Short-Term Elevation Change Dynamics within Tidal Forested Freshwater Wetlands in the Lower James River Watershed

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Introduction

Sediment accretion and the corresponding ability to keep pace with sea-level rise in both mature tidal forested freshwater wetlands and restored wetland sites represent significant data gaps in the current body of literature pertaining to wetland sustainability. In order to address these data gaps, Surface Elevation Tables (SETs) were installed along with feldspar marker horizons to measure elevation change and accretion rates in three mature tidal forested freshwater wetlands and one tidal marsh currently undergoing restoration. These are the first SETs installed in tidal freshwater forests in the James River estuary, and this high resolution dataset initiates a long-term study of resilience in these wetland ecosystems.

Methods

Surface Elevation Tables (SETs): 18 SETs were installed in 4 wetland ecosystems to measure elevation change over time (Figure 1).

Feldspar Marker Horizons (MH): In each SET sampling station, 4 feldspar marker horizons were established to measure sediment accretion. MHs were sampled via liquid nitrogen cyro-coring (Figure 2).

Measurements were taken at 8 week intervals during this initial growing season of the study to give us a high resolution dataset at the onset of the study.

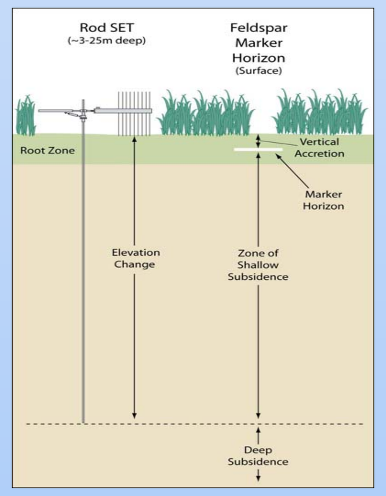


Figure 1: Diagram of a Surface Elevation Table (SET) and corresponding Marker Horizon. Image from http://www.pwrc.usgs.gov/set/theory.html

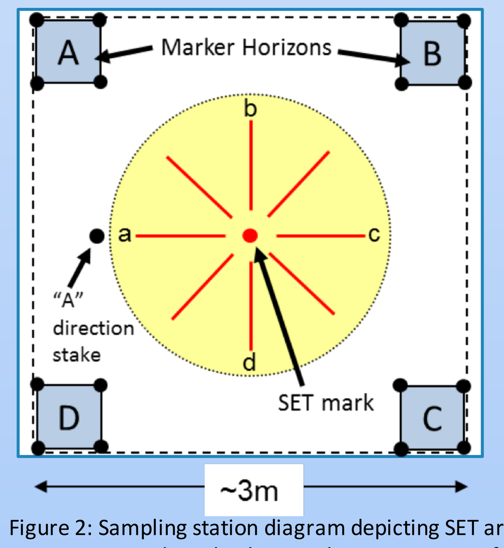


Figure 2: Sampling station diagram depicting SET arm orientations and marker horizon locations. Image from https://irma.nps.gov/DataStore/DownloadFile/531681

Study Locations

Kimages Creek: Located at the Rice Rivers Center, this second order coastal plain stream previously existed as a tidal forested freshwater wetland but currently exists as a restored freshwater marsh (Figure 3).

Harris Creek: A mature tidal forested freshwater wetland adjacent to the Kimages Creek wetland restoration.

Presquile National Wildlife Refuge (PNWR): A mature tidal forested freshwater wetland upstream from the Rice Rivers Center.

James River National Wildlife Refuge (JRNWR): A mature tidal forested freshwater wetland downstream from the Rice Rivers Center.

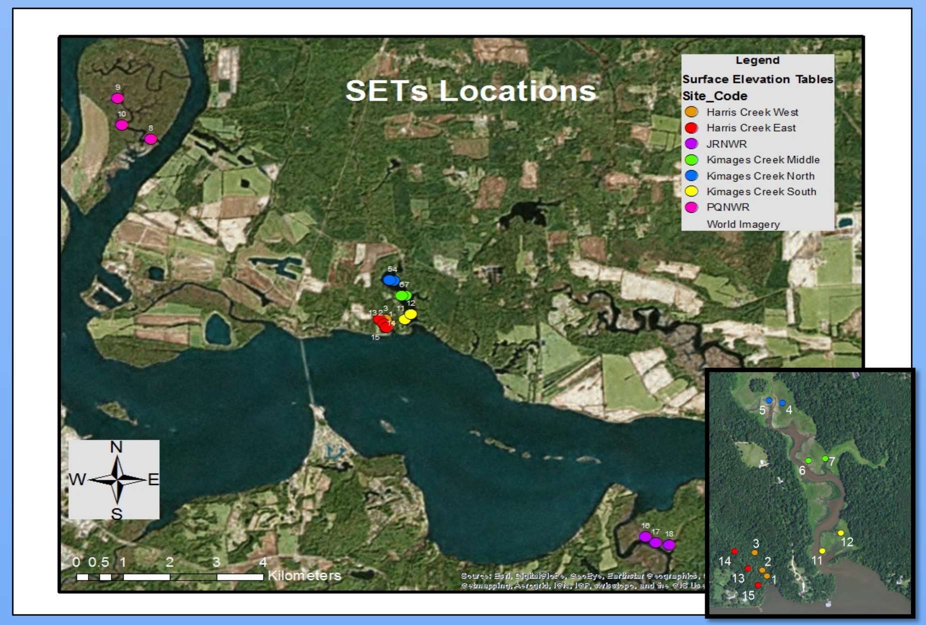


Figure 3: Map of SET locations; Kimages Creek and Harris Creek close-up inset.

Results

- Elevation change rates and accretion rates were calculated via linear regression, the slopes of the trend lines give rates of change per month (Figure 4).
- Elevation change rates were generally negative, while accretion rates were typically positive. Positive elevation change rates did occur in Harris Creek (Figure 4B).
- Mean accretion rates among wetland sites did not vary significantly from one another. Mean rate of elevation change at Harris Creek did vary significantly from elevation change at Kimages Creek (ANOVA, $p<0.02$, Tukey's HSD, $p<0.01$)(Figure 5).
- For this sampling period, accretion and elevation change rates across all sites varied significantly from one another (Welch's T-test, $F(23.44)=-5.12$, $p=0.00003$)(Figure 6).

Elevation Change

Accretion

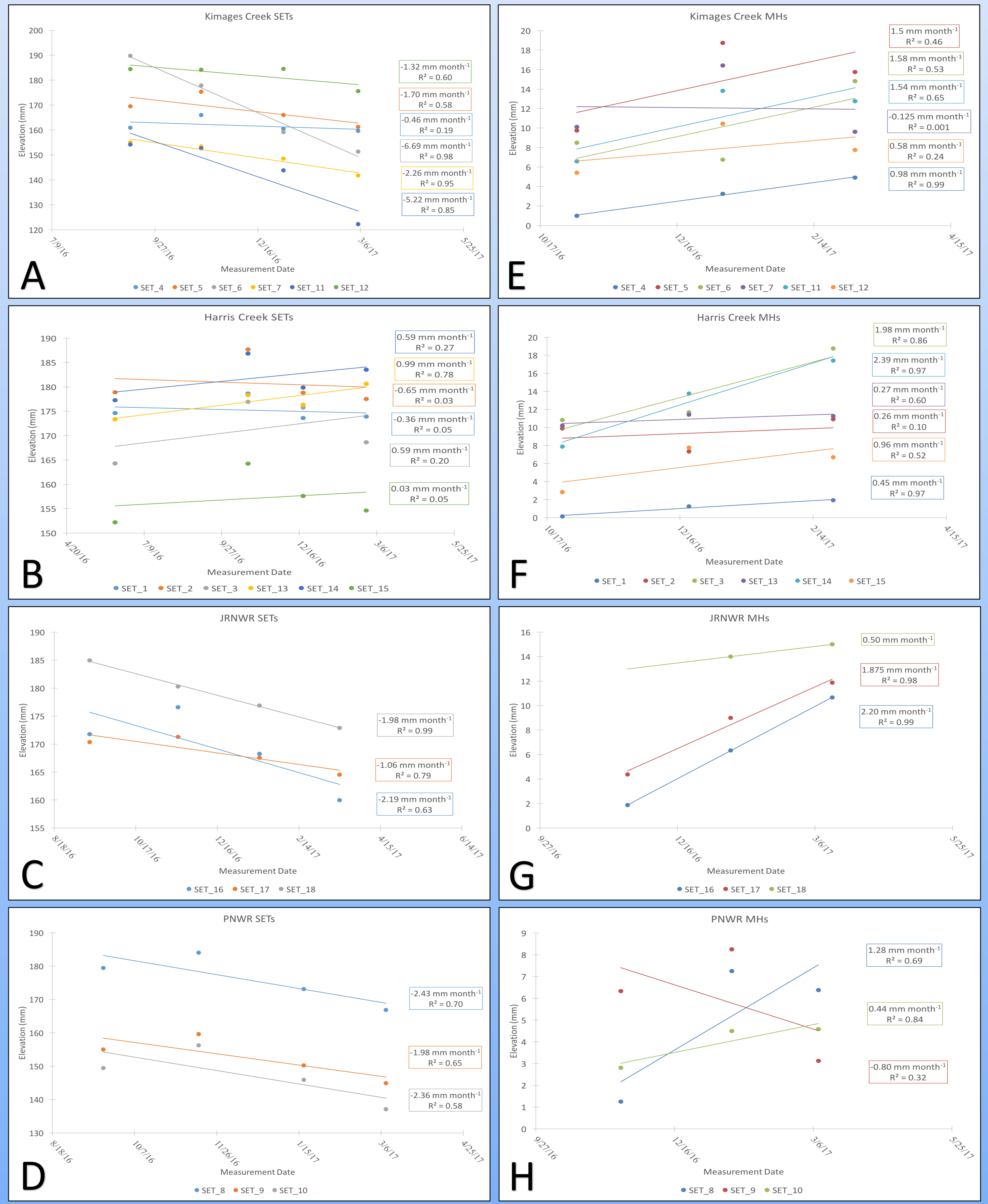


Figure 4: Trend lines displaying rate of change (mm month[-1]) and R^2 for elevation change (A-D) and accretion (E-H) at each SET sampling station.

Group Mean Elevation Change and Accretion Rates

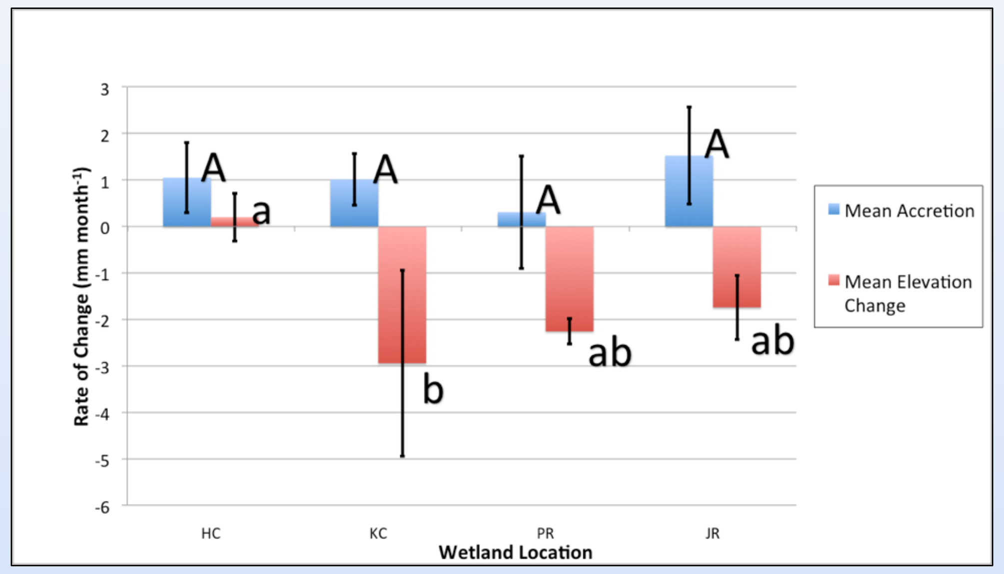
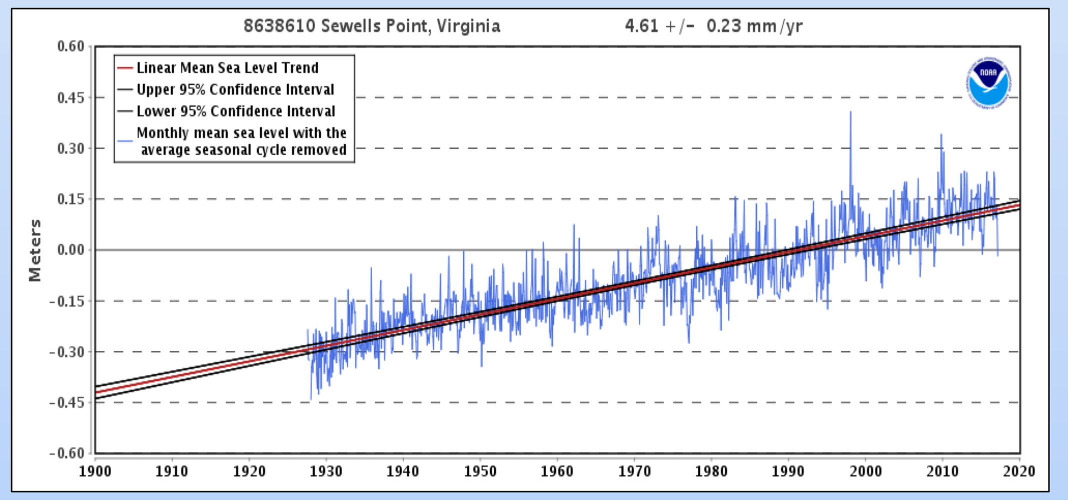


Figure 5: Mean rates of elevation change and accretion for each wetland location (mm month[-1] +/- standard error). Rates of change calculated via least squares regression. Uppercase letters indicate significant differences among group means of accretion rates (p=0.41). Lowercase letters indicate significant differences among group means of elevation change rates (p=0.01). HC = Harris Creek, KC = Kimages Creek, PR = Presquile National Wildlife Refuge, JR = James River National Wildlife Refuge.

Keeping Pace with Rising Sea Levels



Mean sea-level rise at Sewells Point, VA, showing historical trend and rate of change. Image from https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8638610

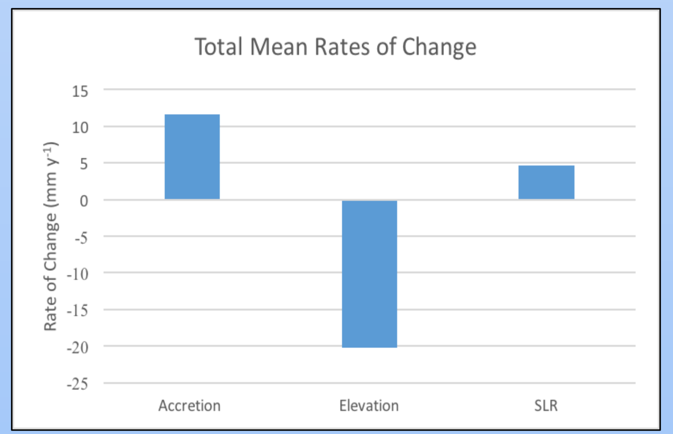


Figure 6: Total mean elevation change and accretion rates for all wetland ecosystems in this study compared with RSLR observed at Sewells Point, VA.

Conclusions

- Accretion rates in tidal forested freshwater wetlands of the James River Estuary suggest that these wetlands may be able to keep pace with current rates of relative sea-level rise.
- Net elevation loss suggests that these wetlands are not able to keep pace with sea-level rise.
- The deficit between positive accretion and elevation loss observed during this initial study period suggest shallow subsidence is occurring beneath the marker horizons.
- The restored wetland at Kimages Creek had the highest rate of mean elevation loss.
- We will continue taking measurements at our sites so that we will be able to evaluate if the short-term trends shown here are representative of longer-term trends in elevation change and accretion.

Acknowledgements

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