Denitrification Rates, Potential, and Limitations in a Newly Constructed Wetland near Bishopville, MD

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Background

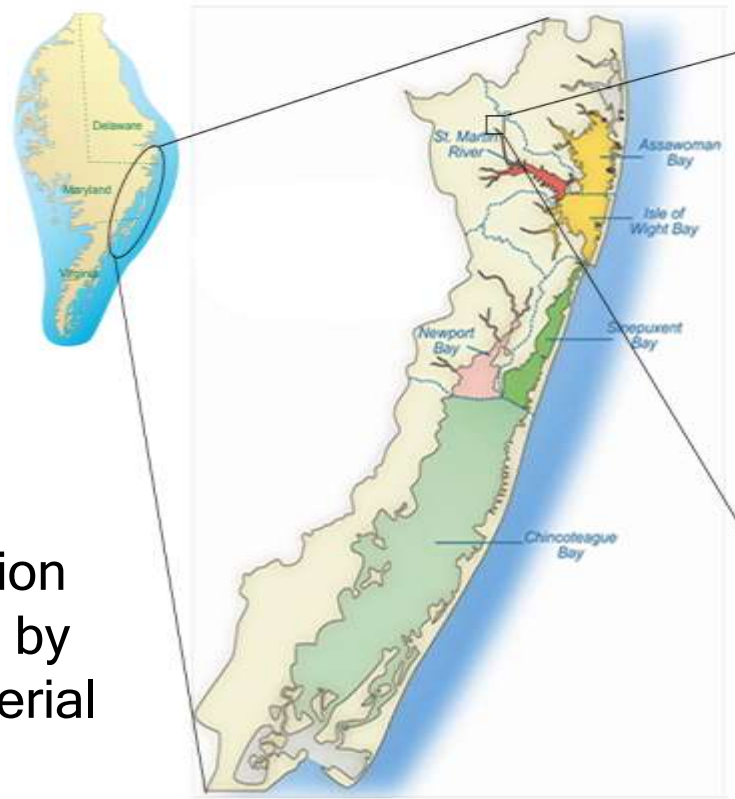
Lizard Hill Wetland: Atlantic white cedar wetland created on an abandoned sand mine along a tributary of the St. Martin River.

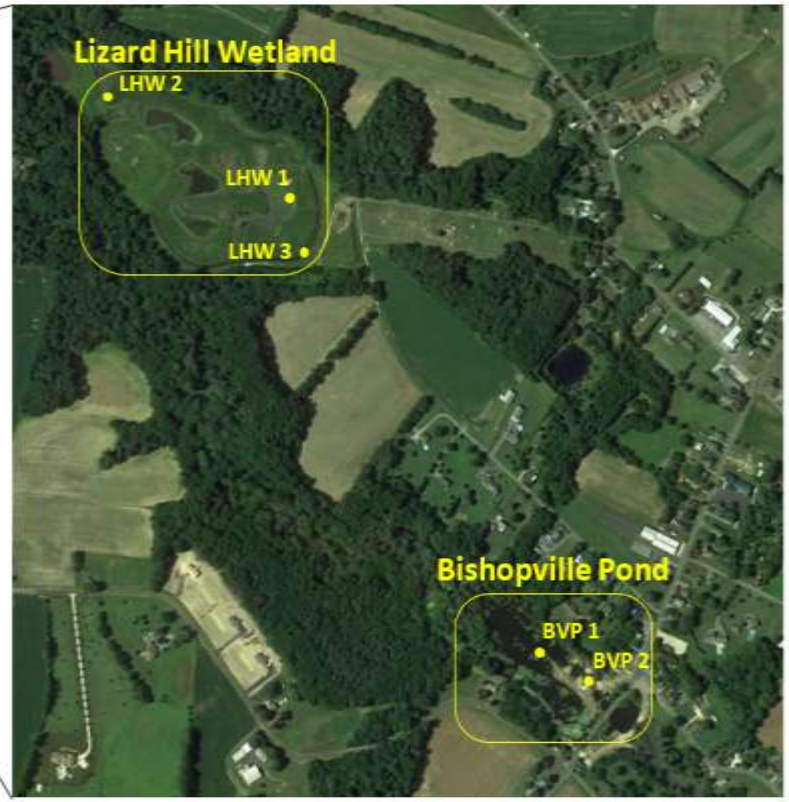
Bishopville Pond: Impounded by an old mill dam that has recently been replaced with a riffle system.

St. Martin River is the most degraded region in Maryland Coastal Bays.

Extensive agriculture and residential development.

Wetland restoration/creation used to manage nutrients by enhancing plant and bacterial processes.





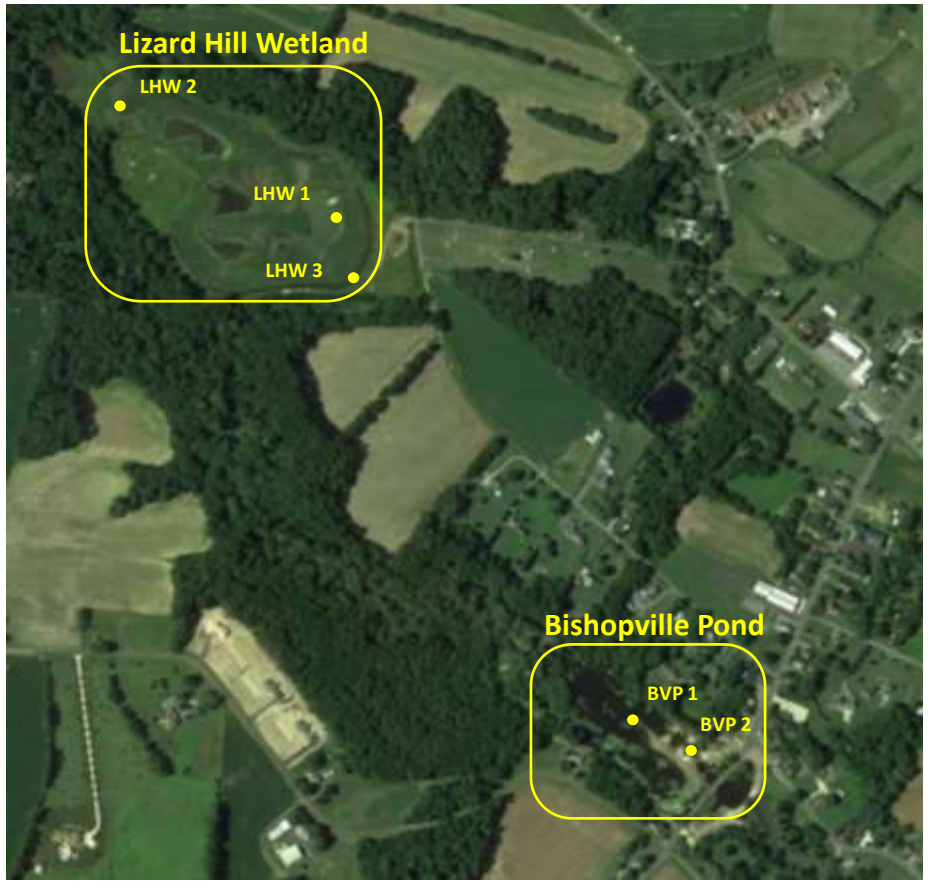
Objectives

Examine whether the created wetland is successfully removing nitrogen entering the wetland by measuring bacterial denitrification, and how it compares with Bishopville Pond and other wetland systems.

Establish a baseline for future study of ecological function in the newly created wetland system.

Methods

Intact sediment cores (triplicate) were collected from the five sites below in the spring and summer of 2016.

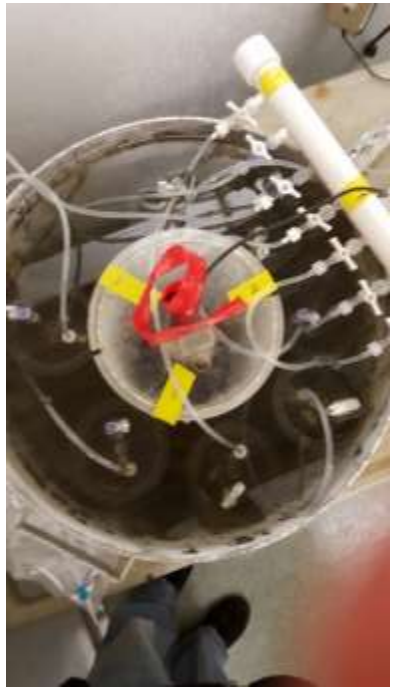


Cores were equilibrated in incubation chambers overnight at Horn Point Laboratory.

Dark and light incubations continued the following day with periodic water sampling for both nutrient and gas analysis.

Nutrients: NO_3^-, NH_4^+, and SRP were measured using standard analytical methods.

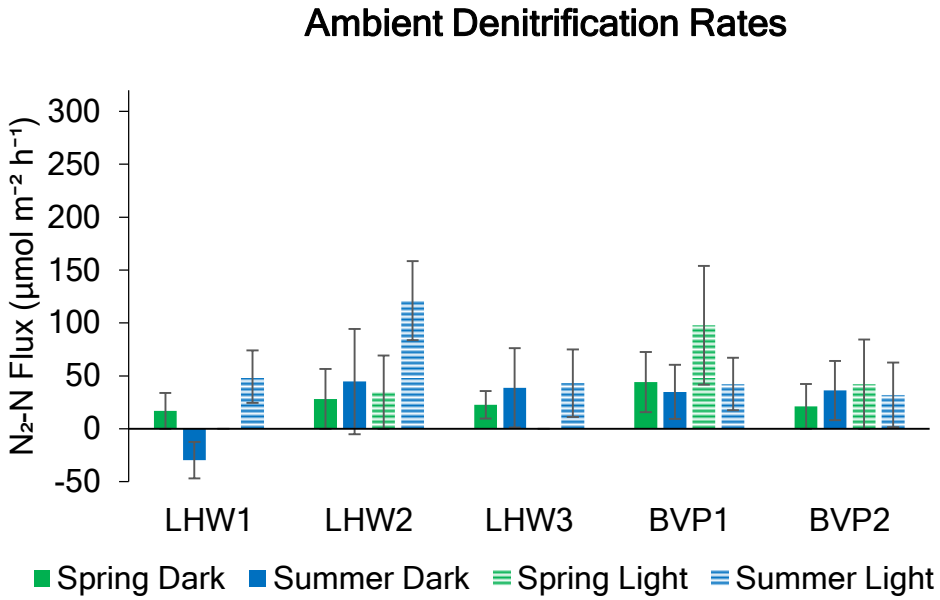
Gases: N_2 and O_2 fluxes were analyzed using membrane inlet mass spectrometry.

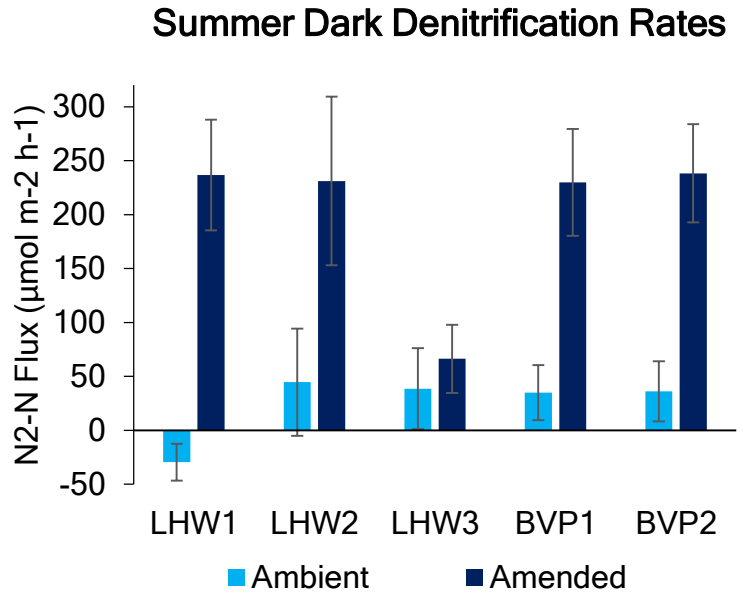


A NO_3^- amendment of 250 µmol $NaNO_3$ L^{-1} was added to each incubation chamber after the summer flux experiment to measure the denitrification potential.

The NO_3^- addition was based on measurements by the Maryland Coastal Bays Program at the sites during periods of high nutrient loading.

Results





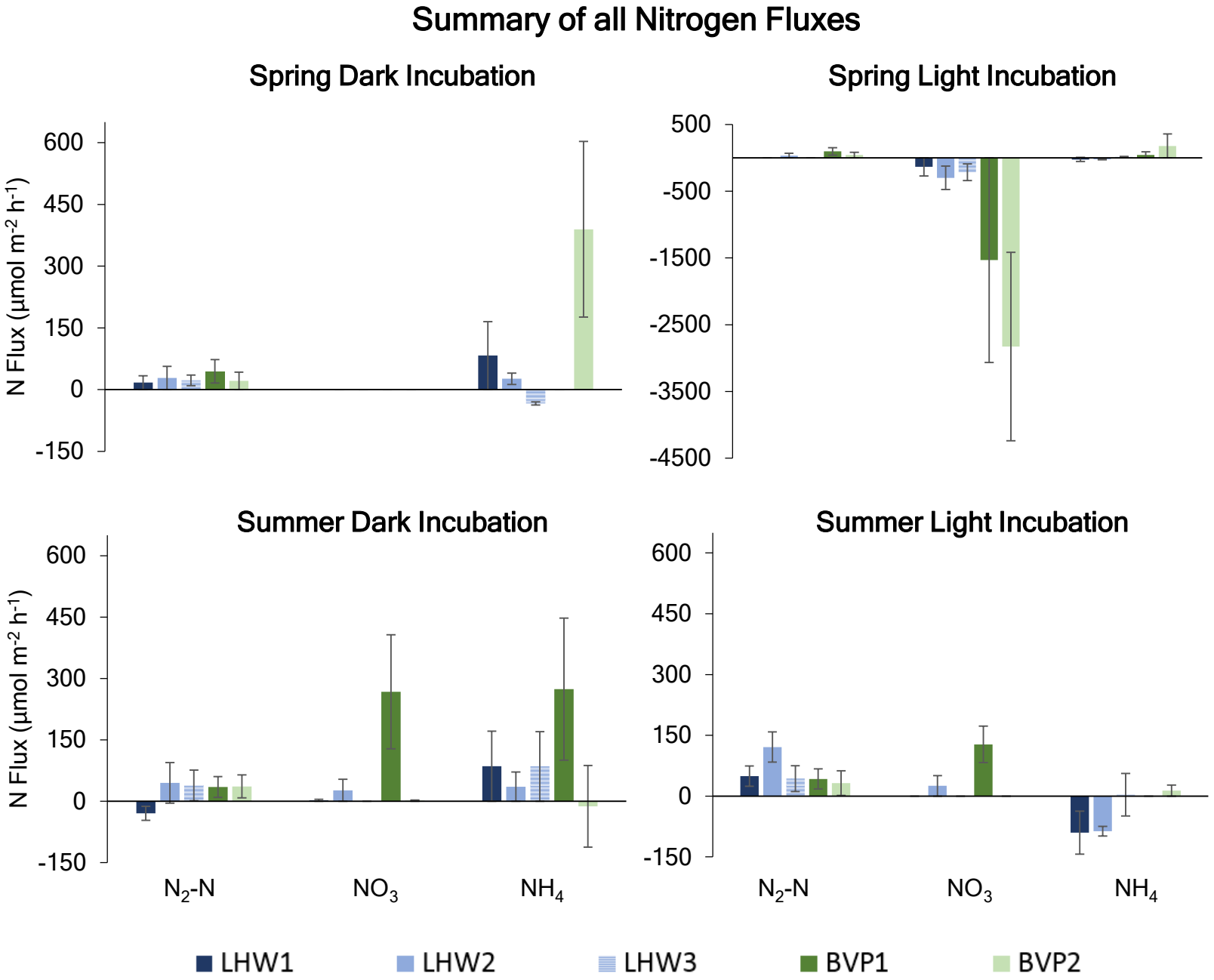
N_2-N fluxes were highly variable for all five sites, with no differences in denitrification rates.

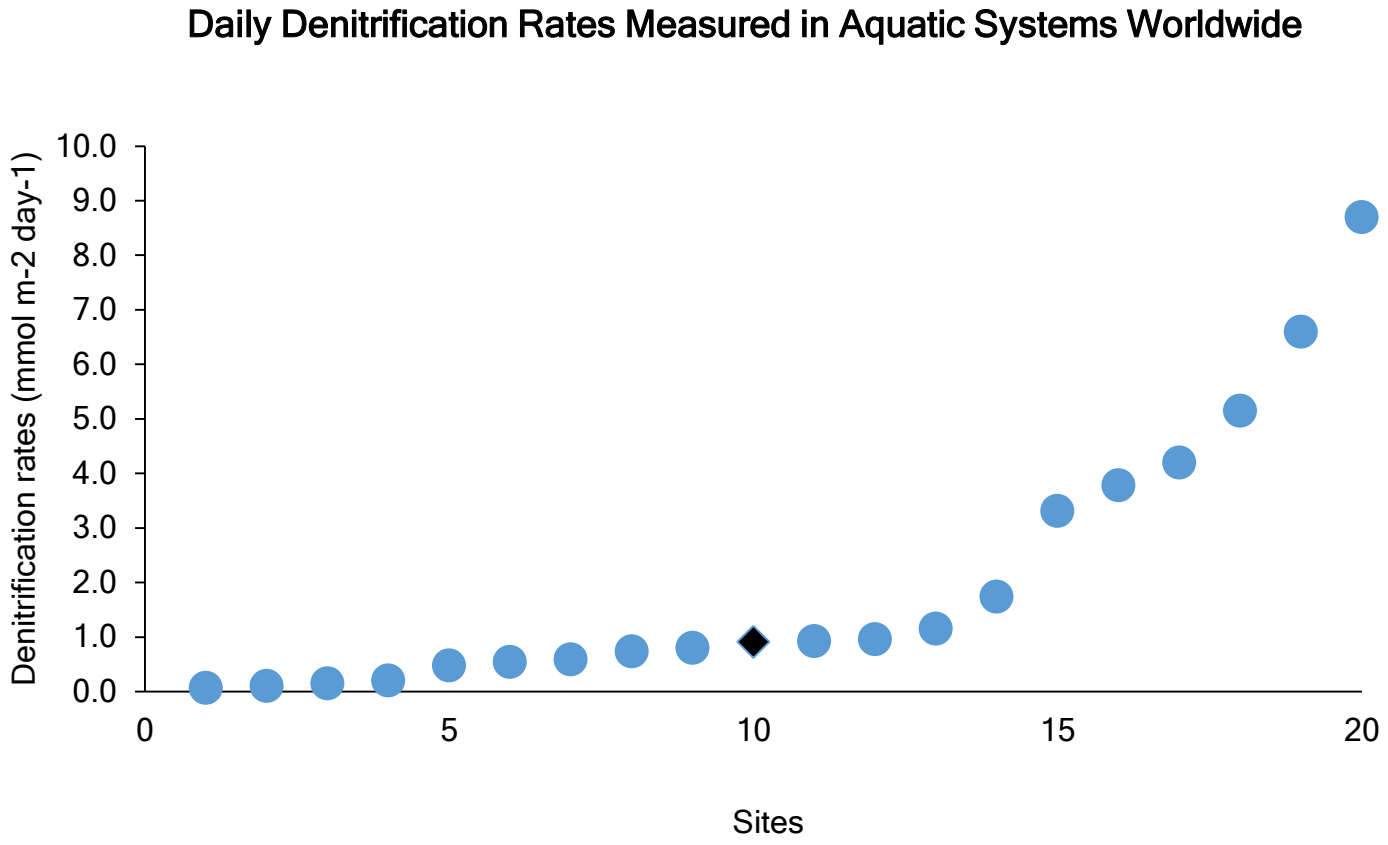
Across all sites, rates averaged 26 µmol N_2-N m^{-2} h^{-1} and 46 µmol N_2-N m^{-2} h^{-1} in the dark and light, respectively.

Following the NO_3^- amendment, N_2-N fluxes increased in all sites.

NO_3^- was removed from the water column and largely exceeded N_2-N fluxes in the spring light incubations, while all other cores exhibited no NO_3^- flux or a release into the water column.

NH_4^+ was generally released into the water column during dark incubation at all sites, but during light incubations it was removed from the water column at Lizard Hill and released at Bishopville Pond.





My research sites exhibited low denitrification rates relative to rates measured in other sites that used the MIMS methodology (modified from Joye and Anderson 2008).

Conclusions

Denitrification rates can be unpredictable in shallow wetland systems with abundant benthic algae and plants that compete with denitrifiers for NO_3^-.

Assimilation by plants and benthic algae was the dominant fate of NO_3^- during the spring.

Nitrification and/or groundwater is most likely the source of NO_3^- for denitrification in these sediments.

Both systems were NO_3^- limited for bacterial denitrification at the time of sampling, except for the LHW3 site.

The bacterial community is capable of responding to pulses of NO_3^- that are typical of storm events that occur on Maryland's Eastern Shore.

The Lizard Hill wetland creation project has the potential for managing excessive nutrient loads through bacterial denitrification.

Next Steps

I plan to analyze the relative abundance and diversity of four critical denitrifying genes (nirS, nirK, nosZ-I, and nosZ-II), comparing sediment subsamples from each intact core to independent cores taken at the same time and location.

This will give further insight into how the denitrifying community has developed in the newly created Lizard Hill Wetland, and how it may influence denitrification rates and potential.

Further analysis of sediment subsamples will characterize chlorophyll *a*, C:N, and stable C and N isotopes, and a multiple component analysis will be conducted to investigate possible physical and chemical variables affecting denitrification rates and the denitrifying communities.

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