Beneficially Using Dredged Sediment to Enhance Marshes, Build Resiliency and Restore Habitats in The Seven Mile Island Innovation Lab and New Jersey's Back Bays

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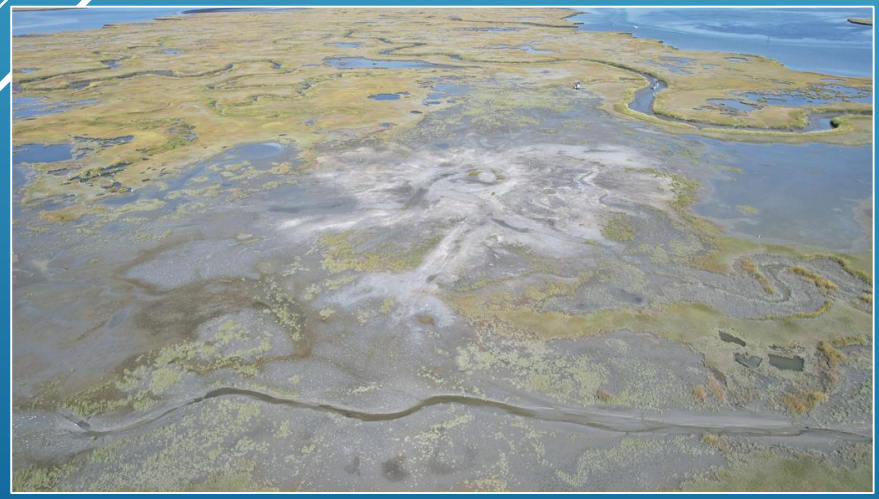

- A Proving Ground Using Natural and Nature-Based Features to Provide Ecological Uplift and Enhanced Resilience for Ecosystems and Coastal Communities
- A Test Bed to Advance and Improve Dredging Techniques and Marsh Restoration and Coastal Feature Creation Techniques in Coastal New Jersey
- Using a Landscape Approach and Adaptive Management to Move From Pilot Projects to Ecosystem Solutions
- Based on an International Concept Pioneered by the Dutch
- 24 sq mi Back Bay Marsh Dominated System with Shallow Bays, Sounds and Tidal Inlets Bisected by the NJ Intracoastal Waterway
- 50+ Member Working Group for Knowledge Sharing
- More than 30 Scientists Working in SMIIL

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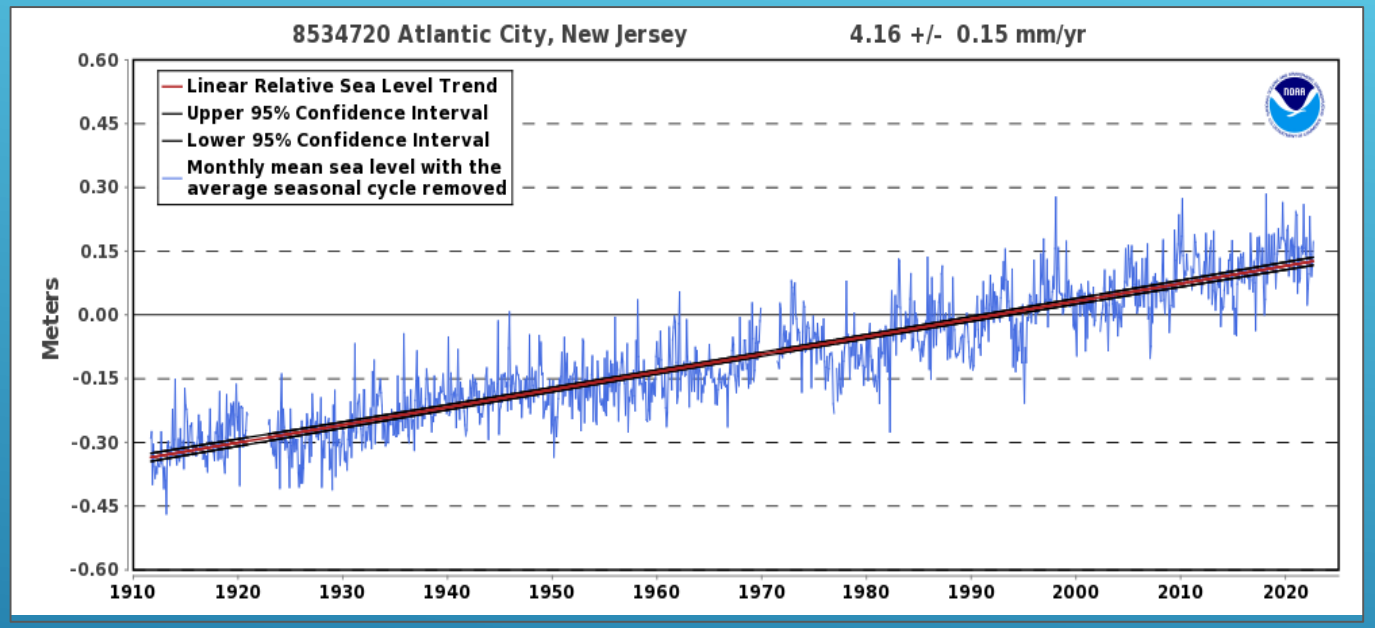
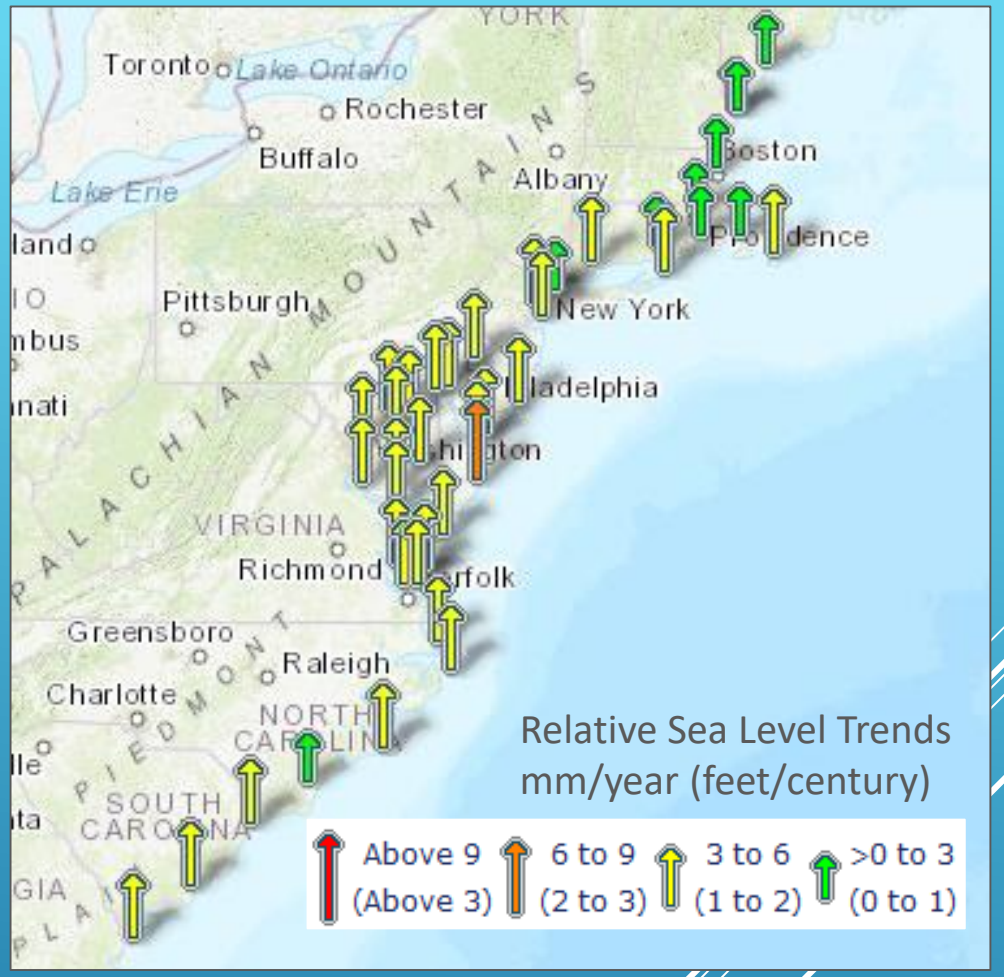
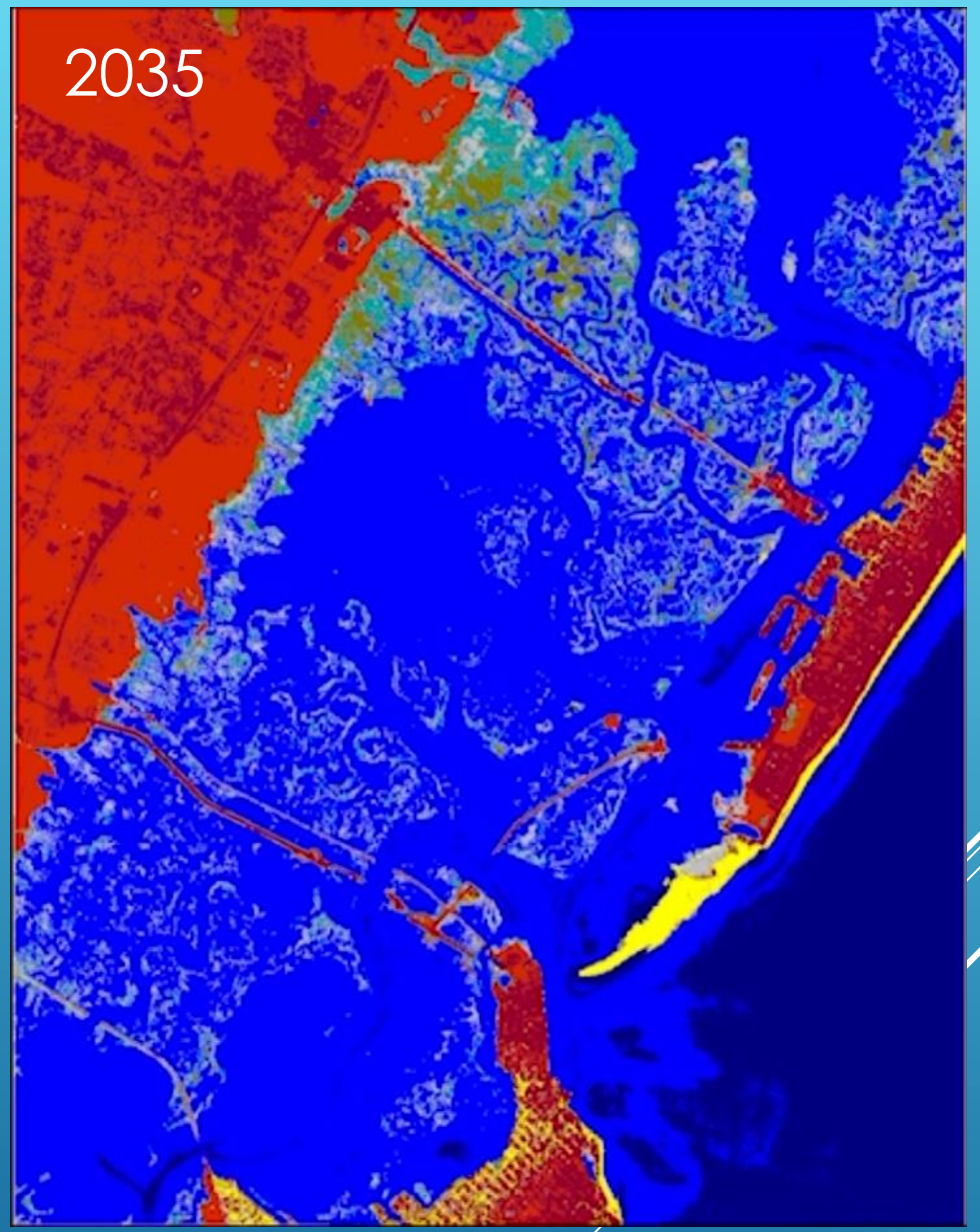
RELATIVE SEA LEVEL TREND





- New Jersey SLR is 2x Global Average
- 1911 – 2021 rose 1.36 feet in 100 years
- Rate has increased from 2010 of 4.04 mm/year to 4.16 mm/year
- Has risen 4" since 2000
- Typical marsh accretion rates in the area are 4 mm/year; SMIIL marshes confirm this rate
- Regional subsidence rates are ~2 mm/year

https://tidesandcurrents.noaa.gov/sltrends/sltrends.html



HIGH TIDE FLOODING (MHW SLAMM) AND COASTAL RESILIENCE

Weitzman SCHOOL OF DESIGN
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EVIDENCE OF MARSH DROWNING

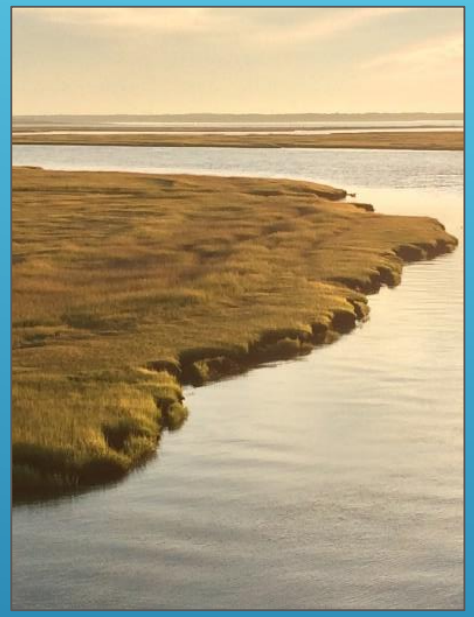
- Marsh conversion to mudflat
- Swiss cheese marshes and expanding pool margins

MARSH EDGE EROSION CONTRIBUTION TO WETLAND LOSS

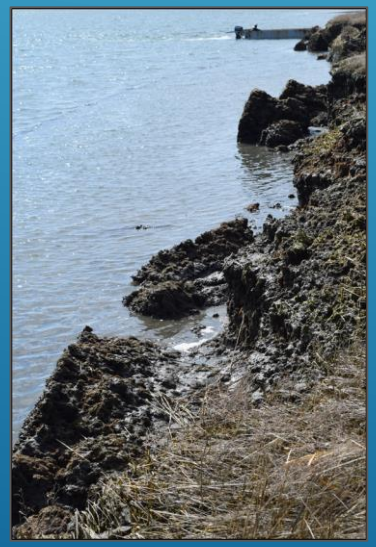
Along open fetch areas from storms

Boat wake induced erosion

Other causes?



USFWS Sea Level Affecting Marshes Model

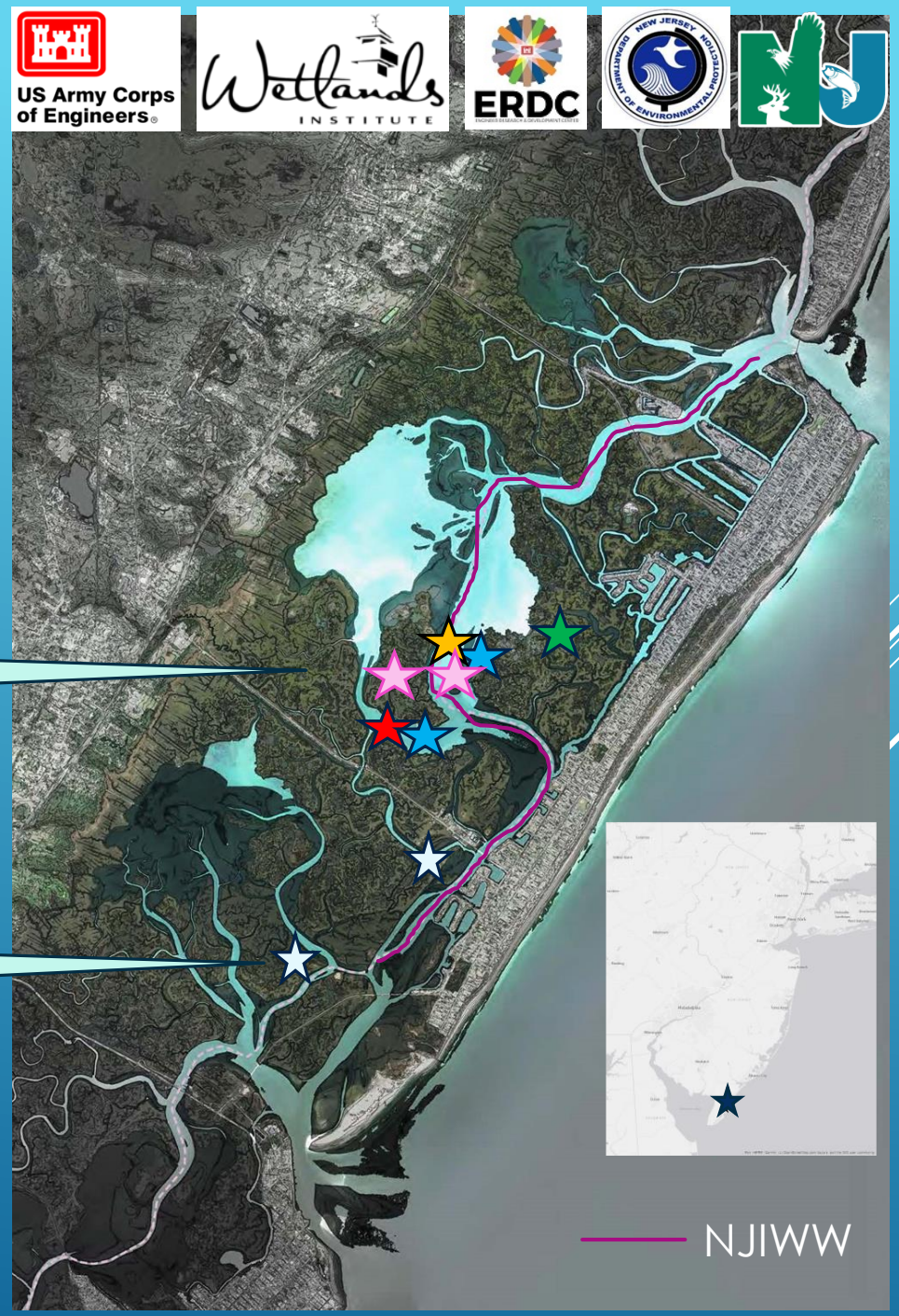


SMIIL BENEFICIAL USE PROJECTS

- Marsh Elevation Enhancement/Wading Bird Nesting Habitat
- Sandy Marsh Edge Protection
- Intertidal Shallows and Tidal Delta Enhancement
- Edge Protection and Tidal Flat Enhancement
- Marsh Elevation Enhancement
- Elevated Nesting Habitat

Sediment Type: Mixed Fine Sand and Mud
Maintenance Dredging NJIWW
Hydraulic Dredging and Transport <1 mi

Sediment Type: Fine to Medium Sand
Maintenance Dredging NJIWW
Hydraulic Dredging and Transport <1 mi



MARRYING SITE SELECTION WITH DREDGING NEEDS

- Once Source Sediments and Dredging Need is Identified Ecological Aspects Take Center Stage
- Marsh Condition Assessments, Habitat and Sensitive Species Status and Concerns Identified, Connections to Community Resilience and Benefits
- Develop Set of Projects to Address Ecosystem and Community Resiliency Needs Utilizing Available Sediment to Address Navigational Dredging Needs
- Marsh Condition Alone is Unlikely to Drive Site Selection
  - Abundant marsh and wildlife need so typically good partnering opportunities
  - Exceptions may be dredging specifically to source material for marsh restoration

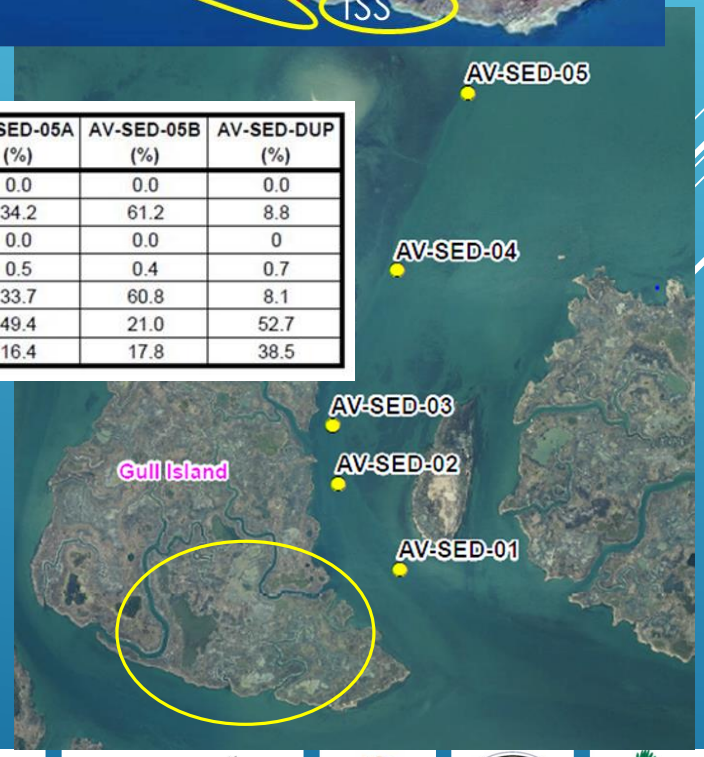
- Sturgeon and Gull Islands are drowning low lying marsh islands
- Historic dredge material placement sites created important wading bird habitat
  - Nesting areas account for nesting for 35% of all colonial wading birds in NJ
- Habitat degrading with elevation loss
- Island drowning destabilizing marshes

CREATE A SYSTEM OF SOLUTIONS

Ecological Goals for Both Gull and Sturgeon Island Placements

- Raise Elevations of Marsh Platform Across a Gradient of Elevations (MEE)
  - Target Wading Bird Nesting Elevations - Transitional Upland Shrub Habitat (>3.5' NAVD88)
  - Target High Marsh Elevations for Salt Marsh Sparrow (2.7' – 3.1' NAVD88)
  - Target Low Marsh Elevation for Fish Habitat (2.0 – 2.7' NAVD88) and Shorebird and Wader Foraging
- Create Marsh Edge Protection Zone (MEP)
  - More Natural Marsh Edge Slope and Wave Energy Buffer
  - Strategic Placement for Marsh Nourishment
  - Intertidal Shoal to Marsh Edge Elevation (2.0'NAVD88)
- Enhance Intertidal and Subtidal Shallows (ISS)
  - Target Elevations to MLLW Where Macroalgal Flats Transition from Sparse to Densely Vegetated (-1.0 MLLW – 0' MLLW)

Sample ID / Analyte	AV-SED-01 (%)	AV-SED-02/03 (%)	AV-SED-04 (%)	AV-SED-05A (%)	AV-SED-05B (%)	AV-SED-DUP (%)
Gravel	0.0	0.0	0.0	0.0	0.0	0.0
Sand	23.1	9.8	17.9	34.2	61.2	8.8
Coarse Sand	0.0	0.0	0	0.0	0.0	0
Medium Sand	1.2	1.5	1.3	0.5	0.4	0.7
Fine Sand	21.9	8.3	16.6	33.7	60.8	8.1
Silt	53.5	61.1	60.1	49.4	21.0	52.7
Clay	23.4	29.1	22	16.4	17.8	38.5



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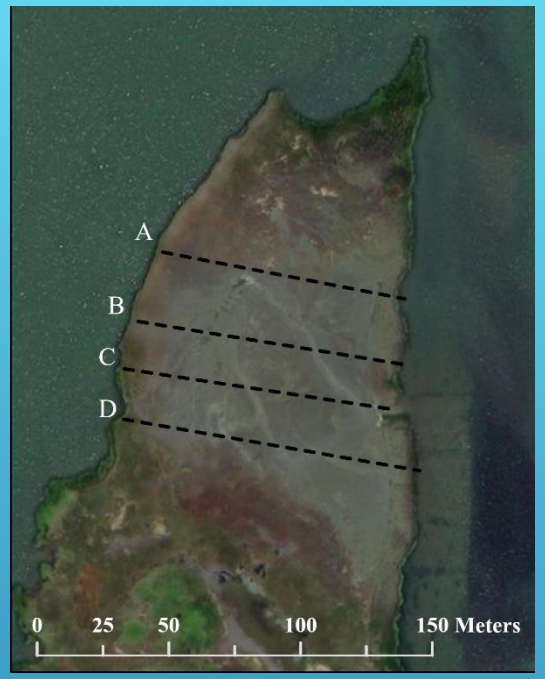
OUTCOMES GULL ISLAND PROJECTS

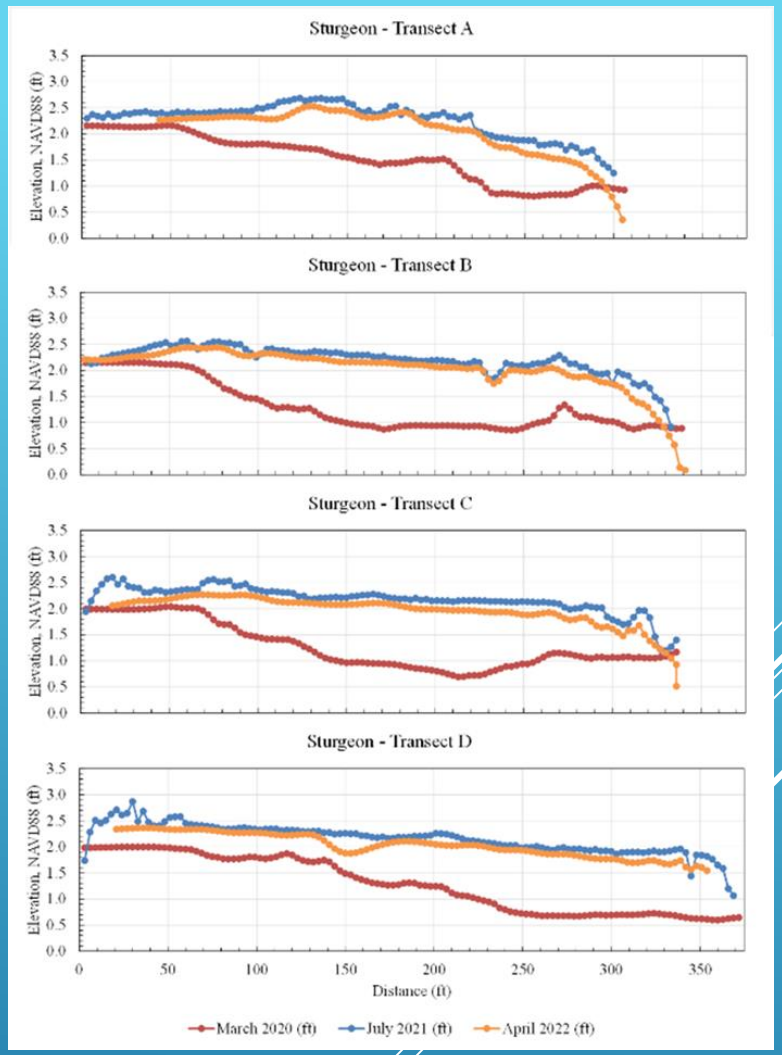
- Marsh Elevation Enhancement (MEE)
  - Unconfined placement of 40,000 cubic yards of mixed fine sand and mud
  - ~22 acres of elevation lift
  - 3.9’ NAVD88 to 1.8’ NAVD88
  - Excellent marsh grass recovery
  - Migratory shorebird and sparrow use
- Marsh Edge Protection
  - Built to marsh edge (2.0’ NAVD88) down to MLLW
  - Placed ~9000 cy and gained 1–2.5’ of elevation
  - 50% reduction in volume (~4700 cy) after 16 months and 1-1.5’ of elevation gain
  - ~Measured wave height and energy reduction along marsh edge during May Nor’easter (Perkey et al.)
- Enhanced Intertidal Shallows
  - Placed ~8700 cy and gained 1-2.5’ of elevation gain and shallowed up to MLLW
  - Reduced to ~4100 cy after 16 months and 1-1.5’ of elevation gain so ~50% reduction in volume
- Documented very low turbidity during and following placement on par with storm generated turbidity and in close proximity to placement (Fall et al., 2022)

September 2020

- Placed in Two Phases in 2020
  - March 2020
    - 4,200 cubic yards
  - September 2020
    - 15,000 cubic yards
  - Mixed fine sand and mud
- Marsh Elevation Enhancement (MEE)
  - 3.5 acres of enhancement
  - 3.0' NAVD88 grading down to 1.9'
- Marsh Edge Protection (MEP)
  - Proof of concept - placed small sand ridge along toe of erosional slope
- Enhanced Intertidal Shallows (ISS)
  - Shallowed above MLLW along eastern island to extend flats northward
- Returned in Fall 2022 for Phase 3

STURGEON ISLAND PLACEMENTS





- 2020 uncontained placement achieved 1.5 – 2.5' of marsh elevation enhancement
- Vegetation recolonization is rapidly occurring naturally via seed bank in year 2

Courtesy of Harris et al.

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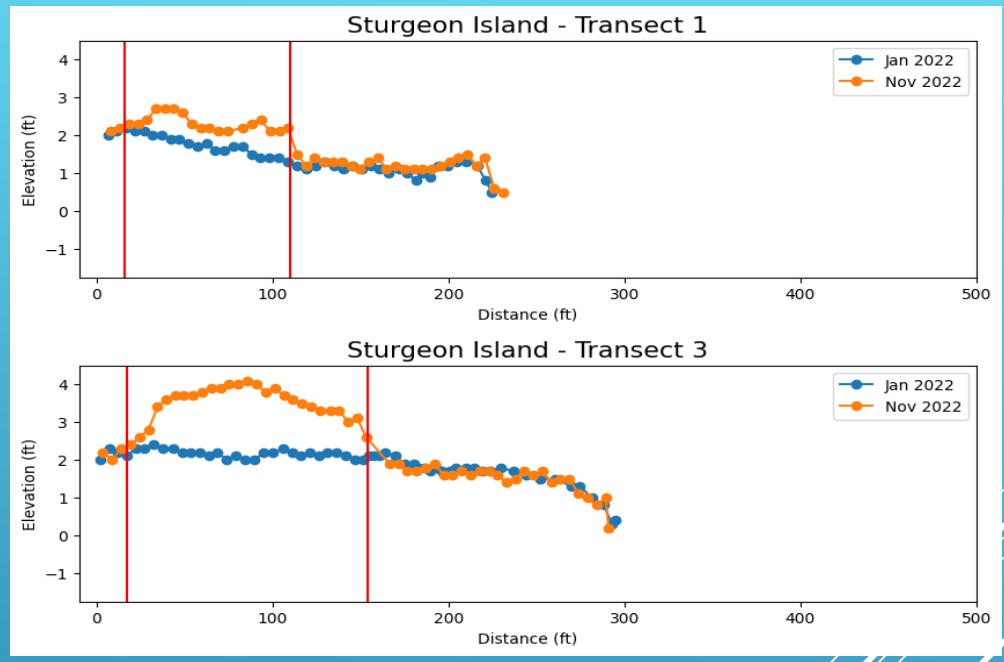
STURGEON ISLAND PHASE 3 – FALL 2022

- Placed 24,000 CY of fine sand to create sandy marsh edge protection features
  - Intercepting wave energy
- Used containment to elevate 0.4 acre for elevated bird nesting habitat
  - Placed more than 3' of material
  - Built to 4.0' NAVD88
- Employed Y-valve to switch between containment and subtidal features
  - Maintain dredging efficiency
  - Allow time for contained area to dewater
  - Slow and manage flow volumes and velocities

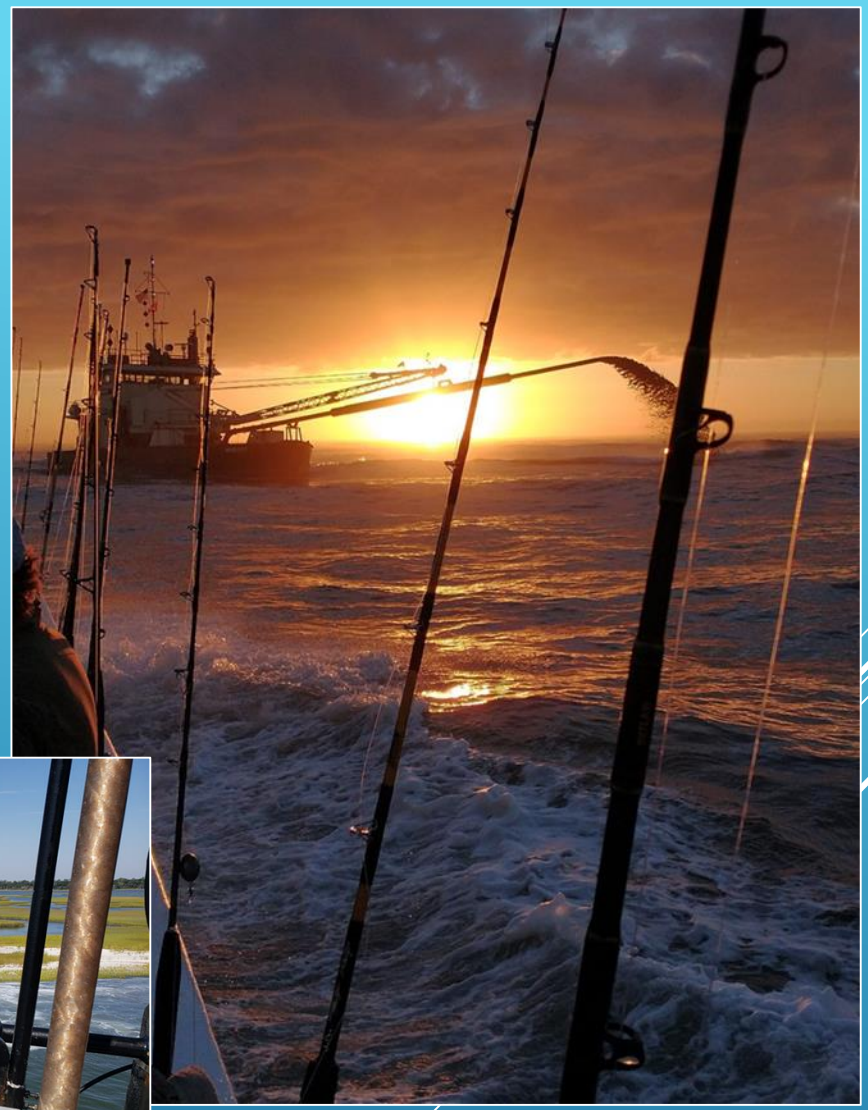


LESSONS LEARNED AND SOME GUIDING THOUGHTS

- Ecological Need and Goals Underpin Projects
  - Driven by material type and location
  - Marsh need is great so marrying need with material availability feasible
  - Understanding progress towards construction/ecological goals during placement difficult and ultimate goal attainment evolves as site evolves.
  - Structure project goals to include habitat and species benefits during site evolution
- Vegetation recovery takes ~two growing seasons to initiate
  - Recovery has been almost entirely by new seeding from the seedbank
  - Planting should be delayed for at least two growing seasons if needed at all
  - Balance placing in thin layers to preserve existing vegetation (rare) vs thicker placement for more ecological uplift
- Don't over engineer projects
  - Sediment containment is challenging, expensive, and often creates its own negative feedback loops
  - Unconfined placement allows material to spread over wide areas and for maintenance/development of tidal flushing
  - Building elevation may require multiple lifts or partial containment
  - Plan for placement at multiple sites to manage changing dredge material composition
- Consider role of monitoring and keep focused on adaptive management or to advance practices

WHAT'S NEXT IN SMIIL

- Pilot to clear shoals with sidecast government dredge Merritt using "Fertilizing the Garden" approach
- Track shoaling rates and patterns for long-term EWN strategies that are nature-based and less "big" construction efforts
- Risk acceptance and adaptive management, take "fail" out of language
- Agricultural & dredging industry coordination
- Leverage SMIIL with communities
- Utilize techniques in remaining portions of NJIWW
- Share lessons learned with Maurice River & Salem Rivers, NJ



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RELEVANT PUBLICATIONS

- Beardsley, Welp, Harris, McFall, Tyler, and Savant (2022): Sediment Distribution Pipe: Modeling Tool and field Application. WEDA Journal of Dredging, v. 20 (1) 16-37.
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- Ecoshape (2018): Living Lab for MUD Brochure, www.ecoshape.org.
- Fall, Perkey, Tyler, and Welp (2021): Field Measurement and Monitoring of Hydrodynamic and Suspended Sediment with the Seven Mile Innovation Laboratory, New Jersey, ERDC/CHL TR-21-9, https://permanent.fdlp.gov/gpo185925/ERDC-CHLTR-21-9(1).pdf
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- Rochette, Chasten, Tedesco, and Kopkash (2019): Seven Mile Island Innovation Laboratory, Overview and Purpose Fact Sheet, www.nap.usace.army.mil.
- Sea Level Rise in New Jersey: Projections and Impacts – New Jersey Climate Change Resource Center," https://njclimateresourcecenter.rutgers.edu/climate_change_101/sea-level-rise-in-new-jersey-projections-and-impacts/.
- Tedesco, Chasten, Ferguson, Collins, and Davis (2021): Using Dredged Sediments to Uplift Marshes, Build Subtidal Shallows and Provide Marsh Edge Protection in the Seven Mile Island Innovation Lab, Delaware Estuary Science and Environmental Summit, https://delawareestuary.org/delaware-estuary-science-and-environmental-summit/