Summary Points:

Long-term monitoring data can be a tremendous asset for coastal research and management, but processing and analyzing the data and extracting key findings can be challenging.

The National Estuarine Research Reserve System's System-wide Monitoring Program (SWMP) has been collecting physical and biological data at estuaries across the country for many years. This webinar featured two projects that analyzed monitoring data from multiple sites to better understand trends in marsh surface elevation and vegetation in relation to sea levels. Project leads shared a few examples of their findings that can inform marsh resilience efforts, and provided tips for others considering additional SWMP synthesis projects.

The webinar wrapped with a discussion of opportunities and strategies for using SWMP data for future research and management applications.

National Estuarine Research Reserve System

Summary Points:

The National Estuarine Research Reserve System (NERRS) is a network of 29 estuarine reserves located in 22 states and Puerto Rico. The mission of the NERRS is to practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

Established by the Coastal Zone Management Act of 1972, the Reserve System represents a unique partnership between NOAA and the coastal states. NOAA's Office for Coastal Management administers the program by providing guidance, coordination, technical assistance, and funding, and state or academic partners manage reserve resources, implement programs locally, and provide funds to match the federal investment.

Learn more about the NERRS:

- Explore the 29 reserves
- NOAA's National Ocean Service
- National Estuarine Research Reserve Association (NERRA)

Objectives:

Highlight two projects that are synthesizing monitoring data for new applications, share examples of findings, and discuss tips and ideas for others considering similar projects.

Webinar Agenda:

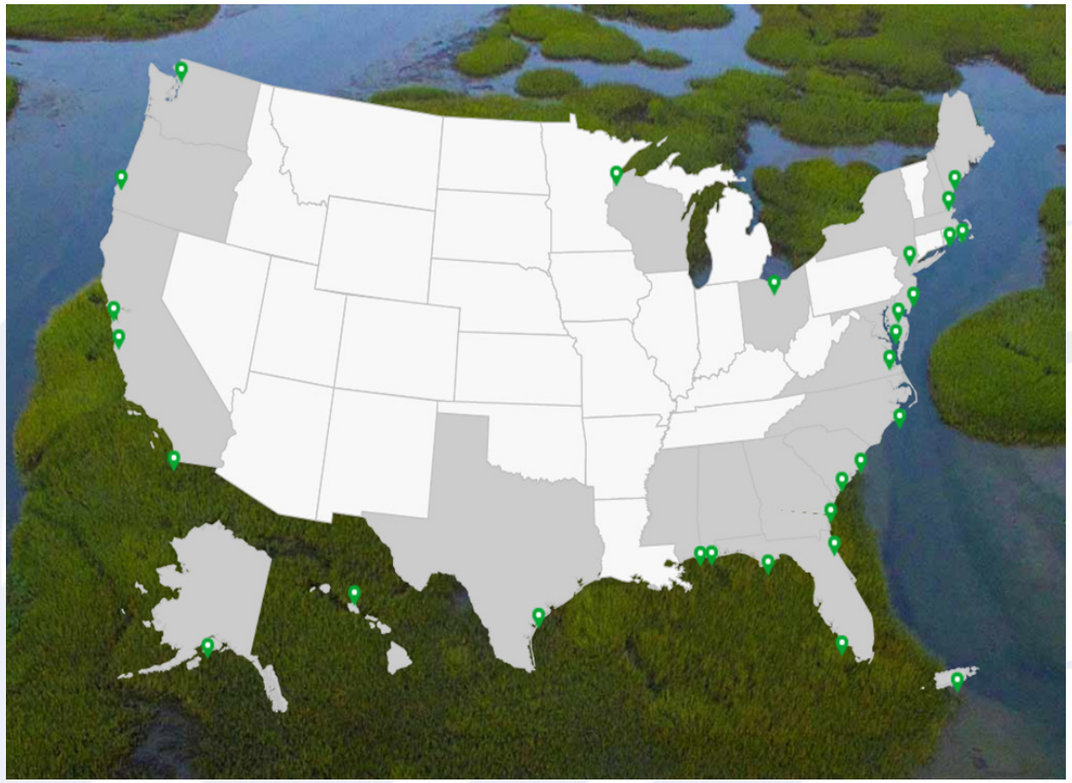
- Brief intro to NERRS Monitoring - Chris Kinkade, NOAA
- Project Features
  - **Kim Cressman**: Is Marsh Surface Tracking Sea Level Change? Developing Tools and Visualizations for Sentinel Site Data
  - **David Burdick & Chris Peter**: Synthesizing Monitoring Data to Improve Coastal Wetland Management Across New England
- Comments on Future Opportunities - Dwayne Porter, CDMO
- Q & A Session
- Adjourn (4:30pm ET)

National Estuarine Research Reserve System Science Collaborative

Summary Points:

Kim Cressman from Grand Bay NERR provided an overview of her catalyst project: Is Marsh Surface Tracking Sea Level Change? Developing Tools and Visualizations for Sentinel Site Data, which developed data analysis and visualization tools for Surface Elevation Table (SET) data. SET measurements enable reserves to track changes in marsh surface height over time. The data are critical for monitoring marsh resilience in the face of rising seas, but SET data require specialized protocols for processing, quality checking and analyzing the data in a consistent way across sites.

David Burdick from the University of New Hampshire and Chris Peter from Great Bay NERR provided an overview of their project: Synthesizing Monitoring Data to Improve Coastal Wetland Management Across New England. This project analyzed Sentinel Site data from four New England reserves, which have individually been monitoring salt marsh vegetation and elevation changes since at least 2011. The team developed data packages linking vegetation change with surface elevation and other data, including output from an inundation tool. In addition to providing an initial summary of patterns, the project developed analysis protocols that can be utilized by other reserves and coastal managers nationwide.



SWMP: Quantitative measurements of short-term variability and long-term changes

Summary Points:

Chris Kinkade, NERRS National Research Coordinator at NOAA's Office for Coastal Management, began the webinar with an overview of the System-wide Monitoring Program (SWMP).

The Reserve system established SWMP in 1995. Its primary mission was to develop quantitative measurements of short term variability and long-term changes in the water quality, biological systems, and land-use and land-cover characteristics of estuarine ecosystems to inform effective coastal zone management.

The monitoring program was designed to address some fundamental questions: 1) how environmental conditions and biological systems vary in space and time within the network of NERRS sites; 2) how ecosystem structure and function varies through space and time within critical NERRS habitats; 3) to what extent are changes in estuarine ecosystems represented in the reserve system attributable to natural variability as comapred to anthropogenic activity.

To do this, reserves collect a suite of water quality, meteorological, nutrient and pigment parameters. SWMP data are collected at multiple fixed locations with each reserve using standardized protocols and equipment.

Given that reserves are sentinels for early detection of environmental change in response to stressors, a recent focus has been on investigating how changes in local water levels impact coastal vegetative habitat.

https://cdmo.baruch.sc.edu/

Summary Points:

SWMP data are managed and served by the Centralized Data Management Office (CDMO). The CDMO ensures data quality assurance and accessibility via a public website.

CDMO also provides web-based graphing applications to help with analysis and interpretation of SWMP data.

Reproducible workflows for understanding and illustrating Surface Elevation Table data

Kim Cressman, Suzanne Shull, Margo Posten, Kristin Evans, Jenni Schmitt, Kari St. Laurent, Megan Tyrrell, Brook Russell

Funding provided by the NERRS Science Collaborative (NSC), Subaward K00009705
Please visit the NSC project website https://tinyurl.com/y9dza46v

Summary Points:

Kim Cressman, the SWMP Coordinator for the Grand Bay reserve, provided an overview of her catalyst project: Is Marsh Surface Tracking Sea Level Change? Developing Tools and Visualizations for Sentinel Site Data, which developed data analysis and visualization tools for Surface Elevation Table (SET) data. SET measurements enable reserves to track changes in marsh surface height over time. The data are critical for monitoring marsh resilience in the face of rising seas, but SET data require specialized protocols for processing, quality checking and analyzing the data in a consistent way across sites.

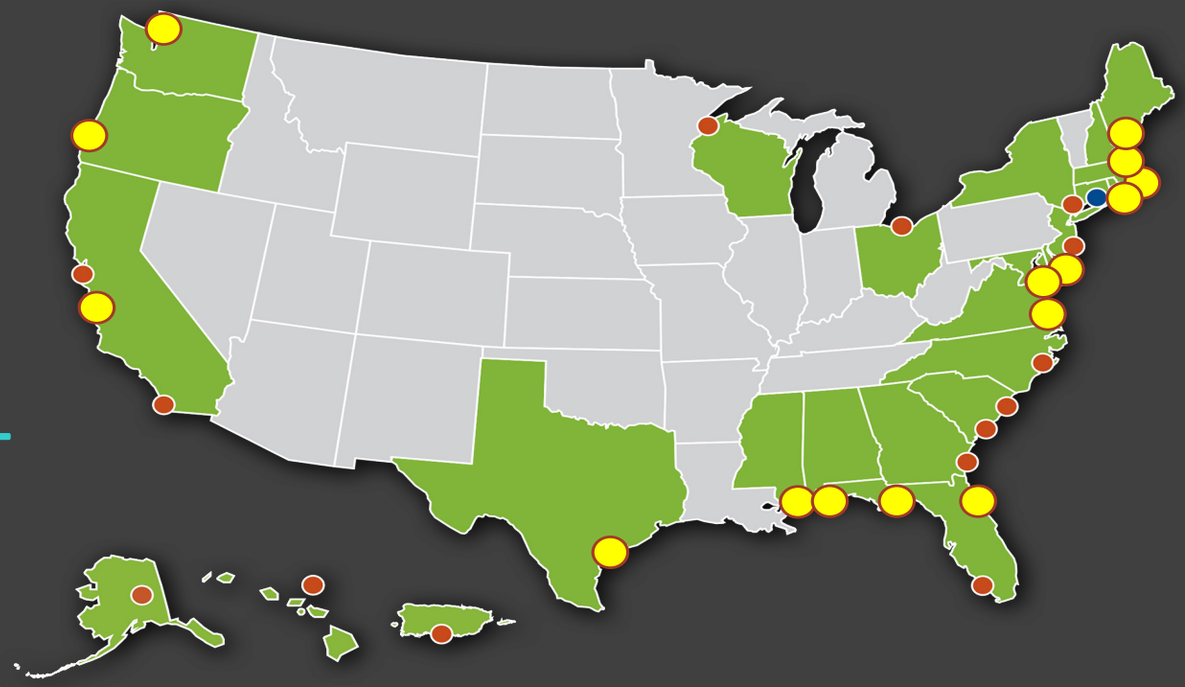
Terminology:

- **Surface Elevation Table (SET)**: A portable mechanical device for measuring the relative change in elevation of wetland sediments.

Overall Goal:

Make it easier for NERRS (and others!) to work with and communicate about SET data

Driven by end-user needs



Summary Points:

Overall, the project sought to develop a standardized way to manage and analyse SET data. The Reserve system is improving this area, and the timing of the project helped support that effort through data formatting and development of a standardized format to which data can be transformed.

The project team also created interactive tools for visualizing and interacting with data - which can help find outliers and make sure data are of sufficiently high quality before running analyses - and developed tools to assist Reserve staff and the broader coastal research and management community in:

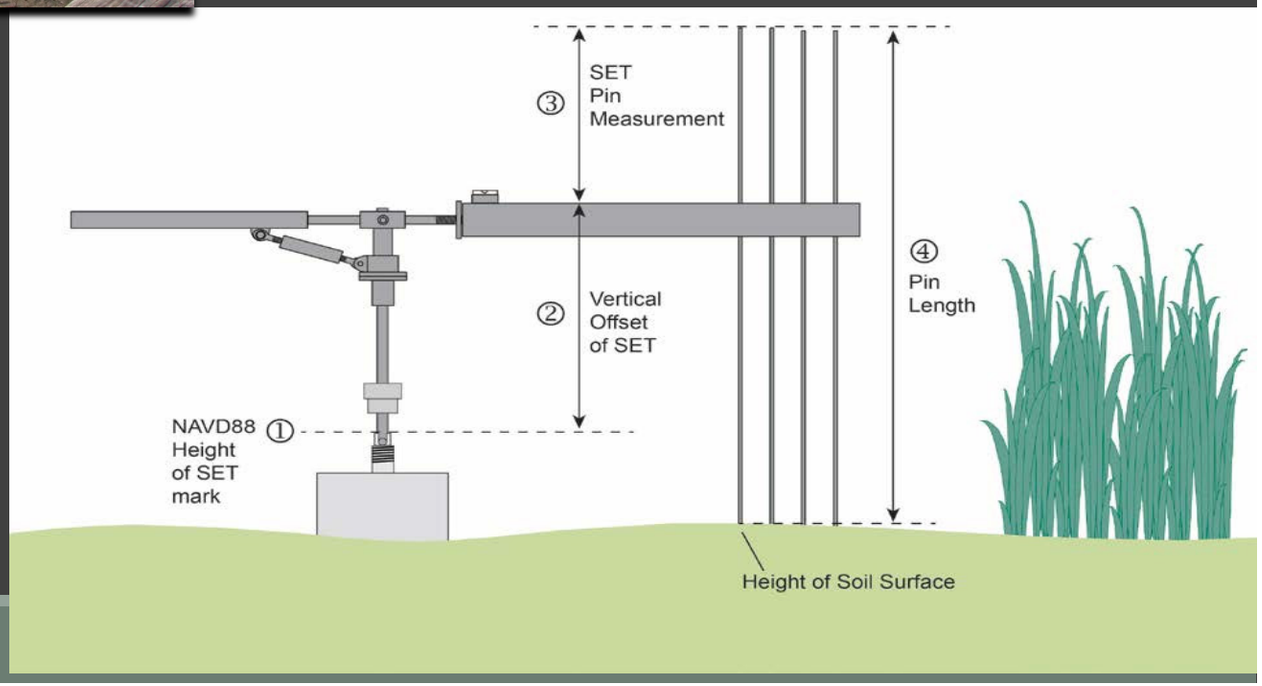
- Facilitating SET data analysis and visualization;
- Communicating information about marsh responses to sea level rise; and
- Quality-checking SET data.

What is a Surface Elevation Table?

photo: Grand Bay NERR

Diagram:
Lynch et al. 2015

The Surface Elevation Table and Marker Horizon Technique
A Protocol for Monitoring Wetland Elevation Dynamics



Summary Points:

SETs enable precise measurements of marsh surfaces.

The collar mounted to the ground is a permanently affixed installation, while the arm assembly is removed whenever measurements are taken. Typically researchers measure how far the pins extend above the horizontal arms, in four different arm directions. These measurements are used as a proxy for where the marsh surface is, relative to either a preliminary measurement or NAVD 88 data.

Terminology:

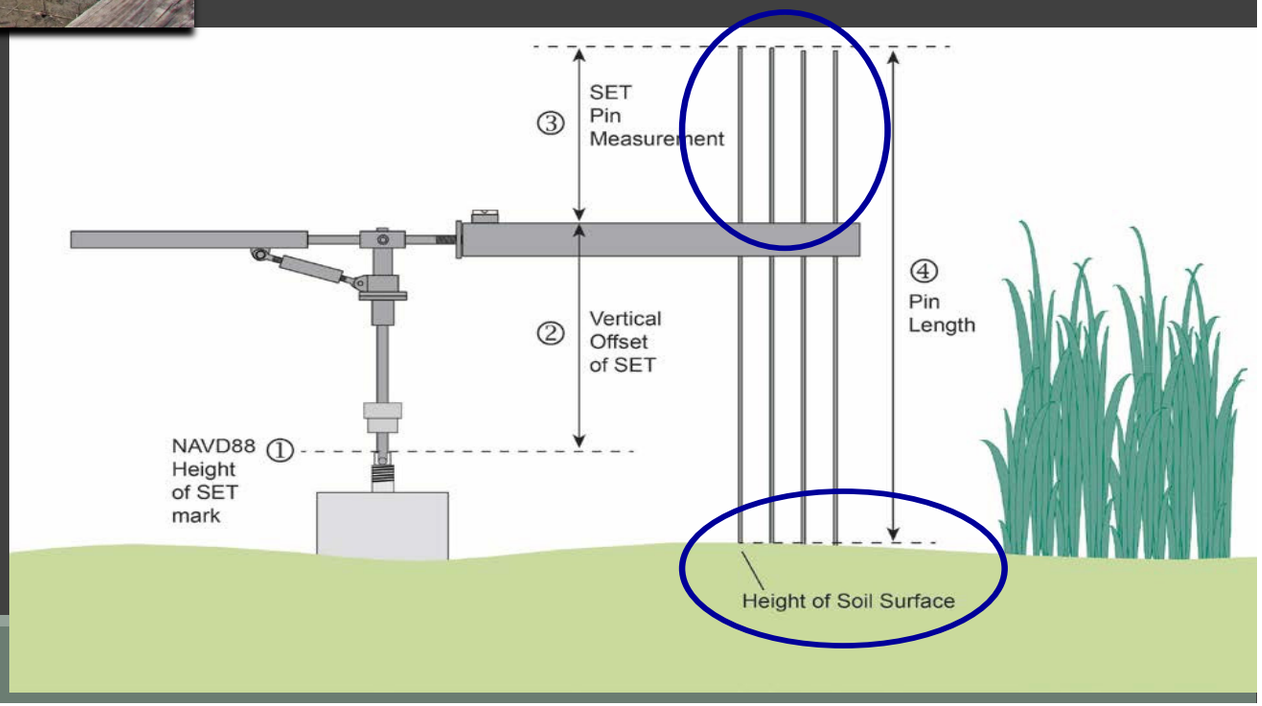
- **North American Vertical Datum of 1988 (NAVD 88)**: The vertical control datum established in 1991 from a common North American point established in 1988. NAVD 88 consists of a leveling network on the North American Continent, ranging from Alaska, through Canada, across the United States, affixed to a single origin point on the continent.

What is a Surface Elevation Table?

photo: Grand Bay NERR

Diagram:
Lynch et al. 2015

The Surface Elevation Table and Marker Horizon Technique
A Protocol for Monitoring Wetland Elevation Dynamics



Summary Points:

Typically each SET has nine pins on an arm, at four different positions, giving a total of 36 measurements on any given date. Analyzing these measurements over time allows the team to look for changes in the marsh surface.

Analyses, tables, and graphics: MS Word output

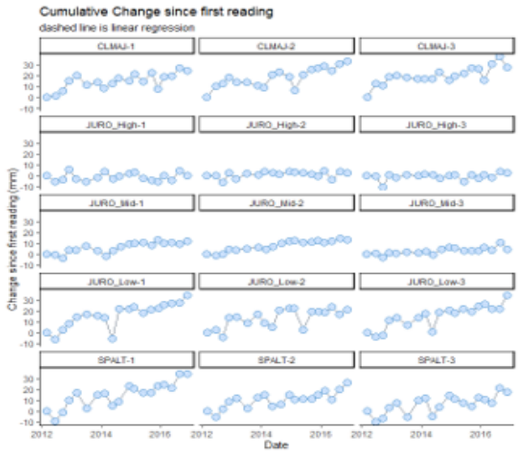
set_id	first_sampled	last_sampled	years_sampled	sample_events
CLMAJ-1	2012-02-29	2016-11-21	4.728	19
CLMAJ-2	2012-02-29	2016-11-21	4.728	19
CLMAJ-3	2012-02-29	2016-11-21	4.728	19
JURO_High-1	2012-02-28	2016-11-22	4.734	19
JURO_High-2	2012-02-28	2016-11-22	4.734	19
JURO_High-3	2012-02-28	2016-11-22	4.734	19
JURO_Mid-1	2012-02-28	2016-11-22	4.734	19
JURO_Mid-2	2012-02-28	2016-11-22	4.734	19
JURO_Mid-3	2012-02-28	2016-11-22	4.734	19
JURO_Low-1	2012-03-02	2016-11-23	4.728	19
JURO_Low-2	2012-03-02	2016-11-23	4.728	19
JURO_Low-3	2012-03-02	2016-11-23	4.728	19
SPALT-1	2012-03-02	2016-11-23	4.728	19
SPALT-2	2012-03-02	2016-11-23	4.728	19
SPALT-3	2012-03-02	2016-11-23	4.728	19

Still on wish list to include:

- NAVD88 elevation (and year determined)
- Distance from closest water body

Cumulative change snapshot

Take a look at your overall change since the first reading - make sure the change looks generally linear, and make sure there are no big breaks in the data that could influence the outputs. Output will be generated even if it is not appropriate - **it is up to you to use discretion and make sure a linear model is appropriate for the data!**



The above graph is saved as:
R_output/figures/cumu_change_plots/cumu_change_noLine.png

Graphs for each SET individually are not shown here but have been saved in *R_output/figures/cumu_change_plots/individual_sets*

Summary Points:

Two main questions about surface elevation tables:
1) How has the marsh surface changed over time?
2) Does it keep up with sea level rise?

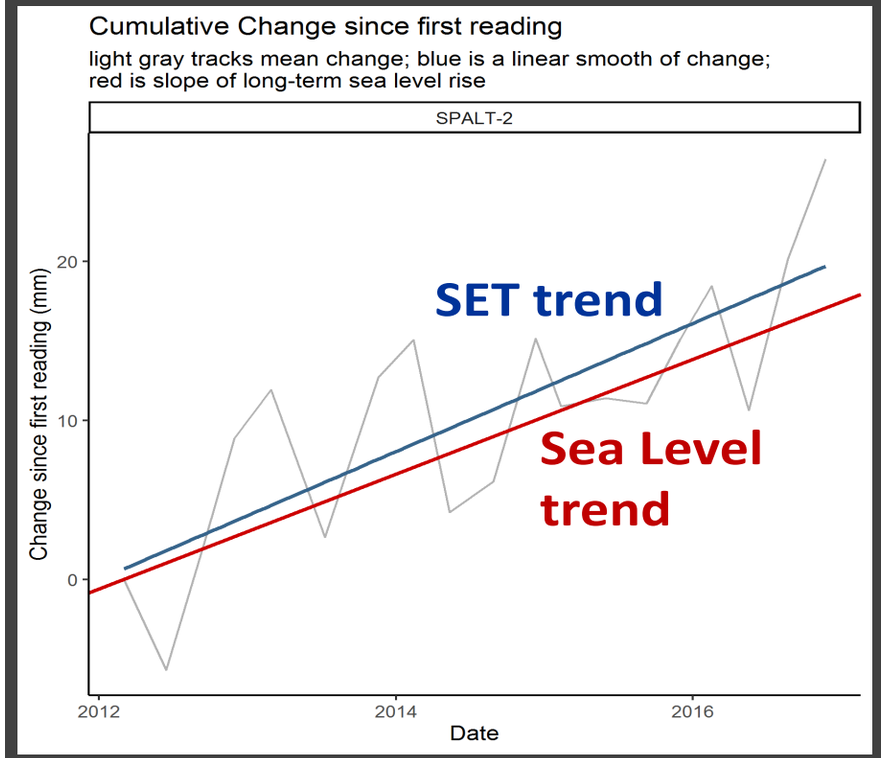
The team transformed existing SET data provided by participating reserves, and produced technical tools designed to improve quality-control procedures and analyses.

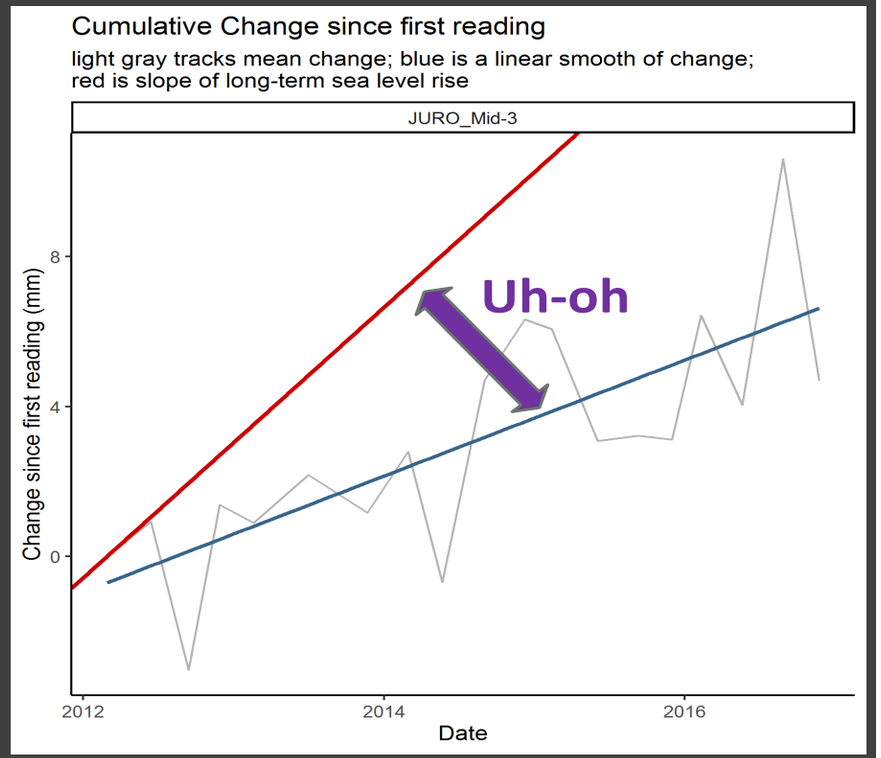
The main output for end users was a Microsoft Word document containing analyses, tables, graphs, and background context for each piece of information. The team compiled these resources so that end users can enter their own data and draw conclusions without having to perform their own computations in R.

Terminology:

- **R**: A programming language and free software environment for statistical computing and graphics used by statisticians and data miners to develop statistical software and data analyses.

For each SET: change since first reading



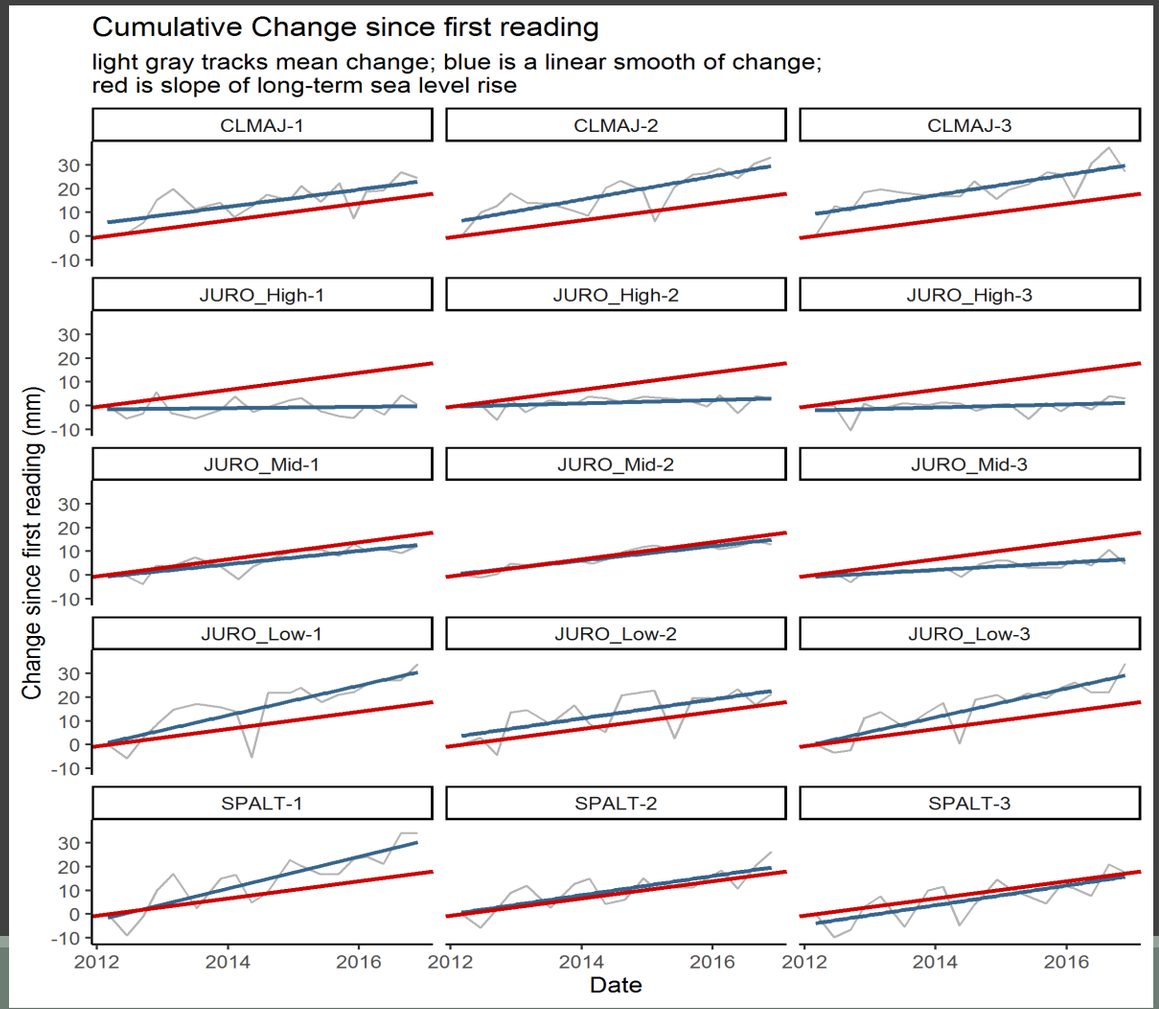


Summary Points:

The example graph on the left shows average pin readings; each point on the graph represents an average of all pin readings from a single surface elevation table on the given date. The light gray line shows the average change in elevation compared to the first measurement. The blue line provides a smoothed linear trend for the data, and the red line represents a linear trend in sea level rise. Taken together, these lines provide a visual representation for how closely the trend in SET measurements mirrors the trend in sea level rise. With these visual representations, parallel trend lines would indicate that a given SET is keeping up with sea level rise.

The graph on the right shows measurements from a different SET, and represents a scenario in which the SET is not keeping pace with sea level rise.

Entire reserve change since first reading + Trends

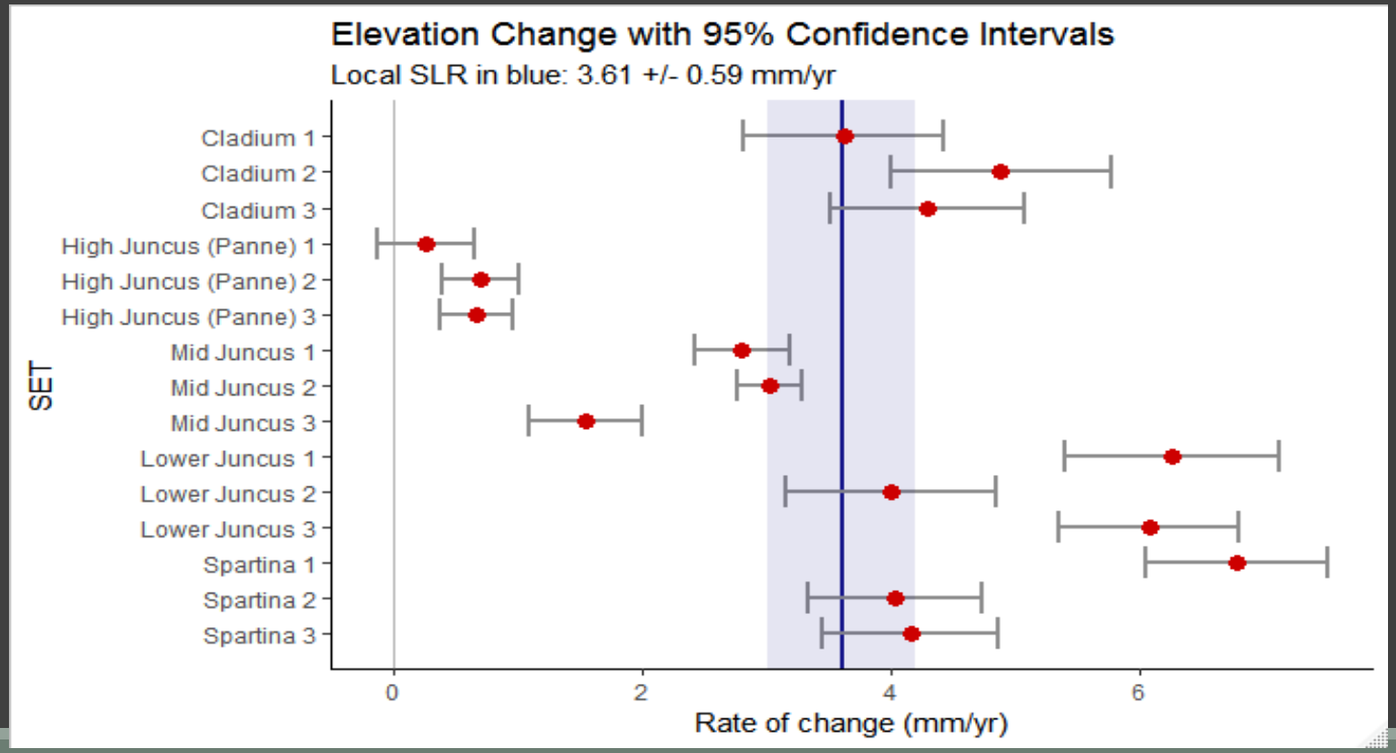


Summary Points:

The image on the slide provides an example of how reserves can produce at-a-glance summaries of SET data for their sites using R scripts developed as part of the project.

Summarizing, graphically

1. **Is the point estimate (rate) Higher or Lower?**
2. **Do the Confidence Intervals overlap?**



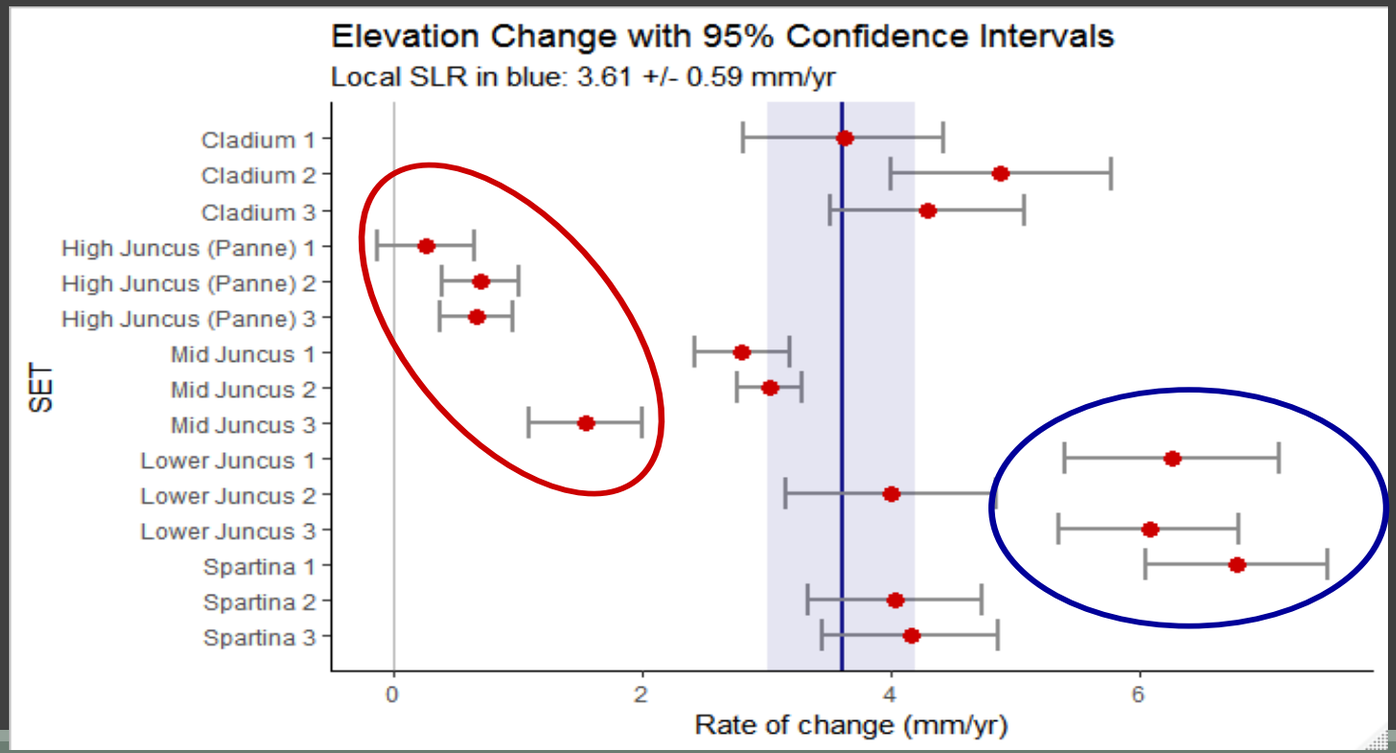
Summary Points:

How to read this graph:

- The X-axis shows rate of elevation change in millimeters per year.
- The Y-axis gives categorical labels designating the name and location of each SET at the reserve from which these data were obtained.
- The blue vertical line marks a calculated sea level rise estimate from NOAA, with the blue shading representing the confidence interval for that estimate.
- Each red dot represents the calculated rate of change for a particular SET, and the whiskers represent the 95 percent confidence interval for each calculated rate of change.

Summarizing, graphically

1. **Is the point estimate (rate) Higher or Lower?**
2. **Do the Confidence Intervals overlap?**



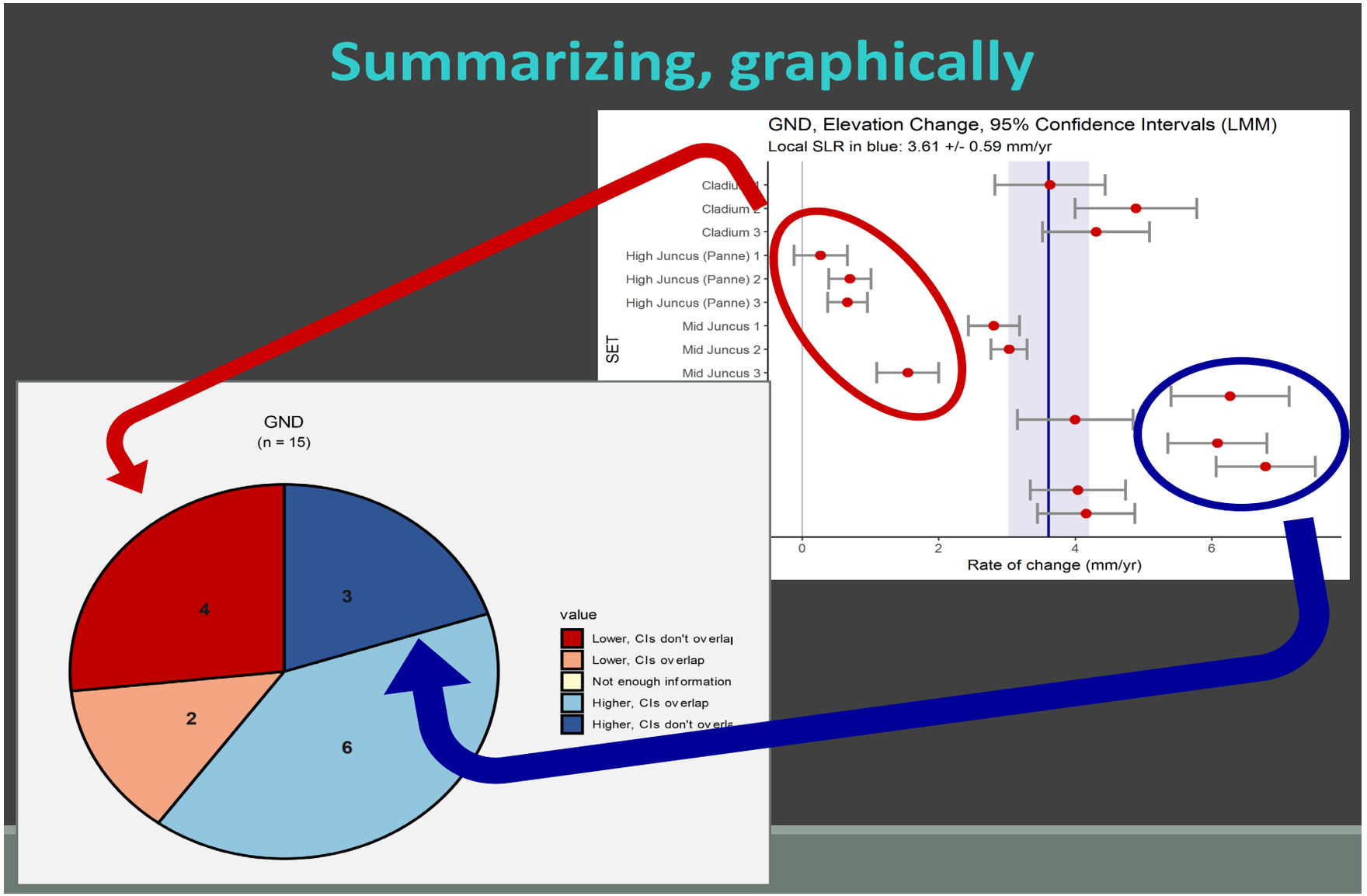
Summary Points:

The team uses these data to determine whether there is any overlap between the confidence intervals for each SET calculation and the confidence interval for sea level rise.

The data points in the red circled area indicate locations where there is high confidence that the rate of elevation change, as measured by the SET, is less than the rate of sea level rise. The data points in the blue circled area indicate locations where the measured rate of elevation change is greater than the rate of sea level rise.

Taken together, these graphical representations indicate locations where elevation change is and is not keeping pace with sea level rise.

Summarizing, graphically

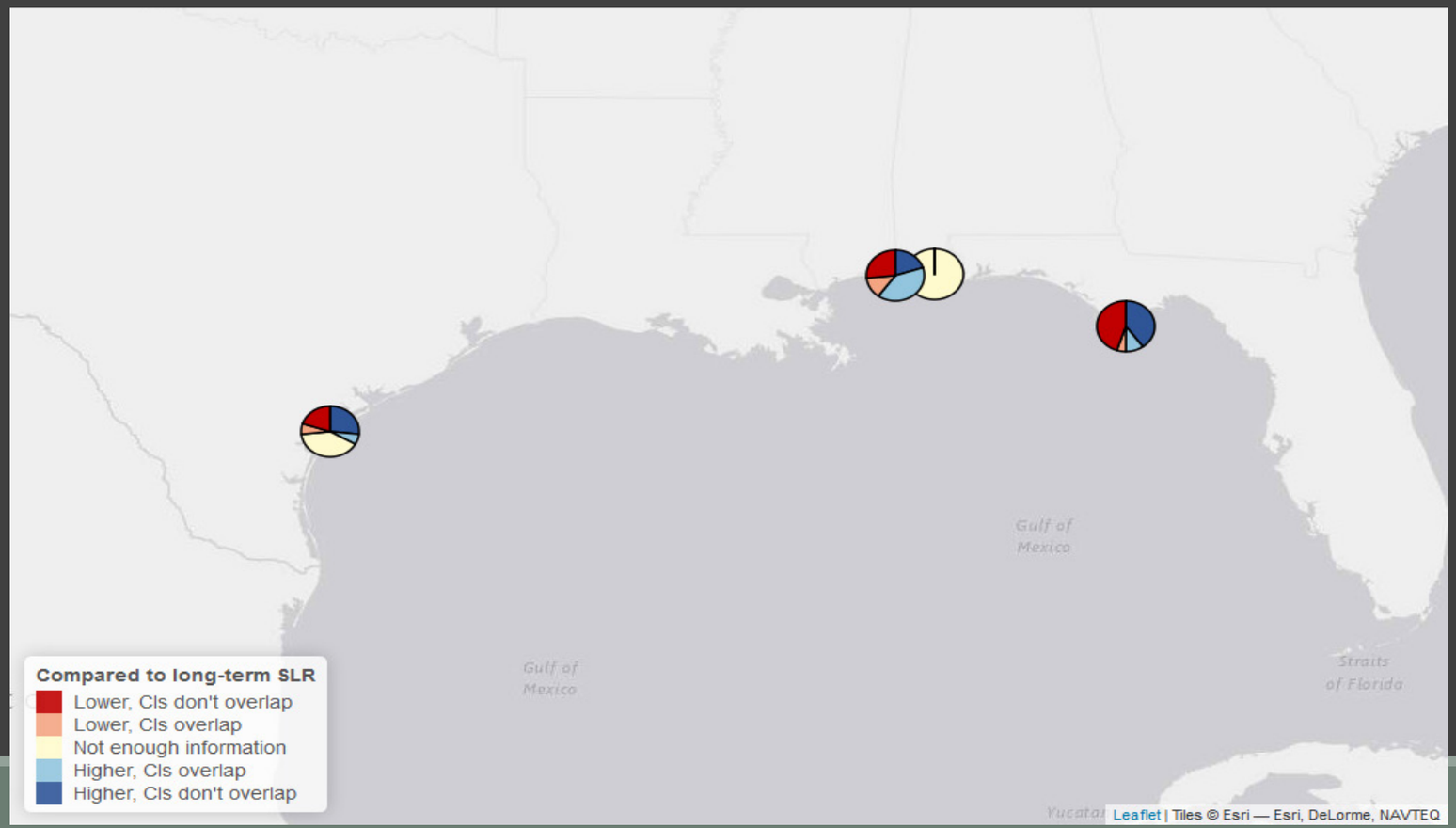


Summary Points:

The team then converted each elevation change graph into a pie chart to assist end users in visualizing localized trends. Each pie chart shows the proportion of sites whose rates of elevation change differ from the rate of sea level rise.

Red coloration indicates SET elevation change is less than the rate of sea level rise, while blue coloration indicates confidence that the calculated elevation change is greater than the rate of sea level rise. Darker coloration indicates greater confidence in the measurements; e.g., dark red coloration indicates a high degree of confidence that elevation change is occurring slower than sea level rise for a specific site, whereas lighter red coloration indicates less confidence.

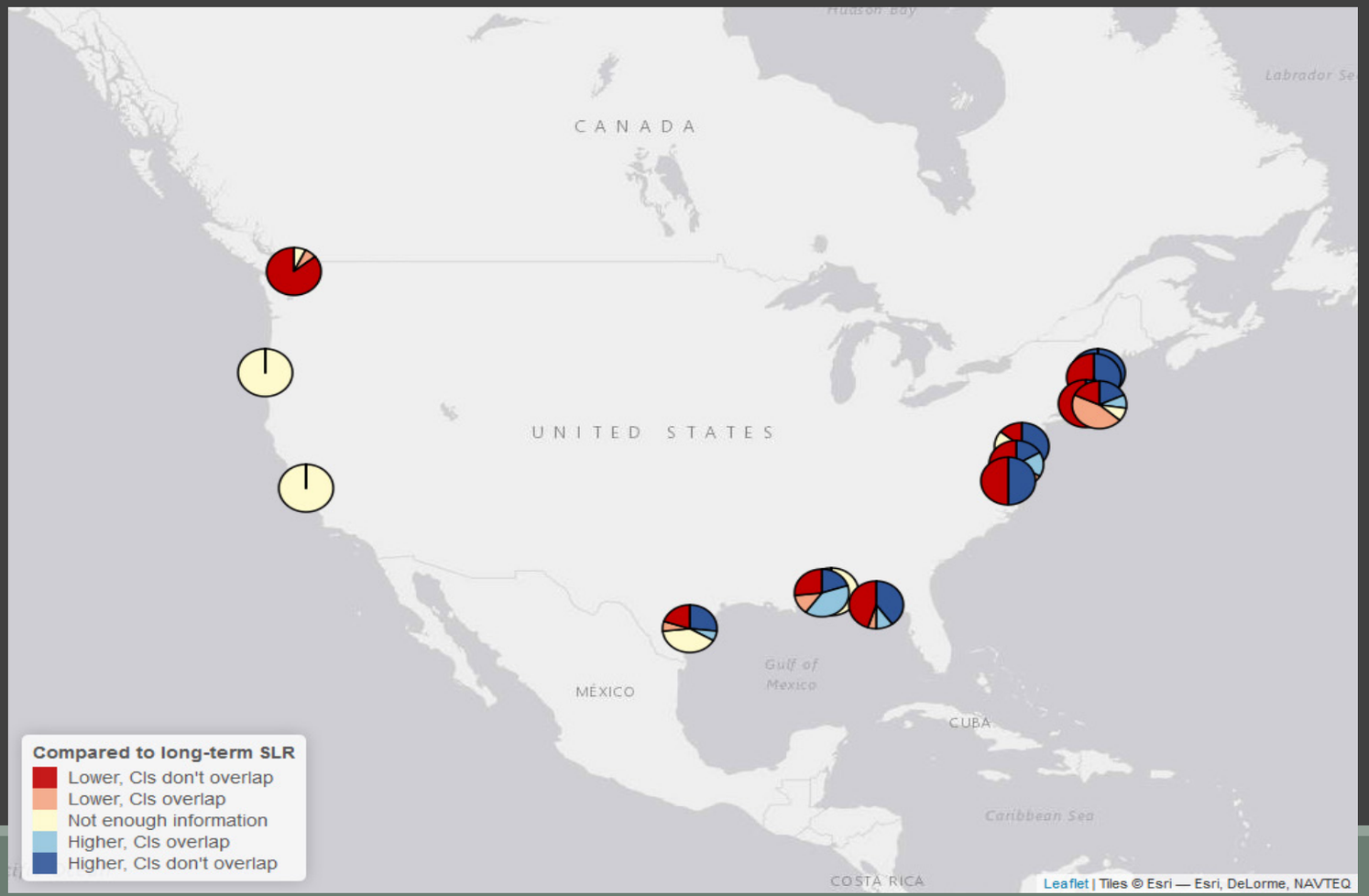
Regional Map – comparison to local, long-term sea level rise



Summary Points:

At larger scales, each local trend pie chart can elucidate whether any potantial trends in long-term sea level rise exist at the regional level...

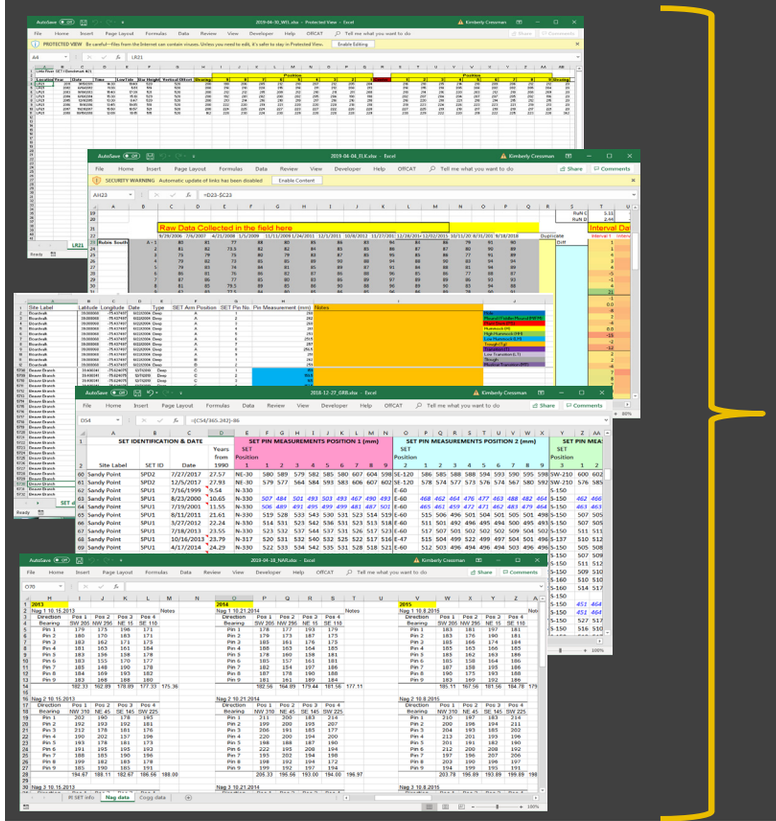
National Map



Summary Points:

...or the national level.

Biggest tip for synthesizing data:
Plan time for tidying



	A	B	C	D	E	F	G	H
1	set_id	year	month	day	arm_position	arm_qaqc_code	pin_number	height_mm
2834	JURO_High-2	2012	9	13	5R		pin_7	166
2835	JURO_High-2	2012	9	13	5R		pin_8	160.5
2836	JURO_High-2	2012	9	13	5R		pin_9	165.5
2837	JURO_High-2	2012	9	13	7L		pin_1	180
2838	JURO_High-2	2012	9	13	7L		pin_2	177.5
2839	JURO_High-2	2012	9	13	7L		pin_3	157
2840	JURO_High-2	2012	9	13	7L		pin_4	165.5
2841	JURO_High-2	2012	9	13	7L		pin_5	169
2842	JURO_High-2	2012	9	13	7L		pin_6	174
2843	JURO_High-2	2012	9	13	7L		pin_7	178.5
2844	JURO_High-2	2012	9	13	7L		pin_8	178
2845	JURO_High-2	2012	9	13	7L		pin_9	175.5
2846	JURO_High-2	2012	11	28	1L		pin_1	189
2847	JURO_High-2	2012	11	28	1L		pin_2	192.5

Papers to check out:

- Wickham 2014: Tidy Data
- Broman and Woo 2018: Data Organization in Spreadsheets

Summary Points:

Kim's team worked with data from 15 reserves, many of which submitted data in different formats. One of the primary benefits of the team's work is that they compiled all of the data from these reserves into a 'tidy' format that is compatible with the tools and R scripts that the team developed for end users.

Biggest tip for collaborating:
Meet people where they are

- Make it easy to provide feedback
- Plan for multiple levels of engagement
- Give people something to respond to, and time to digest it
  - early agendas/draft figures
  - google docs kept open after calls
- Follow up individually

Summary Points:

THANK YOU to our fantastic team and participants!

- 50+ people across 17 states and 25 agencies
- 15 Reserves: APA, CBM, CBV, DEL, ELK, GND, GRB, GTM, MAR, NAR, PDB, SOS, WEL, WKB, WQB

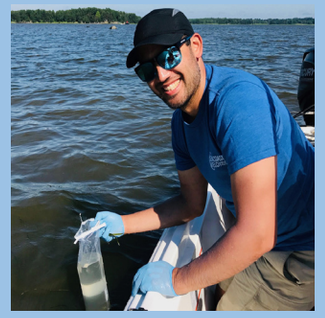
Sign up for our email list

tinyurl.com/SETr-email

Email me:

Kimberly.Cressman@dmr.ms.gov

Summary Points:



Chris Peter
Research Coordinator, Great Bay NERR

David Burdick
Research Associate Professor, University of New Hampshire

Synthesizing NERR Sentinel Site data to improve coastal wetland management across New England

Chris Peter, David Burdick, Briana Fischella, Jason Goldstein, Chris Feurt, Laura Crane, Annie Cox, Megan Tyrrell, Jenny Allen, Jordan Mora, and Kenny Raposa
Project Advisors: Susan Adamowicz, US Fish & Wildlife Service, Kerstin Wasson, Elkhorn Slough NERR

Waquoit Bay National Estuarine Research Reserve | wellsreserve | Great Bay National Estuarine Research Reserve | University of New Hampshire | Narragansett Bay Research Reserve | National Estuarine Research Reserve System Science Collaborative

Summary Points:

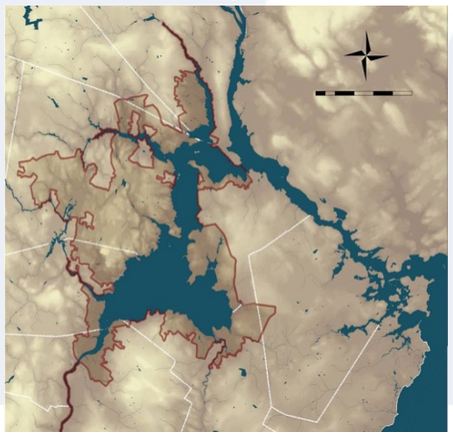
David Burdick from the University of New Hampshire and Chris Peter from Great Bay NERR provided an overview of their project: Synthesizing Monitoring Data to Improve Coastal Wetland Management Across New England. This project analyzed Sentinel Site data from four New England reserves, which have individually been monitoring salt marsh vegetation and elevation changes since at least 2011. The team developed data packages linking vegetation change with surface elevation and other data, including output from an inundation tool. In addition to providing an initial summary of patterns, the project developed analysis protocols that can be utilized by other reserves and coastal managers nationwide.

Project research questions: 1) How are marshes faring given the unprecendent of sea level rise? 2) How can we create a guide or template to facilitate transferrable data acquisition, standardization, quality assurance, visualization, and analysis?

Reserves	IIII	Plots	269	Formats	6
Marshes	~~IIII~~ III	Data points	30,000	Methods	2-3
Years	~~IIII~~ III	Species list	189		

Wells, ME

Great Bay, NH



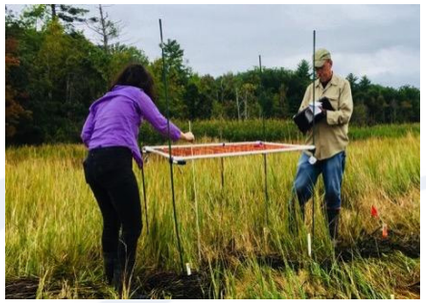
Waquoit Bay, MA

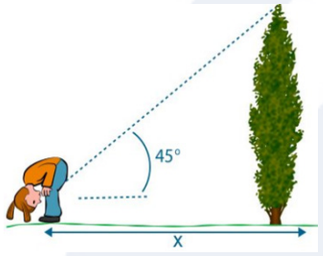
Narragansett Bay, RI

Summary Points:

This project worked with four reserves across eight marshes from 2010 to 2017. Similar to Kim Cressman's project, every reserve utilized its own data formats and a variety of methods for data acquisition; in one case, a reserve provided three different data formats.

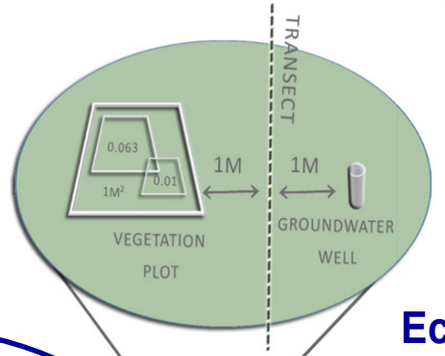
End users included New England reserve staff and a broader suite of coastal research and management stakeholders such as NOAA, EPA, state coastal zone programs, and National Heritage staff.





Methods

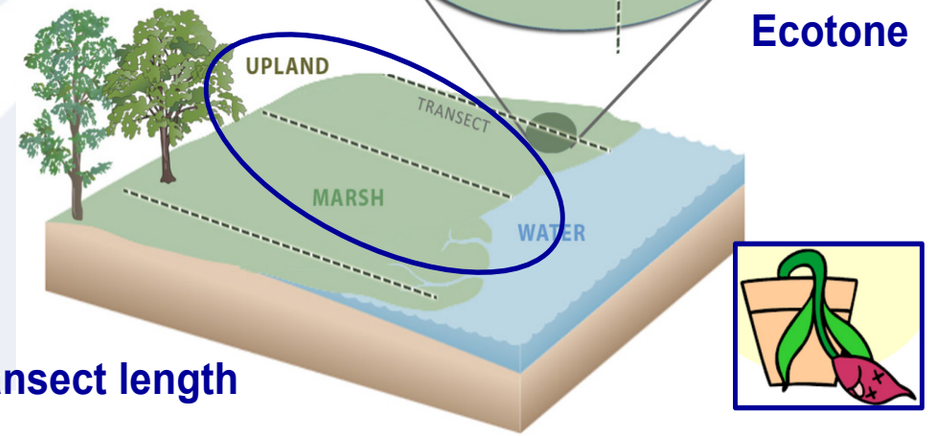
- Canopy height
- 5 tallest
- 12 ‘random’



Marsh Zone

Quadrat

- 1m^2
- 1/16m^2
- 1/100m^2



Ecotone

Transect length

Summary Points:

This slide shows some of the parameters the reserves used to document plant communities, which included plant cover, height, and count.

The team found monitoring plant cover to be the biggest challenge, due primarily to the lack of standardization for estimation methods. In New England, the team noted that approximately 50 perecent of reserves that participated in this project used the point intercept method, and 50 percent used visual estimates. Interestingly, this contrasted with polling conducted during the webinar, in which attendee responses indicated approximately 75 percent point intercept users and 25 percent visual estimation users.

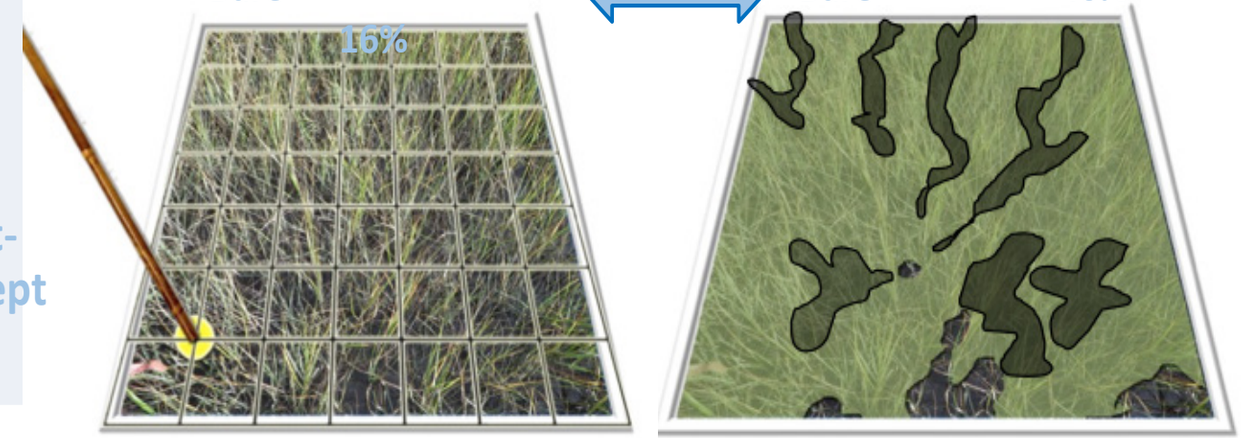
Terminology:

- **Point intercept vegetation sampling**: A method to assess plant cover in a plot by placing sampling poles at systemtic points along a transect. Plant species that touch, or “intercept,” the pole are marked as “hits,” and the total percent cover is then calculated by dividing the number of hits by the total number of points along the transect.
- **Transect**: A straight line or narrow section across a section of land along which measurements are taken or observations are made.
- **Ocular/Visual estimation**: A method for rapidly assessing plant cover by visually estimating species as a percentage of the area within a plot.

	PI	OC
Bare	↓	↑
Dead	↓	↑
Live Cover	↑	↓

S. alterniflora 84%
Bare 16%

S. alterniflora 60%
Bare 40%



PI
Point-intercept

OC
Ocular Cover

Summary Points:

The team noted an emergent pattern in which the point intercept method consistently estimated bare and dead cover to be lower than the ocular estimates, and estimated live cover to be higher than ocular estimates.

The example on the slide demonstrates these observations for *Spartina alterniflora* live cover estimations at a plot. Using both the point intercept and ocular estimation methods, the team analyzed over 100 plots across all New England reserves. By comparing the two methods, they sought to establish a relationship that would enable them to draw conclusions from a combined data set.

PI vs OC

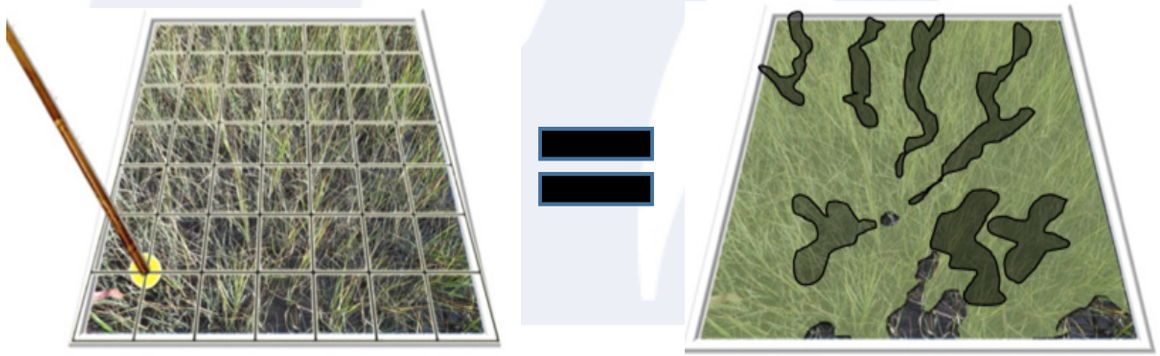
PI Transformations

1. PI: 2x to 100 points/plot

1. PI-N: Normalized to 100%

$$X = \frac{100 - (Bare + Dead)}{Total\ Live\ Cover} * \mathrm{PI}$$

3. PI-RN: Regressing PI vs OC by morphology



	PI	OC
Bare	↓	↑
Dead	↓	↑
Live Cover	↑	↓

Summary Points:

To reconcile the differences in these estimations, the team explored a variety of options for transforming the data.

In the first method, the team doubled point intercept values from the 50-point grids to estimate using 100 points per plot.

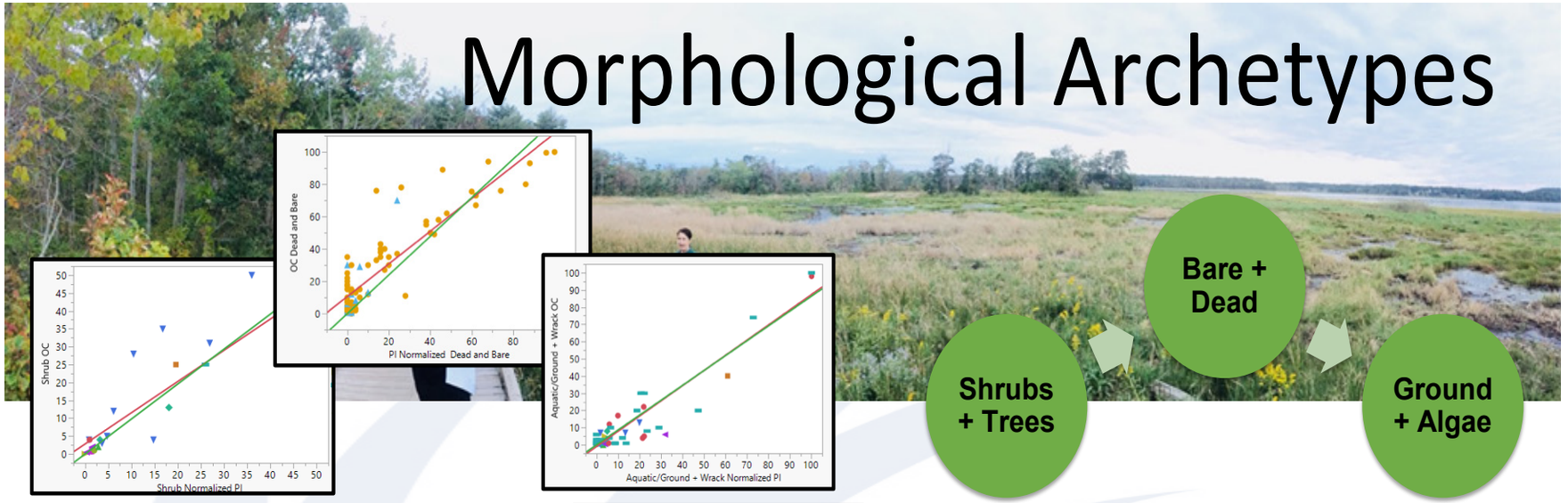
The second possibility involved normalizing the point intercept data to 100 percent using the calculation shown on the slide. As point intercept methods can frequently yield values over 300 percent when multiple species are present, this option theoretically reduces the possibility of overestimating live cover.

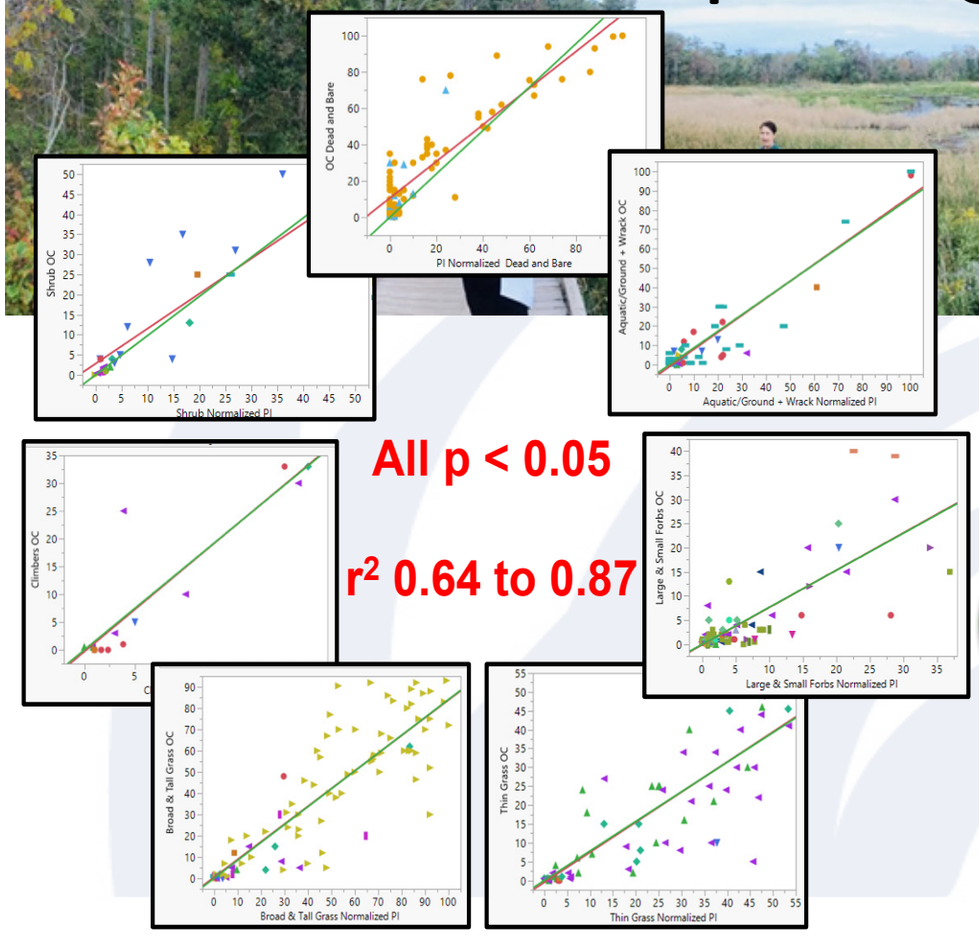
Lastly, the team opted to employ a statistical regression, which is explained in more detail on the following slide.

Terminology:

- **Data transformation**: The process of converting data from one format or structure into another format or structure for the purpose of data integration, management, and/or warehousing.

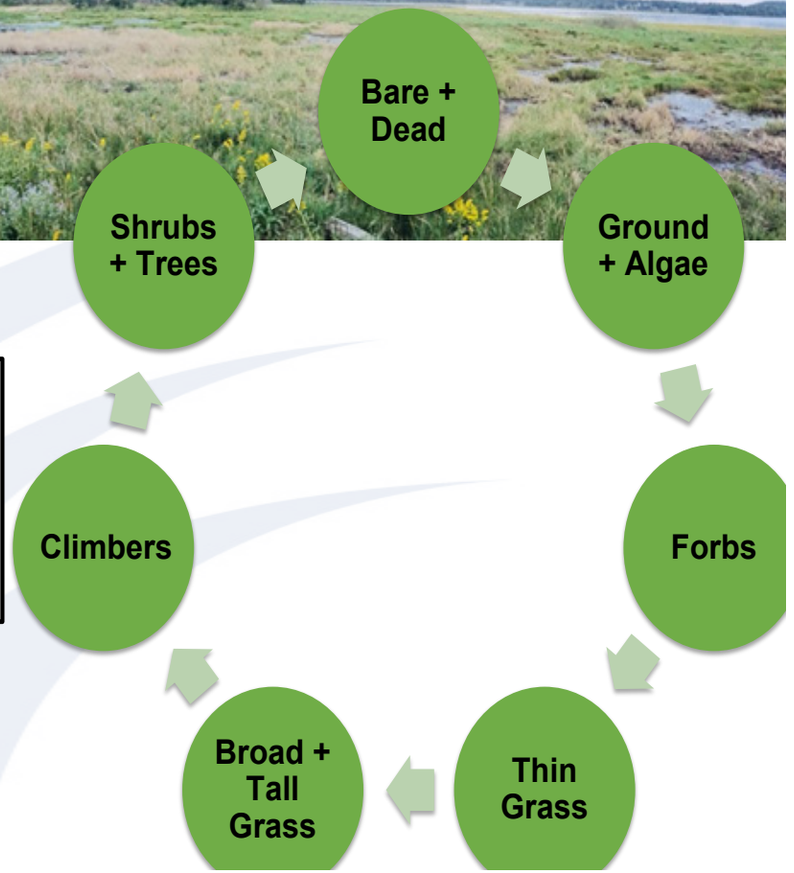
Morphological Archetypes





All p < 0.05

r^2 0.64 to 0.87



Summary Points:

Using cover categories based on morphology, the team performed regression analyses comparing the relationships.

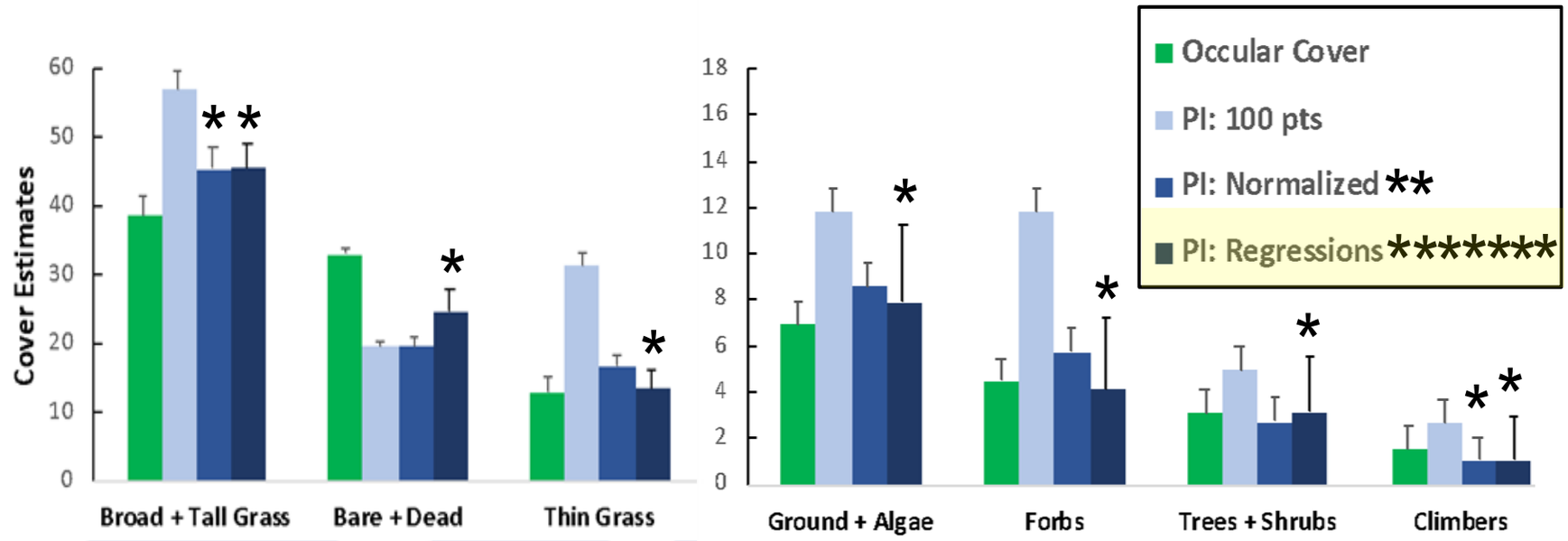
Terminology:

- **Regression analysis**: A set of statistical processes for estimating the relationships between a dependent variable and one or more independent variables.

Intepreting statistical significance:

- **P value**: A measure of the certainty that the results of a given study were not due random chance. A statistically significant P value is less than 0.05, meaning that there is less than a 5 percent chance that the results obtained from a study occurred by random chance.
- **R^2 value**: Also known as the coefficient of determination, this value is an indication of how close the data are to a fitted regression line. A value of 1 indicates that the regression model perfectly fits the data, while a value of 0 indicates no fit.

Morphological Archetypes



Asterisks indicate which estimation technique yielded results closest to the ocular estimation. For almost every morphological archetype, the regression analysis yielded the closest estimation to ocular cover. In two instances, normalized transformation yielded estimations very similar to both ocular estimation and regression analysis.

Summary Points:

The graphs on this slide show how the three transformation methods compare to the ocular cover estimates. For almost every morphological category, the regression analysis transformation yielded the closest results to the ocular cover estimates, as indicated by the asterisks. The team examined these data using both two-way ANOVA and paired t-tests.

Importantly, the team notes that this method is not perfect and that the best way to ensure that data sets have the highest quality possible is to use the same method to collect data.

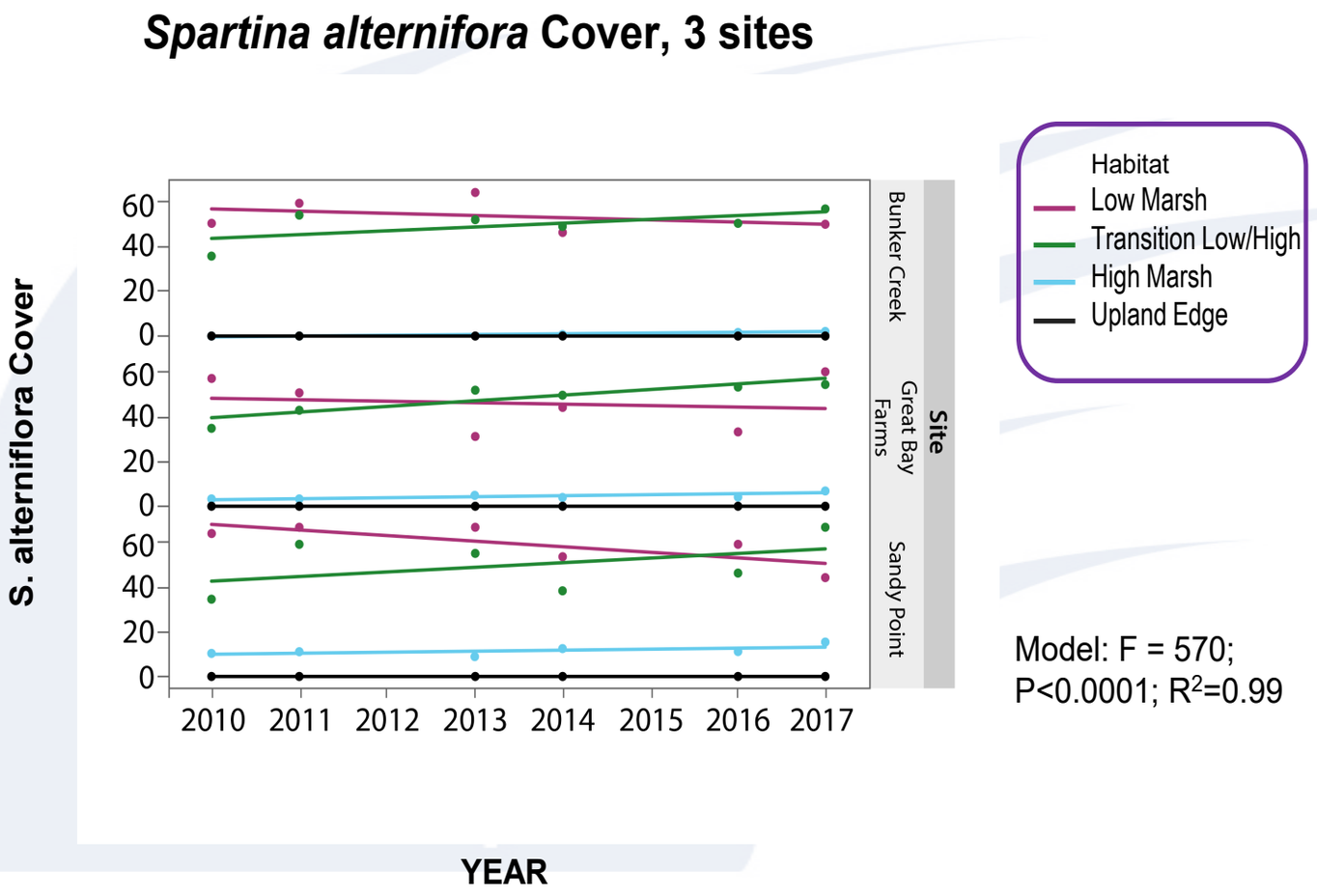
Terminology:

- **Two-way analysis of variance (ANOVA)**: A statistical analysis method that examines the influence of two different categorical independent variables on one continuous dependent variable. Generally a two-way ANOVA tests three hypotheses: 1) that the means of observations grouped by one factor are the same; 2) that the means of observations grouped by the other factor are the same; and 3) that there is no interaction between the two factors.
- **Paired t-test**: A type of test used to compare two population means when there are two samples in which observations in one sample can be paired with observations in the other sample. Paired t-tests are especially effective at comparing two different methods of measurement where the measurements are applied to the same subjects.

Results: ‘Tracking’ Marshes Over Time

Summary Points:

Great Bay NERR



Model: F = 570;
P<0.0001; R^2=0.99

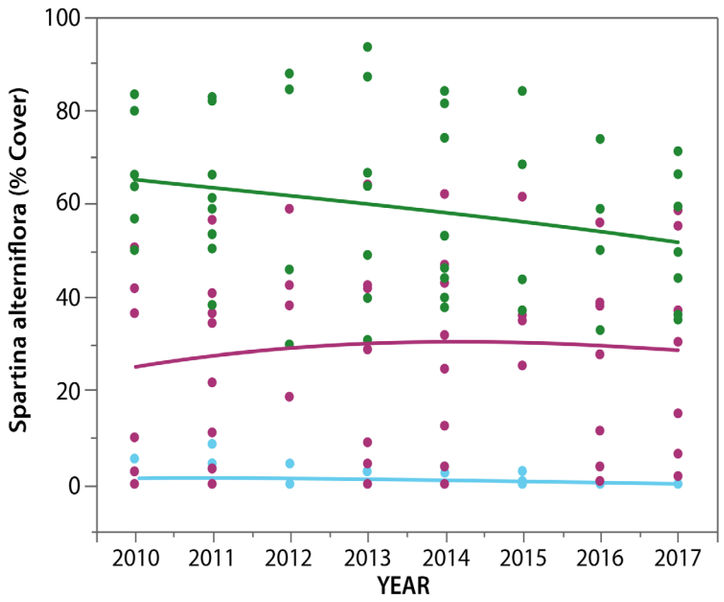
Summary Points:

This graph shows how *Spartina alterniflora* coverage has shifted from 2010 to 2017. In the early years of the monitoring period, *S. alterniflora* coverage primarily existed in the low marsh. Over time, coverage has shifted from primarily low marsh areas to primarily transition marsh areas.

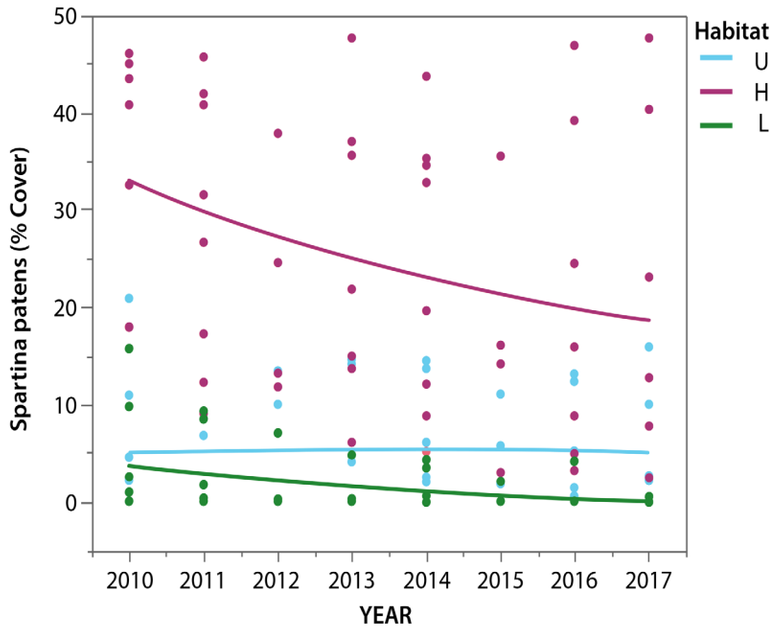
All Four New England Reserves

Univariate Analysis

Spartina alterniflora



Spartina patens



Summary Points:

These plots highlight patterns in *Spartina alterniflora* and *Spartina patens* cover in the four New England reserves from 2010 to 2017.

Observations:

- *S. patens* presence in high marsh areas decreased dramatically over the eight year period, shrinking by over 10 percent overall.
- *S. alterniflora* and *S. patens* coverage in low marsh areas also decreased over the time period by approximately 10 percent and 3 percent, respectively.
- The team observed no plots with *S. patens* in the low marsh by the end of the monitoring period.

These observations, when combined with further analyses shown on the following slides, allowed the team to draw conclusions about marsh vegetation trends.

All Four New England Reserves

Univariate Analysis

General Model is ANCOVA:
Plant Cover = Site + Habitat + Year

Dependent Variable	SITE	HABITAT	YEAR	Site X Habitat	Year X Habitat	Year X Site	Overall F	R2
Non-Living	0.0001	0.0001	0.0003	0.0001	0.8612	0.0319	26	0.89
Spartina alterniflora	0.0001	0.0001	0.3354	0.0001	0.0025	0.0964	72	0.96
Spartina patens	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	257	0.99
SA : SP Ratio	0.0001	0.0001	0.0001	0.0001	0.0001	0.0056	277	0.99
Halophytes	0.0001	0.0001	0.0001	0.0001	0.5210	0.0214	29	0.90
Dispi + Juger + Sppat	0.0001	0.0001	0.0001	0.0001	0.0308	0.0001	194	0.98
Forbs	0.0001	0.0001	0.1973	0.0001	0.2356	0.2608	1.54	0.14
Species richness	0.0001	0.0001	0.4295	0.0001	0.2200	0.1758	40	0.93

Summary Points:

The univariate analysis uses analysis of covariance (ANCOVA) model in which the year is the covariable, and site and habitat are the main independent variables.

Some key takeaways:

- While the specific marsh from which the samples came is always relevant, the habitat type from which samples came is also relevant. In some cases, marshes vary more within a reserve than between reserves.
- According to the team's analyses, there is not a lot of year-to-year variability; instead, the year-to-year change is fairly linear and unidirectional.
- The model allows for analysis of relationships among a variety dependent variables, some examples of which are shown on the slide.

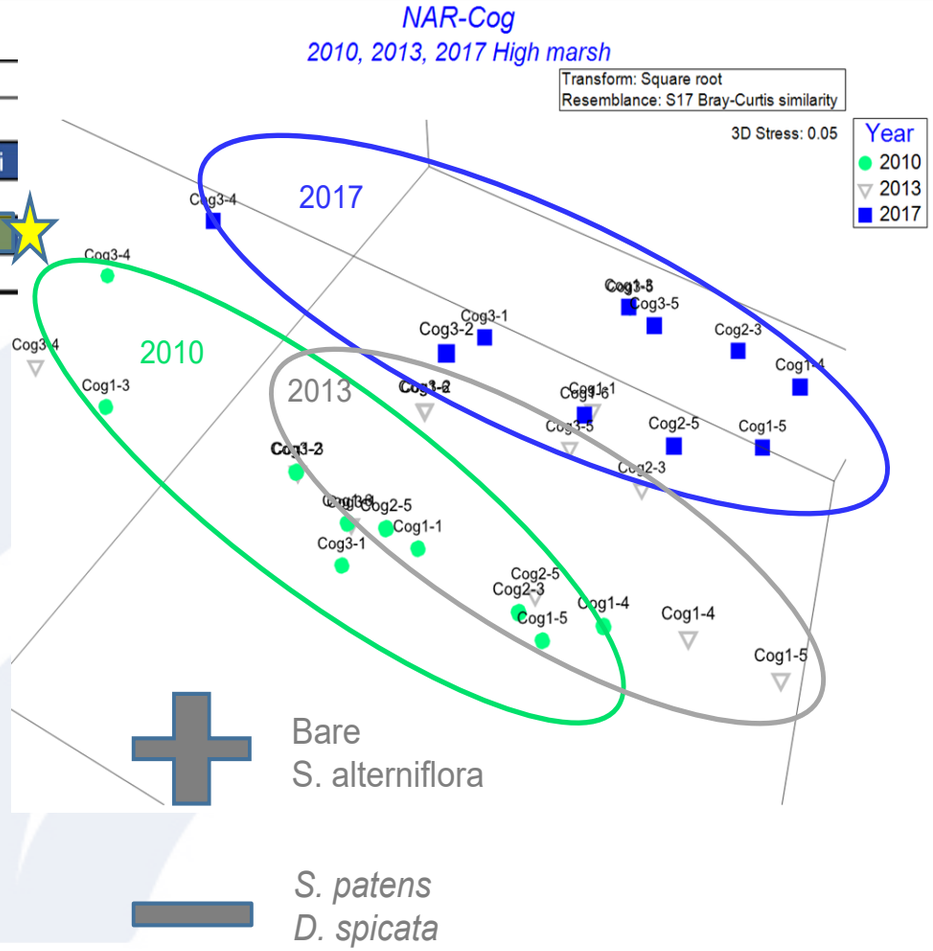
Terminology:

- **Analysis of covariance (ANCOVA)**: A model which blends ANOVA and regression. Generally used when there are differences among baseline groups, ANCOVA enables consideration of a single independent variable at a time without the influence of the others.

Narragansett Bay, RI

	Coggeshall			
2010 vs 2017	ANOSIM	NMDS	+ SIMPER	-
All Plots	0.020	X	Bare	Sp alt, Sp pat, Di spi
Low Marsh	0.839			
High Marsh	0.001	X	Bare, Sp alt	Sp pat, Di spi
Upland Edge	0.600			

Pairwise Tests	
Groups	Significance Level
2010, 2011	0.600
2010, 2012	0.506
2010, 2013	0.428
2010, 2014	0.032
2010, 2015	0.006
2010, 2016	0.019
2010, 2017	0.003



Summary Points:

In this example, a multivariate analysis examined the whole plant community for each observation. Using Primer, the team analyzed data and drew conclusions about how the community composition of high marsh at a site in Narragansett Bay changed over time.

Terminology:

- **PRIMER**: A software tool specializing in nonparametric (does not assume normal distribution) multivariate analyses.
- **Analysis of similarities (ANOSIM)**: A way to statistically test whether there is a significant difference between two or more groups of samples. An R value close to 1.0 suggests dissimilarity between groups, while a value close to 0 suggests an even distribution of high and low ranks within and between groups. R values
- **Non-metric multidimensional scaling (NMDS)**: A variation of multidimensional scaling in which fewer assumptions are made about the data. A smaller number of axes are chosen at the beginning of the analysis than in other types of MDS, and the data are fitted to those dimensions.
  Multidimensional scaling (MDS): A way to visualize the level of similarity of individual cases of a dataset by translating information about the pairwise distances among a set of n individuals into a configuration of n points mapped onto a space.
- **Similarity percentages breakdown (SIMPER)**: A way to detect which variables are the likely cause of any differences discovered by ANOSIM.

Narragansett Bay, RI

	Coggeshall			
2010 vs 2017	ANOSIM	NMDS	+ SIMPER	-
All Plots	0.020	X	Bare	Sp alt, Sp pat, Di spi
Low Marsh	0.839			
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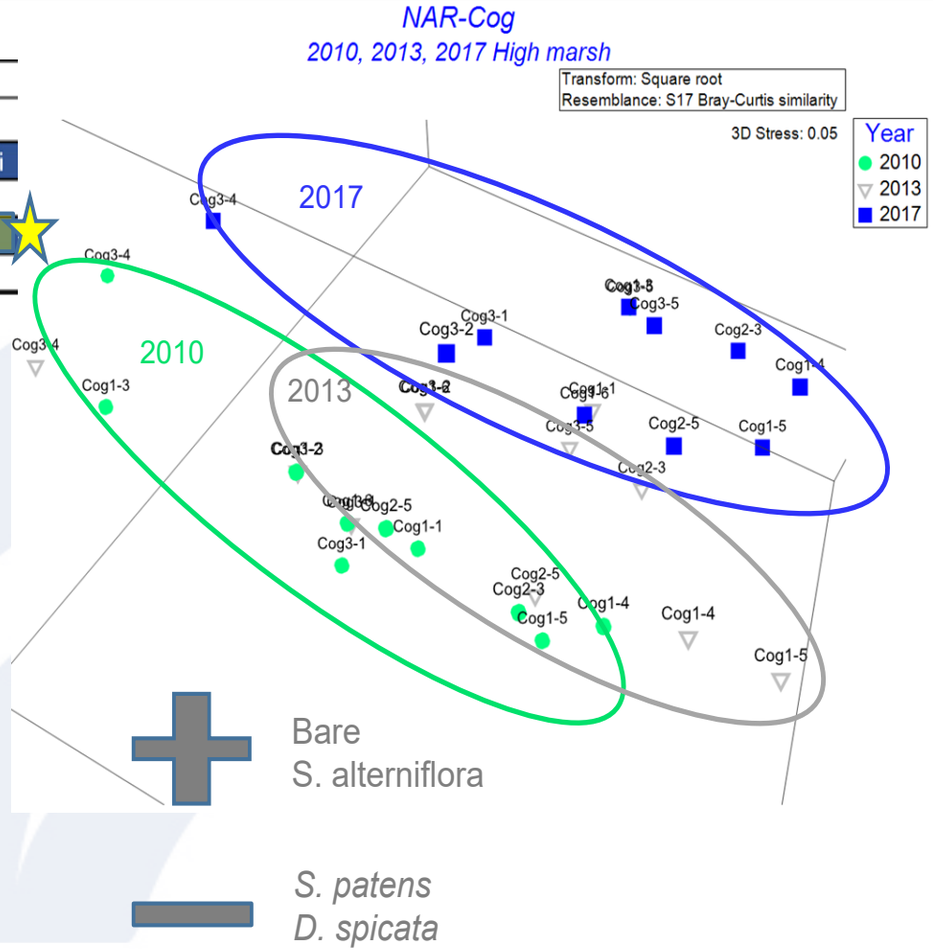


Summary Points:

The Primer output in the table on the top left of the slide indicates that the high marsh habitat type showed the greatest difference over time, shifting away from higher coverage of *S. patens* and *D. spicata*, and becoming more bare or covered by *S. alterniflora*.

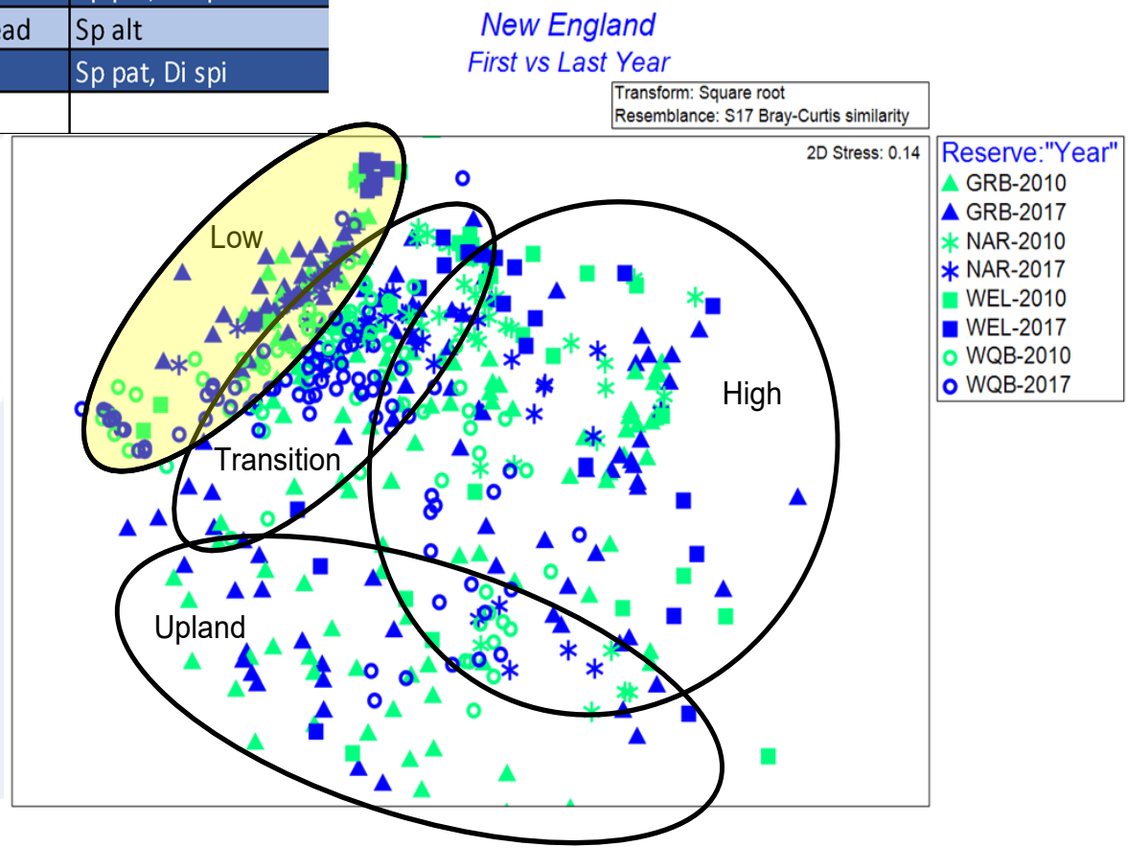
In addition to the benefits of multidimensional visualizations, the multivariate analyses allowed the team to perform pairwise tests for every year. The example on the slide shows how after five years, comparing the species compositions for 2010 to 2014 at the specified location yielded statistically significant ($p < 0.05$) differences in the plant communities observed.

Terminology:

- **Pairwise test**: A way to describe patterns of mean differences by comparing the means of two groups of observational data. This can help reduce the influence of confounding variables by mathematically accounting for variables that are believed to influence the outcome.

All Four New England Reserves

	New England			
	ANOSIM	NMDS	+ SIMPER	-
Overall	0.007	X	**Sp alt**, Bare	Sp pat, Di spi
Low marsh	0.103	X	**Water**, Bare, Dead	Sp alt
High marsh	0.023	X	**Sp alt**, Bare	Sp pat, Di spi
Upland edge	0.542			



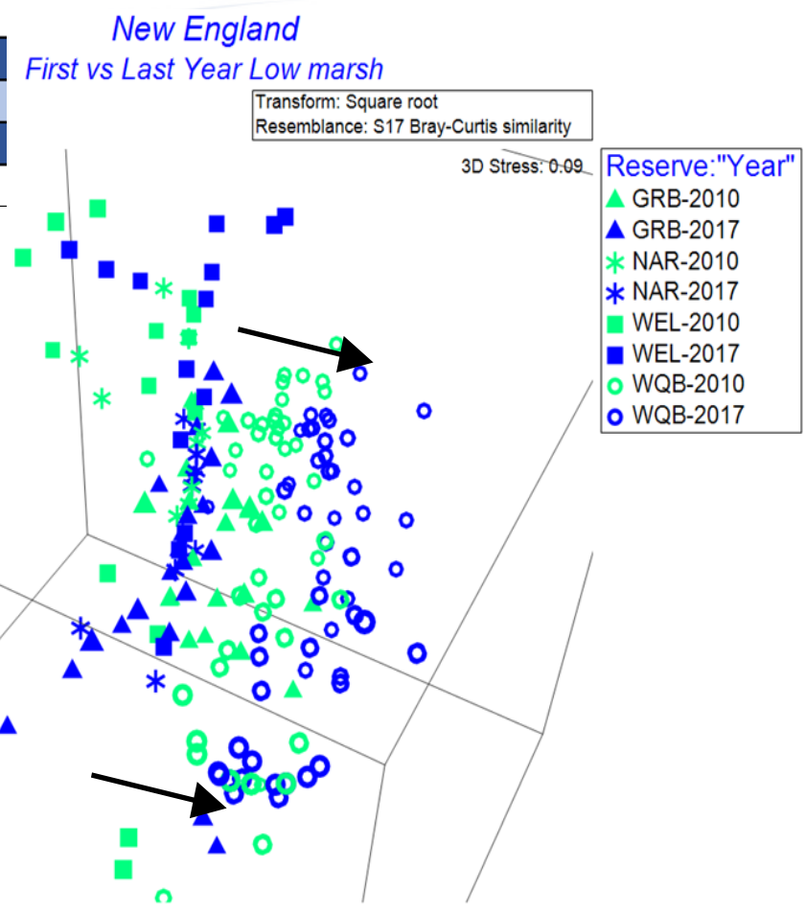
Summary Points:

The same analyses can be performed at the regional level to highlight trends in habitat change when comparing the first year of monitoring to the last year of monitoring.

Based on the visual representation, it is clear that PRIMER has separated observations based on their habitat.

All Four New England Reserves

	New England			
	ANOSIM	NMDS	+ SIMPER	-
Overall	0.007	X	**Sp alt**, Bare	Sp pat, Di spi
Low marsh	0.103	X	**Water**, Bare, Dead	Sp alt
High marsh	0.023	X	**Sp alt**, Bare	Sp pat, Di spi
Upland edge	0.542			



Summary Points:

Looking more closely at the low marsh shows how drowning and disappearing *S. alterniflora* coverage has given way to non-living cover of dead plants, bare soil and open water.

Summary of Results

⬆⬇ S. alterniflora	𝍸 𝍸 I
⬆ Bare	𝍸 𝍸
⬇ S. patens	𝍸 𝍸
⬇ D. spicata	𝍸 III
⬆⬇ Dead	𝍸 I
⬆ Water	III
Wrack	II
J. gerardii	I
S. tenuifolium	I
P. australis	I
T. radicans	I
T. maritima	I

- Marshes are changing, more so in Southern New England where tides are smaller

- Sensitivity: Transition Plots & Spartina spp.

- Lessons Learned: Inconsistent methods
- Recommendations:
  - Unify protocols
  - Data → Information → Action

Summary Points:

In New England, *Spartina alterniflora* and *patens* are the species most sensitive to marsh changes because they are the most likely to exist in all plots, and thus are well-suited for monitoring as indicators of marsh response to sea level rise. Transition plots between high and low marsh were the most senstive in terms of elevation.

As the team invested a significant amount of time syncing inconsistent methods, their primary recommendation involved unifying data acquisition and formatting protocols across reserves.

Reflections and Opportunities

Dwayne Porter

- Comments on the two project presentations and their value to reserve system
  - Data wrangling takes time!
    - Collaborations, including end-user / stakeholder engagement from the beginning, and communication are critical!
      - Findings presented are really just the tip of the iceberg!

Summary Points:

Dwayne Porter is a professor in the school of public health at the University of South Carolina. He is also the director of the NERRS Centralized Data Management Office, which helps process and archive monitoring data from across the reserve system.

Dwayne began the Q&A session with some comments on data management and collaboration.

1. Tidying data takes time, effort, and resources.
2. Community-based research and research-based learning cannot be done in a vacuum; they require collaboration of a wide variety of partners, and engaging end users through the duration of the project.
3. Findings are just the tip of the iceberg. Collaborators and end users are now starting to identify ways to assimilate, assess, and integrate data to address questions not previously considered due to lack of available data informing those questions.

Reflections and opportunities

- Comments on the makeup of our audience
  - Federal government - 33% representing seven (7) agencies
    - State and local government - 17% representing 11 different states
      - Academia - 19% representing 16 institutions
        - NERRS - 17% representing 13 reserves
          - Private and NGOs - 13% representing 11 organizations

Summary Points:

Dwayne's comments, continued:

The broad spectrum of participants in today's webinar is indicative of the types of collaboration supported in the Reserve system.

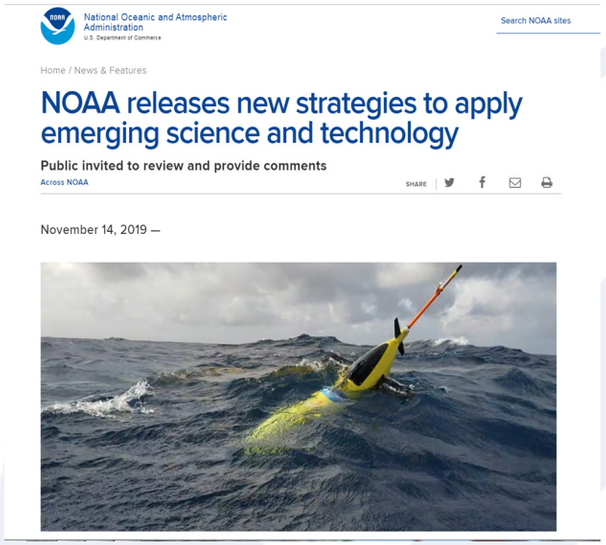
Engaging a range of stakeholders is how collaborators can begin to make a difference and address issues not only within communities, but also regionally and nationally.

Summary Points:

Reflections and opportunities

- Potential needs/opportunities for integrating, synthesizing and applying NERRS data with other environmental, social, and public health data to address complex local to regional to national issues

Reflections and opportunities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NOAA releases new strategies to apply emerging science and technology

Public invited to review and provide comments

Across NOAA

SHARE

November 14, 2019 —

At the recently-held White House Summit, NOAA announced new strategies to dramatically expand the agency's application of four emerging science and technology focus areas — NOAA Unmanned Systems, Artificial Intelligence / Machine Learning, 'Omics, and Cloud computing — to guide transformative advancements in the quality and timeliness of NOAA science, products and services.

Summary Points:

Dwayne's comments, continued:

Collaborative partnerships provide a means of demonstrating how monitoring and observing data lay the groundwork for effecting positive change and increasing quality of life.

Reflections and opportunities

- We (all of us on the webinar) have these great opportunities for integrating, … because of:

Summary Points:

Collaboration is a vital component of the projects in this presentation, and all projects supported by the Science Collaborative.

End users, researchers, and other stakeholders have opportunities for integrating data because collaboration is part of the project design from the outset. Engaging end users throughout the duration of the project enables collaborators to take advantage of information at key moments.

Reflections and opportunities

Data assimilation ≠ Data integration

Summary Points:

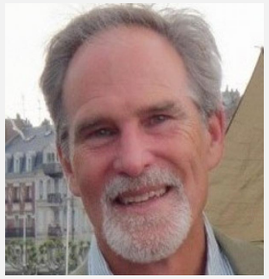
Data assimilation: The technique whereby observational data are combined with output from a numerical model to produce an optimal estimate of the evolving state of the system. For the purposes of the metaphor on the slide, it is the grocery cart in the grocery store.

Data integration: The process of combining data residing in different sources and providing users with a unified view of them; this requires quality assurance and quality control, and provides the metadata necessary for unification. In the metaphor on the slide, it is the stage at which researchers (or chefs) utilize the ingredients and realize their value.

Q&A

Use the “Questions” function in the console to pose a question.

Kim Cressman
SWMP Coordinator
Grand Bay NERR



David Burdick
Research Associate Professor
University of New Hampshire

Chris Peter
Research Coordinator
Great Bay NERR

Chris Kinkade
NERRS National Research Coordinator
NOAA Office for Coastal Management

Dwayne Porter
Director
NERRS Centralized Data Management Office

National Estuarine Research Reserve System Science Collaborative

Questions:

Q: What were the challenges associated with data “tidying” and data “wrangling?” How did you best address those?

- **Kim Cressman**: One major challenge was taking some of the habits that people have for using spreadsheets that make it easy for people to look at data, and turning that into something more machine-friendly. Statistical programs don’t understand color-coding, for example. We addressed this by using R to trace every step from the original data file to our own output.
- **Chris Peter**: We had similar challenges to Kim’s. We had to build spreadsheets that could handle the flexibility of working with multiple reserves, but we believe that Kim’s method is a more effective way to streamline the process.

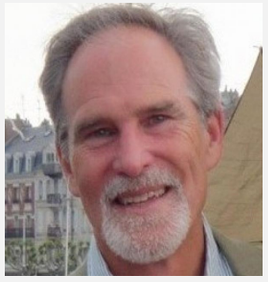
Q: In the table with the univariate analyses, every dependent variable had a high R^2 value except for forbs, which had an R^2 value of 0.14. Can you explain why this value is so much lower?

- **David Burdick**: It looks like the forbs are not responding to sea level rise. They may be increasing in the high marsh in some places and decreasing in others, but it is not a unidirectional change through time. I think this is a great reserach question, and that someone else should explore why the forbs are not responding over time.

Thank you for joining us

Please complete the short survey at the end of the webinar, and be on the lookout for the final draft of the management brief.

Kim Cressman
Grand Bay NERR



David Burdick
University of New Hampshire

Chris Peter
Great Bay NERR

Chris Kinkade
NOAA Office for Coastal Management

Dwayne Porter
NERRS Centralized Data Management Office

National Estuarine
Research Reserve System
Science Collaborative

Summary Points:

Q: There appears to be an interannual variation of about 10 mm in one of Kim's SET trend graph. Can you account for these shifts?

- **Kim Cressman**: Short answer, no. We used to measure quarterly at our reserve. Within a year there's definitely some seasonal variation. We haven't done a deep dive into the factors for that, but just from conversations we've had, water level and root mass matter. One of the recommendations from our project is to make sure you take measurements at the same time period within a year, preferably at the same tide level so that you don't have impacts from soil saturation, etc.

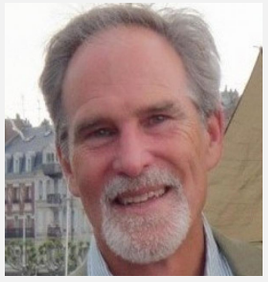
Q: Why did you normalize to the ocular method? It seems to put more emphasis on the ground level, at the expense of the three-dimensional structure of the grasses in the plot.

- **David Burdick**: Using the ocular cover method means that everything goes to 100 percent, so we have a boundary there. One of the problems with interpreting point intercept is the lack of boundaries, so for example you can have a 238 percent abundance value. Since every reserve handled bare ground, wrack, and dead plants very differently, normalizing to point intercept would have been more challening due to different types of cover.
- **Chris Peter**: We're trying to make the two similar because ocular is bound to that 100 percent. Normalizing and bounding them allows us to compare relative proportions that are similar.

Thank you for joining us

Please complete the short survey at the end of the webinar, and be on the lookout for the final draft of the management brief.

Kim Cressman
Grand Bay NERR



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University of New Hampshire

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NOAA Office for Coastal Management

Dwayne Porter
NERRS Centralized Data Management Office

National Estuarine
Research Reserve System
Science Collaborative

Summary Points:

Q: Any thoughts about the challenges of extending monitoring and analysis beyond upper edge of tidal marshes to get at marsh migration? Any data so far?

- **Chris Peter**: The NERRS does have some ecotone protocols, and one of them is to establish more plots in different ecotones. We didn't have a consistent ubiquitous data set that covered that the New England region, so we didn't dive into the ecotone of the upland edge high marsh for this project, but if we branch out into other regions in future projects then that's something we can look at. That does introduce the challenge that looking at different ecotones across the country means dealing with a wide range of different plant communities.

Q: As I recall, the SET data seemed to be keeping pace with SLR. If so, this seems inconsistent with the vegetation changes. Are there other forces contributing to the shift or just error in the SLR estimates or something else?

- **A**: The SET data Presented by Kim Cressman were not collected from any of the reserves analyzed for vegetation change. That being said, our work did include SET results, and there does seem to be a disconnect between plant response of plots in different habitats and the growth in elevation of the marsh, which appears to be very location-dependent.