# Introducing the New Jersey Tidal Wetland Monitoring Network SET Database & Mapping Platform

Erin O'Brien, Joshua Moody, Kirk Raper, Ceili Pestalozzi,

LeeAnn Haaf, Joe Grzyb, and Metthea Yepsen

Feb 11-12 PDE Science Summit 2025


NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

- NJTWMN Background
- Monitoring Sites & Metrics
- Website & Mapping Platform Overview
- Summary of Current Trends

# What is the NJTWMN?

## Mission Statement

Identify current conditions and trends of tidal wetlands in New Jersey to improve resilience of coastal communities and ecosystems by providing data to prioritize restoration efforts and support informed management decisions.

# What is the point of the NJTWMN

## Benefits of the NJTWMN

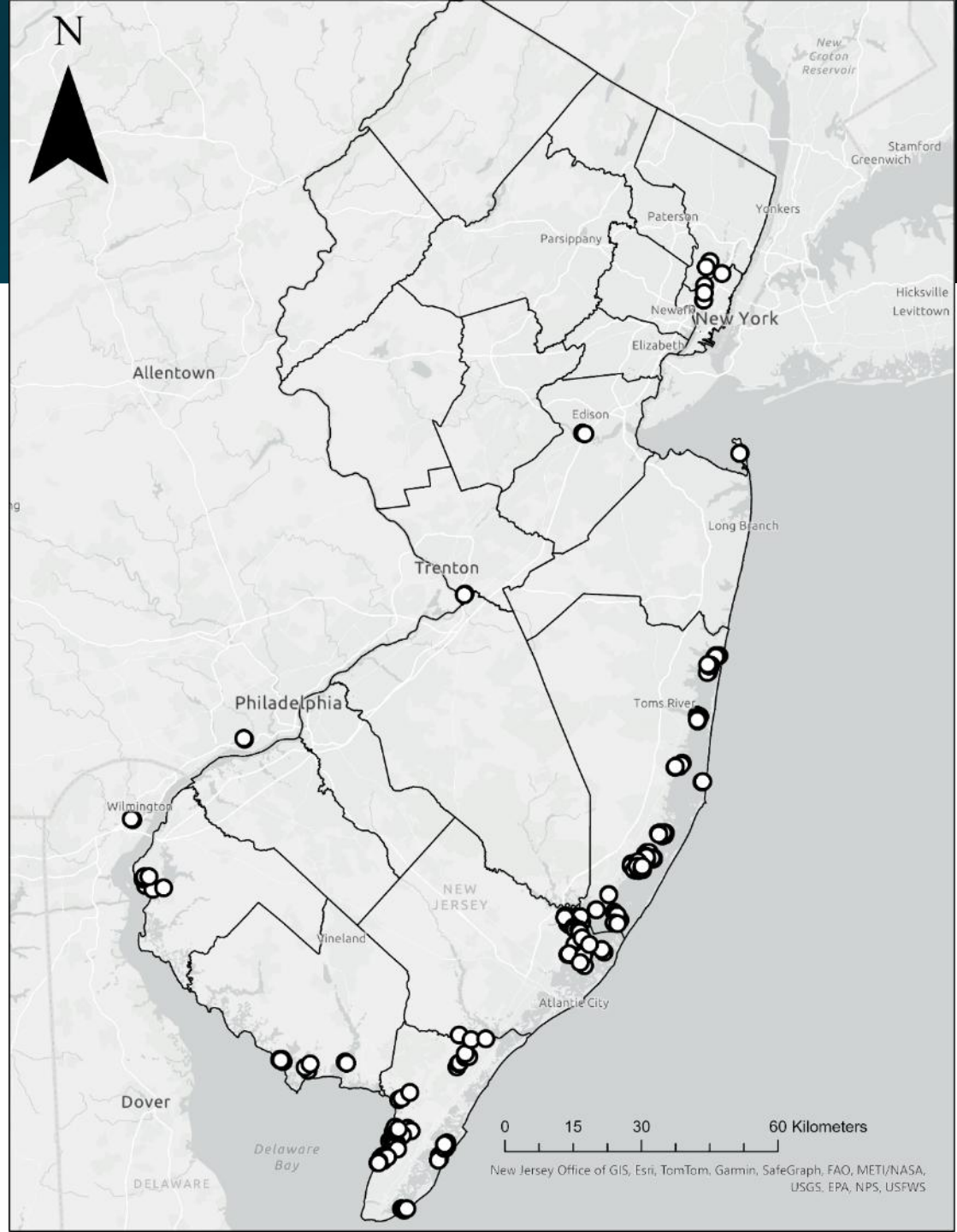
1. Larger impact than sum of its parts
   - Better understanding of trends
   - Shared resources, expertise, & equipment
   - Answering larger, regional-scale questions
2. Outreach: Uniform communication
3. Funding: Expanded opportunities in collaboration
4. Experimental Design and Statistical Analysis
   - Improved data quality control
   - Backup datasets though shared database
   - Standardized and comparable results
- Data sharing

## Objectives Accomplished to Date

1. Data collected from >250 SETs
2. Standardized methodology and QAPP across network
   - Relative elevation change
   - Accretion
   - Subsidence
   - Tidal datum calculation
   - Vegetation
   - Photos
   - Precise/accurate absolute elevation*
3. Database development
4. Filled 2 spatial gaps
5. Annual funding to support database management and monitoring

# Where do we work?

- 200,000ac of tidal wetlands
- 267 Installed SETs
- 246 actively monitored SET locations
- 189 subsidence $\bar{x}$ = 2.98 mm/yrCZM funding for ~100 SETs/yr
- SETs monitored by consistent org
  - Some hand-offs
  - Fund other to monitor federal SETs



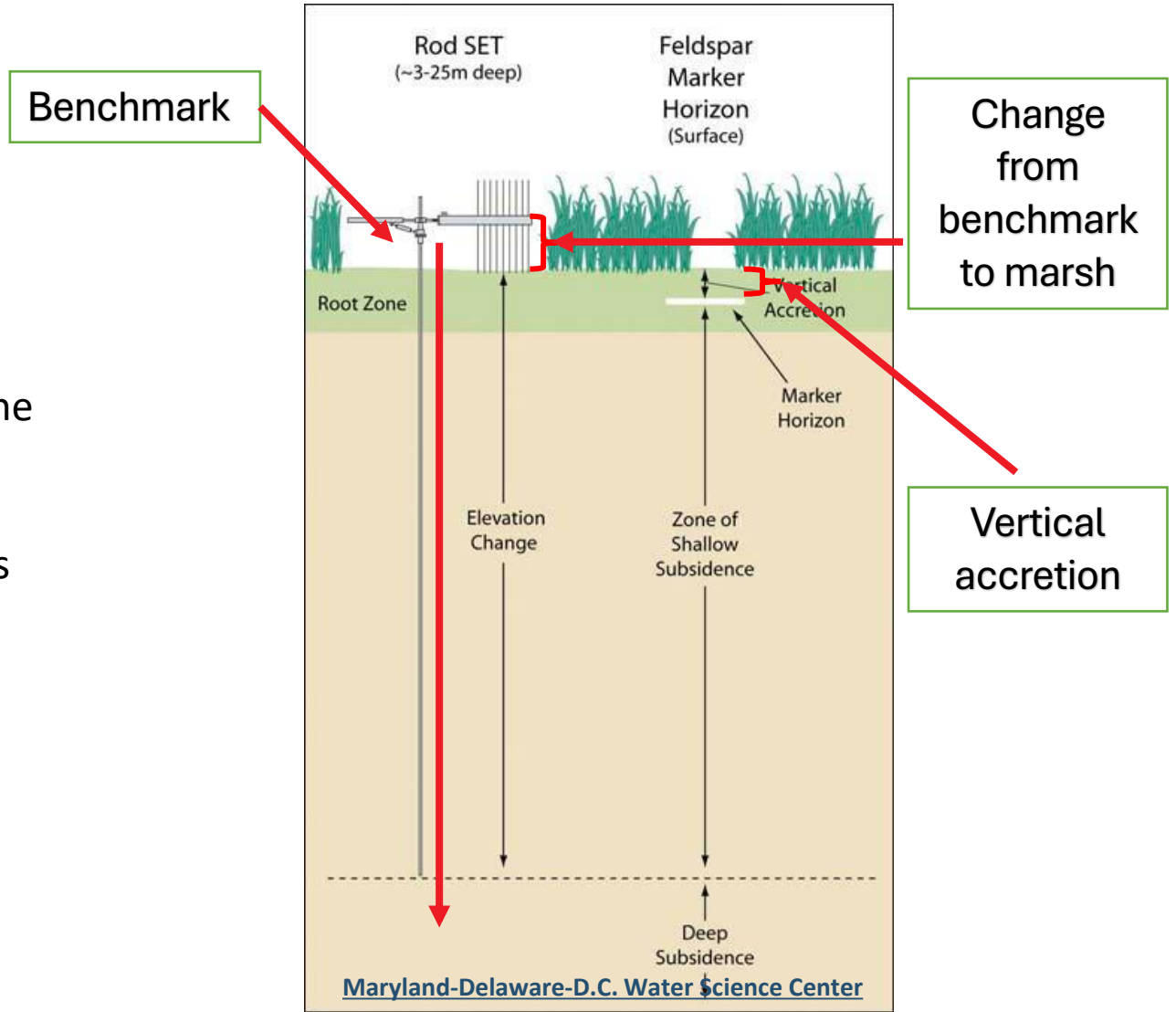
# What types of data do we collect?

**The Surface Elevation Table (SET)** is a portable mechanical leveling device for measuring the relative elevation change (mm) of wetland sediments.

**Marker Horizons (MH)** measure vertical accretion which is the buildup of sediment, roots, and organic material overtime.

**Vegetation Community** is described including percent covers of all species around SET area

**Future Inclusions:**
Water Quality, Soils, & Biomass schema under development

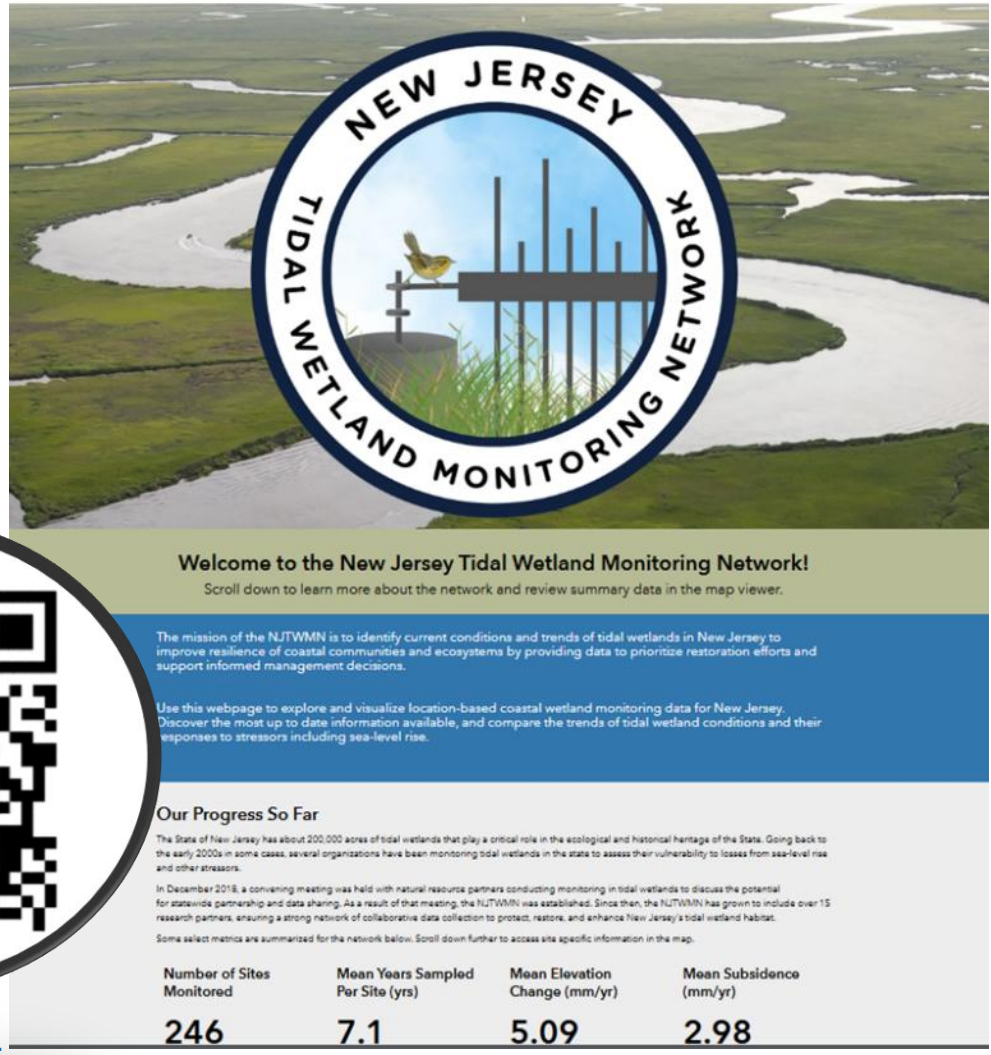


# Database/Webpage Overview

- Hosted through ArcGIS Hub
- Public page with site summary data
- Data updates by DEP staff and partners
- Downloadable data from Hub in multiple formats
- The webpage is now available through NJDEP's DSR wetlands webpage

https://dep.nj.gov/dsr/wetlands/

bit.ly/NJTWMN



# Database: Goals & SOPs/Best Practices

## Research Goals & Objectives

The NJTWMN data workgroup seeks to (1) develop research goals and objectives, (2) collect and combine data from member entities, (3) statistically analyze data, and (4) lead writing reports and/or publications. The current main research goal is to determine how tidal marsh elevation dynamics throughout New Jersey are changing relative to sea-level rise. To reach this goal, the following metrics and others are currently being assessed.

**NJTWMN partners follow the 2024 Quality Assurance Project Plan, provided through NJDEP's Tidal Wetland Monitoring Grant Program.**

### Surface Elevation Tables (SETs)

A Surface Elevation Table is a mechnical device that allows for high-resolution measurements of relative elevation change in tidal wetlands relative to the depth of the SET mark. Elevation change refers to the change in the height of the wetland surface relative to the base of the SET mark.

SET Best Practices

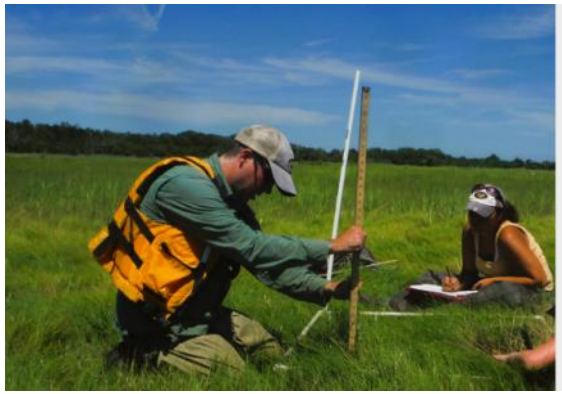
### Sea-Level Rise (SLR)

Long-term Sea-Level Rise (SLR) and 19-year water level change rates were calculated for each SET based on the nearest National Water Level Observation Network (NWLON) station.

### Marker Horizons (MHs)

A Marker Horizon (MH) is an artificial soil horizon (commonly made of feldspar) placed on a wetland surface to measure vertical accretion. The term "vertical accretion" refers to the accumulation of material above the MH.

MH Best Practices



### Vegetation

We conduct a rapid vegetation monitoring protocol near the SET and corresponding Marker Horizon plots. Parameters collected include species richness, species specific percent cover, maximum vegetation height, etc.

See our SET-MH Vegetation Survey standard operating procedure (SOP) for details on how these data are collected.

# Database: Related Tools and Datasets

## NJ Restoration Tool Organization Suite (NJ ResTOrS)

The New Jersey Restoration Tool & Organization Suite (NJ ResTOrS) is a group of tools developed in NJ by restoration practitioners and academic institutions that aim to provide a comprehensive platform for data relevant to restoration practices. Many of these tools can be used in tandem to guide users through the stages between project siting and implementation. NJ ResTOrS is home to the following tools and applications:

- Coastal Ecological Restoration and Adaptation Planning (CERAP) Explorer: The NJ Coastal Ecological Restoration and Adaptation Planning (CERAP) tool displays both areas of concern (polygons) and discrete project locations (points) and overlays them with NJ-defined Issues of Concern (IOCs). Both the areas and projects include information such as the site-specific issues, stage of the project (if applicable), interested stakeholders, and additional information related to the IOCs, including habitat degradation, carbon sequestration potential, erosion, flooding, diversity, equity, inclusion, and justice (DEIJ) considerations, and historical financial loss post-storm. The goal of CERAP is to allow users to identify areas and project sites for future ecological projects that have value in increasing community resilience, ecosystem health, and carbon sequestration. This tool is appropriate for use in the site and partner identification stages of project development.
- Marsh Explorer: The Marsh Explorer tool (found within TNC's Restoration Explorer tool) includes maps of hydrological alterations and condition metrics related to marsh health and long-term status under continued sea level rise, including: unvegetated:vegetated ratios, marsh retreat, tidal restriction, carbon sequestration potential, and erosion. This tool is appropriate for use during the high-level/low resolution site evaluation stage of project development to develop landscape-level understanding of the site, its history, and available coincident geospatial data.
- Wetlands Assessment Tool for Condition & Health (WATCH): WATCH provides a method to evaluate the condition and trajectory of a tidal wetland site to inform decision-making, restoration project prioritization, and the selection of restoration tactics. Metric categories include horizontal and vertical position, hydrology, user-selected biological attributes, sediment considerations, and soil & water chemistry conditions. This tool is used during the high-resolution site evaluation phase with in situ data to provide the user with information related to site-specific ecological deficiencies and trajectories. Additionally, the trajectory component of WATCH can be used to inform the project design phase.
- Living Shorelines Explorer: Similar to the Marsh Explorer, the Living Shorelines Explorer provides a high-level view of the proposed project site to allow users to garner a better understanding of the site-specific conditions that can inform project design. This tool provides guidance for living shoreline designs that may be appropriate in a particular location, based on erosion, tide range, wave height, ice cover, and both shoreline and nearshore slope. These metrics and their respective levels are described in the Stevens Institute of Technology's Living Shoreline Engineering Guidelines. This tool is appropriate for use during initial discussions of the design phase of a project to generally plan for installation components related to energy attenuation and project stability.
- **Marsh Futures Mapper**: The Marsh Futures mapper (coming 2025) will allow users to investigate habitat trade-off considerations within coastal wetlands, including the spatial extent of various within-site sub-habitats. This tool is appropriate for use during the design phase of a project to better understand how decisions related to material configuration, placement, and ecological development will integrate with the current conditions and trajectories of the site.
- The Living Shoreline Feasibility Model (LSFM): The LSFM is a tool that evaluates the considerations involved in constructing and maintaining a living shoreline at a specific location. Metric categories include physical (waterbody, position, boat wake, & wave energy, and shoreline condition), ecological (vegetation & fauna community, substrate condition), site access (material delivery and staging, landowner & regulatory considerations, and personnel access), and community resources (education potential, stewardship, funding, enthusiasm for NNBS and EJ considerations). This tool is appropriate for use in the site selection, design, and implementation planning phases of project.

## New Jersey Reference Wetland Tool

The New Jersey Reference Wetland Tool integrated reference wetland data, including biological and chemical metrics specific to New Jersey, into a publicly available interactive tool. Data sources included the National Wetland Condition Assessment, Mid-Atlantic Coastal Wetland Assessment, and other initiatives. The physical, chemical, and biological measurements from reference sites can also be used to help design mitigation and restoration projects. The tool displays summary statistics for twenty-eight metrics collected from 410 tidal wetland sites across the state. Drop-down menus located across the top of the tool allow users to select subsets of wetlands (by area, salinity, tidal range, and/or condition) and display metric summary data. This tool is appropriate to be used in the site evaluation phase, particularly in tandem with WATCH where reference data are required to fully develop all possible outputs.

## Sediment Pancakes

The Sediment Pancakes Restoration Tool is an innovative approach designed to enhance marshland resilience and restoration. The tool displays suspended sediment for the whole northeast portion of the country and within the estuary centerlines layer, including all New Jersey waterways excluding the Atlantic Ocean, using SPARROW model data. The SPARROW (SPAtially Referenced Regression on Watershed attributes) modeling approach developed by the USGS is a tool for estimating nutrient, sediment, and dissolved solids transport in streams. It combines these data with watershed attributes to predict water quality conditions and identify the sources of pollutants. This model can inform management decisions and restoration efforts by providing insights into the spatial distribution of nutrient and sediment loads across watersheds, ultimately aiding in the development of effective strategies to improve and protect water quality in diverse ecosystems, including marshlands.

## NJ Bay Islands Restoration Planner (NJ BIRP)

The New Jersey Bay Islands Restoration Planner (NJBIRP) is a tool designed to guide the restoration of bay islands within the Barnegat estuary. These islands are critical for coastal protection and wildlife habitat, but they face significant threats from erosion, sea-level rise, and human activities. The tool provides information on the ecological status of bay islands and project planning to support sustainable management practices and long-term conservation goals. Data are limited to the Barnegat estuary.

## NJ Map

NJ MAP is an interactive online mapping platform developed by the Geospatial Research Lab at Rowan University in New Jersey. It provides a suite of tools and applications designed to support land use planning, environmental management, and conservation efforts across the state. The platform integrates various data layers and mapping tools to help users visualize, analyze, and make informed decisions about New Jersey's natural and built environments, including: a municipal land use tool, environmental dashboard, watershed management tool, and a landcover change tool.

## The Nature Conservancy Resilient Land Mapping Tool

The Nature Conservancy's (TNC) Resilient Land Mapping Tool is an online platform designed to help conservationists and planners identify lands crucial for biodiversity conservation and climate resilience. It is a resource for directing conservation efforts toward landscapes that will endure and support biodiversity in a changing climate. This tool includes resilience score mapping, connectivity analysis, climate gradient mapping, habitat quality assessment, and human impact analysis.

## NJ Flood Mapper

The NJ Flood Mapper interactive website was developed by the Rutgers University CRSSA to support flood risk management and coastal resilience planning. It offers a user-friendly platform that allows users to visualize potential flood impacts under various sea-level rise and storm surge scenarios. The NJ Flood Mapper is a resource for planners, policymakers, and community members working to enhance coastal resilience and adapt to the challenges posed by climate change. The map layers include state-wide Sea Level Affects Marsh (SLAM) marsh habitat change predictions for 1, 2, and 3 feet of sea level rise and erosion predictions for 2050.

## NOAA Sea Level Rise Viewer

The NOAA Sea Level Rise Viewer offers a suite of specific tools and features designed to provide detailed insights into the potential impacts of sea-level rise. These tools are essential for assessing vulnerabilities and planning for resilience in coastal areas. The NOAA Sea Level Rise Viewer's tools collectively provide a comprehensive and interactive approach to understanding and addressing the challenges posed by rising sea levels. These tools are instrumental in crafting informed, data-driven strategies for coastal resilience and adaptation.

## Coastal Blue Carbon Map

The Coastal Blue Carbon Map was developed by the Nicholas Institute of Duke University to help stakeholders prioritize wetlands for carbon sequestration. The InVEST coastal blue carbon model was used to estimate the amount of carbon stored in coastal habitats at set time points and the amount of carbon sequestered by those habitats over time. It also calculated carbon emitted due to disturbance or conversion of those habitats. In addition, it also identified potentially restorable salt marshes where restoring tidal connectivity or allowing marshes to migrate inland with sea level rise could increase net carbon sequestration by reducing methane production.

# Database: Reports & Publications

## Reports and Publications

Below is an incomplete list of peer-reviewed scientific research and reports that incorporate surface elevation table (SET) monitoring data collected by NJTWMN member organizations. This includes variety of focal subject matter across a broad range of locations in and around New Jersey, from the Meadowlands to the Delaware Bay.

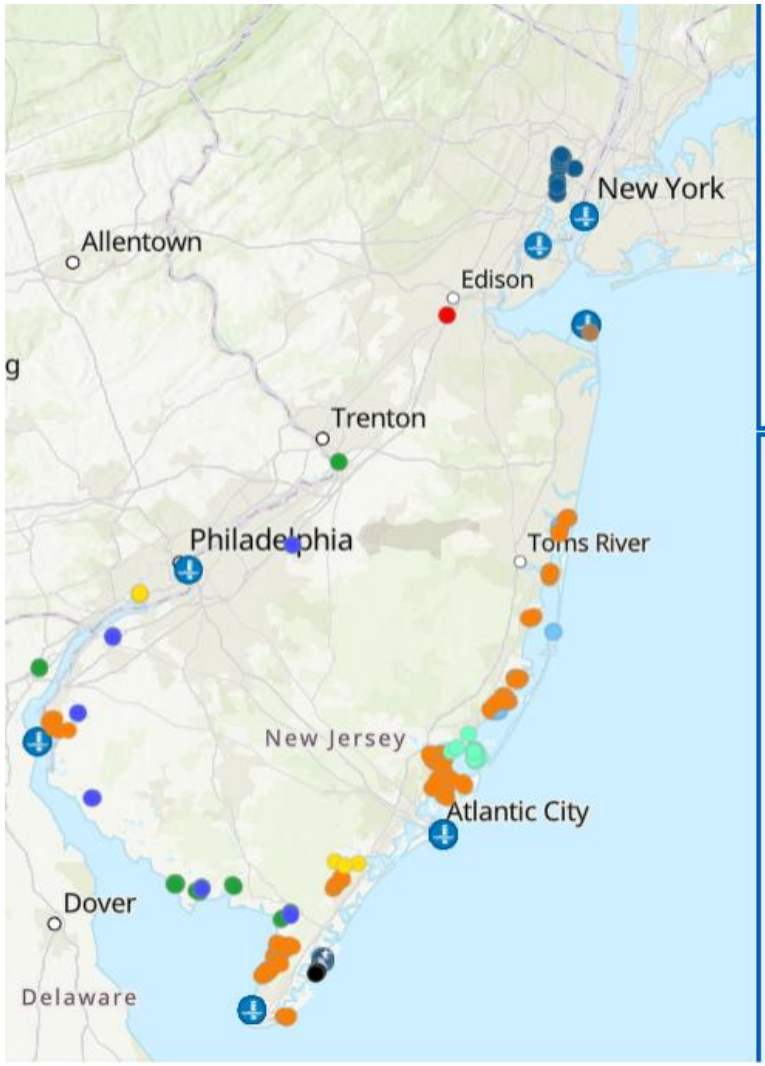

- Artigas, F.J., J. Grzyb, and Y. Yao. 2021. Sea level rise and marsh surface elevation change in the Meadowlands of New Jersey. *Wetlands Ecology and Management*, *29*(2), pp.181-192.
- Cahoon, D.R., J. H. Olker, A. G. Yeates, G. R. Guntenspergen, J. B. Grace, S. C. Adamowicz, S. C. Anisfeld, A. H. Baldwin, N. Barrett, L. Beckett, and A. Benzecry. 2019. *Hurricane Sandy impacts on coastal wetland resilience* (No. 2018-1142). US Geological Survey.
- Elsey-Quirk, T. 2016. Impact of Hurricane Sandy on salt marshes of New Jersey. Estuarine, Coastal and Shelf Science, 183, pp.235-248.
- Elsey-Quirk, T. and S. C. Adamowicz. 2016. Influence of physical manipulations on short-term salt marsh morphodynamics: Examples from the North and Mid-Atlantic Coast, USA. *Estuaries and Coasts*, *39*, pp.423-439.
- Elsey-Quirk, T., E. B. Watson, K. Raper, D. Kreeger, B. Paudel, L. Haaf, M. Maxwell-Doyle, A. Padeletti, E. Reilly, and D.J. Velinsky. 2022. Relationships between ecosystem properties and sea-level rise vulnerability of tidal wetlands of the US Mid-Atlantic. *Environmental Monitoring and Assessment* 194(4): 1-25. https://doi.org/10.1007/s10661-022-09949-y
- Haaf, L., E.B. Watson, T. Elsey-Quirk, K. Raper, A. Padeletti, M. Maxwell-Doyle, D. Kreeger, D.J. Velinsky. 2022. Sediment accumulation, elevation change, and the vulnerability of tidal marshes in the Delaware Estuary and Barnegat Bay to accelerated sea level rise. *Estuaries and Coasts* 45: 413-427.
- Ladin, Z. and W. G. Shriver. 2017. *USFWS salt marsh surface elevation table (SET) data analyses*.
- Kennish, M.J., R. G. Lathrop Jr, A. Spahn, G. P. Sakowicz, and R. Sacatelli. 2016. The JCNERR sentinel site: research and monitoring applications. Bulletin of the New Jersey Academy of Science, 61(1), pp.1-9.
- New Jersey Department of Environmental Protection and The Nature Conservancy (2023). Beneficial use of dredged material to Enhance Salt Marsh Habitat in New Jersey: Monitoring and Project Assessment. (Eds. M. Yepsen, B. Wilburn, J. Woollard). Trenton, NJ. 122 pp.
- Wasson, K., N. K. Ganju, Z. Defne, C. Endris, T. Elsey-Quirk, K. M. Thorne, C. M. Freeman, G. Guntenspergen, D. J. Nowacki, and K. B. Raposa. 2019. Understanding tidal marsh trajectories: evaluation of multiple indicators of marsh persistence. *Environmental Research Letters*, *14*(12), p.124073.
- Weis, J.S., E.B. Watson, B. Ravit, C. Harman, M. Yepsen. 2021. The status and future of tidal marshes in New Jersey faced with sea level rise. *Anthropocene Coasts*. 4(1): 168-192. https://doi.org/10.1139/anc-2020-0020
- Yeates, A.G., J. B. Grace, J. H. Olker, G. R. Guntenspergen, D. R. Cahoon, S. Adamowicz, S. C. Anisfeld, N. Barrett, A. Benzecry, L. Blum, and R. R. Christian. 2020. Hurricane Sandy effects on coastal marsh elevation change. *Estuaries and Coasts*, *43*, pp.1640-1657.

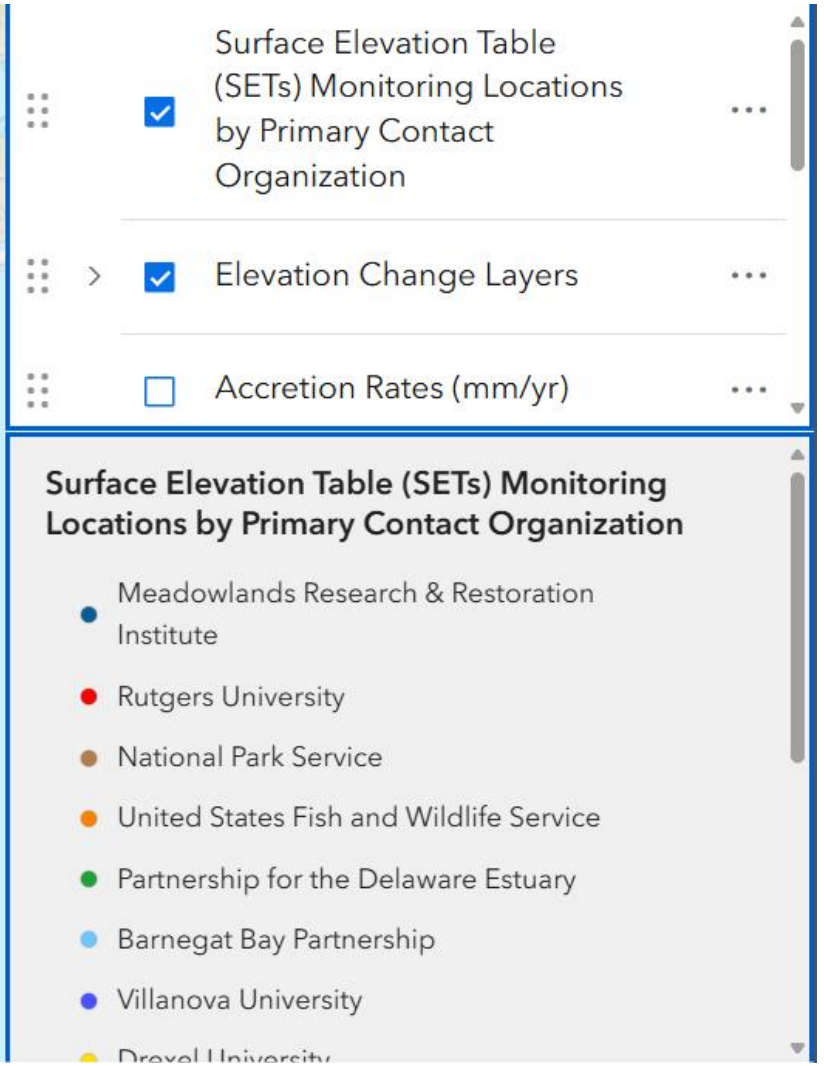
# Summary Statistics

- 11 Organizations
- 3 NWLON Stations

- 246 consistent SETs

- 229 long term (>5y)
  - $\bar{x}$ = 7.1 years
- 197 ele change (>3y)
  - $\bar{x}$ = 5.09 mm/yr
- 189 subsidence (good MH)
  - $\bar{x}$ = 2.98 mm/yr

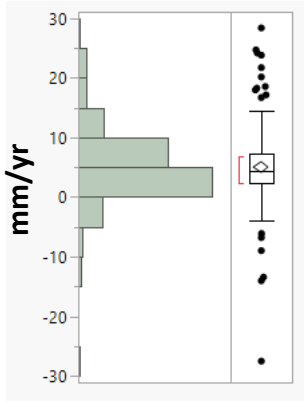


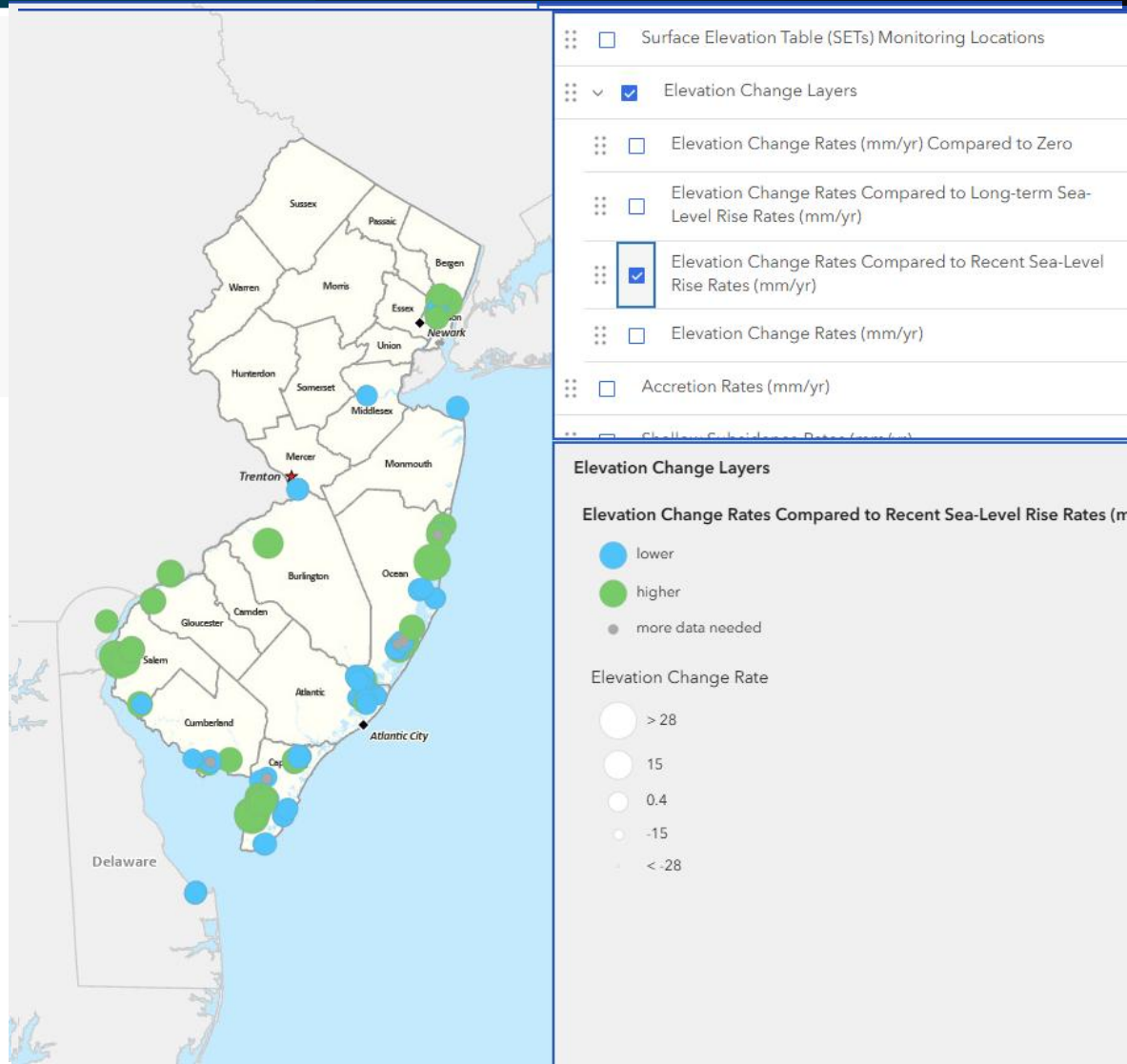



# Summary Statistics

## Preliminary Results

- Elevation change rates in the network were 5.1 mm/yr on average (197 sites)
- 22 sites had rates below zero (11%)
- 88 sites fall below long-term SLR rates (45%)
- 121 sites fall below recent 19-year SLR rates (61%)



# Summary Statistics

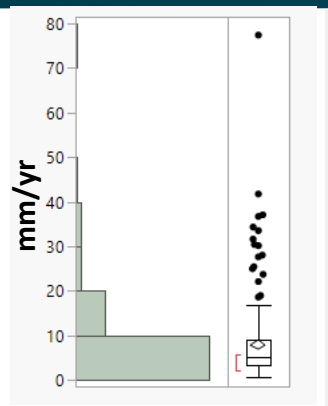
## Preliminary Results

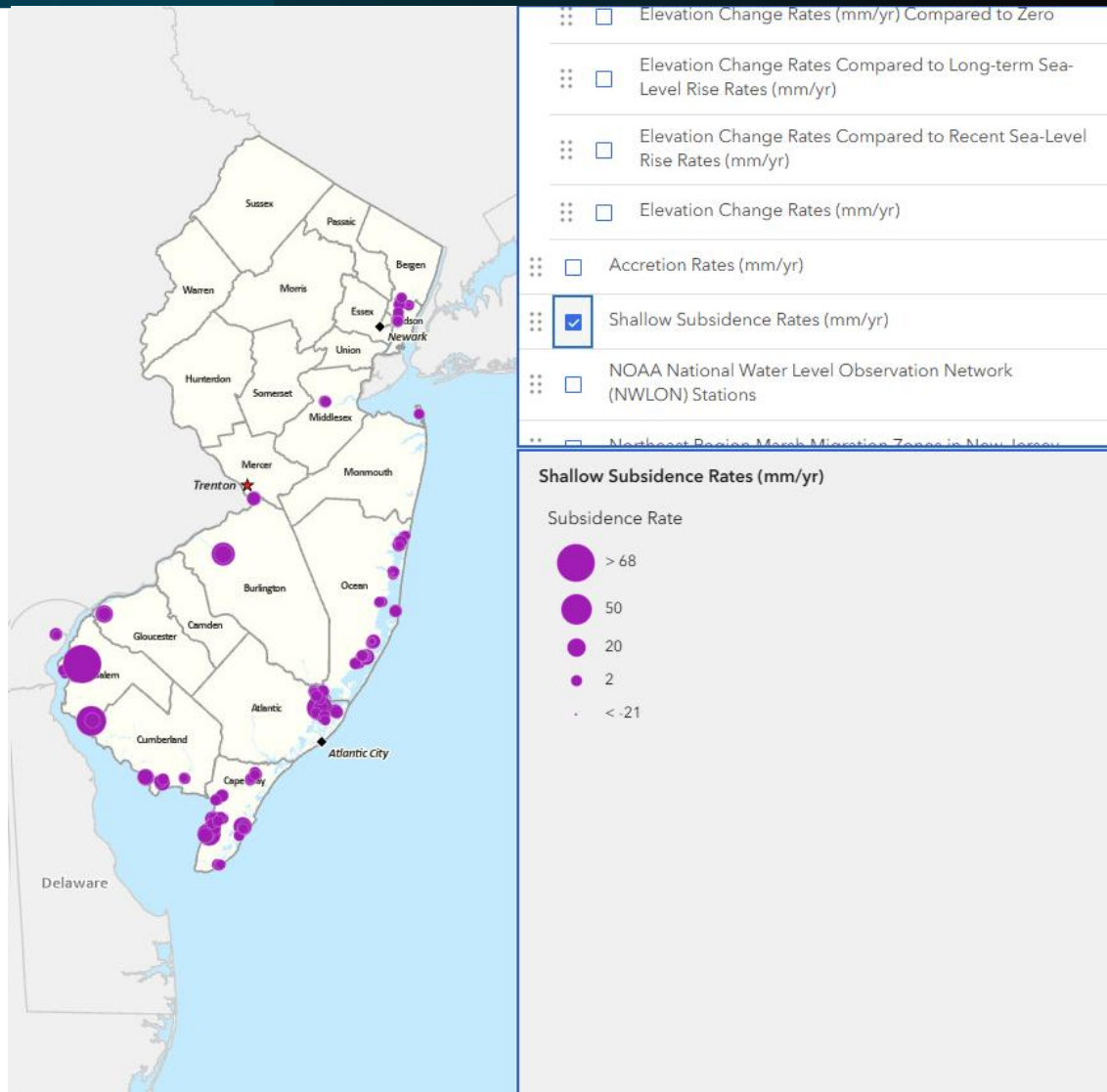
**Accretion rates** (marker horizons)

- Averaged 8 mm/yr
- Ranges from < 1 to 77 mm/yr
- Most sites 0-10 mm/yr

**Shallow Subsidence** (Acc-Δele)

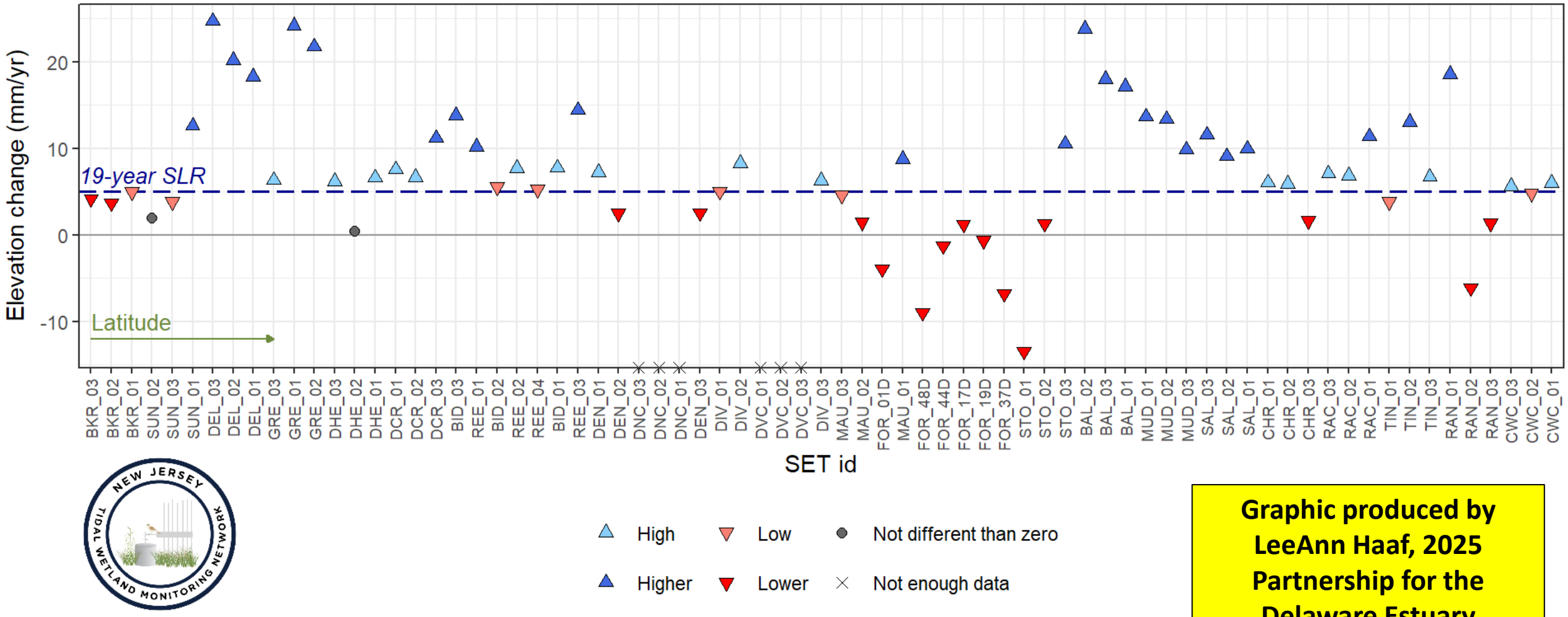
- Negative values indicate uplift
  - 2mm (acc) – 1mm (Δele) = +1mm (SS)
  - 2mm (acc) – 4mm (Δele) = -2mm (SS=gain)
- $\bar{x}$ = 3 mm/yr, range -20 – 68 mm/yr
- Most -10 – 10 mm/yr



# Regional Update: Delaware Estuary

*Are these marsh keeping pace with SLR?*




**Graphic produced by LeeAnn Haaf, 2025 Partnership for the Delaware Estuary**

# Regional Update: Delaware Estuary

*Are these marsh keeping pace with SLR?*

Number of SETs higher or lower than 19-year SLR

| Comparison with 19-Year SLR | N |
|---|---|
| High | 17 |
| Higher | 24 |
| Low | 8 |
| Lower | 16 |
| Not different than zero | 2 |
| Not enough data | 6 |
| Total | 73 |

Almost keeping pace.

A third are definitely keeping pace+! (32.8%)

Maybe not keeping pace.

Definitely *not* keeping pace. (21.9%)

# Next Steps

1. Including these data in the continued development of online resources
   - New marsh change & restoration needs layers (CZM 309)
   - Integrate into CERAP, NJ ResTOrS
2. Develop schema to include additional available data:
   - Vegetation metrics
   - Soil data (NRCS)
   - Hydrogeomorphology assessment
3. Develop protocols for additional data collection
   - Replacement of marker horizons
4. Continue to explore consistent funding options
   - Federal uncertainty
   - Leverage collaboration of network

# Questions & Discussion

Metthea Yepsen: NJDEP, Metthea.Yepsen@dep.nj.gov
LeeAnn Haaf: Partnership for the Delaware Estuary, LHaaf@delawareestuary.org
Ceili Pestalozzi: Barnegat Bay Partnership, cpestalozzi@ocean.edu
Ildiko Pechmann: NJ Sport & Exhibition Authority, IPechmann@njsea.com
Kirk Raper: NJDEP, Kirk.Raper@dep.nj.gov
Josh Moody: NJDEP, Joshua.Moody@dep.nj.gov
Erin O'Brien: NJDEP, Erin.Obrien@dep.nj.gov

https://dep.nj.gov/dsr/wetlands/