast.net
508-763-2390

Jim Turek James.G.Turek@noaa.gov
401-782-3338

Joe Shisler jkshisler@gmail.com
732-740-0359

Jeanne Christie jeanne.christie@aswm.org
207-892-3399

Marla Stelk marla@aswm.org
207-892-3399


Thank you for your participation!
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