



Coastal Geomorphology: Monitoring Mangrove Soil Surface Elevation Tables in Biscayne National Park

2019

Importance

Mangrove wetlands provide flood control, storm protection, shore stabilization, water filtration (capturing soil runoff), carbon sequestration, and habitat for fish and wildlife communities. The economic value of the services derived from mangroves has been estimated as high as \$200,000–\$900,000 per hectare (Wells et al. 2006).

Soil elevation, hydrology, and mangrove forest health exist in a feedback loop. The soil elevation in mangrove forests affects tidal inundation period and frequency, overall hydroperiod, sedimentation, erosion, and the shrink and swell of soil materials, all of which affect mangrove seedling species recruitment, community composition, and survival (Whelan et al. 2005; Whelan et al. 2009). If the rate of relative sea level rise (2.28–2.56 millimeters per year [0.09–0.10 inches] in Key West, Florida; tidesandcurrents.noaa.gov) is greater than the rate at which mangrove soil elevation increases, as the trees die off and there is no mangrove recruitment to replace them, these areas will eventually convert to shallow open water marine habitats and the mangrove forest will move inland (upslope).

Understanding the rate of change in mangrove soil elevation is critical to predicting the long-term ability of mangrove forests to regenerate.

Objectives and Approach

The objective is to monitor rates of soil accretion and erosion to determine if soil processes are keeping pace with the rate of relative sea level rise. The approach uses Soil Surface Elevation Tables (SETs) and marker horizons. A SET instrument is designed to temporarily (upper photo) attach to a permanent benchmark and fiberglass pins are lowered to measure the distance to the sediment surface. The marker horizons are a layer of feldspar placed on the soil surface allowing measurement of deposition at the site using soil cores. There are two soil elevation monitoring stations (SETs) located in Biscayne National Park.

Our approach has been documented using a [protocol implementation plan](#) with seven standard operating procedures and four appendices specific to this network (Whelan et al. 2016).



Figure 1. Kevin Whelan, SFCN ecologist, is measuring soil surface elevation using the Soil Elevation Table (SET). The SET is attached to a permanent benchmark. The height of the pins transcribes the elevation of the soil and standardizes it to a fixed reference point (the metal arm). Repeated measurements over time monitor the rate of soil elevation change.



Figure 2. Measuring accretion, which is the material deposited above the white line. The white line is feldspar, a mark layer placed at the site on a previous sampling event. Here we can see turtle grass (*Thalassia testudinum*) that is becoming incorporated into the soil.



Results

Both BISC SET sites were monitored in spring 2018 and spring and fall 2019. Over the monitoring timeframe of BISC 1, established in February 2011, the soil surface appears to be gaining in elevation. The accretion levels seem to be steadily increasing. Total soil surface elevation indicated an increase for a period of time (until 2016) then more recently the surface elevation has decreased. This suggests that while the overall soil elevation is still gaining accretion at the surface level, below ground processes (e.g., subsidence, compaction) may be decreasing. BISC 2 was established in January 2012, and appears to also be increasing in overall elevation. Both sites are subject to periodic seagrass inputs that cause spikes in accretion that then appear to incorporate into the soil. One such spike occurred during the most recent sampling in August 2019 (Figures 3 and 4).

In 2017, the South Florida SET sites were affected by Hurricane Irma. Since the hurricane, sites were visited and exhibited signs of wind storm damage. Immediate effects of the storms on the elevation data appeared to be minimal. However, the long-term impacts of mangrove die-off are not yet known and will require continued long-term elevation monitoring.

In Figures 3 and 4, below, Top of sea grass was included as a measurement at some visits due to an overwhelming amount of deposited sea grass. The sea-level estimate is from the Virginia Key NOAA tide gauge station (<https://tidesandcurrents.noaa.gov/>)

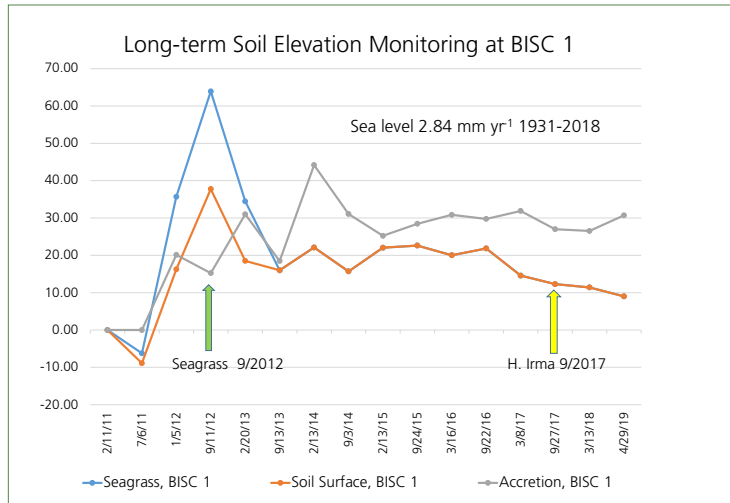


Figure 3. The graphs depict the absolute change in mangrove soil surface elevation and accretion at BISC 1.

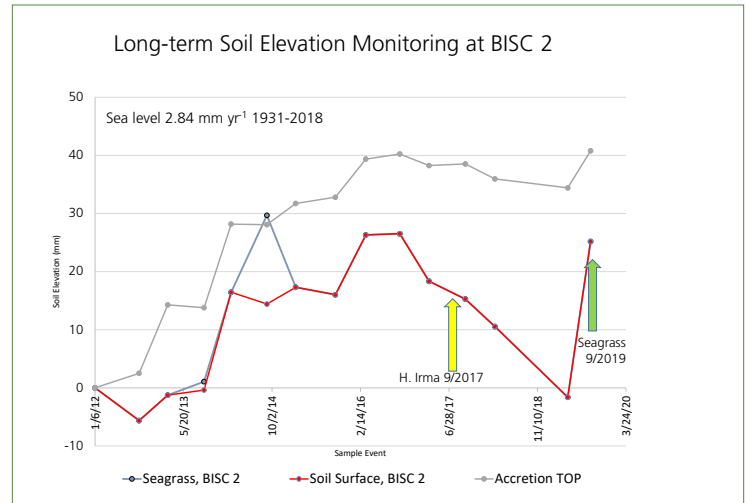


Figure 4. The graphs depict the absolute change in mangrove soil surface elevation and accretion at BISC 2.

Other News

In 2018, the network had a Future Park Leaders of Emerging Change (FPL) intern, Malcolm Wells, working with the SET data (Figure 5). The network also hosted three Indonesian resource managers and scientists to sample the BISC SET sites through the Department of Interior's International Technical Assistance Program (ITAP; Figure 6.).



Figure 5. Future Park Leaders of Emerging Change (FPL) intern, Malcolm Wells, sampling SET sites in Biscayne National Park.



Figure 6. A group of Indonesian resource managers and scientists from the International Technical Assistance Program (ITAP), observing the SFCN ecologist measure pins on the RSET at a Biscayne National Park SET site.

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Whelan, K. R. T., T. J. Smith III, G. H. Anderson, and M. L. Ouellette. 2009. Hurricane Wilma's impact on overall soil elevation and zones within the soil profile in a mangrove forest. *Wetlands*, 29(1):16–23.

Whelan, K. R. T., T. J. Smith III, D. R. Cahoon, J. C. Lynch, and G. H. Anderson. 2005. Groundwater control of mangrove surface elevation: Shrink and swell varies with soil depth. *Estuaries*, 28(6): 833–843.

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<https://www.nps.gov/im/sfcn/coastal-geo.htm>

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