Nitrification Potential and Nitrate Reduction to Ammonium in a Nitrogen-Polluted Estuary

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Outline

- Introduction to nitrogen loading and nitrogen cycle
- Description of study site
- Potential nitrification
  - Methods
  - Results
- Dissimilatory nitrate reduction to ammonium (DNRA)
  - Methods
  - Results
- Conclusions and implications for future research

Importance of Nitrogen

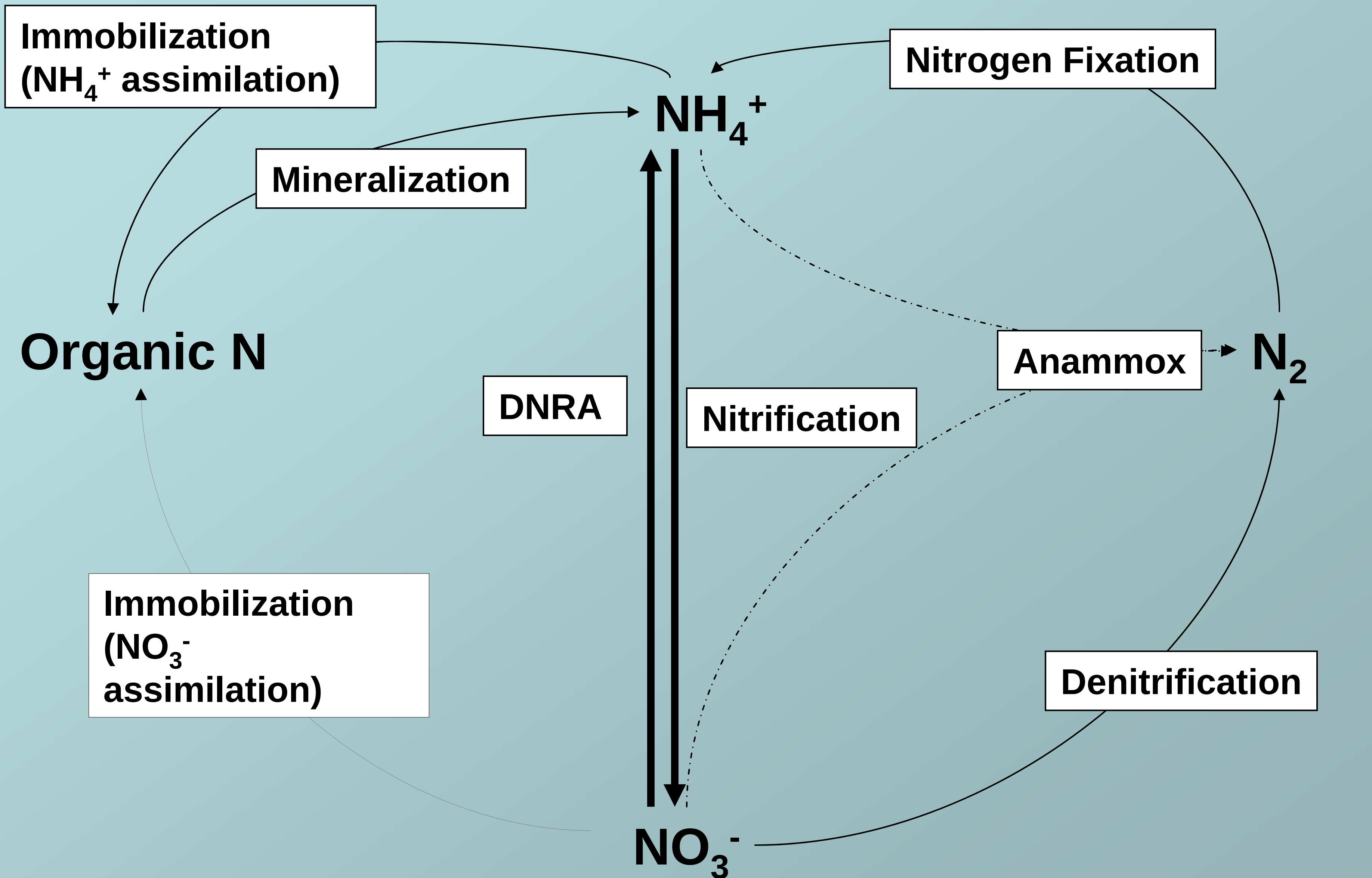
- Nitrogen is a nutrient required for plant growth – primary limiting nutrient in marine systems (Smith 1984)

- Excess nitrogen loading can cause phytoplankton and algae growth in coastal systems (Howarth 2000)

Importance of Nitrogen

- Reduced forms of nitrogen (NH_4^+) are more readily utilized by plants (Dortch 1990)
- Recycling of organic matter yields NH_4^+ through mineralization
- Most sources of new nitrogen into estuaries are oxidized (NO_3^-) (Glibert 1998)

Nitrogen Cycle



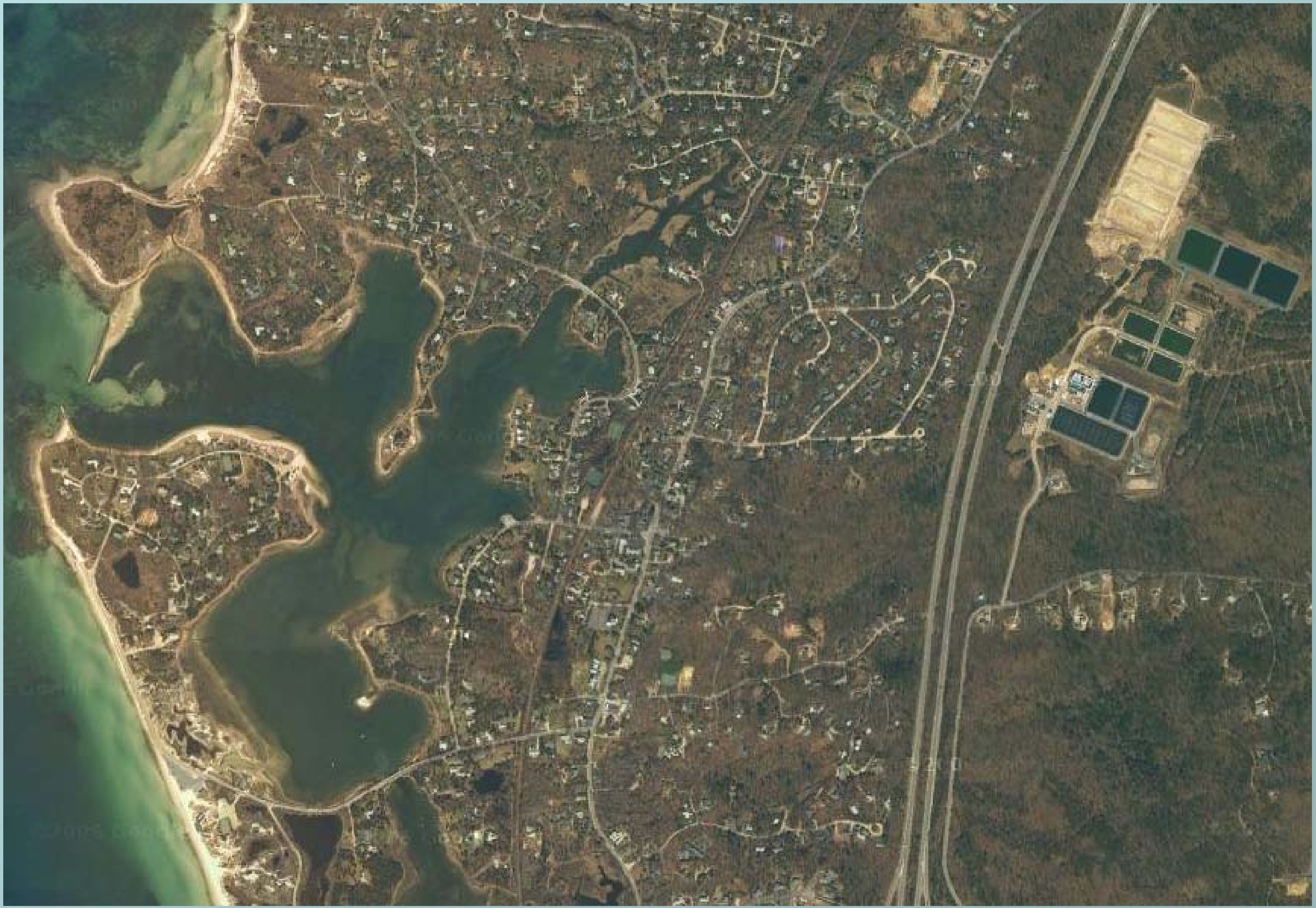
Nitrification and DNRA

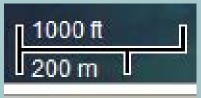
- Nitrification
  - Obligate aerobic
  - Oxidizes ammonium (NH_4^+) to nitrate (NO_3^-)
  - Often coupled with denitrification
- DNRA
  - Anaerobic process
  - Functional reverse of nitrification
  - Favored over denitrification in heavily reduced environments or environments with high amounts of labile carbon

Goals

- Determine if potential nitrification differs between different locations in the harbor or different vegetation types.
- Determine if DNRA is a significant biological process in West Falmouth Harbor

Study Site – West Falmouth Harbor





Google Maps


Mashapaquit Creek
Outer Harbor
Snug Harbor
South Basin

Potential Nitrification Methods

- Duplicate cores collected from eelgrass and non-eelgrass sediment at each sampling location
- Cores sectioned into 3 cm segments to depth of 9 cm
- Sections homogenized, ~ 2 g put into twelve 50 mL centrifuge tubes
- Add 300 μM NH_4^+ and 30 μM PO_4^{3-} artificial seawater solution
- Measure NO_3^- increase over four days - three tubes per sampling point

www.dnr.metrokc.gov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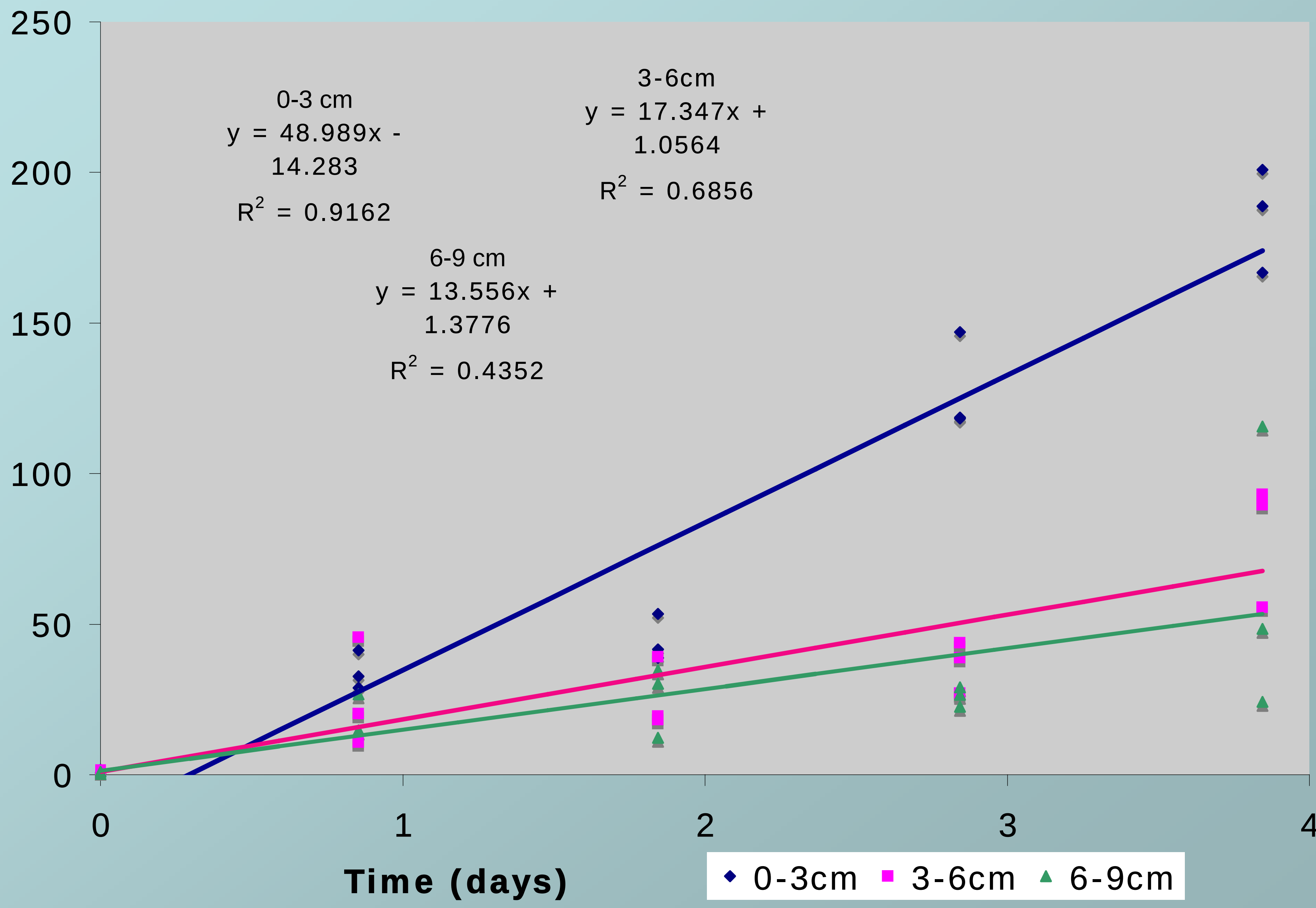
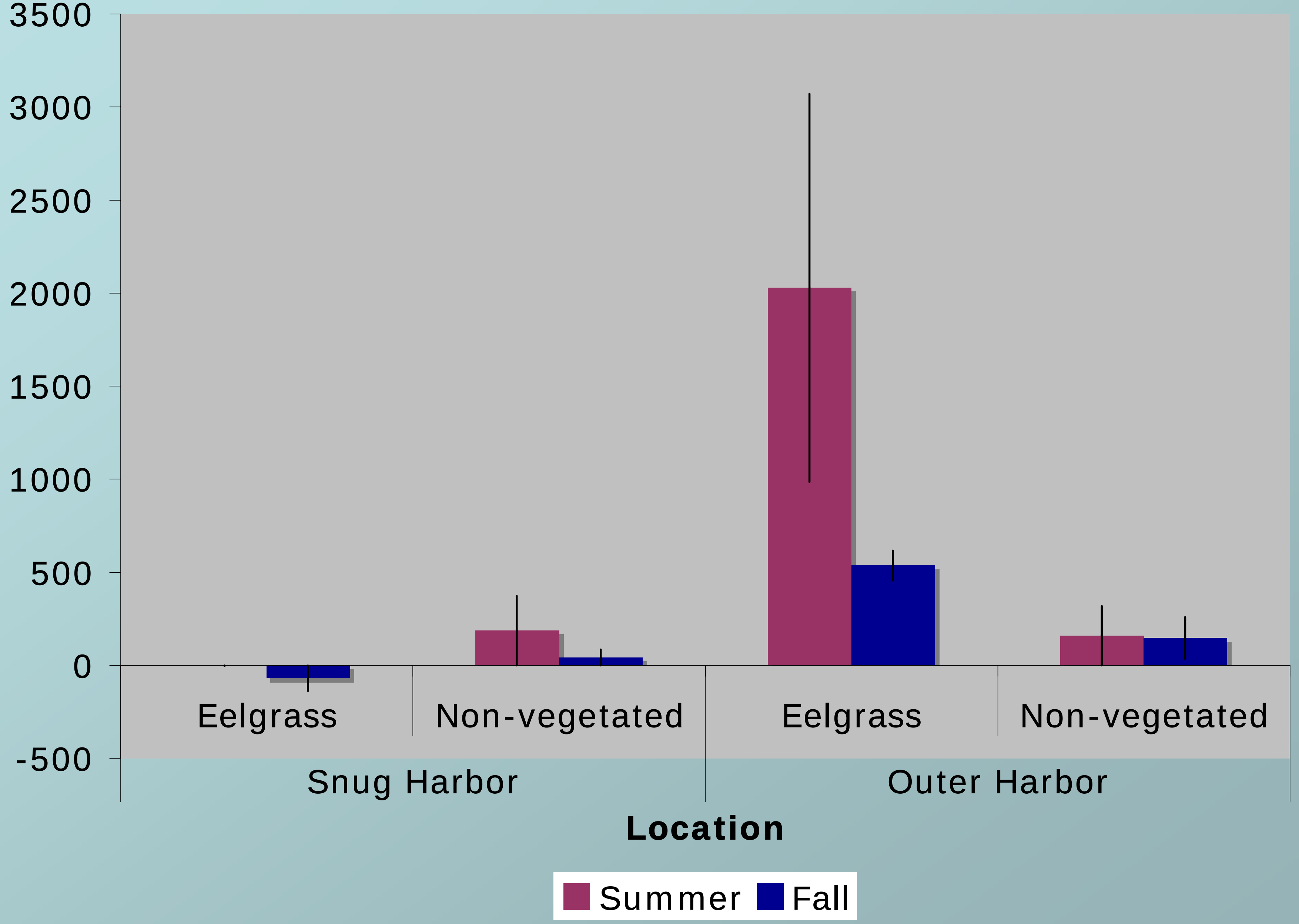
Hood
If Caught Stealing This Case,
You Will Be Prosecuted.

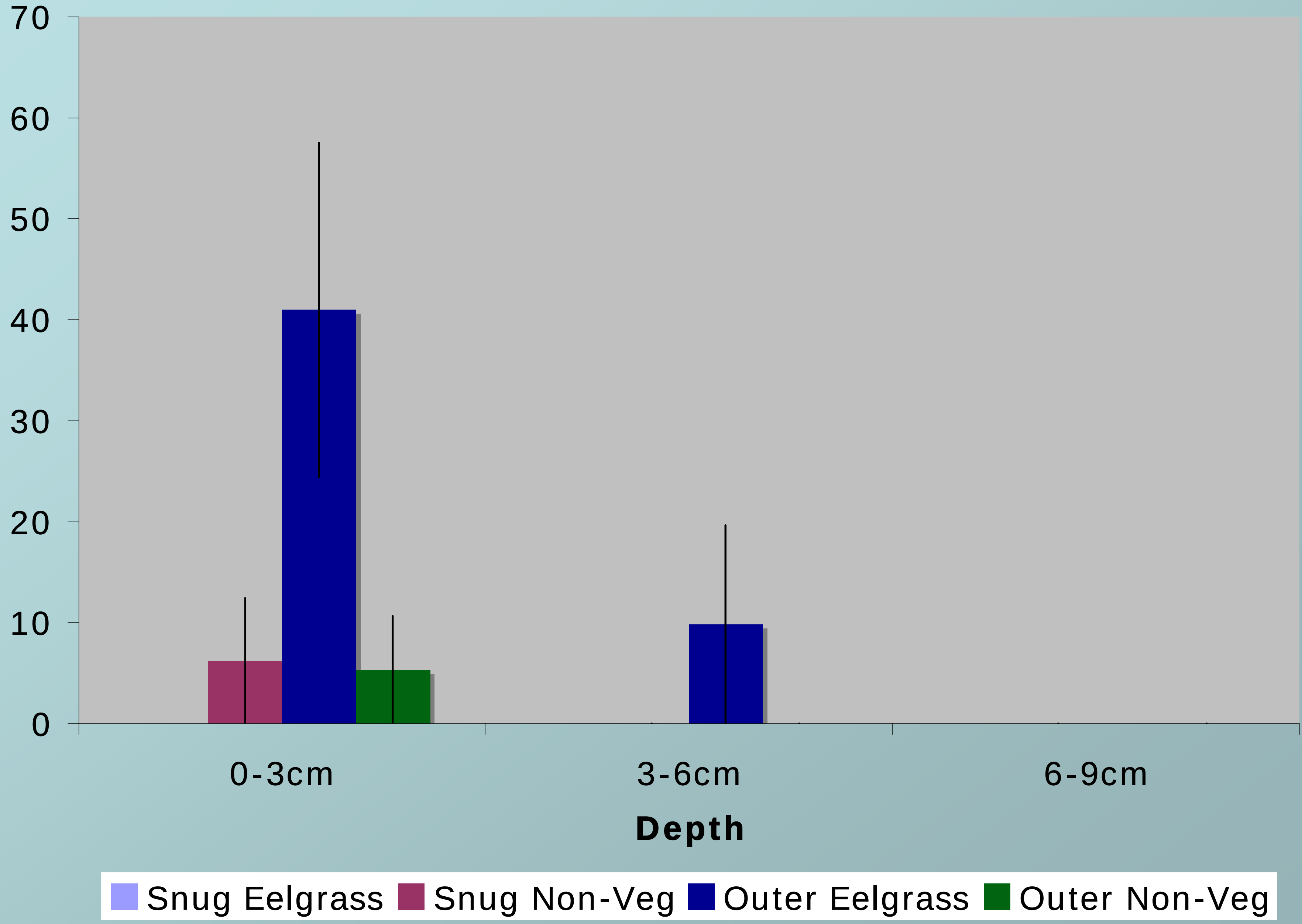
Nitrate Regression



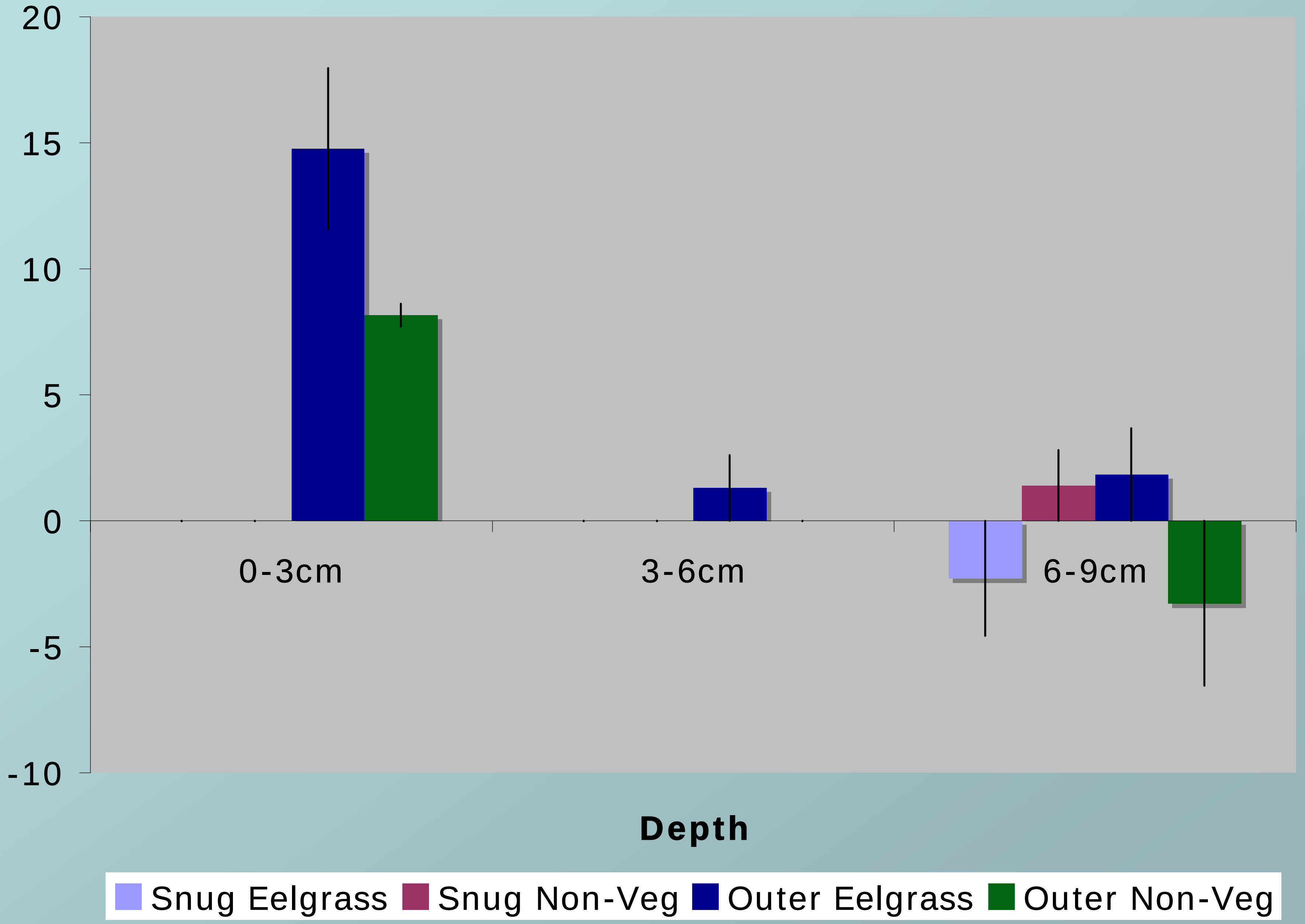
Potential Nitrification Results



Summer Potential Nitrification



Fall Potential Nitrification



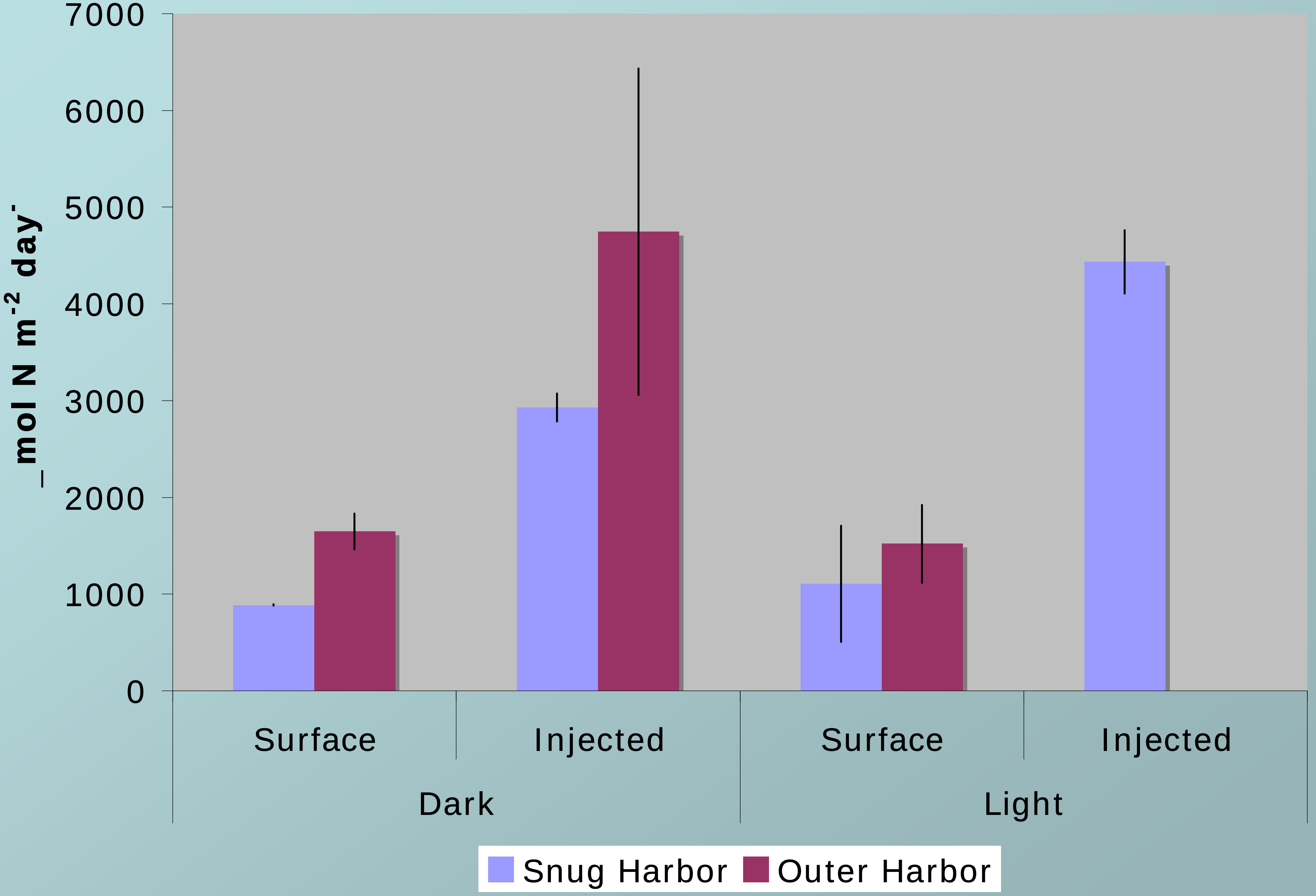
Potential Nitrification Implications

- Lack of potential nitrification in summer likely due to anoxic conditions
- Failure to recover in the fall means anoxic conditions still exist or the population of nitrifiers in Snug Harbor has crashed

DNRA Methods

- Collect eight cores from eelgrass at each location
- Add 100 μmol $K^{15}NO_3^-$ to each core - either injected or added to surface
- Incubate for 15-18 hours at 17^0c
- Four cores incubated in light, four incubated in dark
- Measure overall ^{15}N on sediments as well as $^{15}NH_4^+$ produced

DNRA Results



DNRA Implications

- DNRA favored in environments that are either highly reducing (Jorgensen 1989).
- If Snug Harbor is anoxic at surface, would expect those sediments to be more reducing.
- However, results indicate more DNRA in Outer Harbor.

DNRA Implications

- Possible answer: DNRA also favored in environments with high labile carbon (Kelso et al 1997)
- Eelgrass provides source of labile carbon at depths where sediment is reducing

Conclusions

- Nitrification potential is severely inhibited in Snug Harbor in both summer and fall. This is likely due to anoxia in the sediments and possible population crash.
- DNRA is a significant process in the harbor. It appears as though rates are higher in the Outer Harbor - possibly due to more labile carbon.

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