# Vegetation Survey and Shoreline Change Analysis of Battery Island, NC

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## Abstract

Battery Island, located in the mouth of the Cape Fear River, North Carolina, is an important breeding area for a variety of tree-nesting shorebirds including white ibis (*Eudocimus albus*) (Parnell, Golder, & Henson, 1995). Nesting on the island occurs in red cedar (*Juniperus virginiana*), yaupon (*Ilex vomitoria*), and several shrub species. Shoreline erosion is a potential threat to the nesting habitat on Battery Island, although the extent of erosion over time has not previously been quantified. The objectives of this study were to survey the vegetative community in the nesting area and assess the extent of shoreline erosion. Our results indicate that low recruitment of red cedar and ongoing shoreline erosion both have the potential to impact the nesting area. Between 2008 and 2017, the shoreline adjacent to the nesting area eroded an average of 2.2 meters overall. Projecting the 2008-2017 shoreline change rate fifteen years into the future indicates that erosion will continue to occur along the northwestern side of the nesting area. These data will be useful in developing a plan to mitigate shoreline erosion and sustain the trees necessary for nesting on Battery Island.

## Introduction

**What are the potential impacts of shoreline erosion to the shorebird nesting area on Battery Island?**

**Objective 1:** Survey the vegetative community composition in the nesting area

**Objective 2:** Determine the historic rate of shoreline change


**Figure 1.** Sitemap of study area

## Methods

**Objective 1: Vegetation Survey**

- Sampled vegetation within 4 m diameter circular plots every 15 m along transects spaced 30 m apart
- Recorded stem density and diameter at breast height (DBH) for woody species
- Obtained vertical structure data by placing a 2 m tall pole at the center of each plot and recording the vegetation species touching the pole in half-meter intervals

**Objective 2: Shoreline Change Analysis**

- Mapped the current shoreline with Trimble RTK-GPS unit (+/- 2 cm accuracy) at 1-meter interval
- Digitized shoreline on aerial photos from 1961 and 1993 with ArcMap 10.3.1
- Obtained 2008 shoreline from Estuarine Shoreline Mapping Project (ESMP)
- Performed shoreline change analysis between timesteps using AMBUR (Analyzing Moving Boundaries Using R) (Jackson, 2015)
- Calculated uncertainty for each timestep (digitization, rectification, GPS positional errors combined)

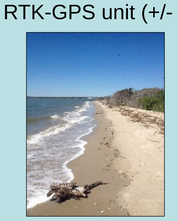

**Figure 2.** Shoreline was mapped following the wet/dry line

$$U_T = \pm\sqrt{E_{d1}^2 + E_{d2}^2 + E_r^2}$$

**Figure 3.** Uncertainty calculation

## Results

**Objective 1: Vegetation Survey**

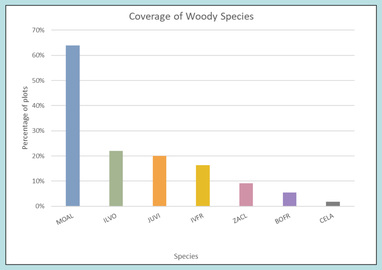


**Figure 4.** Presence of woody species across study plots (n=54)

| Symbol | Scientific name | Common name |
|---|---|---|
| MOAL | *Morus alba* | Mulberry |
| ILVO | *Ilex vomitoria* | Yaupon |
| JUVI | *Juniperus virginiana* | Red cedar |
| IVFR | *Iva frutescens* | Jesuit's bark |
| ZACL | *Zanthoxylum clava-herculis* | Hercules' club |
| BOFR | *Borrichia frutescens* | Salt-marsh elder |
| CELA | *Celtis laevigata* | Sugar hackberry |


**Figure 5.** Species representation by size class

- In the nesting area, 64% of plots surveyed contain mulberry (n=54)
- There was no red cedar present with a DBH under 12.7 cm
- 52% of plots suitable for nesting (nesting suitability = presence of woody species with DBH >2.54 cm)
- Across all transects, average distance from the shoreline to the first plot suitable for nesting was 32.5m

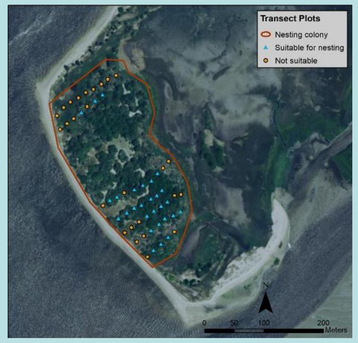


**Figure 6.** Plots with vegetation suitable for nesting

**Objective 2: Shoreline Change Analysis**

- Between 1961 and 2017, the southern shoreline experienced an average shoreline change rate (SCR) of -0.39 m/yr
- Projection of the SCR fifteen years into the future indicates potential for additional erosion along the nesting colony

**Table 1.** Mean net change and shoreline change rate (SCR) results using AMBUR

| Era | Mean Net Change (meters) | SCR (m/yr) | Annualized Error (m) |
|---|---|---|---|
| 1961 - 1993 | -11.9 | -0.38 | +/-0.12 |
| 1993 - 2008 | -8.55 | -0.57 | +/-0.11 |
| 2008 – 2017 | -2.24 | -0.25 | +/-0.16 |
| **1961 – 2017** | **-21.3** | **-0.39** | **+/-0.06** |


**Figure 7.** 1961 – 2017 Shoreline Change Rate (SCR)


**Figure 8.** 2008 – 2017 SCR and 15-year projection of SCR

## Discussion

**Objective 1: Vegetation Survey**

There is little recruitment of red cedar on the island. Lack of seedling presence is a concern for the survival of the cedar population, since they are frequently used for nesting. Results also show that mulberry is abundant in all size classes. Mulberry is a fast-growing species and could be competing with red cedar, which is a shade-intolerant species. If red cedar is preferred over other tree species for nesting, then lack of recruitment could lead to nesting habitat loss as older trees die off.

**Figure 9.** Nests in cedar tree

**Objective 2: Shoreline Change Analysis**

Although small amounts of accretion have occurred in areas along the shoreline in front of the nesting area, there has been an overall trend towards erosion since 1961. This erosion has the potential to impact the nesting colony as vegetation along the shoreline dies from increased salt exposure.

**Figure 10.** High tide on Battery Island

Overall, the data collected in these studies will help in developing a management plan to protect the nesting colony on Battery Island. Selectively girdling mulberries and planting red cedar could help increase the amount of preferred nesting habitat on the island, while implementing shoreline stabilization techniques could aid in decreasing the amount of erosion that is occurring along the nesting colony.

## Future Work

- Complete vegetation survey in center of nesting area (previously avoided due to active nesting)
- Count nests along transects to determine tree species preferred for nesting
- Install wave sensors along the western shoreline to record wave energy impacting the shore

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## References

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