

National Wildlife Refuge Resiliency Projects

Locations

- Chesapeake Marshlands
- Chincoteague
- Prime Hook
- Cape May/ Supawna Meadows
- Forsythe
- Long Island NWR Complex
- RI NWR Complex
- Parker River/ Great Marsh
- Regionwide –
 - SMI/GNSS
 - Shoreline Surveys
 - Impoundment analysis

Techniques

- Living Shoreline
 - Oyster/ bivalve restoration
 - Eelgrass restoration
 - Tidal flat restoration
- Sediment enrichment
- Dune/ Barrier Island restoration
- Marsh Hydrologic Improvements
 - Runnels
 - Tidal flow
 - Fish passage
 - Ditch Remediation
- Invasive Species
- Hydrology Modelling
- Black Duck Carrying Capacity



Living Shorelines

Objectives: Stabilize/enhance shoreline to protect existing coastal resources; improve nearshore water quality; restore/improve shoreline wildlife habitats

Performance Metrics:

Biotic

- **E. Oyster size-frequency distributions, density; Atlantic Ribbed Mussel density**
- **% cover of protected marsh, created marsh**
- American oystercatcher nest counts
- Areal extent new intertidal marsh and sandy berm
- % cover in protected SAV beds

Abiotic

- **Water quality – temp., salinity, DO**
- **Wave attenuation**
- **Accretion rates and areal extent of protected and created marsh**

Structural/Engineering

- Reef dimensions and height (**Structural resilience, Vertical accretion rates**)
- **1-D, 2-D Shoreline position and topography** (DSAS, profile transects)
- Stable breakwater crest elevation



Marsh Hydrologic Improvement

Objectives: Alleviate waterlogged marsh, restore native marsh vegetation, improve surface and belowground accretion (culvert replacement, ditch remediation, runnels)

Culvert Replacement Performance Metrics:

Biotic

- Salt marsh plant community metrics, invasive plant % cover
- SMI - Nekton abundance & species richness, TMO integrity index
- Wintering waterfowl – benthic and veg food sources, waterfowl

Abiotic

- Marsh accretion/erosion rates
- Groundwater dynamics
- Water quality: salinity, conductivity, temperature, dissolved oxygen, pH

Structural/Engineering

- Marsh surface elevations – as built and trend



Addressing Ditch Legacy

Ditch Remediation

Performance Metrics:

Biotic

- Marsh platform vegetation: % cover
- In-ditch vegetation: % cover, # stems, plant height

Abiotic

- Groundwater depth
- Water quality: salinity
- Ditch depth, width

Runnels

Performance Metrics:

Biotic

- Marsh vegetation: % cover

Abiotic

- Marsh surface elevation (SETs)



Sediment Enrichment

Objectives: Enhance/restore tidal marsh habitat by increasing the marsh surface elevation, reducing inundation stress on vegetation community

Performance Metrics:

Biotic

- Salt marsh plant community metrics, invasives % cover
- SMI - Nekton abundance & species richness, TMO integrity index
- Marsh belowground biomass & bearing capacity
- Wintering waterfowl – benthic and veg food sources, waterfowl surveys

Abiotic

- Marsh accretion/erosion rates
- Groundwater dynamics (marsh); also local groundwater inputs
- Average daily and monthly tide range
- Water quality: salinity, conductivity, temperature, dissolved oxygen, nutrients
- Suspended sediment concentrations in wetland channels & marsh

Structural/Engineering

- Marsh surface elevations – as built and trend



Marsh Tidal Re-Connection

Objectives: Restore natural hydrologic regime (diked impoundments or obstructed tidal channel); increase salinity, restore native tidal marsh

Performance Metrics:

Biotic

- Salt marsh plant community metrics, invasives % cover
- SMI - Nekton abundance & species richness, TMO integrity index
- Marsh belowground biomass & bearing capacity
- Wintering waterfowl – benthic and veg food sources, waterfowl surveys
- Estuarine fish and shellfish abundance, species richness, acoustic tag work

Abiotic

- Marsh accretion/erosion rates
- Groundwater dynamics (marsh); local groundwater inputs
- Average daily and monthly tide range
- Water quality: salinity, conductivity, temperature, dissolved oxygen, nutrients
- Suspended sediment concentrations in wetland channels & marsh

Structural/Engineering

- Marsh surface elevations – as built and trend



Dune/Back Barrier Shoreline Restoration

Primary Objectives: Restore/establish dune and back barrier beach complex stable enough to withstand tide and storm surges

Performance Metrics:

Biotic

- Vegetation cover of dunes pre and post event
- Fish and wildlife population/ recruitment/ overwintering/stopover weight/health relative to other mitigating factors

Abiotic

- Post-storm volume of sand in the shore face
- **Recovery rates of beach and dunes - 1-D, 2-D Shoreline position and topography** (DSAS, profile transects)

Structural/Engineering

- Beach width, elevation, volume, shoreline position (post-event)
- Dune characterization (height, width, length, texture, substrate)



Impoundments

- **Objective:** Develop correction factors for LiDAR models used to evaluate resiliency of impoundments and as a decision tool in management/restoration

Abiotic

- basin bottoms and side slopes
- tops of dikes - highs and lows
- emergency spillways
- upstream valley cross sections
- downstream valley cross sections
- marsh platform elevations (high and low)
- pipe elevations of water control structures



Regional Support

- **In-house Global Navigation Satellite System (GNSS)**
- **Salt Marsh Integrity Assessments**
- **GIS/ Visioning**



Regional Support

- **In-house Global Navigation Satellite System (GNSS)**
 - Establish temporary and permanent elevation benchmarks
 - GNSS RTK
 - high precision elevation data to check contractor performance on-the-fly
 - monitoring stability of constructed coastal features (TDL elevation, shoreline profiles, breakwater crests, shorelines and profiles)
 - GNSS RTK – help partners improve precision in water level monitoring, referencing common datum (USGS SwATH network, University hydrologists)



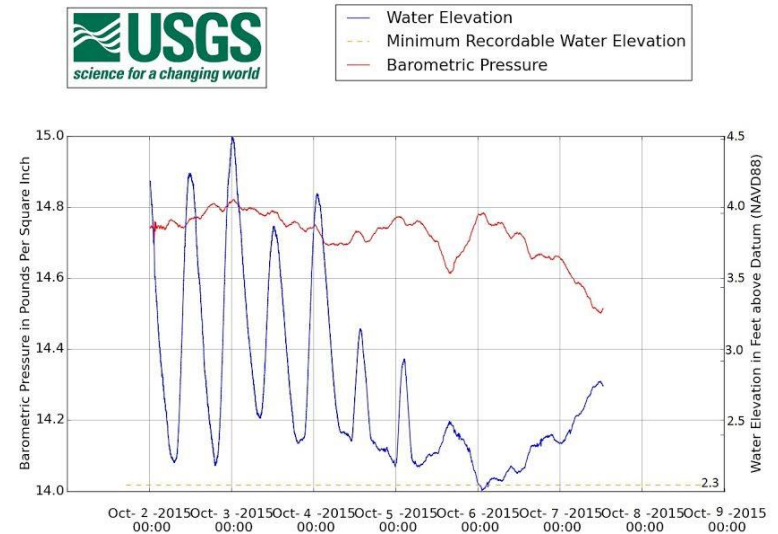
Regional Support

- Salt Marsh Integrity Assessment (2012)
 - Elevation monumentation (10 refuges)
 - SETs: Annual marsh surface readings, accretion, static GPS occupations:
<https://irma.nps.gov/App/Reference/Profile/2225005>
 - SMI protocol: Avian, nekton, vegetation, water quality, landscape metrics
- Shoreline Surveys and Dune Profiling
 - 2-D biannual shoreline surveys of swash line (with USGS)
 - 3-D dune profiling
- GIS and Visioning Tools
 - FWS Portal/ ArcGOL: GIS portal for FWS use. Maps Hurricane Sandy FWS and Partner Project locations
 - FWS Story Map:
<http://www.fws.gov/hurricane/sandy/storymap/>



SwATH

- Primary Objectives: Track changes in wave attenuation and tidal flooding levels, over time, as marsh is restored
 - USGS/FWS deployed in partnership
- SwATH sensor data collected along a SwATH transect at Prime Hook NWR, Unit 2
- This graph shows flooding during period of hurricane Joaquin, Oct. 2015, at the high marsh/coastal forest interface
- FWS conducted RTK to tie sensors to NAVD88
- Will be deployed during large storm events



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