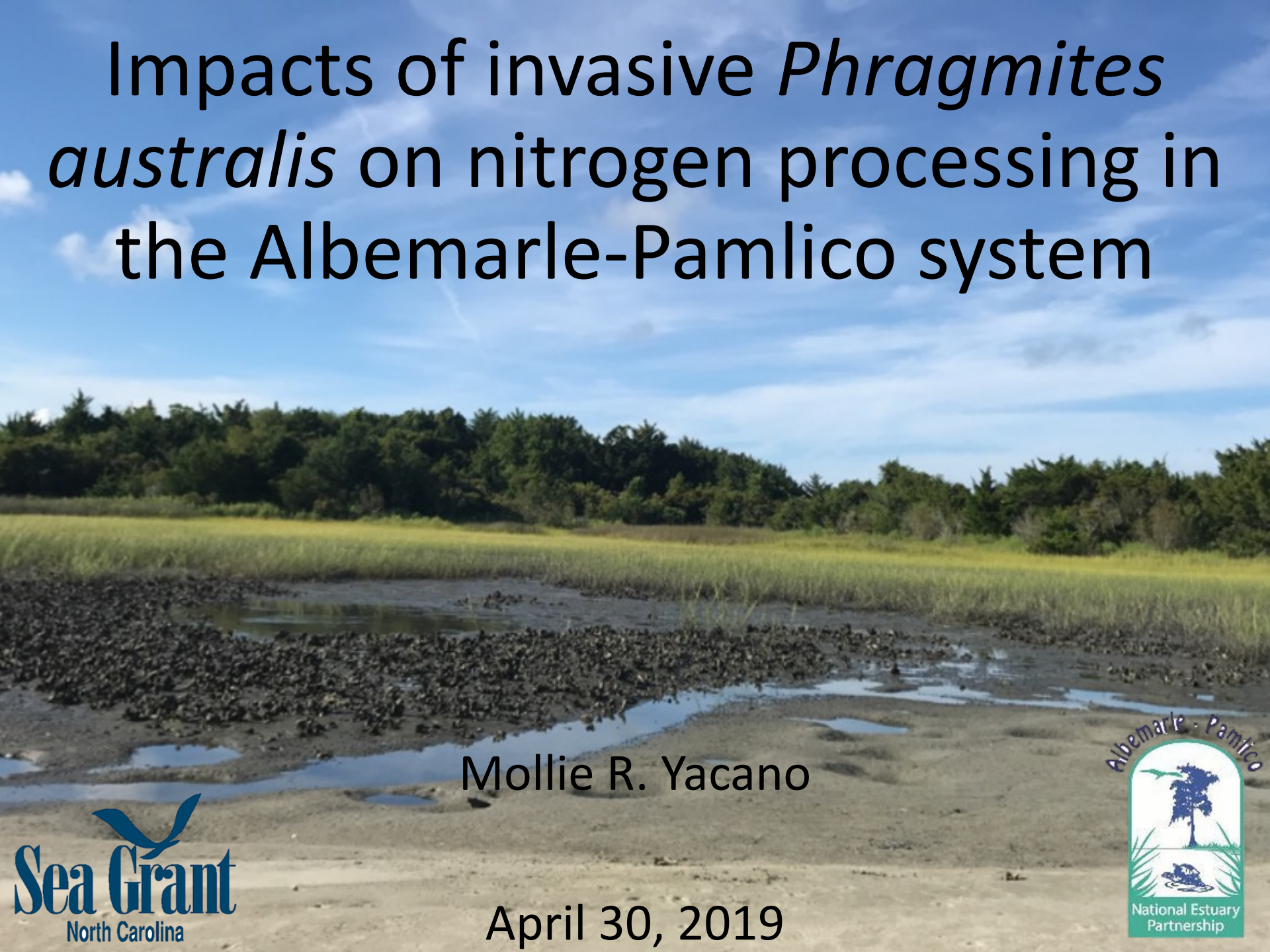
Impacts of invasive *Phragmites australis* on nitrogen processing in the Albemarle-Pamlico system



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April 30, 2019

Sea Grant North Carolina

Albemarle - Pamlico National Estuary Partnership

Salt Marshes – Ecosystem Services

- Water purification
- Recreation/Tourism
- Fish habitat
- Shoreline stabilization

- Coastal protection
- Carbon sequestration
- Nitrogen Removal

(Mcleod et al., 2011, DeGroot et al., 2002)

Nitrogen

- Nitrogen is required for primary production in marine ecosystems (Howarth and Marino, 2006)
- Excess nitrogen loading results in a decline in ecosystem function:

Eutrophication

(Seitzinger et al., 2006)

Harmful Algal Blooms

(Anderson et al., 2002)

Anoxia

(Diaz and Rosenberg, 2008)

Salt Marshes – Ecosystem Services

- Play a key role in global biogeochemical cycles of nitrogen (Valiela et al., 1975)
- Capacity to remove and retain excess nutrients (Valiela et al., 1975)
  - As much as 20-50% of externally sourced nitrogen (Galloway et al., 2004, Seitzinger et al., 2006)

Phragmites australis

- One of the most dominant invasive plant species in marshes across the United States (US) is the European haplotype of *Phragmites australis* (Chambers et al., 1999).
- *P. australis* thrives in high nutrient conditions (Minchinton and Bertness, 2003).

Phragmites australis: Eradication & Control

- High priority aquatic nuisance species in North Carolina
- Chemical
  - Herbicides
    - Long-term management required, reinvasion occurs when application is discontinued
- Biological
  - Grazing

Phragmites australis: Eradication & Control

- Mechanical
  - Mowing/disking
  - Burning
  - Smothering

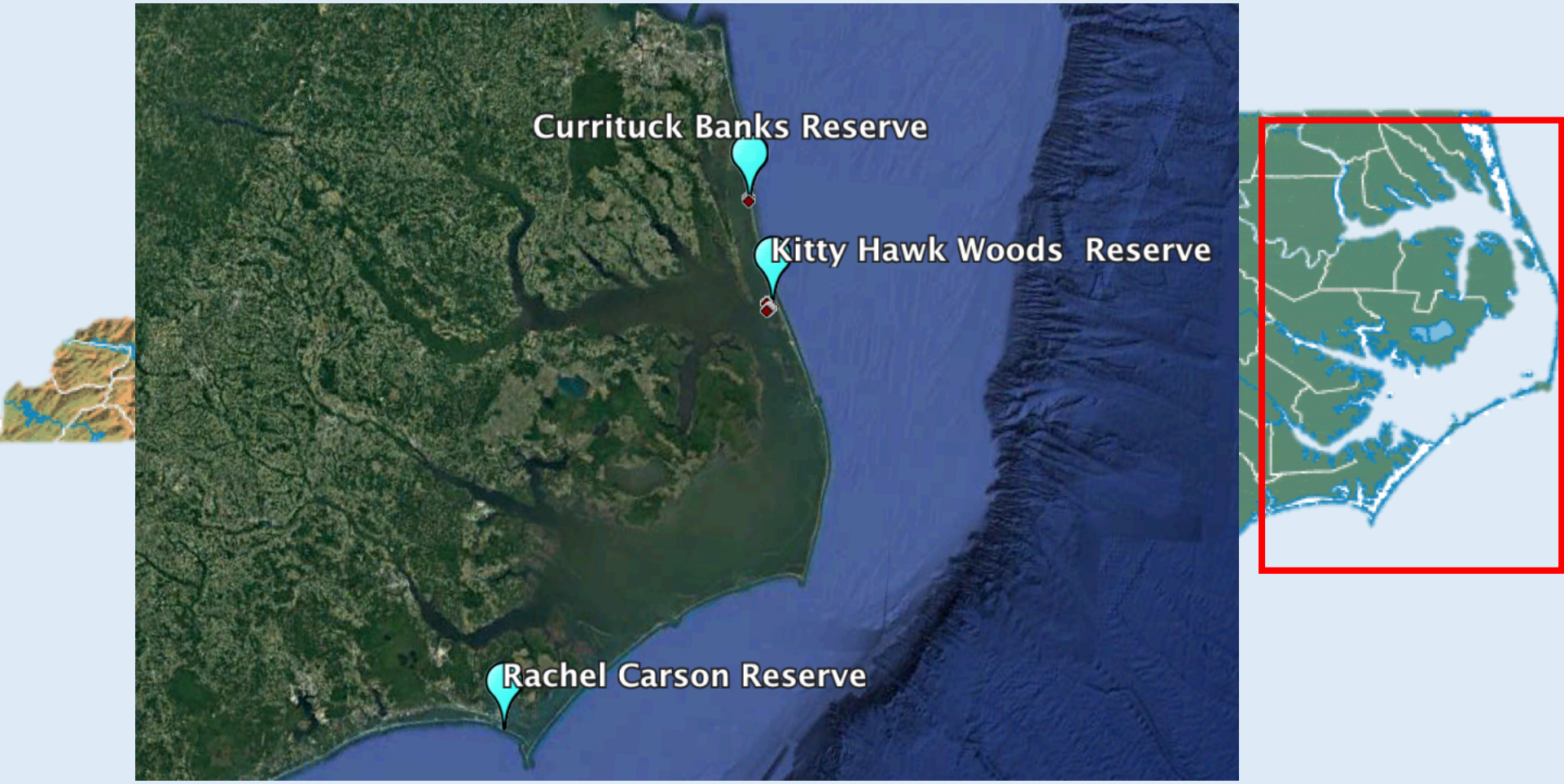
Phragmites australis: Ecosystem Services

- Traditionally considered a nuisance due to negatively impact biodiversity *(*Vitousek et al., 1996)
- Recent work shows *P. australis* performs very closely to native counterparts in terms of:
  - carbon storage & shoreline stabilization (Theuerkauf et al., 2016)
  - vertical accretion (Rooth et al. 2003)
  - greenhouse gas emissions (Emery and Fulweiler, 2014)

Objectives

- Quantify the transformations of nitrogen in the sediments underlying invasive *P. australis*, native marsh grasses likely to be displaced (i.e. *Spartina alterniflora*), and unvegetated sediments (mudflat)
- Investigate how pulses of nitrogen (i.e. storm events) impact the processing of nitrogen within the sediments

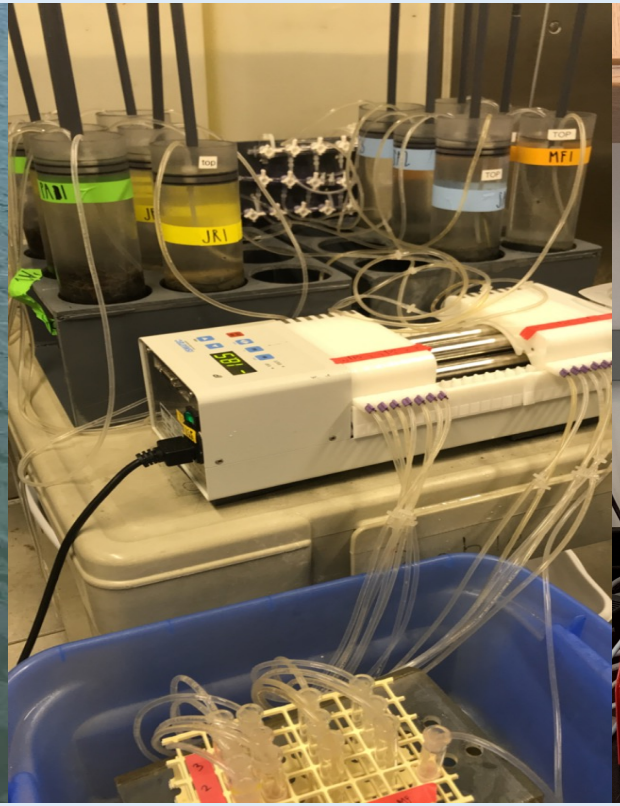
Sites


Currituck Banks Reserve
Kitty Hawk Woods Reserve
Rachel Carson Reserve

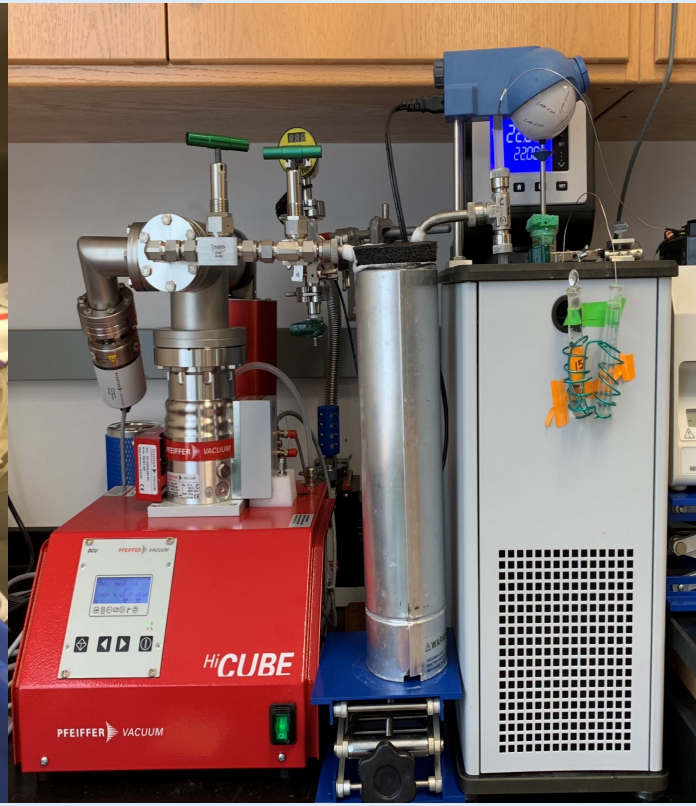
Methods

Core Collection

Core Incubation



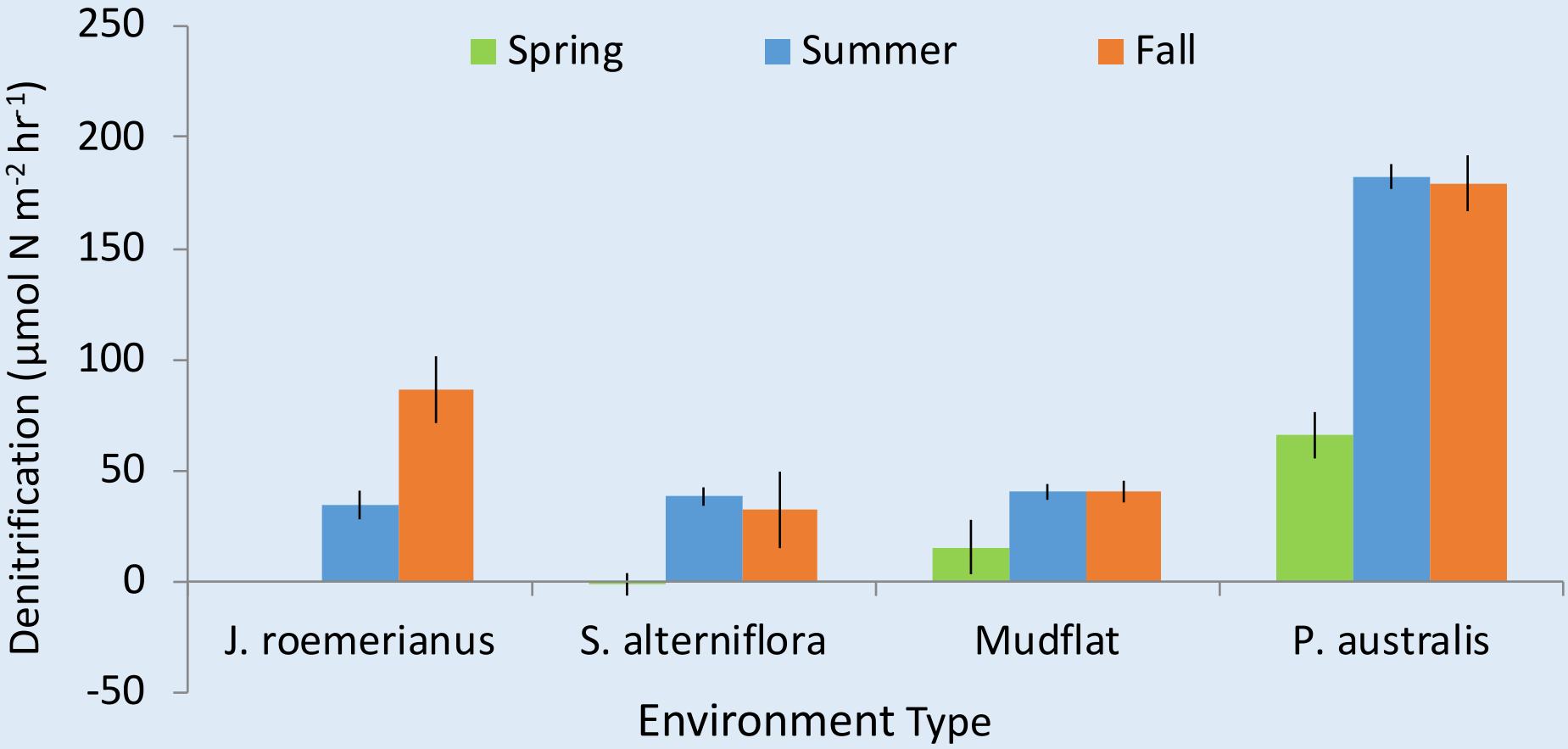
Mass Spectrometer



- Cores were collected directly to adjacent environments (native grasses, unvegetated mudflat, *Phragmites australis*)
- A continuous flow through system was used to incubate the cores
- Samples analyzed using a membrane inlet mass spectrometer (MIMS)

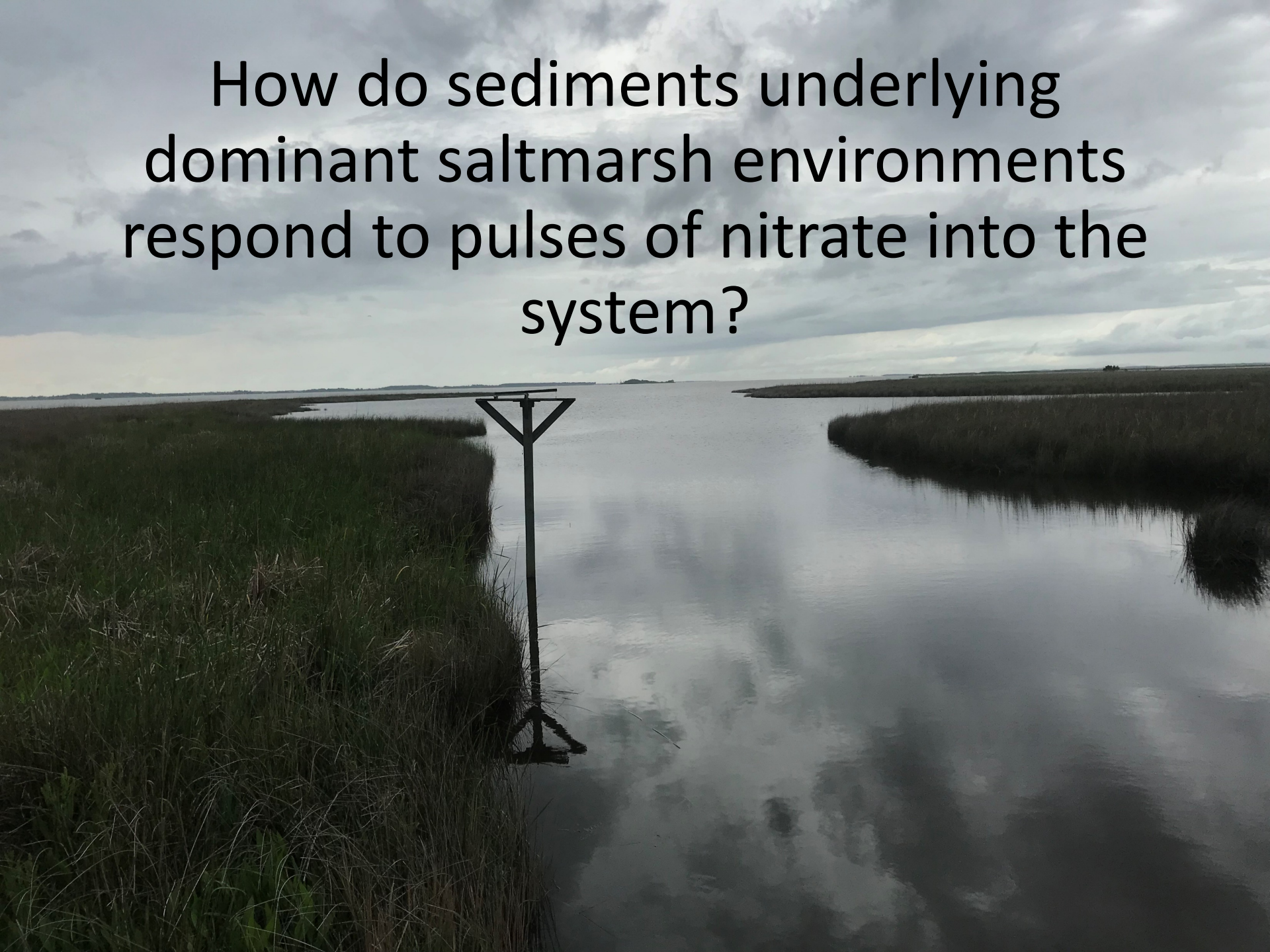

How do sediments underlying dominant marsh environments process nitrogen?

Rachel Carson

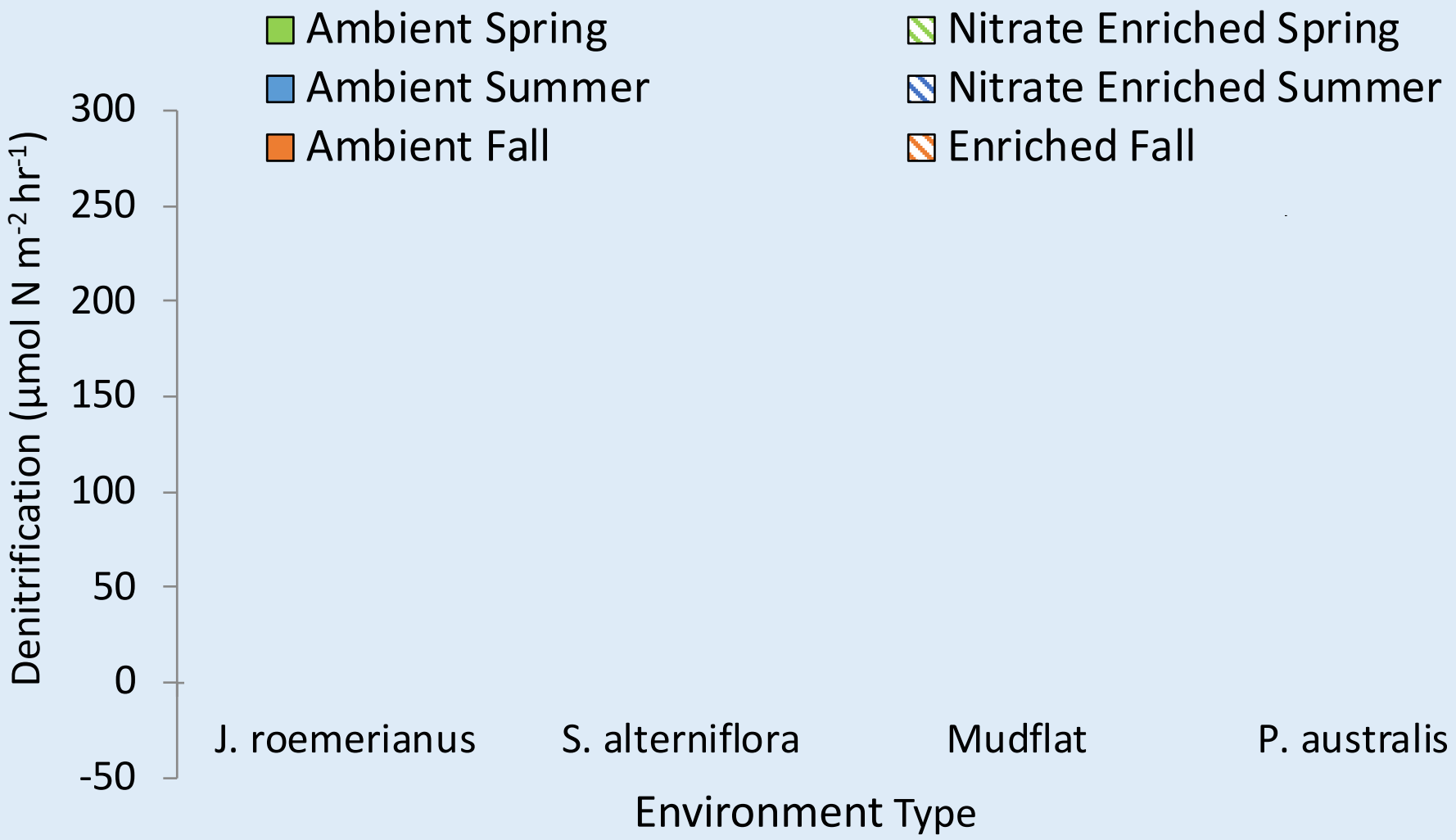


Results/Discussion

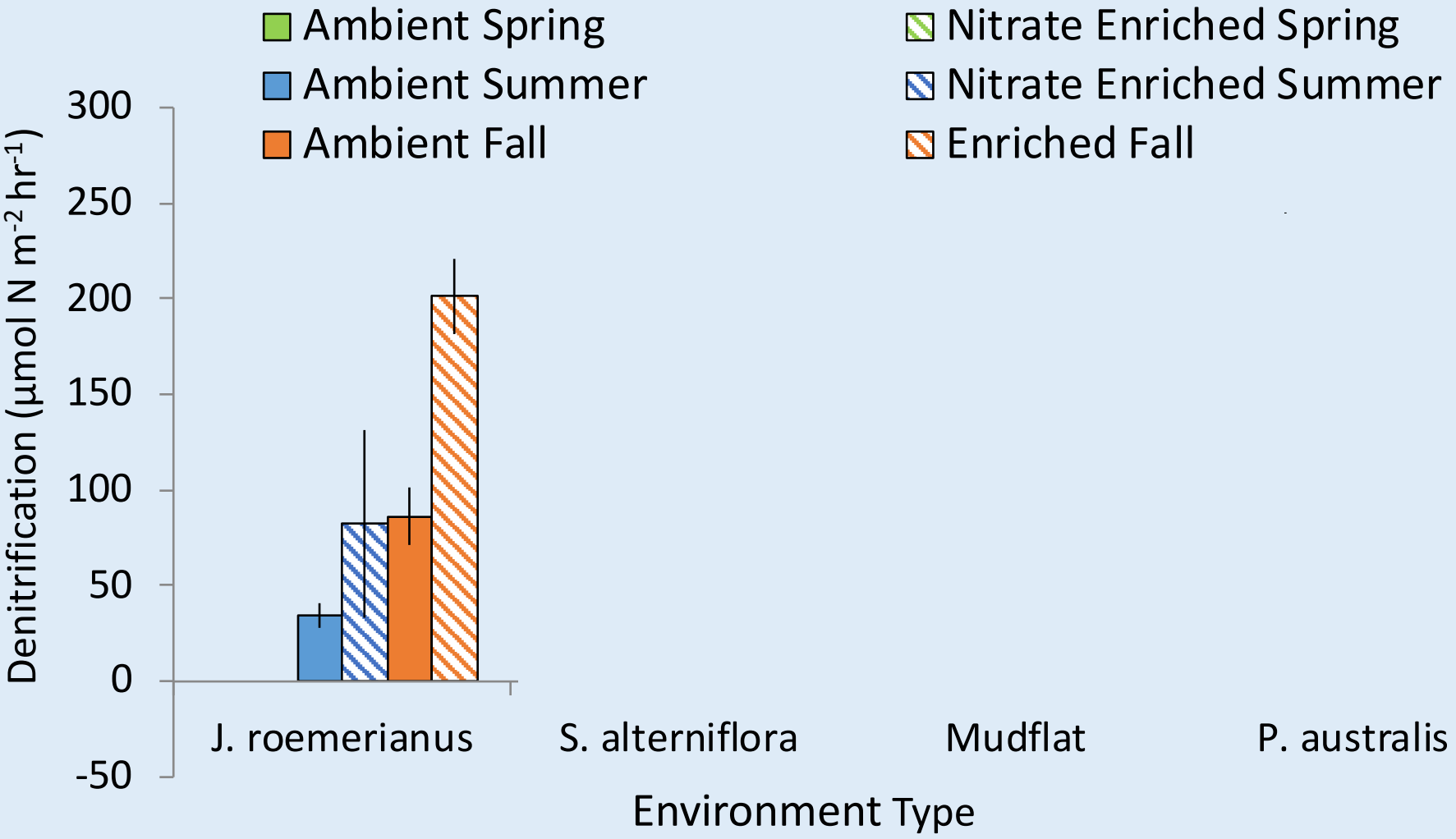
- *P. australis* has significantly higher rates of denitrification across all seasons ($p<.05$)
- Warmer summer temperatures may allow for higher rates of denitrification
- These data suggest a steady rate of denitrification across native grasses and unvegetated mudflat


How do sediments underlying dominant saltmarsh environments respond to pulses of nitrate into the system?

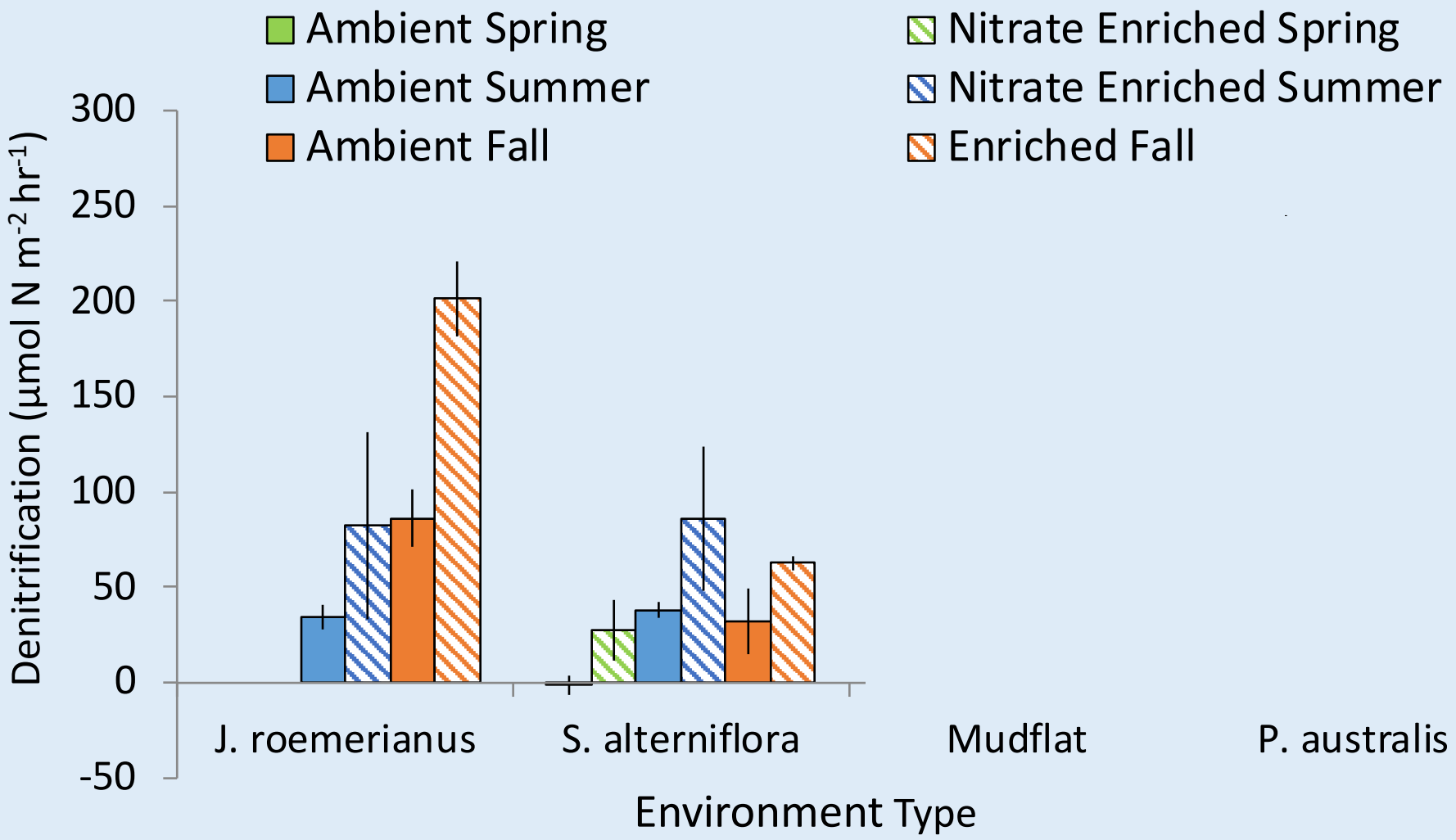
Rachel Carson



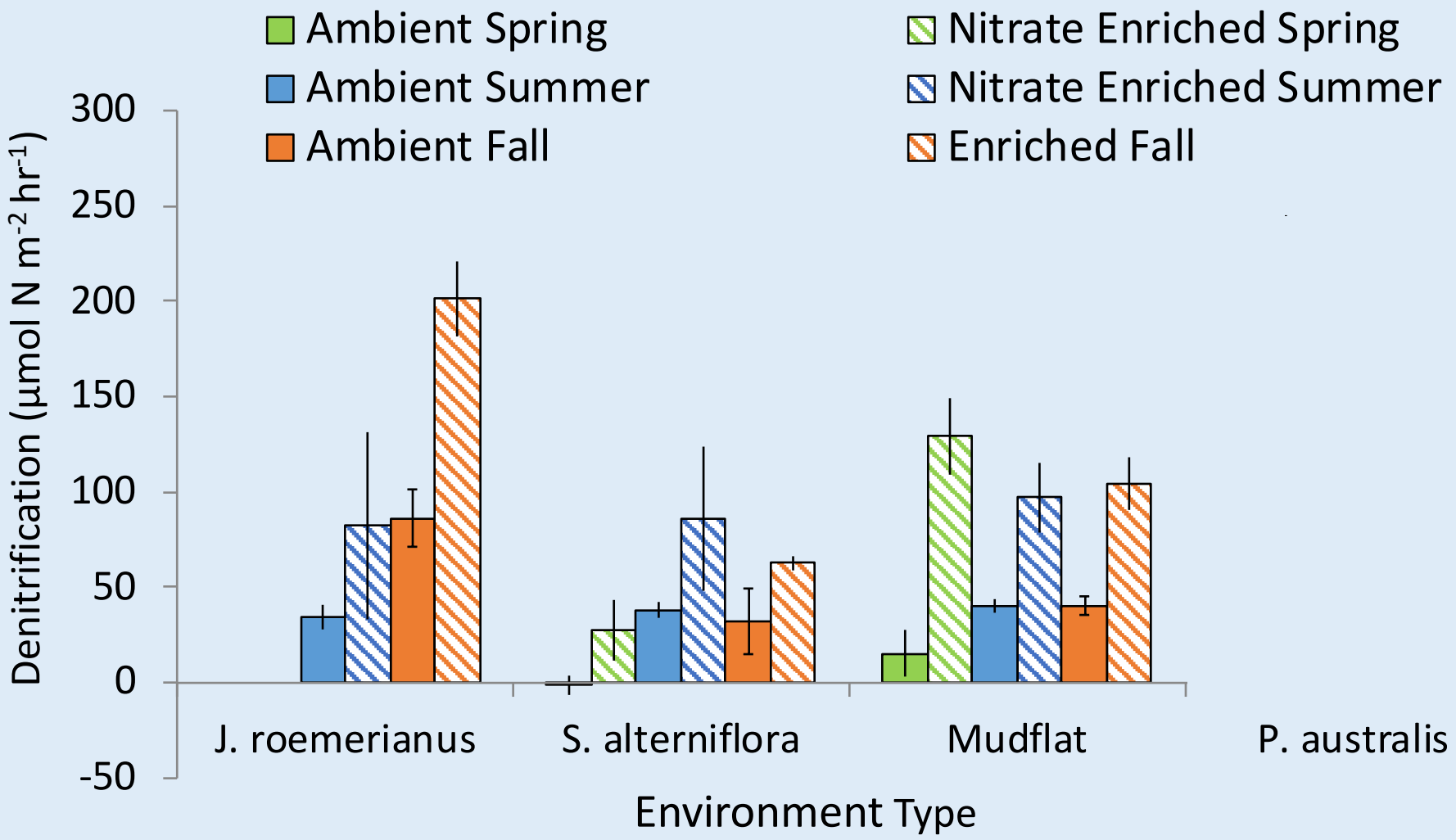
Rachel Carson



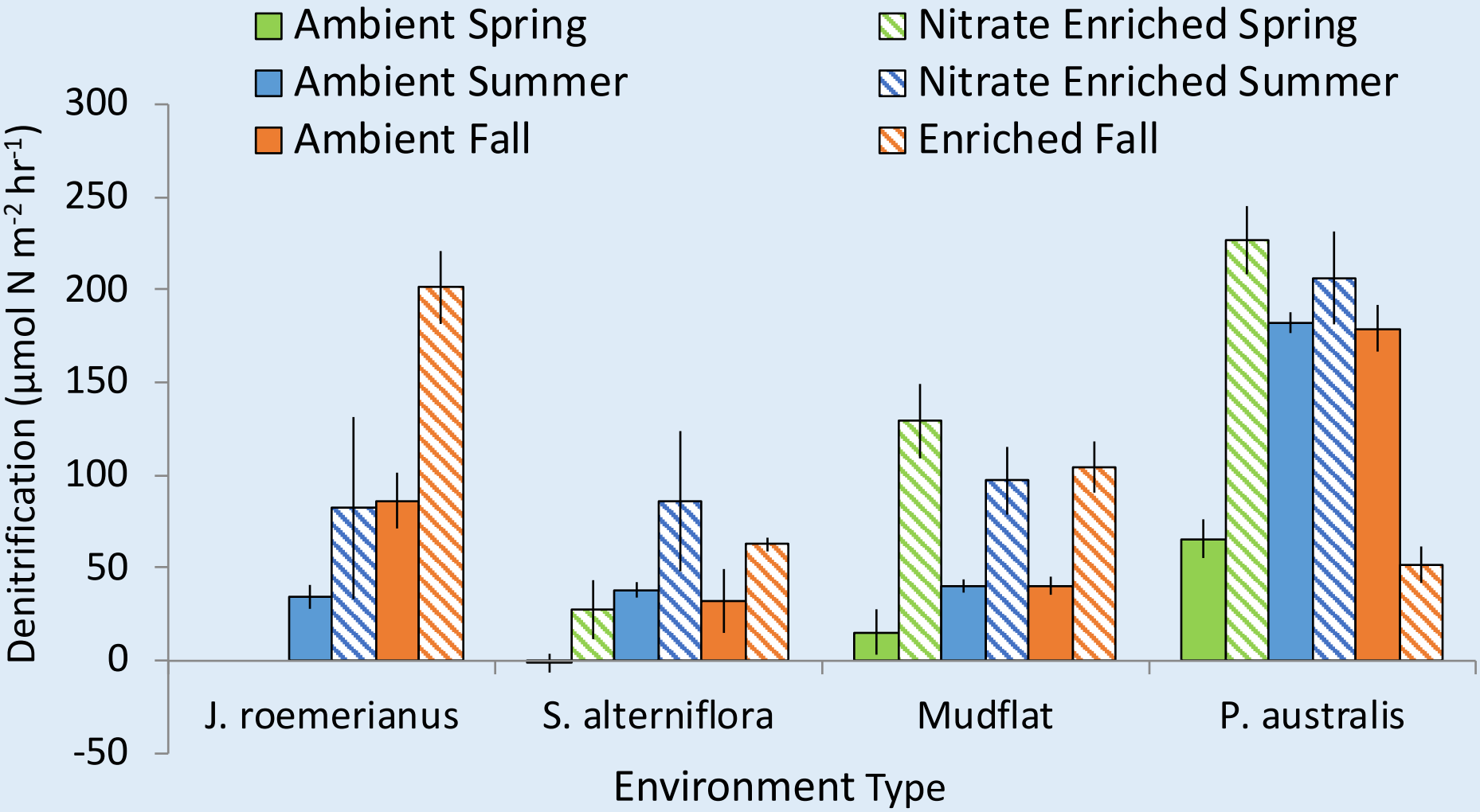
Rachel Carson



Rachel Carson



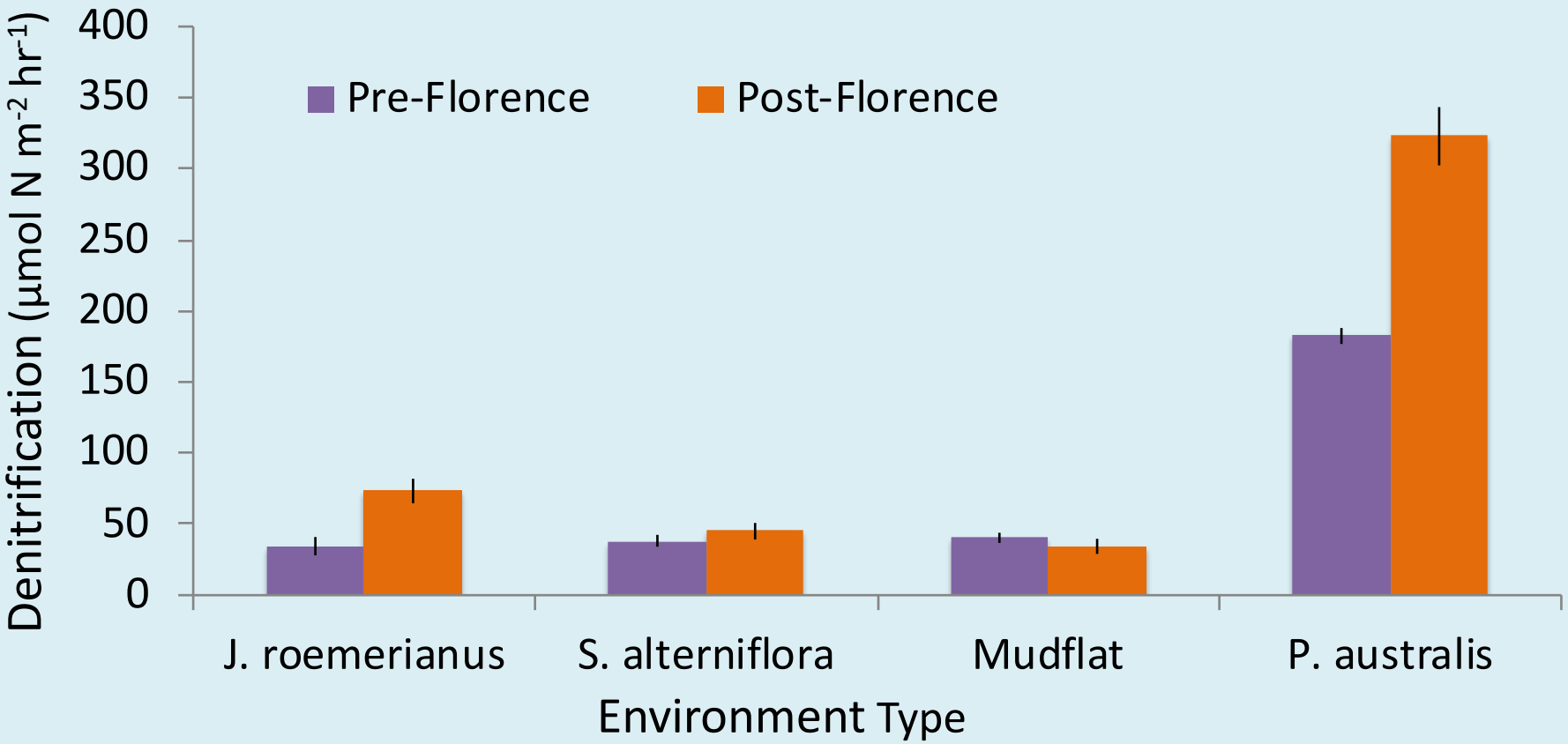
Rachel Carson



Results/Discussion

- During storm events, all environment types in the Rachel Carson may experience higher rates of denitrification, though response is sometimes variable/small

Rachel Carson Reserve: Florence



Results/Discussion

- *P. australis* had a significantly higher ($p<.05$) rate of denitrification than both native species and the unvegetated mudflat following Florence, and a significantly higher rate of denitrification than prior to Florence

Conclusions

- *P. australis* sediments have the potential to perform denitrification at similar or higher rates than sediments associated with native grasses in both ambient and nitrate enriched conditions

- This may have important implications for invasive species ecosystem management

Implications for ecosystem management:

- Traditional management methods (particularly chemical) have significant shortcomings
  - Impact on wildlife, human health concerns, logistical feasibility, cost
- Coastal managers often have to choose between mapping efforts & eradication
  - Wasted money going into unsuccessful eradication could be better used in mapping spread and understanding scale of ecosystem services

Acknowledgments

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Questions?
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