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Supplementary Material

Floating Wetlands beyond Retention Ponds: Estimating Nitrogen Cycling and Removal in Tidal Waters

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Section 1: Methods

A. Plant Biomass Calculations

Plant biomass was estimated by comparing the difference between initial plant nitrogen concentration and final plant nitrogen concentration combined with the dry weights of the plant tissue extrapolated to each tank. To estimate initial plant biomass (above and below ground) and N mg we used the following equation:

$$B_i = \frac{P_B * N_P}{A_M}$$

where B_i is the initial estimated plant biomass (mg DW m^{-2}), P_B is the plant biomass average from three plant samples (mg DW) and N_P is the number of plants that were planted in each tank and A_M is the surface area of the floating media (m^{-2}). We assumed all plants to contain the same amount of initial N content. The same equation was used to estimate below ground biomass. To estimate the final plant biomass accumulation, we used the following equation:

$$B_f = B_i - T_F$$

where B_f is the final estimated plant biomass accumulation (mg DW m^{-2}), B_i is the initial estimated biomass (mg DW m^{-2}) and T_F total plant biomass collected in (mg DW m^{-2}). This was done individually for all tanks. The same equation was used to estimate below ground biomass.

B. Experimental Calculations for nutrient, oxygen and denitrification fluxes

(1) The equations below describe the approach for computing a net sediment-water flux from a time-series of a constituent measured in the water overlying the sediment in the incubation of an intact core. First, the height of water above the sediment surface in the sediment core chamber (Core Water Depth; m) is computed from the core area and volume of water measured after the incubation.

$$Core\ H_2O\ Depth = (CORE\ VOL^a / CORE\ SURFACE\ AREA^b)/100^c$$

where

- *a* is the measured volume of water in the sediment core (cm^3)
- *b* is the surface area measurement of the core cylinder (cm^2)
- *c* converts measurement units to m

The slope of the linear regression fit of the constituent time-series during the incubation (concentration versus time) is then used to estimate an hourly net sediment-water flux per unit area, expressed by the general equation below:

$$NET\ SEDIMENT\text{-}WATER\ FLUX\ (\mu mol\ m^{-2}\ h^{-1}) = [(SLOPE^a)\ x\ (Core\ H_2O\ DEPTH^b)\ x\ (60^c)]$$

where

- *a* variable-specific slope of linear fit (NH_4^+, NO_{2+3}^-, O_2, N_2)
- *b* converts measurements from volumetric to areal basis
- *c* converts time units from minutes to hours

Blank corrections were made by simply subtracting the slope (slope of oxygen or nutrient concentration versus time plot) of the blank core from the slope of the oxygen or nutrient concentration versus time plot for the full sediment core. These corrections were generally either zero or quite small.

C. Criteria for accepting, rejecting, and modifying variable slopes used in calculating net sediment water fluxes: Constituent concentrations were plotted against time of sampling and the slope of this curve is used to calculate net sediment-water exchanges. The following steps assume that all data have been previously verified following normal protocols.

1. If the slope of the nutrient concentrations vs. time plot was statistically significant ($p<0.05$), the slope was used in calculating fluxes without modification.
2. Occasionally, there were plots which indicated a clear increasing or decreasing trend in concentrations over time but had one observation which diverged strongly (either higher or lower concentration) from the trend. We consider these divergent data to represent contaminated samples (either by addition of the compound or addition of water having a much lower concentration of the compound) and they were not used. The slope was recalculated using lower degrees of freedom and a higher "r" value as a criteria for significance. If the slope is statistically significant, it was used in calculating fluxes.
3. If the concentration vs. time plots were erratic (i.e. no statistically significant increasing or decreasing trend in concentration over time), and if the difference in concentration among variables was greater than twice the detection limit for that variable, the data for that variable were considered to be non-interpretable. The slope was not calculated and the entry for that variable was recorded as "NI".
4. If the concentration vs. time plots were erratic (i.e. no statistically significant increasing or decreasing trend in concentration over time), and if the difference in concentration among variables was less than twice the detection limit for that variable, then the slope was taken to be zero and the net sediment-water flux was reported as zero. Occasionally, statistically significant slopes have been found for some variables (mostly nitrite and dissolved inorganic phosphorus) where concentration differences over the incubation period do not exceed twice the reported detection limit. These slopes were used to calculate net sediment-water exchanges.

D. Indices of N transformation

To quantify metrics of nitrogen cycling associated with the media, we derived a series of indices of nitrogen transformations. First, we computed the nitrification needed to support denitrification using the following equation:

$$Apparent\ Nitrification = N_2 + NO_{2+3}$$

where N_2 is the denitrification fluxes and NO_{2+3} is the nitrate fluxes. This metric assumes that any N that was denitrified in excess of the NO_{2+3} influx was generated through nitrification. We also calculated the denitrification efficiency using the following equation:

$$Denitrification\ Efficiency\ (\%) = \frac{N_2 - N}{\sum N} x100$$

where N_2 is the denitrification rate and $\sum N$ is the summation of the NH_4, N_2, and NO_{2+3} fluxes multiplied by 100 to obtain a percentage. Lastly, we calculated the ammonium recycling index using the following equation:

$$Ammonium\ recycling\ index = \frac{NH_4 +}{\sum N} x100$$

where NH_4 is the ammonium flux and $\sum N$ is the summation of N_2, NH_4 and NO_{2+3} fluxes, all multiplied by 100 to obtain a percentage.

Section 2: Results

A. Environmental characteristics of the mesocosms

Temperature, dissolved oxygen, chlorophyll-a, and salinity variation for 2019 and 2021 mesocosm experiments are shown in Table S1. The 2019 experiments were conducted in the summer months while the 2021 experiments were conducted in the spring months.

Table S1. Environmental characteristics for the mesocosm tanks in summer 2019, and spring 2021. These values represent the minimum, maximum and average values for the length of the experiments.

Parameter	2019 Control			2019 Experimental			2021 Control			2021 Experimental		
	Min	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**
Dissolved Oxygen (mg L^{-1})	1.37	4.07	7.43	1.48	4.06	6.69	2.6	6.8	10.2	3.3	6.9	10.1
Oxygen Saturation (%)	18.3	54.5	103.8	20.5	54.4	89.1	34.8	77.8	107.4	44.9	78.4	105.1
Salinity (PSU)	8.0	10.5	10.5	7.9	12.7	10.5	10.3	11.8	13.2	10.4	11.8	13.2
Temperature (C°)	13.9	17.8	21.4	13.9	17.9	21.3	17.5	21.7	27.0	16.5	21.6	26.5
Active Chlorophyll-a (µg L^{-1})	0.4	3.1	9.5	0.2	2.2	9.3	0.7	6.8	20.6	0.68	6.6	20.1

The inflowing waters contained a higher concentration in chlorophyll-a than in the tanks (fig. S1), suggesting that algal cells in the inflowing water settled within the mesocosms.

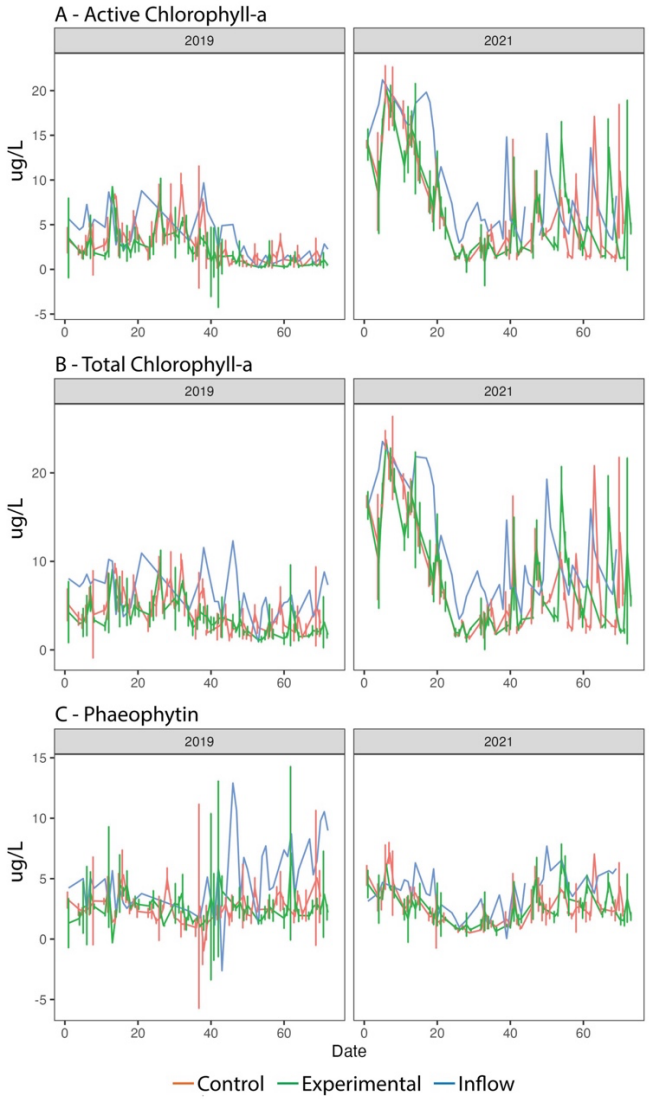

Figure S1. Active chlorophyll-a, total chlorophyll-a, and phaeophytin collected from the inflow and treatment tanks. Experimental and control data represent the average of the three tanks for each treatment. The error bars represent the standard deviation from the mean. Spikes observed in the active and total chlorophyll-a plots indicate that the sample was collected shortly after tanks were cleaned.

The inflowing waters contained a higher PN concentration than in the tanks and outflow (fig. S2), suggesting that PN in the inflowing water settled within the mesocosms. NO_{2+3}^- was elevated in the outflowing water relative to the inflow, while NH_4^+ and DON differences were less clear.

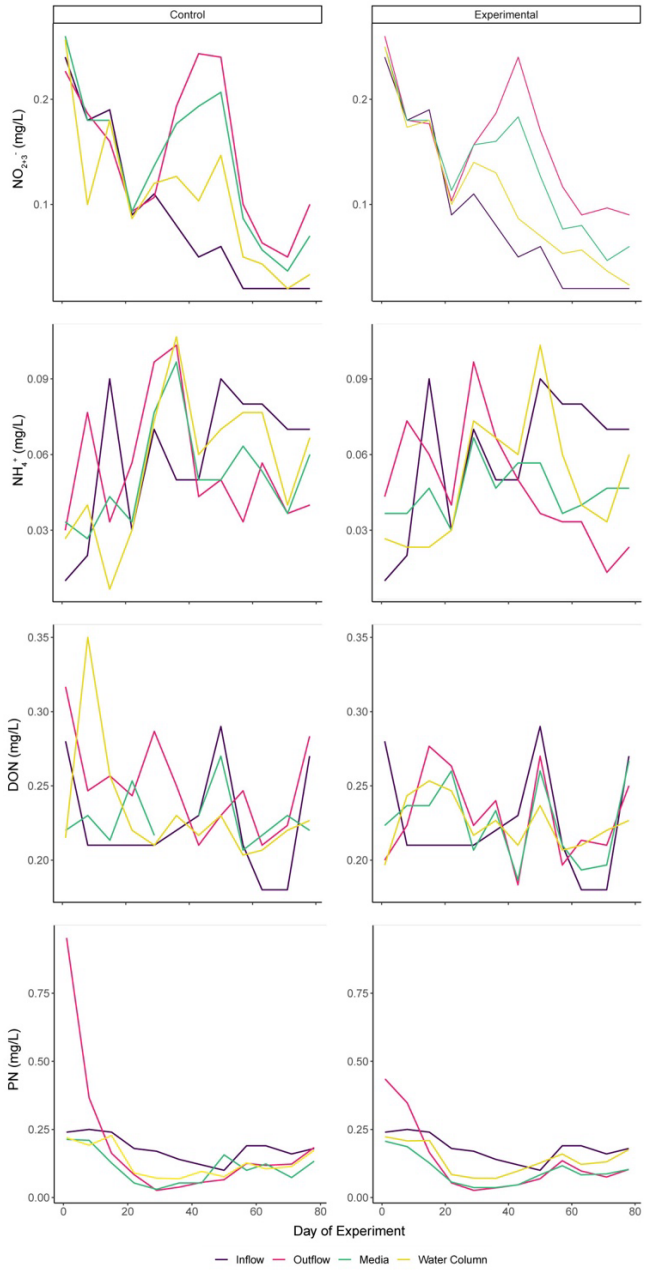

Figure S2. NO_2 + NO_3, NH_4^+, DON and PN concentrations within different environments in the mesocosm experiments in 2021 (Day 0 is April 16, 2021).

B. Periphyton

Periphyton was collected on a weekly basis and analyzed for total mass and nitrogen content. The control tanks accumulated less periphyton when compared to the experimental tanks (fig. S3). Interestingly, when plotting the periphyton biomass (fig. S3) and the periphyton nitrogen content (fig. S3) for the control and experimental tanks, it is clear that although the control tanks accumulated less periphyton, the nitrogen percent contained in that periphyton is actually 0.8 percent N higher than in the experimental tanks, although not statistically significant

(p>0.05) (fig. S3). The weight of periphyton also declined over time in the experimental tanks, but not in the control tanks (fig S3). This behavior can be observed on both experiments in 2019 and 2021.

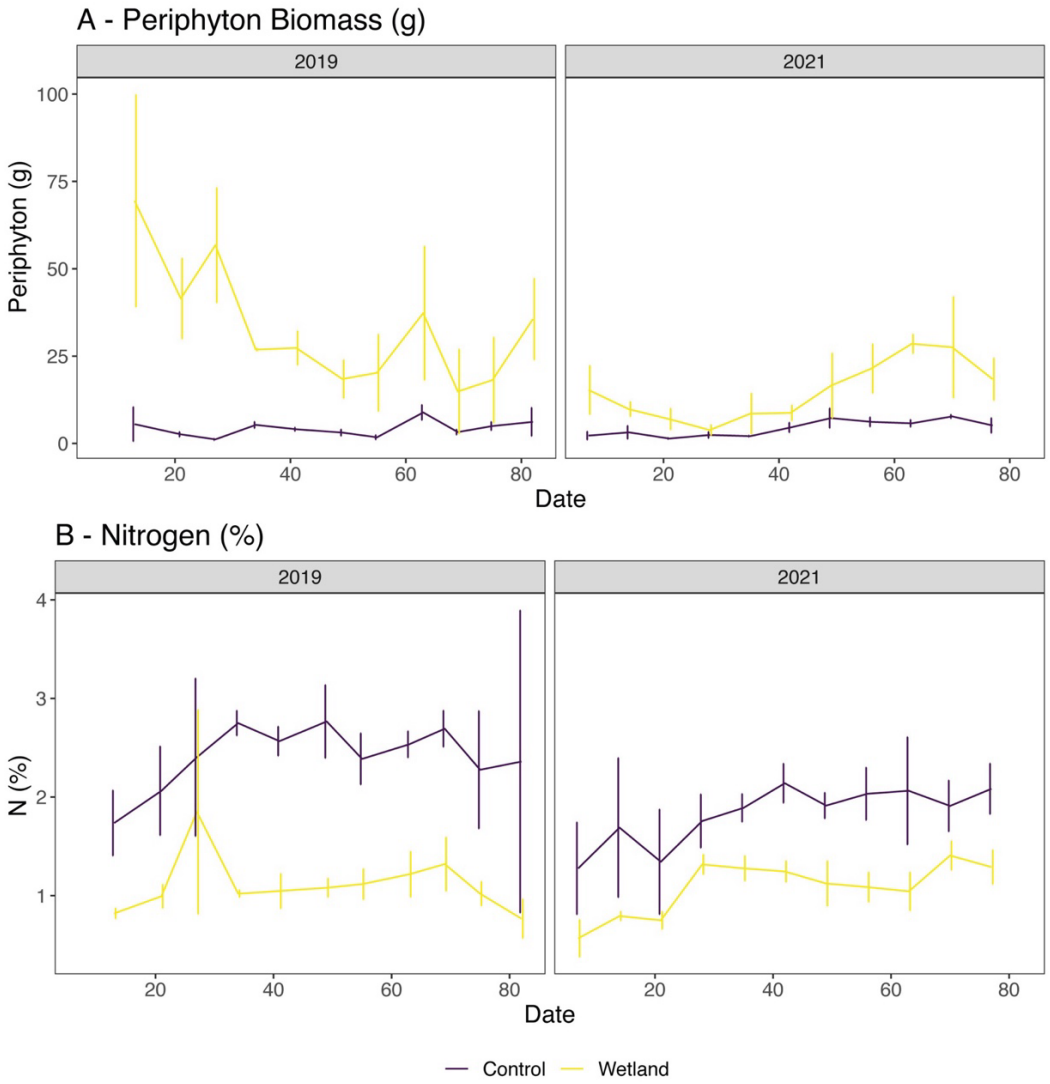

Figure S3. Periphyton weekly accumulation in the control and experimental tanks. Periphyton was collected during weekly cleaning utilizing a plankton net. Error bars indicate the standard deviation from the mean of the three tanks.