# SETr: Developing Tools and Visualizations to Track Changes in Wetland Surface Elevation

## Overview

Can tidal wetlands keep up with sea level rise? To better understand this critical coastal management question, the National Estuarine Research Reserve System expanded long term monitoring of coastal marshes, and most reserves across the continental United States have been collecting data with Surface Elevation Tables (SETs) for several years. These precise measurements of marsh surface height over time can track the natural changes in marsh elevation that occur through plant root growth and sediment deposition, and that rate can then be compared to sea level rise. Despite widespread interest, marsh elevation data across the reserve system has been a largely untapped goldmine that can help scientists, managers, and the public understand how changes in marsh elevation compare to sea level rise and the nature of climate impacts in different coastal regions.

In order to better utilize this rich dataset, this project developed new tools to process, analyze, and communicate about surface elevation change. The project produced a suite of open-source data analysis tools and a workflow using R that help users generate reports and visualizations to communicate with technical and nontechnical audiences. The user-friendly tools and collaboration created through this project filled a key gap, enhanced the usability of SET data to address coastal management challenges, and supported more effective communication with general audiences.

## Project Approach

The project team assembled technical and outreach teams that represented coastal training, education, research, and stewardship program staff from National Estuarine Research Reserves across the United States, and also engaged a statistician to ensure sound analyses. Input from these groups guided the development of data analysis and communication tools in order to meet diverse end-user needs. Webinars, working groups, email lists, and one-on-one phone calls kept these stakeholders involved from the project's kickoff to its close and accommodated diverse levels of participation.

The team first standardized data from an initial group of seven participating reserves, using this pool of data to develop code (R scripts) and user interfaces that offered an easily understandable and replicable workflow even for those unfamiliar with R software.

### Project Location

15 reserves on the East, West and Gulf Coast

### Project Duration

September 2018 to February 2020

### Project Lead

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### Project Type

Catalyst – Targeted investment for advancing collaborative science

### Products

- Surface Elevation Table data analysis tools and workflow guide, and example datasets
- National synthesis report of National Estuarine Research Reserve SET data
- Reserve-specific technical and outreach reports
- Two webinar recordings that introduce the project's outreach and data analysis tools

### Project Partners

- Clemson University
- 15 National Estuarine Research Reserves, including: Apalachicola, Chesapeake Bay–Maryland, Chesapeake Bay–Virginia, Delaware, Elkhorn Slough. Grand Bay, Great Bay, Guana Tolomato Matanzas, Mission Aransas, Narragansett Bay, Padilla Bay, South Slough, Waquoit Bay, Weeks Bay, Wells

### Project Webpage

*nerrssciencecollaborative.org/project/Cressman18*

An invitation to share data was extended across the reserve system, resulting in data from fifteen reserves being included in the project. In monthly technical working group calls and two in-person workshops, the project team solicited input, tested R scripts, and developed a workflow to guide users through the data analysis products. These included a QA/QC app to interact with raw data and easily identify points that need inspection, automated report generation for basic analyses of rates of change and comparison to sea level rise, and annotated visualizations that can be tailored to communicate results to technical and non-technical audiences alike. Analysis code, tools and sample datasets have been made publically available through a GitHub repository.

## Results

Newly developed code and templates were used to create visualizations for each reserve's SET data. Each report includes a series of graphs and tables that represent the rate of wetland elevation change compared to sea level rise, and associated confidence intervals (some reports also include dominant wetland vegetation). The report then presents wetland elevation changes visually on a map of the reserve. These visualizations make it easier for reserve managers and educators to understand and communicate key questions, including: Are tidal wetlands are keeping up with sea level rise? How much certainty do we have about this data? Are some vegetation communities gaining or losing elevation more quickly than others?

Reserve-specific reports showed considerable variation in wetland surface level elevation and rates of change at the local and regional level due to a variety of factors such as human disturbances, plant community composition, inundation patterns, and whether wetland systems are ocean- or river-driven. When combined with local knowledge, this information can help reserve managers and researchers compare trends within and across regions.

This project also produced the first synthesis of SET data for tidal wetlands across the National Estuarine Research Reserve system. The project compared tidal wetland elevation change at 15 reserves to local (reserve-specific) long-term sea level rise and 19-year water level change, showing rates of change for sites where SET data were available for at least 4.5 years. For reserves along the Mid-Atlantic, Gulf and Southeast coasts, findings show a roughly equal split between coastal wetlands where surface elevation is increasing faster than sea level rise and those whose elevations are falling behind sea level rise (Figure 1). In the Northeast, marsh elevation gains were very low and over half were not keeping pace with sea level rise. Wetlands at the Wells Reserve in Maine were an exception to this pattern, but only two SETs were recorded. There was not enough data for the West coast to identify patters for that region.

## Benefits

- This project increased usability of National Estuarine Research Reserve SET data by providing tools the reserves need to analyze, understand, communicate about these important, underutilized datasets.
- The team created a workflow that can be used for future data entry and analysis as marsh elevation datasets continue to grow.
- Visualization and communication tools developed in collaboration with reserve staff have enhanced the ability of reserves to communicate about local climate impacts with a variety of audiences.
- By aggregating data across the reserve system, this project revealed differences in how reserves collect and handle field data situations. The project made strides toward developing a system-wide vocabulary to document and flag irregular data and identify strategies to improve data consistency and comparability.

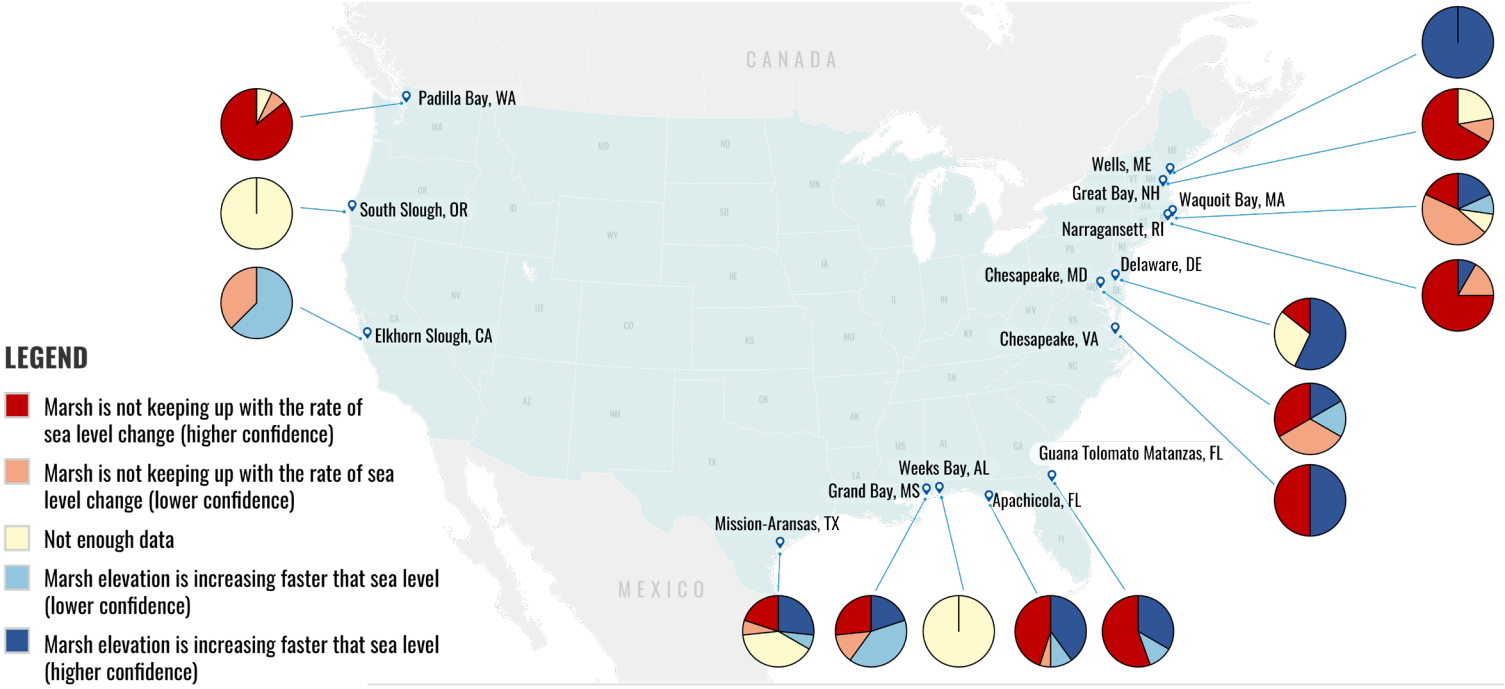


*Figure 1. Each pie chart summarizes findings from the multiple surface elevation measurement stations at a single reserve.*

## What's Next

- The project team will collaborate with the New England Vegetation Synthesis project to determine how vegetation communities are changing in response to climate impacts.
- The team will continue to refine and update tools that have been publically available through a GitHub repository, and will work to help develop a standardized relational database for elevation data across the reserve system.
- Responding to requests from external groups, the project team has shared tools and is continuing to offer trainings on the data analysis approach developed by this project.
- Reserve Education Coordinators plan to use project outputs as part of their professional development workshops for K-12 teachers.

**About the Science Collaborative**

*The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.*