Nutrient inputs and their modification by coastal swashes across a sandy shoreline

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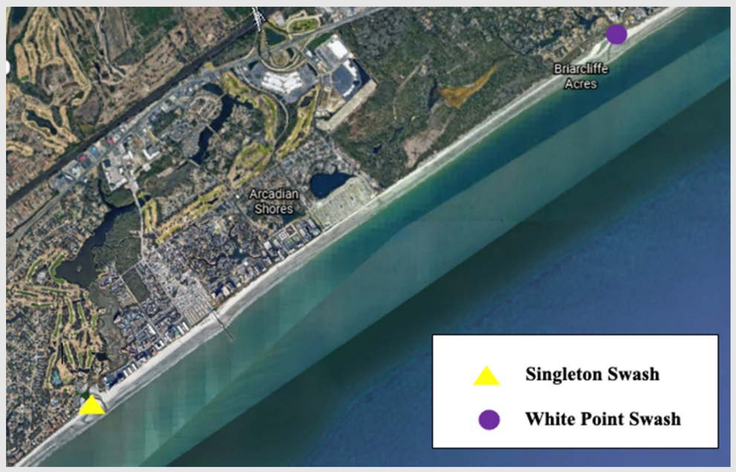
ABSTRACT

Coastal water quality in the Grand Strand of South Carolina is directly influenced by human activities. Nutrient-rich runoff, stemming from numerous anthropogenic sources, finds its way into coastal waters through freshwater inputs often through tidal creeks, termed swashes, that terminate onto sandy beaches. In order to better describe the amount of nutrient inputs into two such swashes of the Grand Strand, Singleton Swash and White Point Swash, we examined anthropogenic runoff from isolated identifiable point discharges and their nutrient concentrations. Concentrations of dissolved inorganic nitrogen (DIN = the sum of nitrate, nitrite and ammonium) and phosphate in discharge water were significantly higher than those in creek water. However, despite these elevated nutrient concentrations, the discharge rate of such isolated point discharges is minor, and inputs are not significant enough to alter primary channel chemistry due to rapid flow rates. We hypothesize that non-point sources, including groundwater inputs, may play a larger role in nutrient loading in the coastal zone. The next stage of our study will focus on capturing seasonal rates of discharges of both point sources and non-point sources and their nutrient concentrations, in contrast with those of coastal ocean waters, to better determine their role in nutrient loading within the coastal zone. Moreover, we will study the role of photosynthesizers, such as microphytobenthos and submerged aquatic macroalgae, in ameliorating the observed nutrient loads entering this coastal zone.

STUDY SITES



For this project two sites were studied, Singleton Swash and White Point Swash both located in Horry County, South Carolina. Singleton Swash and White Point Swash are both influenced by urban development and human activities. Freshwater point discharges have been repeatedly seen at both locations by the Sand Biogeochemistry research program at Coastal Carolina University.

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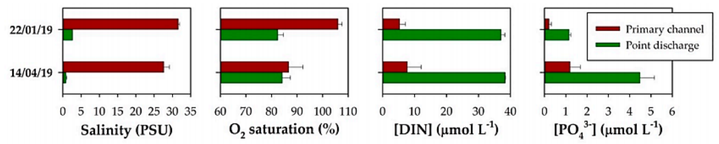
INTRODUCTION

Coastal Water Quality: Why does it Matter?

- Anthropogenic water pollution is one of the most significant environmental problems.
- Rise in coastal population has led to an increase in urban land and modified landscapes.
- Estuarine tidal creeks, termed swashes, are an important pathway for land discharges to the coastal ocean.

"Future studies should focus on freshwater discharges and how their chemistry compares with immediately adjacent channel water and shore (ocean) water."



Legut et al. 2020

Hypotheses:

- Freshwater inputs have higher nutrient concentrations than tidal creeks.
- Point discharges supply excess nutrients to the primary channels of the tidal creeks.
- Concentrations of nutrients from isolated, minor point discharges are not significant enough to alter primary channel chemistry due to rapid flow rates.

METHODS

Field sampling and observations

- **Three sampling events in Jan-Mar 2021: channel and discharges**
- **In situ temperature, salinity, and oxygen** (YSI ProDSS)

Point discharges at Singleton Swash (left) and White Point Swash (right)

Analytical

- **Dissolved inorganic nitrogen** (DIN)
  - **Nitrate (NO_3^-)** (Strickland and Parsons 1972)
  - **Nitrite (NO_2^-)** (Bendschneider and Robinson, 1952)
  - **Ammonium (NH_4^+)** (Holmes et al. 1999)
- **Phosphate (PO_4^{3-})** (Murphy and Riley 1962)

Statistical

MS Excel used to explore data:

- Graphically
- Statistically:
  - White Point Swash - ANOVA: two factor with replication
  - Singleton Swash - ANOVA: single factor

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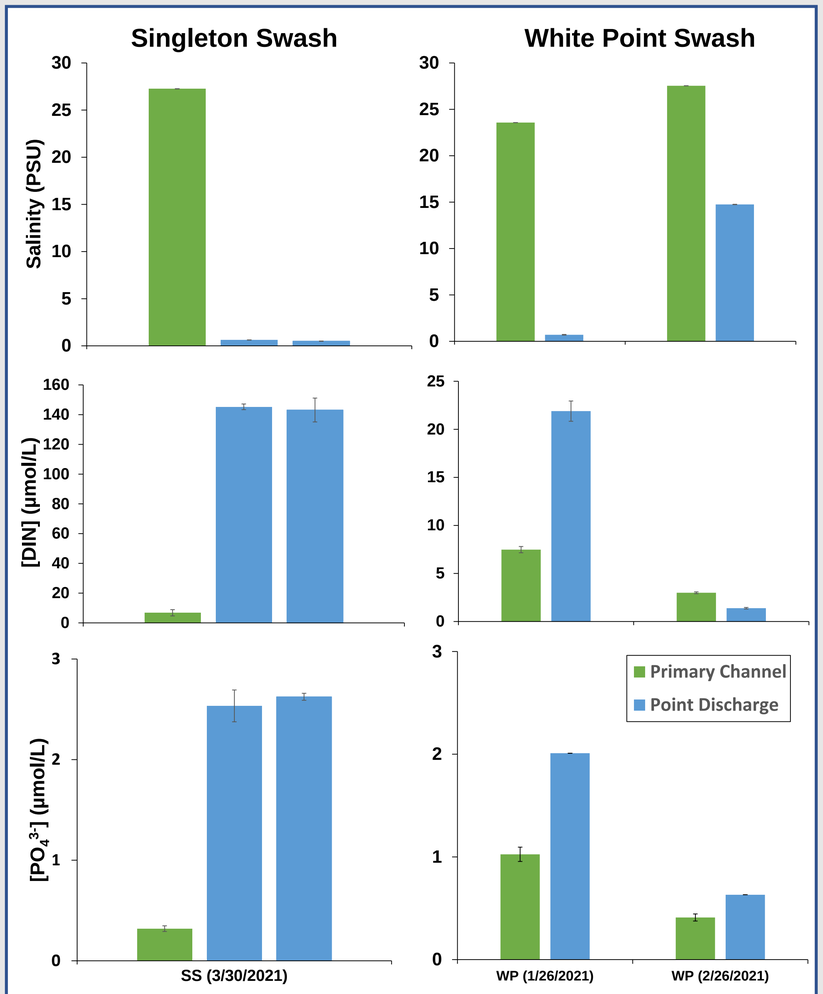
RESULTS



Flow rates and nutrient supply for Singleton Swash were used to determine the significance of nutrient inputs to the primary channel chemistry.

Location	Water Flow (L/min)	[DIN] (µmol/L)	[PO_4^{3-}] (µmol/L)	% Significance [DIN]	% Significance [PO_4^{3-}]
Primary Channel	*1.26 x 10^6	6.8	0.3		
Point Discharge 1	30.00	145.3	2.5	0.1%	2.1%
Point Discharge 2	25.9	143.1	2.6	4.0 x 10^{-2}%	1.9%

* Based on ebb-flow measurements in primary channel from Pastore et al. (2019)

DISCUSSION & NEXT STEPS

Freshwater Point Discharges supply excess nutrients to the primary channel. However, nutrient concentrations are not significant enough to alter primary channel chemistry due to rapid flow rates. We suggest that non-point sources may play a larger role in nutrient loading in the coastal zone.

This will be addressed in the next stage of our study where we will focus on:

- Obtaining seasonal rates of discharges from both point and non-point sources, including groundwater,
- Documenting source nutrient concentrations, and how they compare with those of the coastal ocean,
- Determining the relative contributions of all sources on nutrient loading within the coastal zone,
- Evaluating the influence of nutrient loading on primary producer abundance in these systems.

This will allow us to obtain a better understanding of the role that point discharges play in nutrient loading in the coastal ocean.