

# Accrual of Nutrients in Living Shorelines in Relation to Natural Fringing Tidal Marshes

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## Introduction

Living Shorelines are narrow (<30m) fringing tidal marshes created as mitigation for the impacts of erosion and rising sea level. These created marshes are sand filled, and thus start with low organic matter content in soils. However, over time these created marshes mirror the natural fringing tidal marshes by rapidly accreting organic matter and establishing bulk soil characteristics representative of more mature wetland systems. Living Shorelines provide many ecosystem services beyond shoreline protection. This current study investigates the potential for carbon and nutrient accumulation by comparing rates of nutrient accrual to observed pools of nutrients in natural fringing marshes.



Pair #2: Living Shoreline and the Natural Fringing Marsh

## Method

Soil metrics were determined for thirteen paired sites of natural fringing tidal marshes and Living Shorelines in Virginia. The paired sites varied along a spectrum of marsh connectivity and age of Living Shoreline.



Along three transects in each marsh, 30cm soil cores were taken from upper and lower elevations dominated by *S. patens* and *S. alterniflora*, respectively.



30cm soil core divided into 3 sections

- Bulk density was determined gravimetrically.
- Organic Matter content was determined from loss on ignition.
- Total Carbon and Total Nitrogen were determined via elemental analysis.
- Total Phosphorus was determined using an ashing-acid hydrolysis method.

## Results

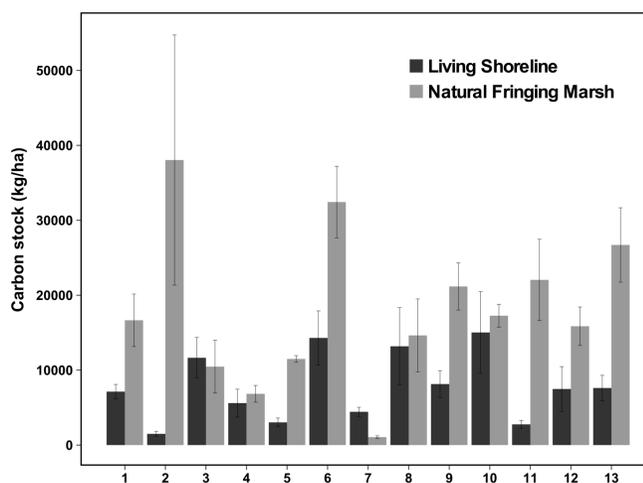
Table 1. Living Shoreline Marsh Soil Characteristics of top 10cm, means  $\pm$  standard error.

	Bulk Density	%Organic Matter	%C	%N	%P
High Marsh	1.30 $\pm$ 0.03	1.59 $\pm$ 0.19	0.65 $\pm$ 0.11	0.06 $\pm$ 0.01	0.004 $\pm$ 0.0004
Low Marsh	1.27 $\pm$ 0.03	2.12 $\pm$ 0.29	0.76 $\pm$ 0.12	0.08 $\pm$ 0.01	0.005 $\pm$ 0.0003

Table 2. Natural Fringing Marsh Soil Characteristics of top 10cm, means  $\pm$  standard error.

	Bulk Density	%Organic Matter	%C	%N	%P
High Marsh	0.95 $\pm$ 0.04	6.91 $\pm$ 0.86	2.57 $\pm$ 0.40	0.19 $\pm$ 0.02	0.010 $\pm$ 0.0008
Low Marsh	0.93 $\pm$ 0.049	7.32 $\pm$ 0.94	3.13 $\pm$ 0.41	0.23 $\pm$ 0.03	0.008 $\pm$ 0.0007

- Low marsh soils tend to accumulate a higher percentage of nutrients, relative to high marsh soils.
- Living Shorelines have much lower %Organic Matter, %CNP, and higher bulk density relative to natural fringing marshes.



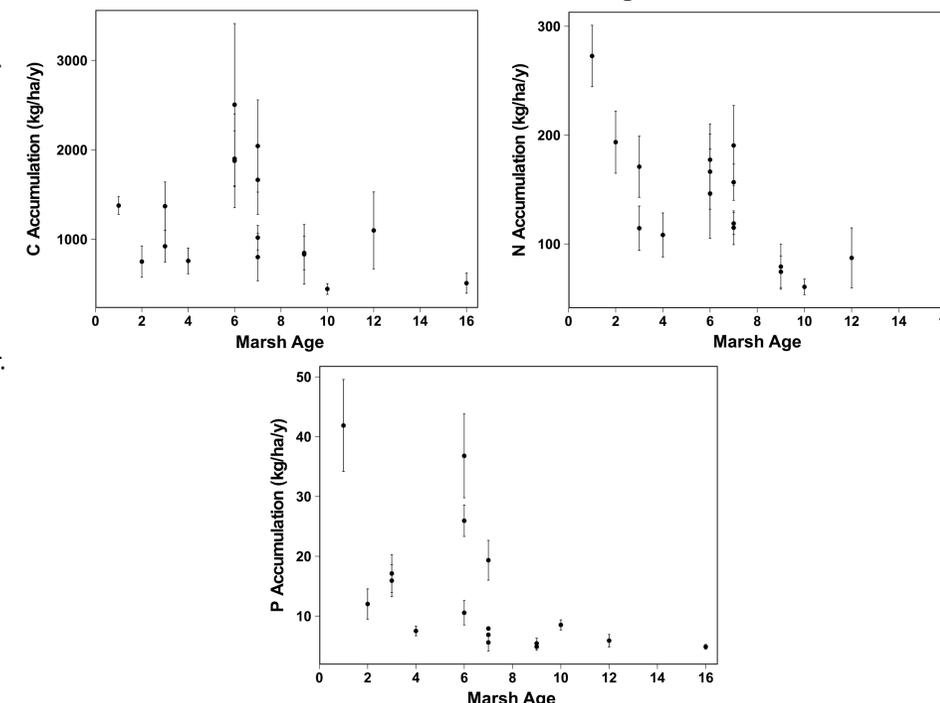
Variation of carbon stock between pairs of marshes. Error bars represent the standard error.

Pools of C, N and P varied widely for both types of marshes and were site-specific. For example, the average coefficient of variation for pools of carbon was 44% amongst Living Shorelines and 35% amongst natural fringing marshes.

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## Nutrient Accumulation Rates in Living Shorelines



Mean  $\pm$  S.E. rates of accumulation of nutrients in the upper 0-10cm of marsh soil were plotted as a function of the age of the constructed Living Shoreline.

- The rates of carbon accumulation varied from  $\sim$ 444-2505 kg/ha/yr.
- The rates of nitrogen accumulation varied from  $\sim$ 61-273 kg/ha/yr.
- The rates of phosphorus accumulation varied from  $\sim$ 5-42 kg/ha/yr.

## Conclusions

- Rates of C, N and P accumulation vary widely and are site-specific; those rates generally decrease with age of the Living Shoreline.
- Using the measured rates of standing stocks of C, N and P, we estimated the number of years for Living Shorelines to accrue nutrients at the level found in reference fringing marshes:

- **Carbon:** 18 years, with a range of 2 to 51 years.
- **Nitrogen:** 13 years, with a range of 5 to 29 years.
- **Phosphorus:** 8 years, with a range of 2 to 18 years.

