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

Bart Wilson P.G. Ph.D. Coastal Resiliency Coordinator
Coastal Delaware NWR Complex, USFWS

Susan Guiteras, Supervisory Wildlife Biologist
Coastal Delaware NWR Complex, USFWS

Al Rizzo, Project Leader
Coastal Delaware NWR Complex, USFWS

Art Coppola, Refuge Manager
Prime Hook NWR, USFWS

Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

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

- NOAA Fisheries: Greater Atlantic Region
- 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

Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

Historic Shoreline (1926 to present)

Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
**History of Shoreline Overwashes & Breaches**

- **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
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*

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
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

---

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
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)

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
A) Primary Channels (Box Cut)

B) Secondary Channels (Box Cut)

C) Tertiary Channels (Box Cut)

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
10” Shallow Draft Dredges

Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
Discharge on to Mudflat and Very Shallow Open Water
Discharge on to Shallow Open Water

Berming to Avoid Sediment Inflowing
Remote Spray Barge

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

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

Channel Surveys

Storming Back:
Restoration, Resiliency and Readiness
at Northeast National Wildlife Refuges
And the birds love us!

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

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

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

October – Prior to Construction
November

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

December
January

Storming Back:
Restoration, Resiliency and Readiness
at Northeast National Wildlife Refuges
Impact of the Storms

Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

Impact of the Storm

at Northeast National Wildlife Refuges
Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
Aerial Seeding

- Used over 10,000 lbs of seed from 17 different species
- 1,000 acres of exposed mudflat
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*
Storming Back: Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
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

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
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”

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
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

Vegetation Community Response

Pluchea odorata
(Saltmarsh fleabane)

Leptochloa fascicularis
(bearded sprangletop)

Spartina alterniflora
(Saltmarsh cordgrass)

Eleocharis parvula
(dwarf spikerush)

Echinochloa crus-galli
(barnyardgrass)

Storming Back:
Restoration, Resiliency and Readiness
at Northeast National Wildlife Refuges
Vegetation Community Response

Dredged channel and thin-layer deposited material

Vegetation Community Response

Planted back-barrier platform

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges
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

<table>
<thead>
<tr>
<th>Total Unit Acres</th>
<th>Open Water (acres)</th>
<th>Vegetated Marsh (acres)</th>
<th>2015 % Open Water</th>
<th>2016 % Open Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit I (East)</td>
<td>805</td>
<td>255</td>
<td>550</td>
<td>628</td>
</tr>
<tr>
<td>Unit I (West)</td>
<td>851</td>
<td>133</td>
<td>718</td>
<td>773</td>
</tr>
<tr>
<td>Unit II</td>
<td>1438</td>
<td>1249</td>
<td>189</td>
<td>442</td>
</tr>
<tr>
<td>Unit III</td>
<td>2335</td>
<td>1504</td>
<td>830</td>
<td>1036</td>
</tr>
</tbody>
</table>

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

Storming Back:
Restoration, Resiliency and Readiness
at Northeast National Wildlife Refuges

Vegetation Community Response

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

Storming Back:
Restoration, Resiliency and Readiness
at Northeast National Wildlife Refuges
Vegetation Community Response

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

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
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
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

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
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

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
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

Storming Back:
Restoration, Resiliency and Readiness at Northeast National Wildlife Refuges

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?