

Large Scale Coastal Tidal Marsh and Barrier Beach Restoration at Prime Hook NWR – Recovering from Hurricane Sandy and Building Resilience in Former Freshwater Impoundments.

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Project Team

- USFWS
- Resiliency
 - AMEC Foster Wheeler
 - EA Engineering, Science, and Technology Inc.
 - Dredge America
- Atkins Global
- Stantec, Inc.

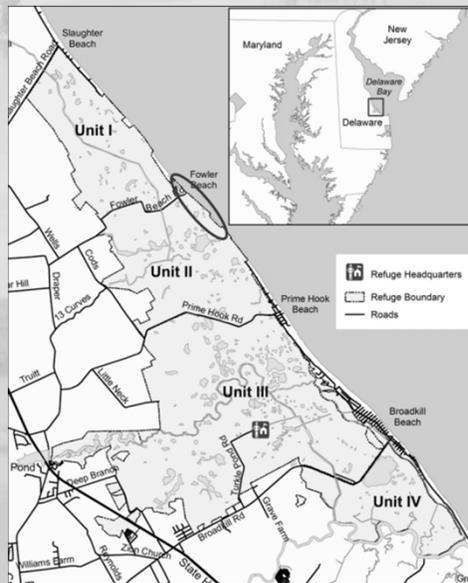
- Recovery
 - ACOE
 - Norfolk Dredging Company
 - TI Coastal
 - ER&M



US Army Corps of Engineers

Prime Hook NWR

- ❖ 10,000 acres, mostly wetlands
- ❖ Two central units – Unit II and Unit III – managed as freshwater impoundments for waterfowl habitat through installation of water control structures in 1980's
- ❖ Impoundment management successful until series of storms created breaches in Unit II shoreline
- ❖ Hurricane Sandy brought largest final blow to the system
- ❖ Rapid peat collapse and extensive conversion to open water in Unit II and Unit III



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Historic Shoreline (1926 to present)



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History of *Shoreline Overwashes & Breaches*

Unit I breach closing

- **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**
 - Moderate overwash in Unit II
 - Repaired in October 2008
 - 2009 freshwater vegetation management successful
- **2009 – October/November Nor’Easters**
 - Two breaches formed in Unit II
 - Salt marsh fared well but the impounded freshwater wetlands experienced peat loss and rapid conversion to mostly open water
 - Reconsidered wetland management
- **2012 – Hurricane Sandy**
 - Two new large breaches
 - Total breached area nearly tripled

Prime Hook NWR Comprehensive Conservation Planning (CCP) Process

- CCPs guide refuge management for 15 years
- Prepared through the NEPA process, evaluating the impacts of several alternatives and seeking public input
- ***Final Decision*** = Salt & Brackish Marsh Restoration
- Also considered “No Action” & “Return to Impoundments”

Meanwhile, an unhappy public...

- Prime Hook Road (divides Units II and III) was only route in and out of a beach community, and now flooded regularly; Many locals considered “life and limb” to be at risk
- Locals passionate, well-organized, politically connected; Media didn't appear to be on our side
- Meanwhile... Others opposed our plans to take any action at all, resulting in legal delays and a very polarized debate
- The CCP process pressed on... “Answers are coming,” we told them



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Unit 1 Overwash
April 2, 2010

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Planning Marsh Restoration

Steps taken to help with marsh restoration planning

- Extensive data collection with DNREC, through cooperative agreement (elevations, water levels, salinity, etc)
- Two workshops with agency and academic partners
- Many informal conversations
- Breach repair analysis
- ***Hydrodynamic modeling our most important tool***



Unit II



Unit I

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Hydrodynamic Modeling

- Worked with Atkins Global to develop hydrodynamic model for wetland complex
 - Circulation, flushing/residence time, salinity
 - Delft3D
 - Delaware Bay from Trenton, NJ to Atlantic Ocean
- Built a Robust Model of Existing Conditions
 - 2+ years of local water level and salinity data
 - Additional elevation and flow data
 - Calibrated very well against normal tide as well as Sandy conditions

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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

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Prime Hook National Wildlife Refuge Restoration Project Permits

Army Corps of Engineers Permits
Clean Water Act Section 404
Rivers and Harbors Act Section 10

State of Delaware
Wetlands and Subaqueous Lands
Coastal Zone Management Federal Consistency
Water Quality (Section 401)
Shoreline and Waterway Management
Erosion and Sediment Control

Coastal Barrier Resource Area Exemption
SHPO (Cultural Resources Act Section 106)

Tribal Consultation

NOAA EFH

US Fish and Wildlife Service ESA Section 7

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Develop A Strategy to Avoid Misunderstandings

- Frame the Issue well
- Develop a conceptual plan using the best science available
- Discuss concepts with regulators at all levels early in the process
- Solicit input from regulators and practitioners prior to submitting permit applications
- Engage the public early in the process and maintain transparency
- Manage the message with the media (don't let the media manage you)

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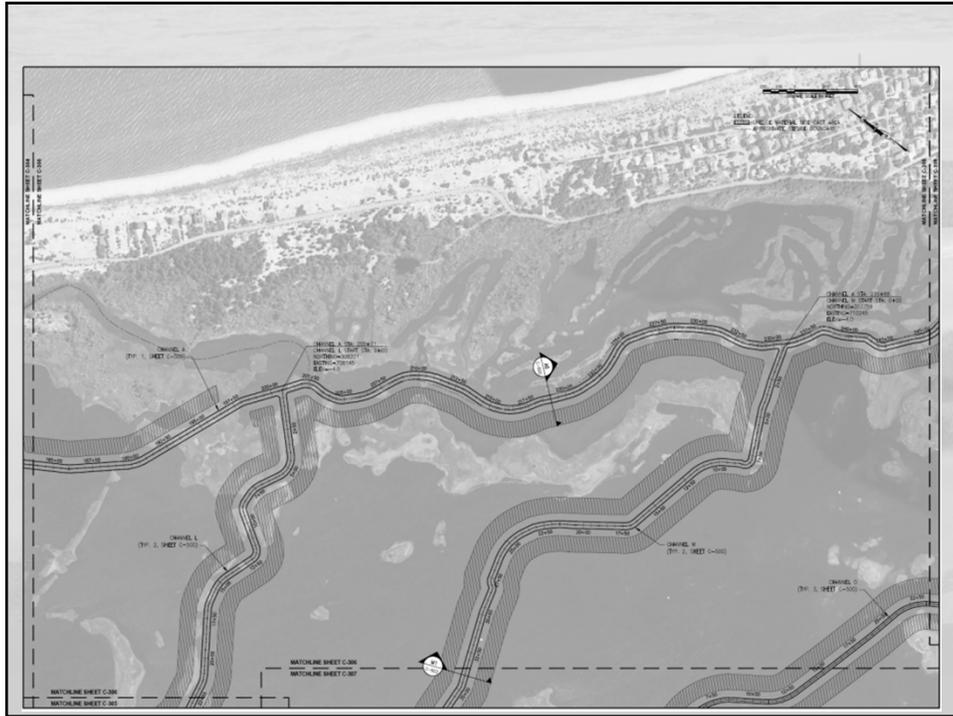


Marsh Interior Restoration Sandy Resiliency Project

- *Begin to rebuild ecosystem processes*
- Improve tidal circulation by creating conveyance channel network
 - ~ 25 Miles of channels -
- Use material from on-site dredging work to restore lost elevation in some areas of the marsh interior (thin-layer application)
 - Kinda.....more of a disposal mechanism
 - ~600,000 cy

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10" Shallow Draft Dredges

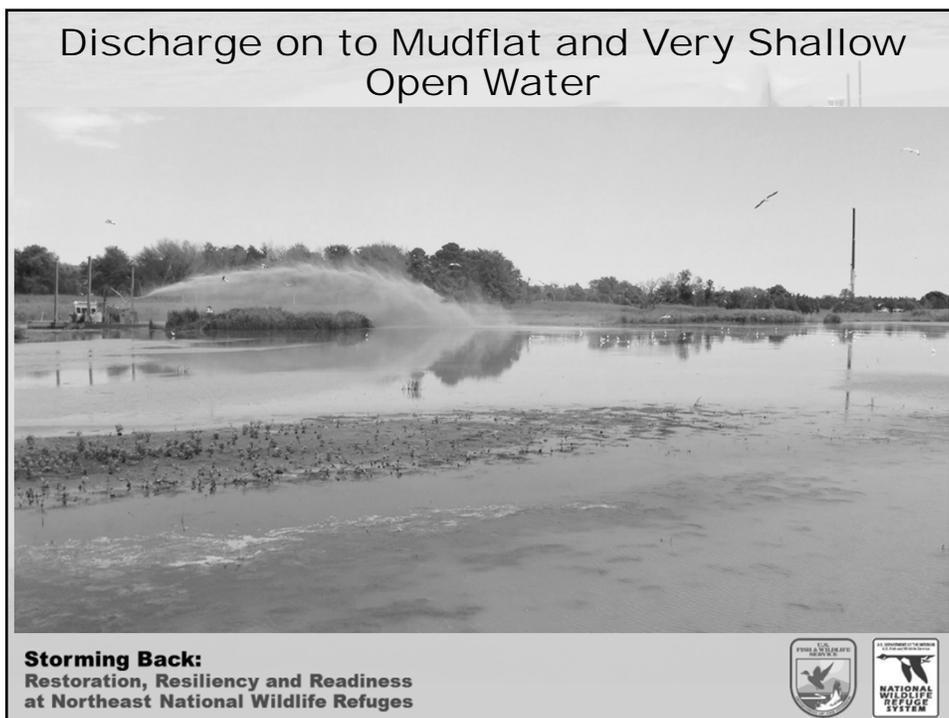


3 Dredges



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Discharge on to Shallow Open Water



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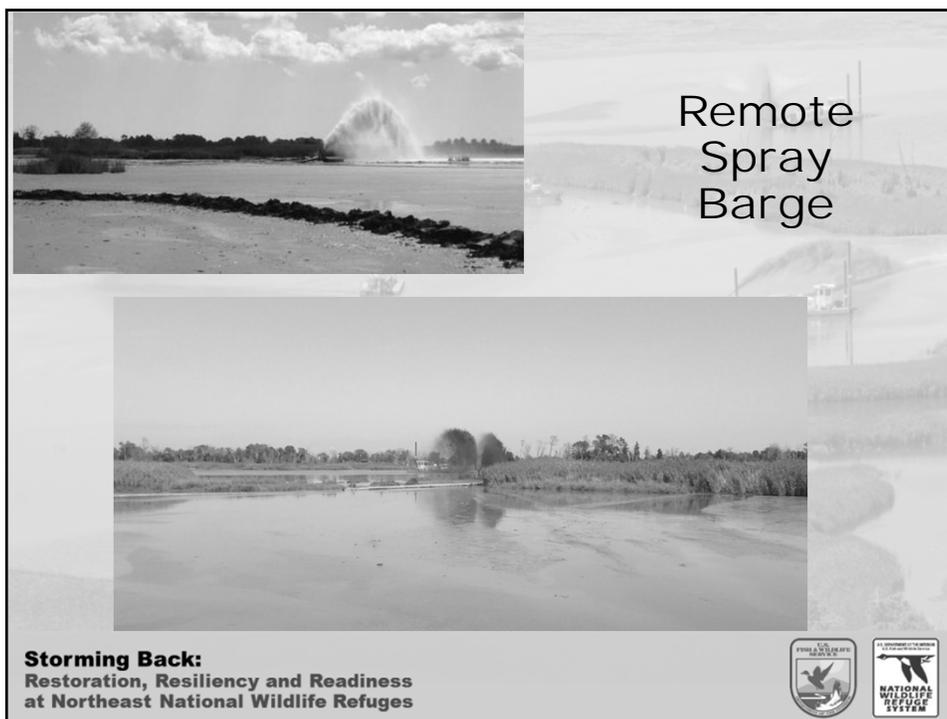


Berming to Avoid Sediment Inflowing



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Remote
Spray
Barge

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Unforeseen Material and Clean-out...and Clean-out...and Clean-out...



Heterogeneous Material



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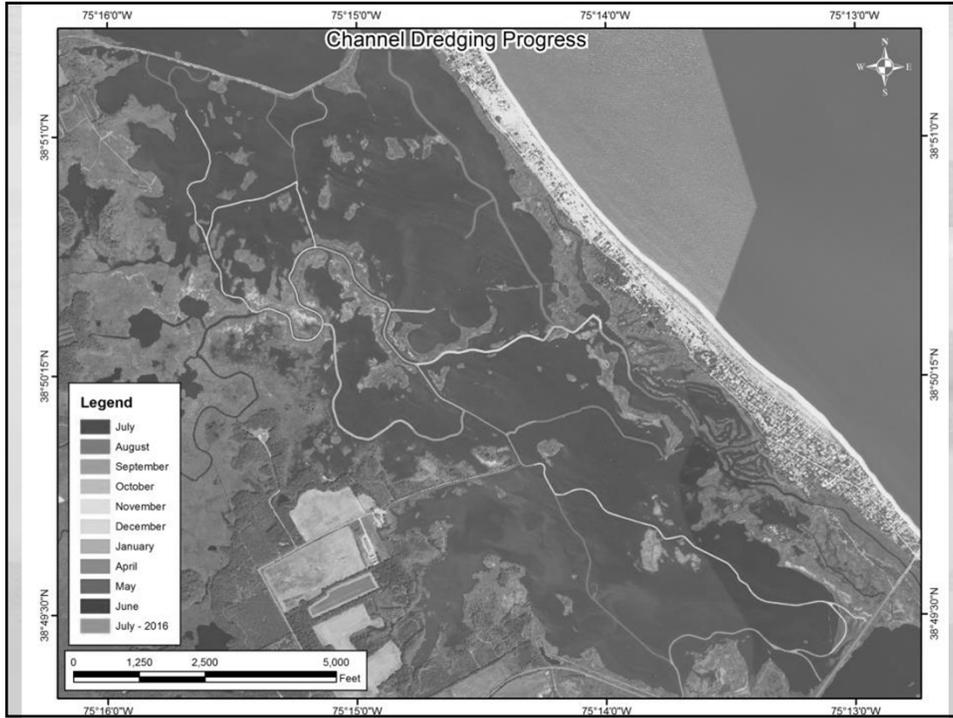


Channel Surveys



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Nozzle Designs

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And the birds love us!



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Beach, Dune and Backbarrier Restoration Sandy Recovery Project

- Close breaches, Restore dune
- 1.41 Million cubic yards of sediment
- About 8,900 linear feet

- Create marsh platform behind restored dune
 - 60 total acres
 - Extend about 100 to 600 feet into back barrier marsh

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November

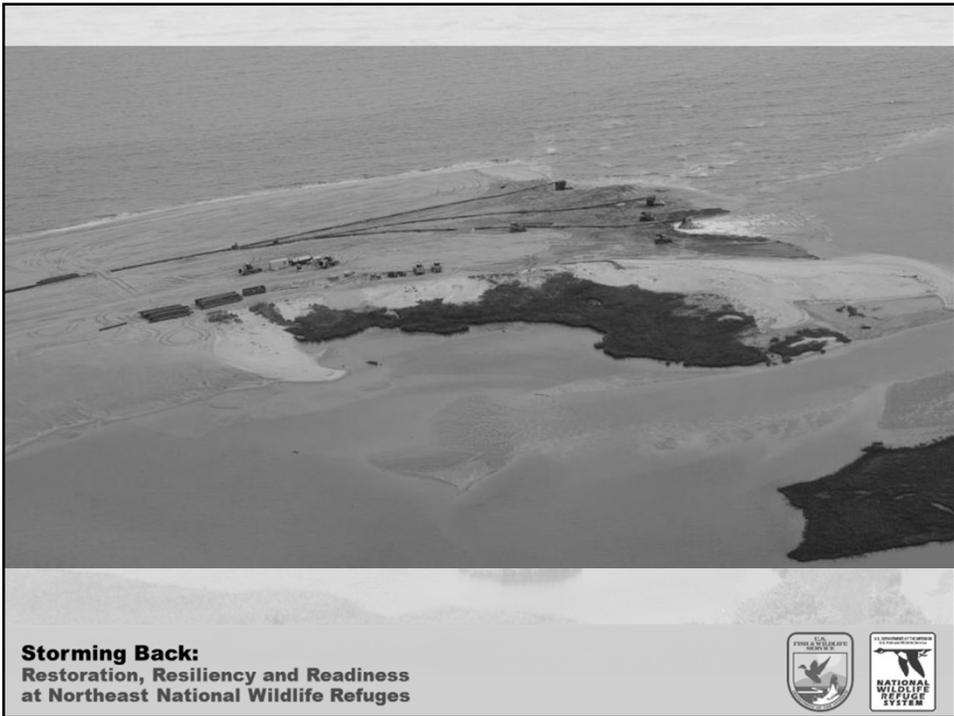
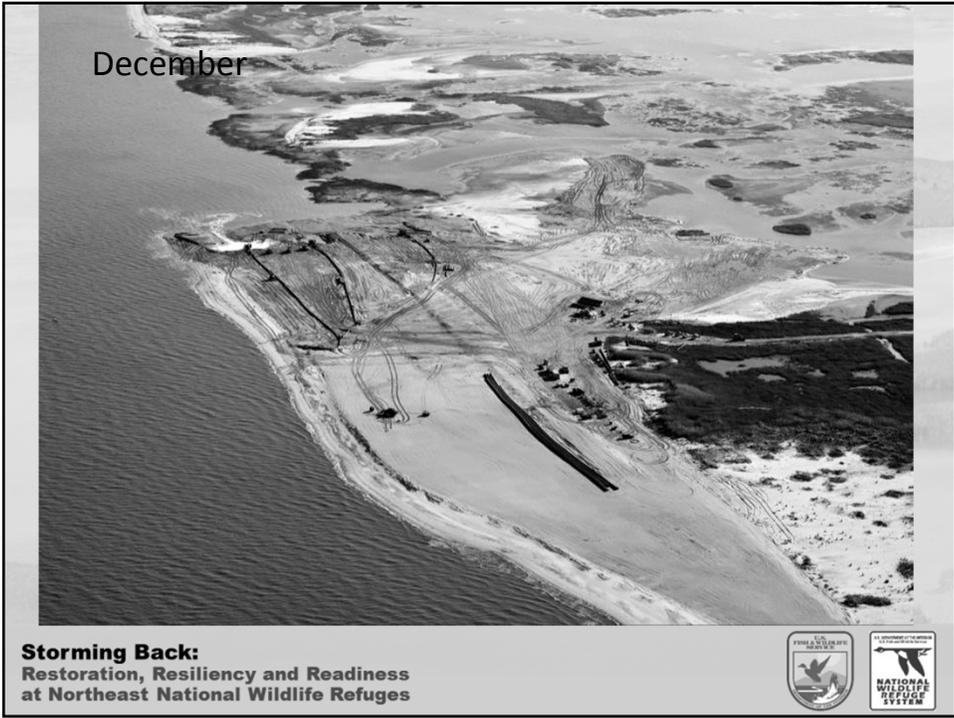


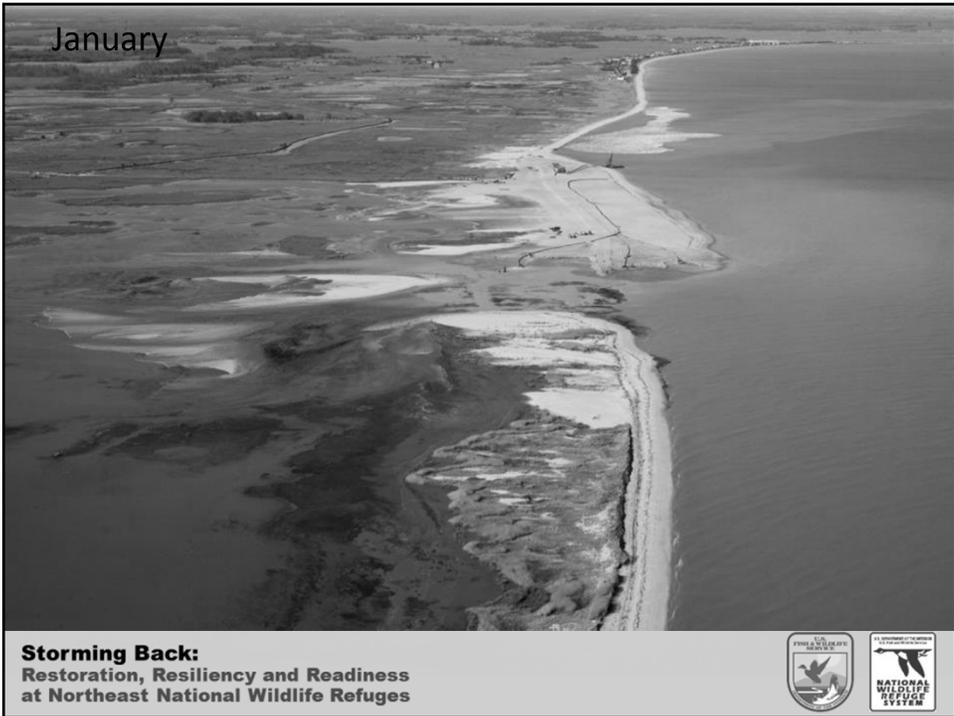
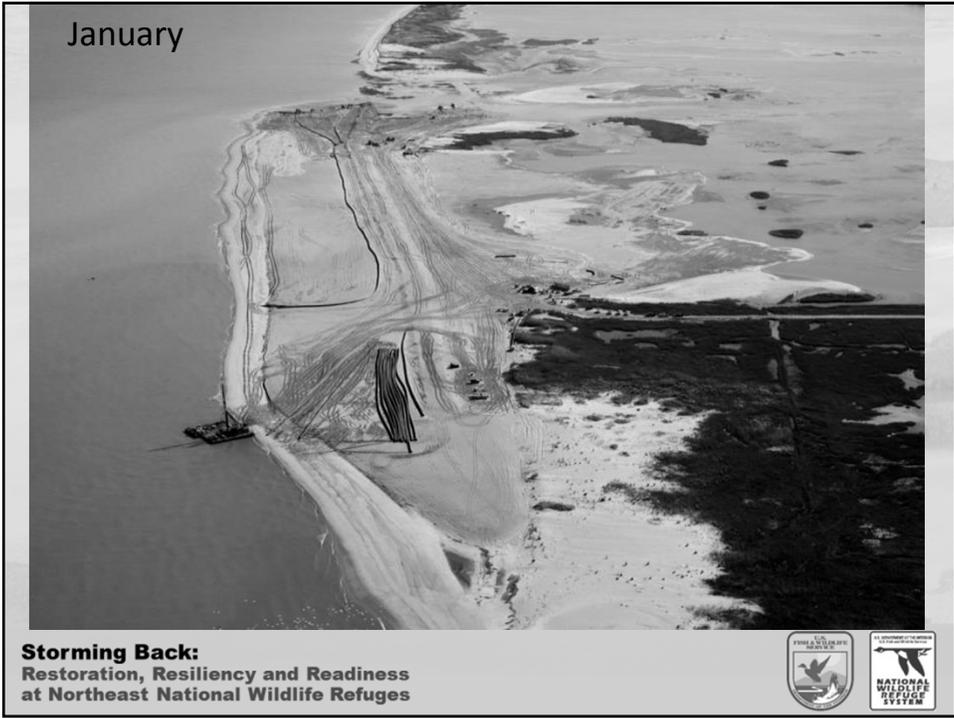
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Impact of the Storms

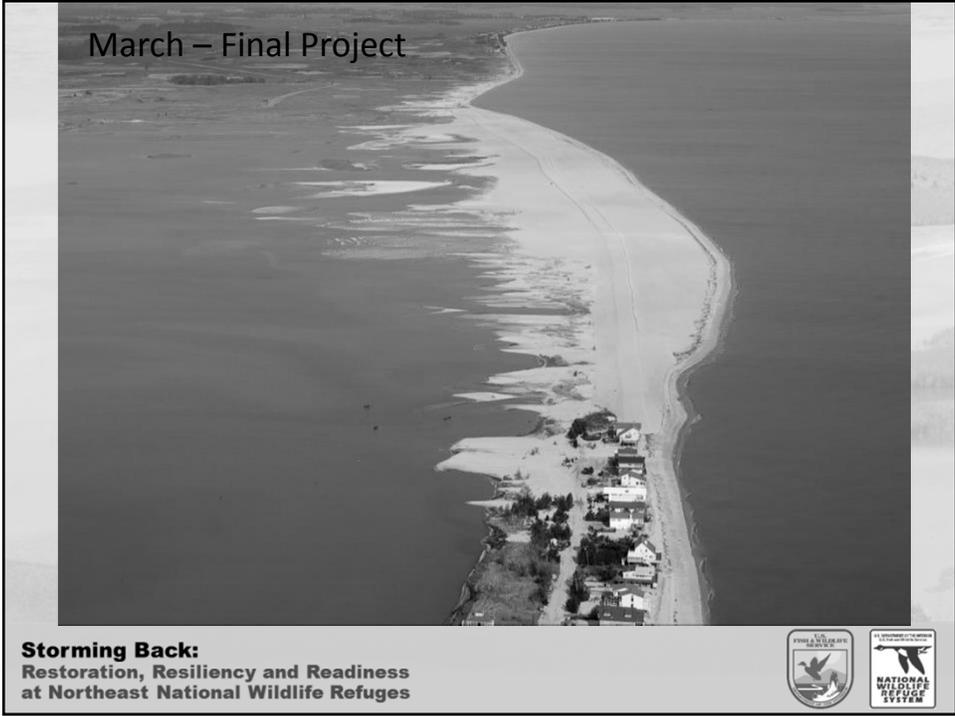
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Impact of the Storm

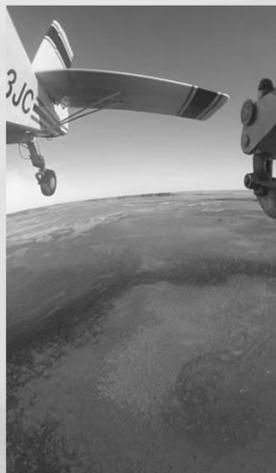
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Aerial Seeding

- Used over 10,000 lbs of seed from 17 different species
- 1,000 acres of exposed mudflat



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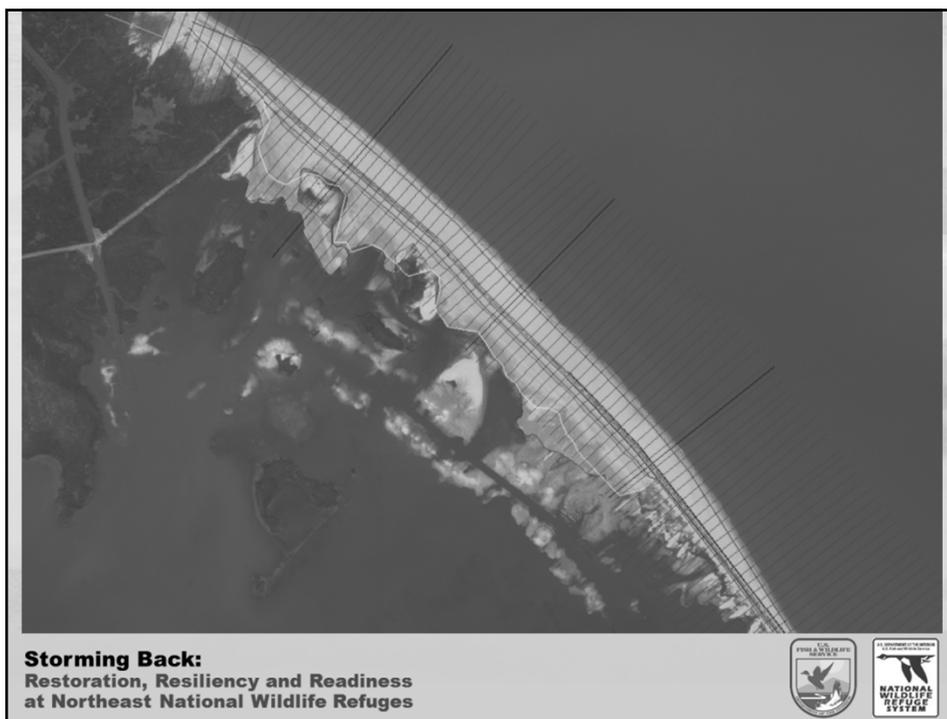


Planting of Backbarrier

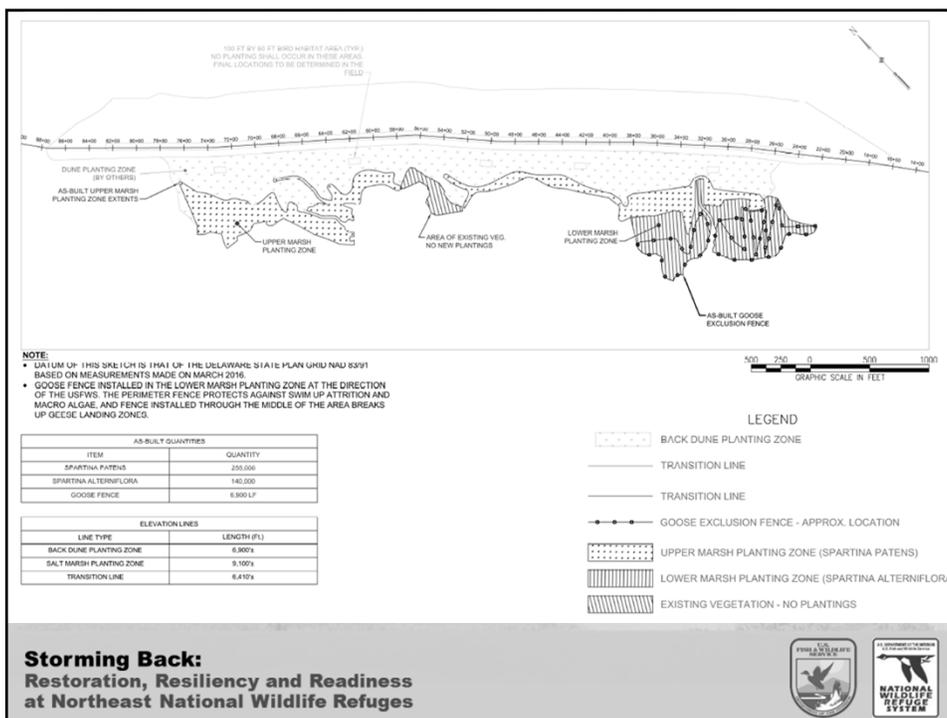
- Building resiliency through stabilization of backbarrier
- Increasing seed stock
 - 40 acres, seeded with *Panicum*
 - 18 acres planted with *Spartina* grasses
 - 255,000 plugs of *patens*
 - 140,000 plugs of *alterniflora*

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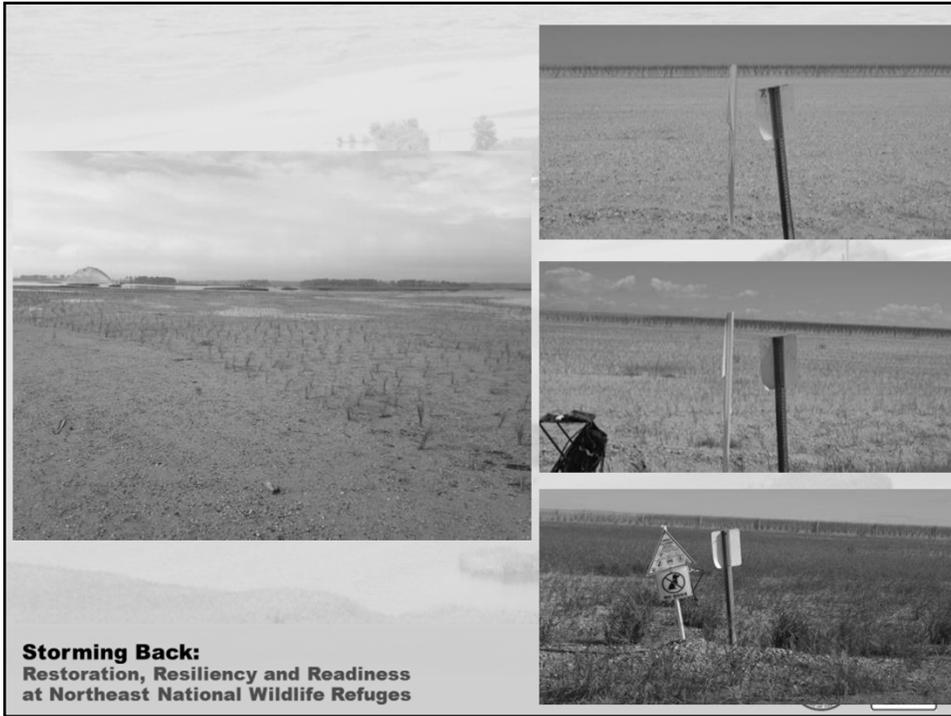


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Monitoring

- **Why Monitor ?**
 - To determine if project is meeting performance standards
 - To detect changes in the system and benchmarks when to employ adaptive management strategies
- **Where to monitor?**
- **When to monitor?**
 - Temporal considerations such as spawning seasons
 - Growing season
 - Minimize wildlife harassment
 - Episodic events such as storm surges

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Monitoring our Progress with Partners

- Delaware Department of Natural Resources and Environmental Control (DNREC)
 - Coastal Programs / DNERR
 - Wetland Assessment
- University of Delaware
 - Chris Sommerfield, Tom McKenna, Greg Shriver, Chris Williams
- USFWS Maryland Fish & Wildlife Conservation Office
- USFWS Northeast Regional I&M and LMRD staff
- Refuge staff
- USGS
- Rutgers University

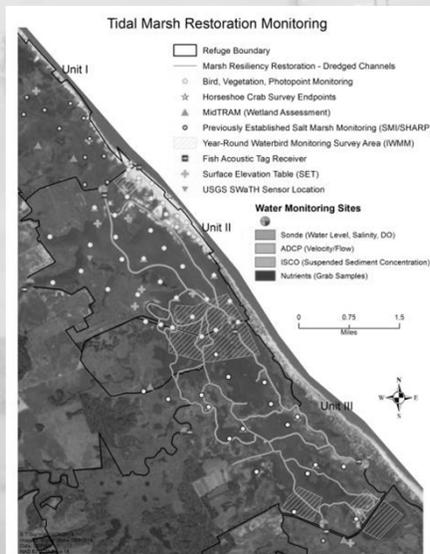
Table with 2 columns: Monitoring Plan, Monitoring Period. The table lists various monitoring activities and their corresponding timeframes.



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Biological Monitoring Overview

- 15-20 Bird & Vegetation Survey Points in each unit
- Unit I (north) and Unit IV (south) serve as reference areas
- Fish survey locations varied, focused at WCS and in channels
- Compiled into a Monitoring Plan as a "living document"



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Water Monitoring Network

METHODS

- Network of EXO2 sondes
 - Water level, salinity, temperature, pH, dissolved oxygen
 - Continuous data, every 15 minutes
 - 3 sites included on real-time online StormCentral website
 - Maintained by **DNREC/DNERR and Refuge Staff**
- Sediment Flux study (**Dr. Chris Sommerfield, Univ of Delaware**)
 - Isco for discrete sampling (SSC, backscatter calibration)
 - ADCP / ADV for continuous sampling (flow, backscatter)
- Nutrient monitoring
 - Monthly grab samples taken by **Refuge Staff**
 - Analysis coordinated by **DNREC/DNERR**



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Vegetation Community Response

METHODS

- Salt Marsh Integrity (SMI) and Saltmarsh Habitat and Avian Research Program (SHARP) (*Univ of Delaware; Refuge Staff*)
 - 50-meter radius around bird survey points
 - Community cover types and dominant species
 - Point-intercept transect (100 meters long)
 - Photopoints (North, East, South, West)
- Mid-Atlantic Tidal Rapid Assessment Method (MidTRAM)
 - Habitat Attribute: Bearing capacity, horizontal vegetation obstruction; Also - biomass, RTK elevation (*DNREC*)
- NDVI (Normalized Difference Vegetation Index) (*USFWS I&M*)
 - Open Water : Vegetated Marsh ratio from imagery



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Vegetation Community Response



Pluchea odorata
 (Saltmarsh fleabane)

Leptochloa fascicularis
 (bearded sprangletop)

Spartina alterniflora
 (Saltmarsh cordgrass)

Eleocharis parvula
 (dwarf spikerush)

Echinochloa crus-galli
 (barnyardgrass)

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Vegetation Community Response

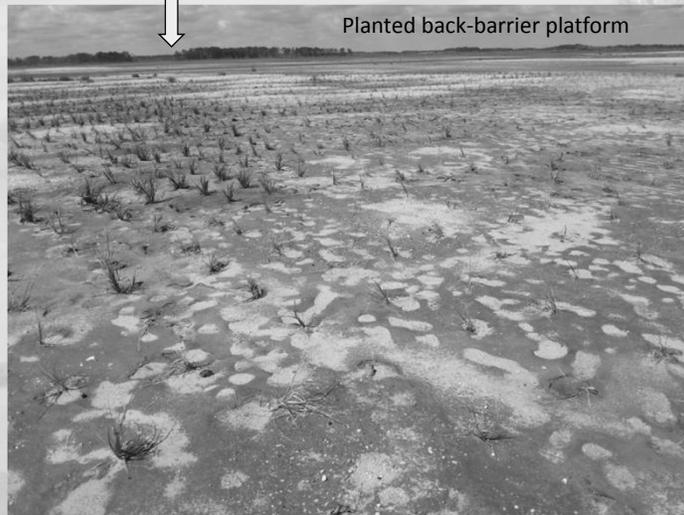


Dredged channel
and thin-layer
deposited material

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Vegetation Community Response



Planted back-barrier platform

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Vegetation Community Response

RESULTS / HIGHLIGHTS – NDVI

- “Hot off the Press”
- Preliminary results, not closely examined yet
- Different imagery sources (USDA NAIP vs DigitalGlobe WorldView3)
- Tide timing not controlled

	Total Unit Acres	Open Water (acres)		Vegetated Marsh (acres)		2015 % Open Water	2016 % Open Water
		2015	2016	2015	2016		
Unit I (East)	805	255	178	550	628	32%	22%
Unit I (West)	851	133	78	718	773	15%	9%
Unit II	1438	1249	996	189	442	87%	69%
Unit III	2335	1504	1299	830	1036	64%	56%

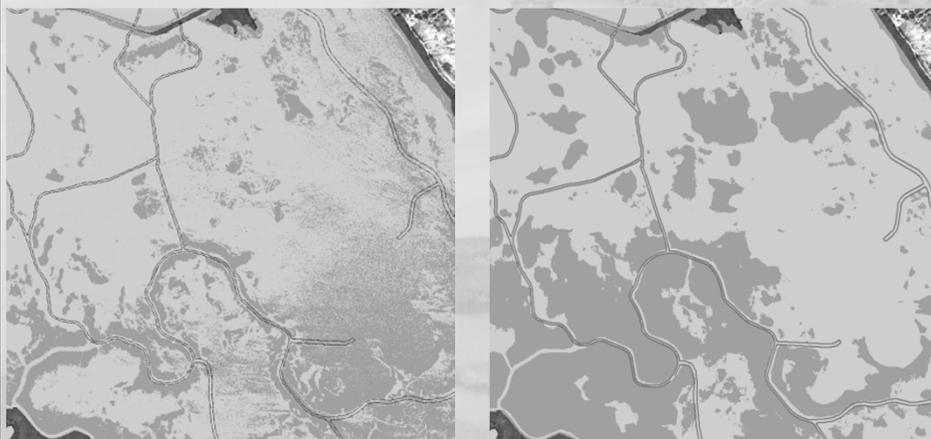
- In restoration units, % open water starting to drop
- Unit I had also been affected by increase in flooding and ponding

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Vegetation Community Response

- Some large areas in Unit III adjacent to dredged channels, where material has been sidescast, filled in substantially

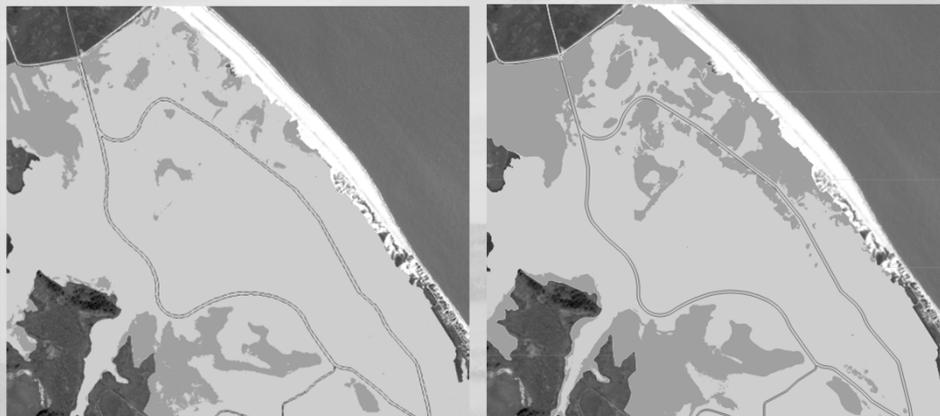


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Vegetation Community Response

- Planted vegetation in back barrier area is evident (dune not included in analysis)



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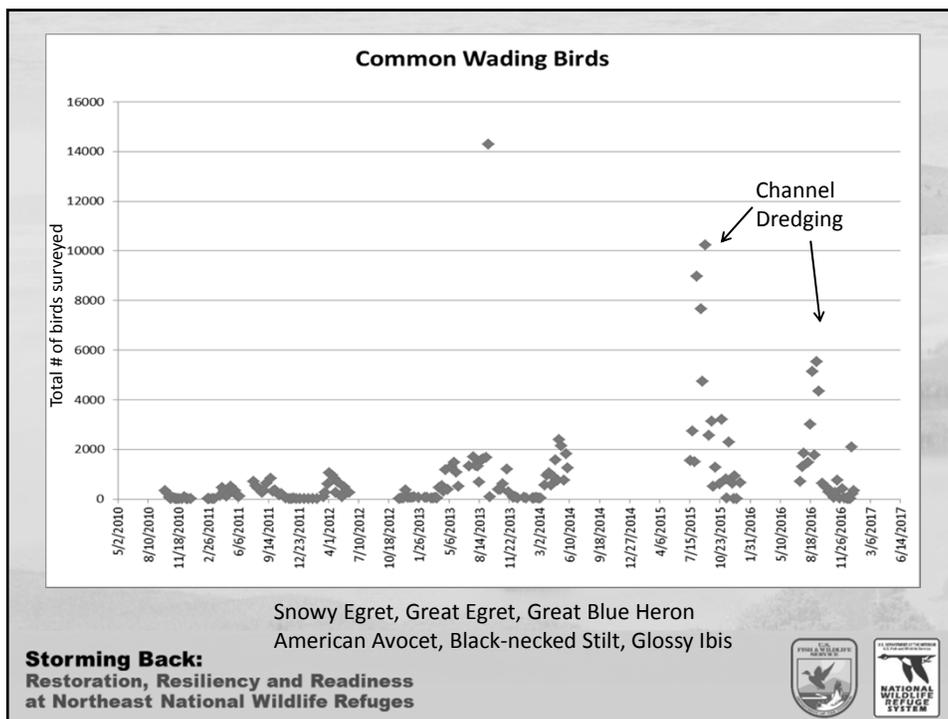


Bird Community Response

METHODS

- Salt Marsh Integrity (SMI) and Saltmarsh Habitat and Avian Research Program (SHARP) (*Univ of Delaware*)
 - 15-20 bird survey points per unit (including adjacent salt marsh units as reference)
 - 5-minute passive point count followed by secretive marshbird callback sequence
 - 3 visits per year (usually)
 - Ultimately... Tidal Marsh Obligate (TMO) analysis
- Integrated Waterbird Management & Monitoring (IWMM)
 - Year-round routine roadside surveys by *Refuge staff*
- Beach nesting birds
 - Routine beach surveys in partnership with *Refuge volunteers and DNREC staff*
 - Nest monitoring and protection





Bird Community Response

RESULTS / HIGHLIGHTS – Beach-nesting Birds

- Most “robust” least tern (LETE) colony in the state for years
- American oystercatchers (AMOY) nested but were not successful
- First ever documented Piping Plover nest on the refuge in 2016
- Already 4 active PIPL nests this year

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Horseshoe Crab Response

RESULTS / HIGHLIGHTS – Horseshoe Crab Spawning

Surveys conducted by
Refuge staff per DE Bay
Horseshoe Crab Survey
protocol

More horseshoe crabs than
expected in first year!

Pre-restoration surveys
were done in area just
north (Unit I), serves as
benchmark for comparison



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Fish Community Response

METHODS

- **Seasonal fish community surveys**
(Spring, Summer, Fall)
- Fyke nets, Seine nets, Clover traps
(varied as restoration progressed)
- **Acoustic tags** deployed to see how
diadromous fish are using the system
prior to, during, and after restoration
- 8 receiver sites (11 in 2015)
- Tag data downloaded seasonally, data
comes from other researchers in the
network as well



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Fish Community Response

RESULTS / HIGHLIGHTS – Fish Community Surveys

- Results thus far still being summarized
- Species that increased:
 - White perch
 - Sheepshead minnow
 - Black drum
- Species caught 2016 not detected previously:
 - Atlantic croaker
 - Diamondback terrapin
- Species that decreased:
 - Common carp
 - Killifish spp
 - Silverside spp
 - Mummichog



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Elevation Monitoring

METHODS

- Surface Elevation Tables
 - 6 in Unit II, 3 in Unit I, 3 in Unit IV
 - Read twice per year by **Refuge Staff**
 - Includes feldspar plots
- Shoreline Position (1D) (**Refuge Staff; Rutgers Univ assisting**)
 - Conducted with National Park Service protocol
 - Spring and Fall
- Shoreline Topography (2D/3D) (**Refuge Staff; Rutgers Univ assisting**)
 - Conducted with National Park Service protocol
 - 2D Spring and Fall; 3D in Spring



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Ongoing Monitoring

- Post-restoration monitoring will continue
- Key monitoring partnerships funded through 2022!! 😊
- Some monitoring will be the “new order of business” for refuge biology program



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2016 Army Corp of Engineers External Partnering Team Award

2016 World Organization of Dredging Associations (WODA)
Silver Environmental Excellence Award winner in the “Environmental Dredging” category

2017 American Shore and Beach Preservation Association (ASBPA) Best Restored Beach Award

Thank You

Questions?

USFWS Photo