# Tidal Marsh Restoration Design at Prime Hook National Wildlife Refuge.


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# Overview of Presentation

- Brief history of the wetland management and current management challenges at Prime Hook NWR
- Brief review of the findings of our recent hydrodynamic modeling effort
- Explanation of how modeling results will guide marsh restoration design
- Steps and current status of restoration
- Description of proposed monitoring efforts

# Prime Hook NWR

- Located on the western shore of the Delaware Bay, in southern DE
- Established in 1963
- 10,132 acres, primarily wetlands
- Refuge divided into management units: Unit I through Unit IV, north to south, primarily divided by roads

# History of Prime Hook's Marshes

- Historically, wetlands almost entirely salt marsh
- Numerous impacts and alterations … Ditching, draining, mosquito management, grazing and haying, trapping, hunting
- **In the 1980's, the two central units – Unit II and Unit III – were converted to freshwater impoundments** through the installation of new water control structures
  - Combat *Phragmites* and provide waterfowl habitat
  - Largest such freshwater impoundments east of the Mississippi
  - Very successful
  - Dunes were supplemented at that time
- The dunes have undergone minor repair/restoration several times since: 1992, 1998, 2006, 2008, 2011

# History of Prime Hook's Marshes
## *Shoreline overwashes & breaches*

Photo:USFWS/Keith Ramos

- **2006 - Hurricane Ernesto**
  - In Unit I only
  - Rejuvenated the Unit I salt marsh
  - Decision not to repair, natural salt marsh
- **2008 - Mother's Day Storm**
  - Small breach in Unit II
  - Repaired in October 2008.
  - 2009 freshwater vegetation management successful
- **2009 – November Nor'Easter**
  - Two breaches formed in Unit II
  - Game changer
  - Over 1000 acres of marsh → open water

**Unit I – Salt marsh responded to overwash in typical way**

**Unit II – Heavily altered impounded freshwater wetland was not prepared for sudden salt water reintroduction**

# Following the Breaches

- **2010 – Data Collection to support CCP analysis**
  - Cooperative Agreement with DNREC
  - Real-time water monitoring network
  - Extensive elevation, water quality, salinity data collection
  - Proposed one-time repair with onsite material, to slow the damage

- **2011 – Not a fun year**
  - Litigation to prevent breach repair
  - Hurricane Irene packs a punch
  - Attempt at onsite repair is short-lived

- **2012 – CCP and Sandy**
  - CCP nears completion
  - Public meetings to present proposed salt marsh alternative
  - Hurricane Sandy hits, creates two new additional breaches in Unit II

- **2013 – Hydrodynamic Modeling**

# 2011

**Unit I starting to close**

**2010 was a quiet storm year, until Irene in 2011**

Unit I breach closing

2013 aerial imagery courtesy of Atkins Global

# Post-Sandy

**New breaches 4 total now**

# Planning Marsh Restoration

**Steps taken to help with marsh restoration planning**

- Two workshops with agency and academic partners
- Many informal conversations
- Breach repair analysis
- Hydrodynamic modeling our most important tool

**Unit II**

**Unit I**

# Hydrodynamic Modeling

**Built a Robust Model of Existing Conditions**

- Extensive regional and on-site water level data
- Two+ years of local water level and salinity data
- Calibrated against normal tide as well as Sandy conditions

**Evaluate Potential Restoration Scenarios**

- Existing breaches, one breach open, all breaches closed

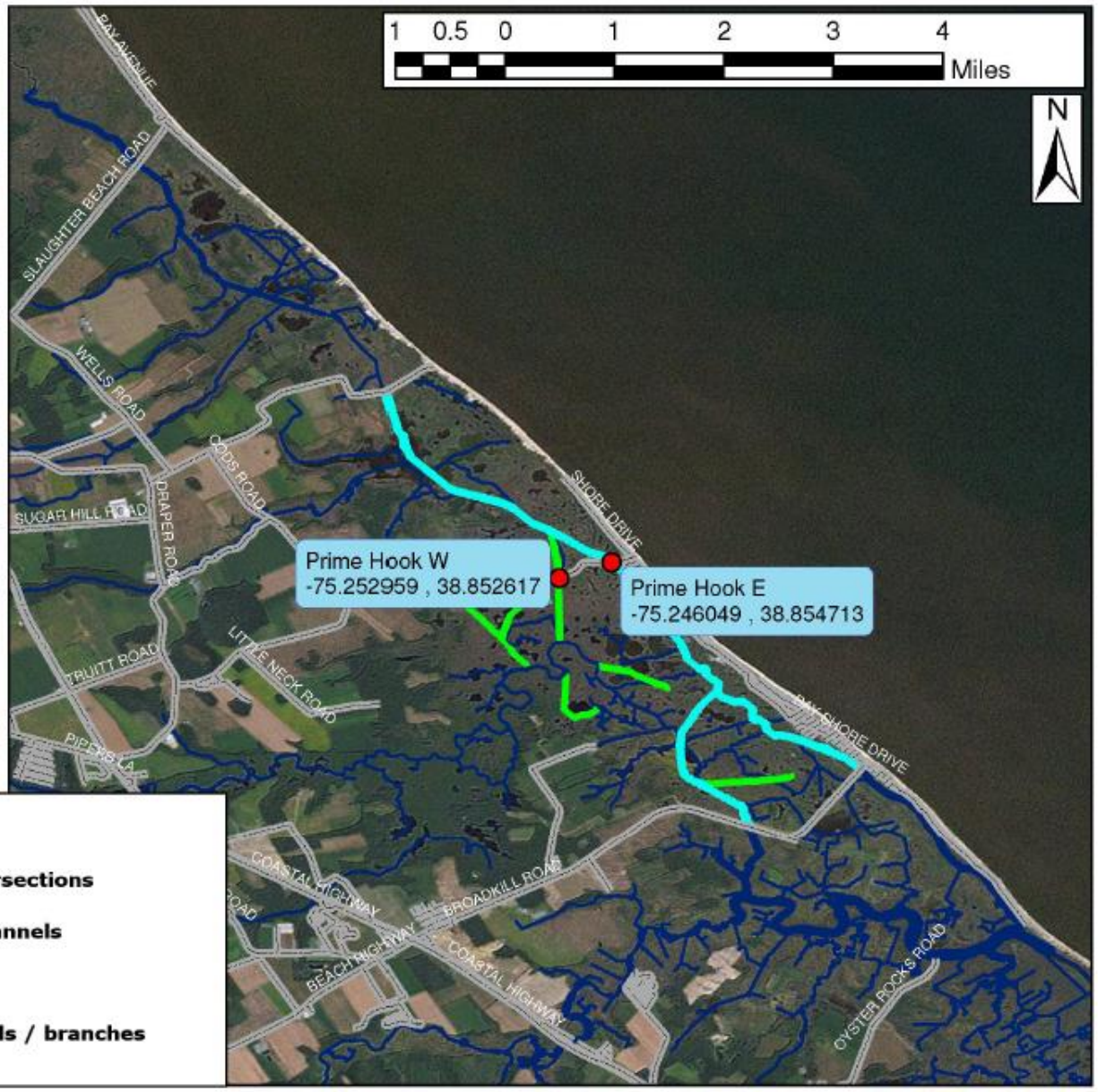
**Addition of Conveyance Channels**

- Focused additional model runs on all breaches closed, water control structures and a eastern Fowler Beach Rd removed
- Main conveyance channel added to improve circulation
- Secondary branching tidal channels added

# Hydrodynamic Modeling

Prime Hook NWR
Proposed
Channel Locations*

*subject to change during design phase




**Legend**

- **Proposed roadway intersections**
- **Existing & historical channels**
- **Proposed main channel**
- **Proposed finger channels / branches**

# Hydrodynamic Modeling

## *Highlights of Results*

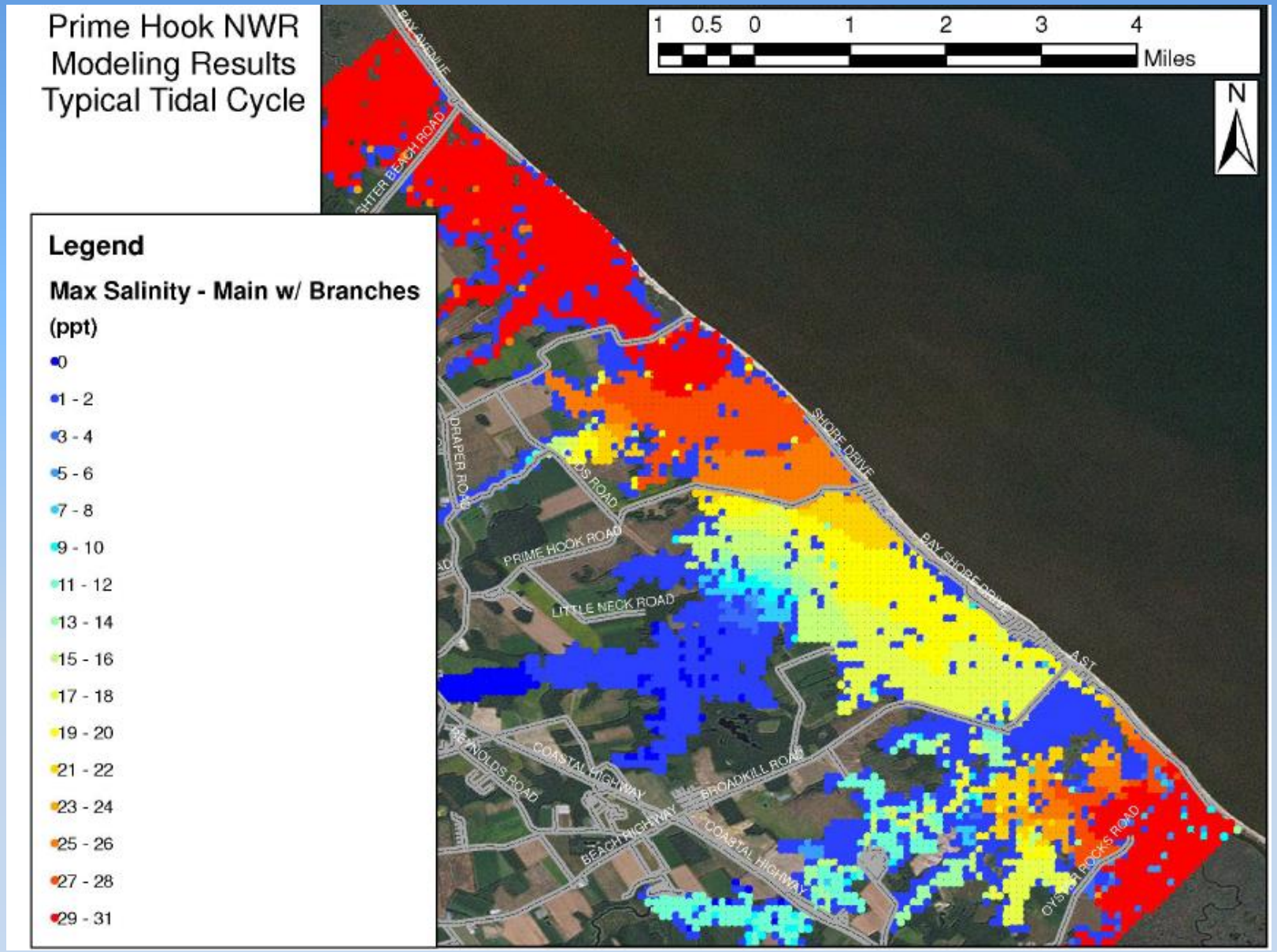
- Closing all breaches + Removal of water control structures + Addition of conveyance channels →

  *Water levels & salinity conducive to salt/brackish marsh*

- From 0 ppt start, system reached average 26 ppt within 3 months

- Salinity well-distributed throughout marsh complex

# Hydrodynamic Modeling



# Salt Marsh Restoration

- GOAL:
  *Restore a Barrier Beach & Salt Marsh Complex that can withstand future storms and overwashes… that can adapt, repair, migrate, and sustain itself*

- HOW?
  *Restore the <u>structure</u> and <u>processes</u> that sustain a functioning salt and brackish marsh*
  *This will not be a short-term endeavor*

- WHAT FIRST?
  *Stabilize the shoreline for the near-term (Phase I)*
  *Begin to rebuild ecosystem processes (Phase II)*

# Salt Marsh Restoration

## PHASE I

*Stabilize the shoreline for the near-term (Phase I)*

- Close breaches, restore dune
- About 6000 linear feet of Unit II
- Extend about 300 feet into back barrier marsh
- Create marsh platform behind restored dune
- About 40 acres, to be planted with *Spartina* grasses
- Removal of water control structures

# Salt Marsh Restoration

## PHASE I

- Working with Army Corps of Engineers
- Design not yet finalized
- Fall/Winter 2014-15 target timeframe

# Salt Marsh Restoration

## FAQ

- *Why aren't you leaving a breach open?*
- *What if breach occurs in the next couple years?*
- *Where will the sand for Phase I come from?*

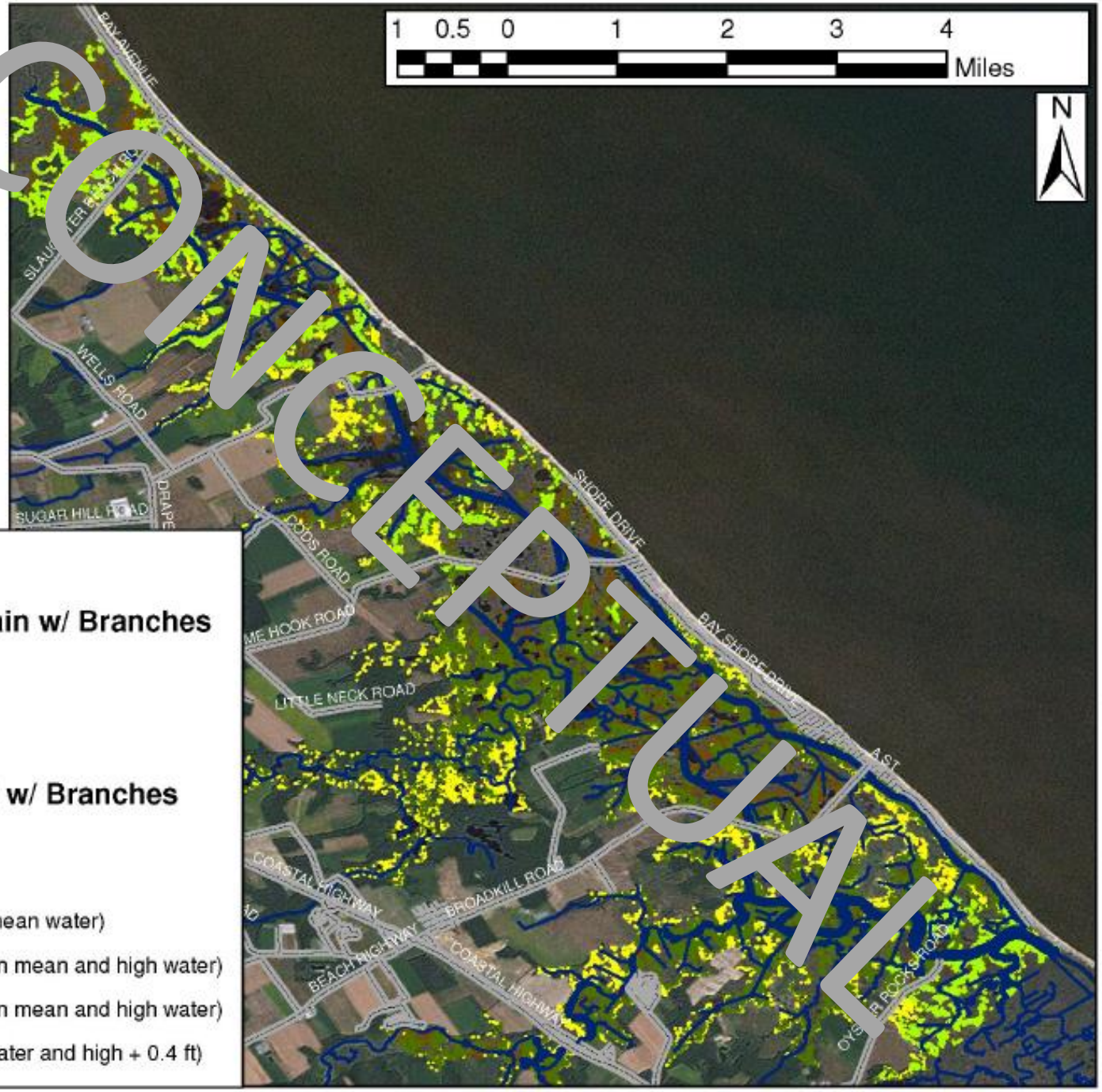
# Salt Marsh Restoration

## PHASE II

- *Begin to rebuild ecosystem processes*

- Improve tidal circulation by creating conveyance channel and tidal channel network
- Use material dredged from on-site dredging work to restore lost elevation in areas of the marsh interior
- Carefully monitor success of Phase I planting, sediment availability and transport, accretion, etc
- Marsh design during 2014, implement in 2015+

# Prime Hook NWR
# Modeling Results
# Typical Tidal Cycle




## Legend

### Bottom Elevation - Main w/ Branches

**elevation (ft NAVD88)**

- below -2.0

—Channel centerlines

### Land Coverage - Main w/ Branches

**Type**

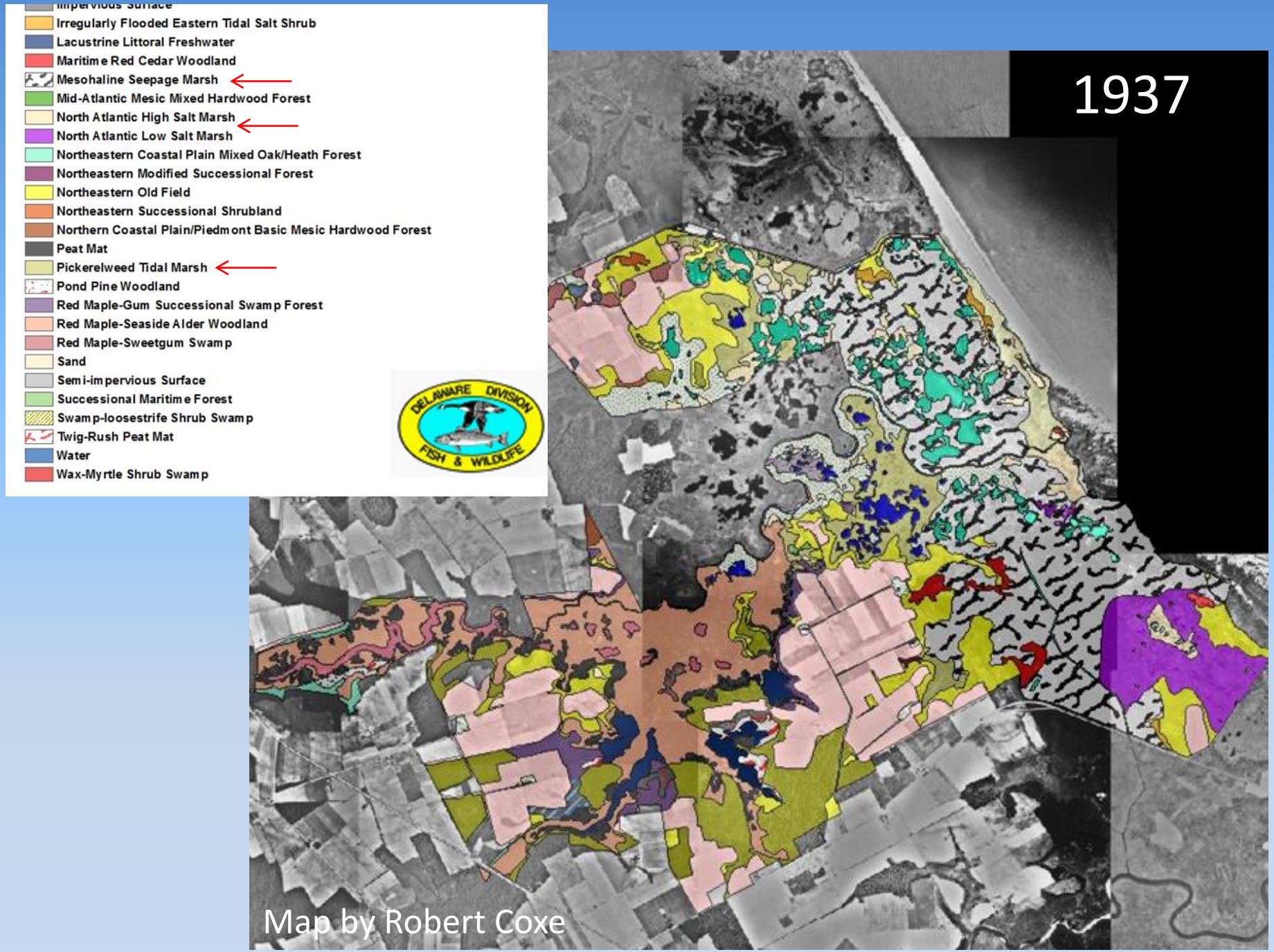
- Open water (< low water)
- Tidal flat (between low and mean water)
- Low marsh > 18 ppt (between mean and high water)
- Low marsh < 18 ppt (between mean and high water)
- High marsh (between high water and high + 0.4 ft)

CONCEPTUAL

# Salt Marsh Restoration

## FAQ

- *I thought the marsh elevation is too low throughout and will need large amounts of dredged fill material?*
- *How will the conveyance channel cross Prime Hook Rd?*
- *Will Unit III be a salt marsh, too?*


1937
Impervious Surface
Irregularly Flooded Eastern Tidal Salt Shrub
Lacustrine Littoral Freshwater
Maritime Red Cedar Woodland
Mesohaline Seepage Marsh
Mid-Atlantic Mesic Mixed Hardwood Forest
North Atlantic High Salt Marsh
North Atlantic Low Salt Marsh
Northeastern Coastal Plain Mixed Oak/Heath Forest
Northeastern Modified Successional Forest
Northeastern Old Field
Northeastern Successional Shrubland
Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest
Peat Mat
Pickerelweed Tidal Marsh
Pond Pine Woodland
Red Maple-Gum Successional Swamp Forest
Red Maple-Seaside Alder Woodland
Red Maple-Sweetgum Swamp
Sand
Semi-impervious Surface
Successional Maritime Forest
Swamp-loosestrife Shrub Swamp
Twig-Rush Peat Mat
Water
Wax-Myrtle Shrub Swamp
DELAWARE DIVISION FISH & WILDLIFE
Map by Robert Coxe

# Salt Marsh Restoration

## "PHASE III"

*Long Term Restoration Opportunities*

- Army Corps of Engineers Regional Sediment Management Plan – Prime Hook NWR identified as potential site for beneficial placement of material dredged for maintenance of navigation
- Through monitoring, will identify areas that may benefit from additional dredged material placement

# Monitoring our Progress

- Monitoring Objectives
- Performance Standards
- Information for Adaptation

# Monitoring our Progress

- Monitoring Objectives

Are the desired water levels being achieved?
If not, where and why not?

Are the desired salinity levels and distribution being achieved?
If not, where and why not?

How is the nekton (fish, shellfish) community changing?

What is the natural recruitment rate of different salt marsh vegetation species (Or do we need to plant more?)

Is the accretion rate sufficient to sustain the marsh?
Is the accretion rate keeping pace with SLR?

Have the salt marsh birds returned?
Are they breeding successfully?

# Monitoring our Progress

- Performance Standards (DRAFT)
  - Target vegetation cover (80% veg, 20% open water)
  - Planted vegetation survival >85%
  - Invasive species cover <5%
  - Plant community productivity target met
  - Vegetated marsh established at proper elevation
  - New marsh platform has desired hydroperiod
  - Vegetated marsh elevation change ≥SLR
  - Suspended Sediment Concentration > 20 mg/L

# Monitoring our Progress

- Information for Adaptation

## IF…. THEN…

| | |
|---|---|
| Vegetation isn't regenerating… | Supplement planting |
| Elevation is insufficient… | Additional fill placement |
| *Phragmites* invading… | Treat early, evaluate |
| SSC is low… | Improve tidal connection |
| Salinity distribution lacking… | Improve internal circulation |

# Monitoring our Progress

- Implementation
  - Partnerships with Delaware State University and the University of Delaware, via a new Cooperative Agreement with DNREC Coastal Programs
  - Monitoring more intensive in certain areas
  - Use of seasonal employees, interns, and a term technician, coordinated by existing staff
  - Build on our USFWS Salt Marsh Integrity Index program for long-term monitoring

USFWS Photo

Unit I

Unit II