The effect of floating vegetation on denitrification and greenhouse gas production in wetlands

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Role of Floating vegetation in wetlands
• Wetlands in the US remove more nitrogen (N) on a per area basis than other aquatic systems (Baron et al., 2012), and remove N permanently through denitrification.
• Wetlands are hotspots for greenhouse gas (N₂O and CH₄) production.
• Floating vegetation may change wetland dynamics (redox, light, and gas exchange), which affect N cycling and greenhouse gas production.

How does floating vegetation affect denitrification and greenhouse gas production in wetlands?

Hypothesis: Floating plants increase the rate of denitrification and greenhouse gas production by creating a barrier to light penetration and oxygen diffusion into the water column, creating a low oxygen environment.

Diel effects

Methods
• Mesocosms were created with wetland sediment and runoff water with two treatments: duckweed cover and "no cover"
• n = 9 for each treatment
• Flow-through setup with approx. 2 d residence time
• Incubated in growth chamber: 17°C, 12 hr. light/dark cycle to mimic local summer/fall conditions
  • [N₂], [N₂O], and [CH₄] were measured in mesocosm water column
  • Water-air gas exchange rates (k) were calculated for each mesocosm using a tracer gas.
  • N₂, N₂O, and CH₄ production were calculated using equation below

Production of X = (Excess Xmeso − Excess Xinflow) * volume/surface area * residence time + Efflux of X

Does floating vegetation affect denitrification in wetlands?

Figure 1. DO concentrations at mid-depth in each mesocosm (minimum of 5 observations for each replicate, n=9 for each treatment and n=7 for inflow water). SE error bars. Blue line is 100% DO saturation.

Figure 2. Average of N species in inflow and outflow water from mesocosms, with n=4 samples per mesocosm. SE error bars. Total nitrogen was significantly different between the inflow and mesocosm outflow (p < 0.001).

Figure 3. Average of denitrification calculated for each sampling date and mesocosm. SE error bars. Denitrification in the two treatments was significantly different (p < 0.001).

Figure 4. Average CH₄ production. SE error bars. Methane production was significantly higher in the no cover treatment (p = 0.018).

Figure 5. Average N₂O production. SE error bars. N₂O production was not significantly different between the two treatments (p = 0.224).

How does floating vegetation affect greenhouse gas production in wetlands?

Figure 6. Average of N species in inflow and outflow water from mesocosms, with 3 mesocosms per treatment and 4 samples per mesocosm. SE error bars.

90% of N loss in the duckweed control treatment was accounted for by denitrification vs. 36% in the +N treatment.

• Duckweed treatments did not denitrify additional N as efficiently as they processed background levels of N

Conclusions
• Denitrification rates were statistically higher in the floating vegetation treatment, leading to different fates of the N in the two treatments.
• Methane production was higher in the no cover treatment, while N₂O production was not different between treatments.
• When additional N was added to the duckweed system, the fate of N changed.
• Duckweed may be a useful management tool to control the fate of N in constructed wetlands.

References

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