Nitrate removal and Woodchip Properties across a Paired Denitrifying Bioreactor Treating Centralized Agricultural Ditch Flows

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Supplemental Material

Figure S1. View of the drainage ditch during installation looking upstream. The drainage contractor provided smoothing and shaping of the ditch bottom to aid the manual construction of the woodchip bag.

Figure S2. View of the drainage ditch 19 months after construction looking upstream. Flow entered the diversion bioreactor (to left of drainage ditch) through the in-ditch riser structure. Water flowing through the in-ditch bioreactor first passed over a stone rip-rap section, located immediately upstream of the in-ditch bioreactor.

Figure S3. View of the diversion bioreactor during construction. The 1.9 m deep excavated pit was filled with 0.9 m of woodchips which were covered with the excavated soil. Drainage ditch is to the right of the photo. Four PVC sampling ports were placed in the bioreactor, with woodchips taken from these sampling ports after 25 months for woodchip nutrient analysis and denitrification potential testing.

Figure S4. View of the in-ditch riser structure looking downstream. Flow entered the diversion bioreactor through the upturned PVC elbow and corrugated plastic tube entering the bank on right side of photo.

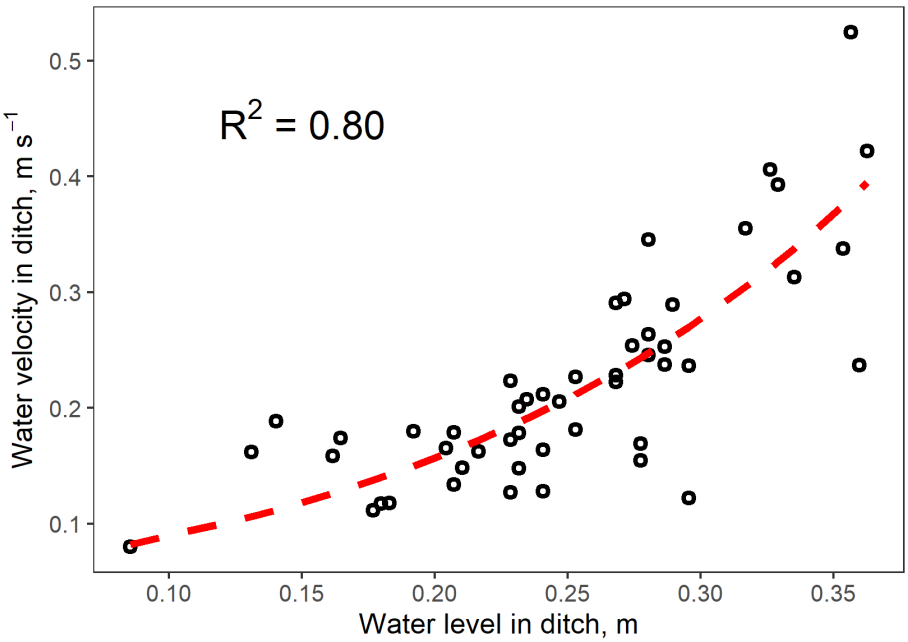

Figure S5. Non-linear regression between manually measured water level in ditch and water velocity measured using the float method. Dashed red line indicates predicted water velocity based on fitted equation. The relationship between water depth and velocity was used to estimate flow through the cinderblock weir between site visits. The resulting relationship of water level and velocity was non-linear ($R^2 = 0.80$) described by the equation velocity = $0.0631 * e^{5.763 * depth}$, where velocity and water depth are in m s^{-1} and m, respectively.

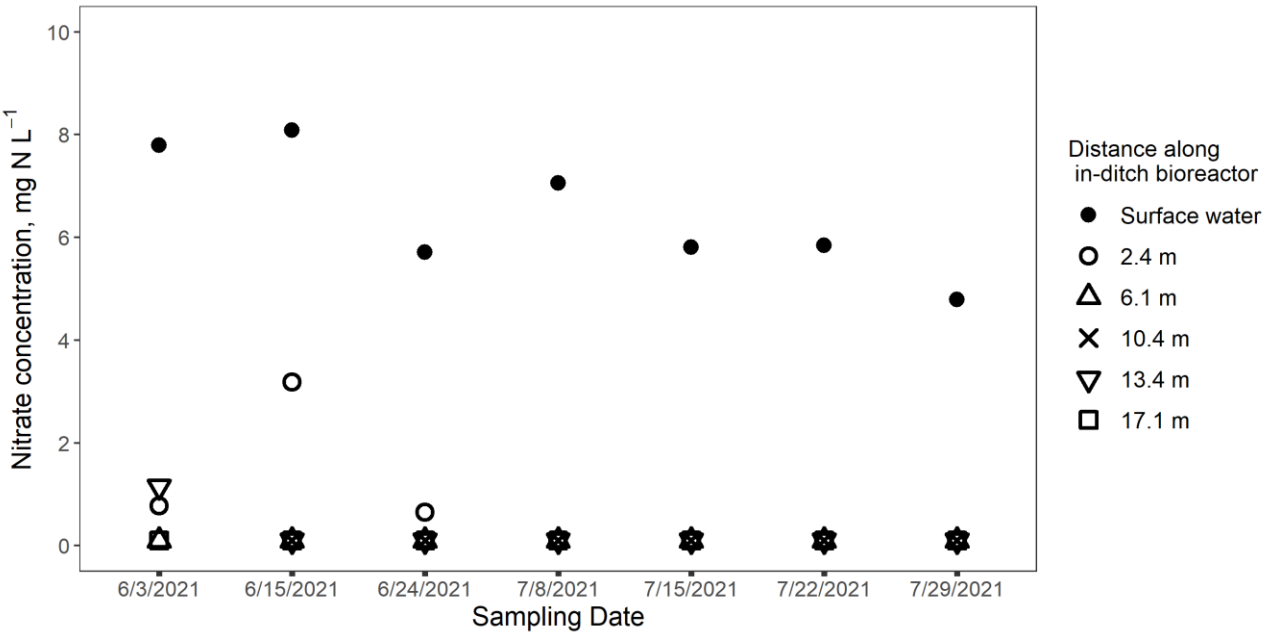

Figure S6. Nitrate concentrations in the surface water and in pore water samples of the in-ditch bioreactor during summer 2021. Samples were drawn from pore water sampling wells located along the length of the bioreactor.

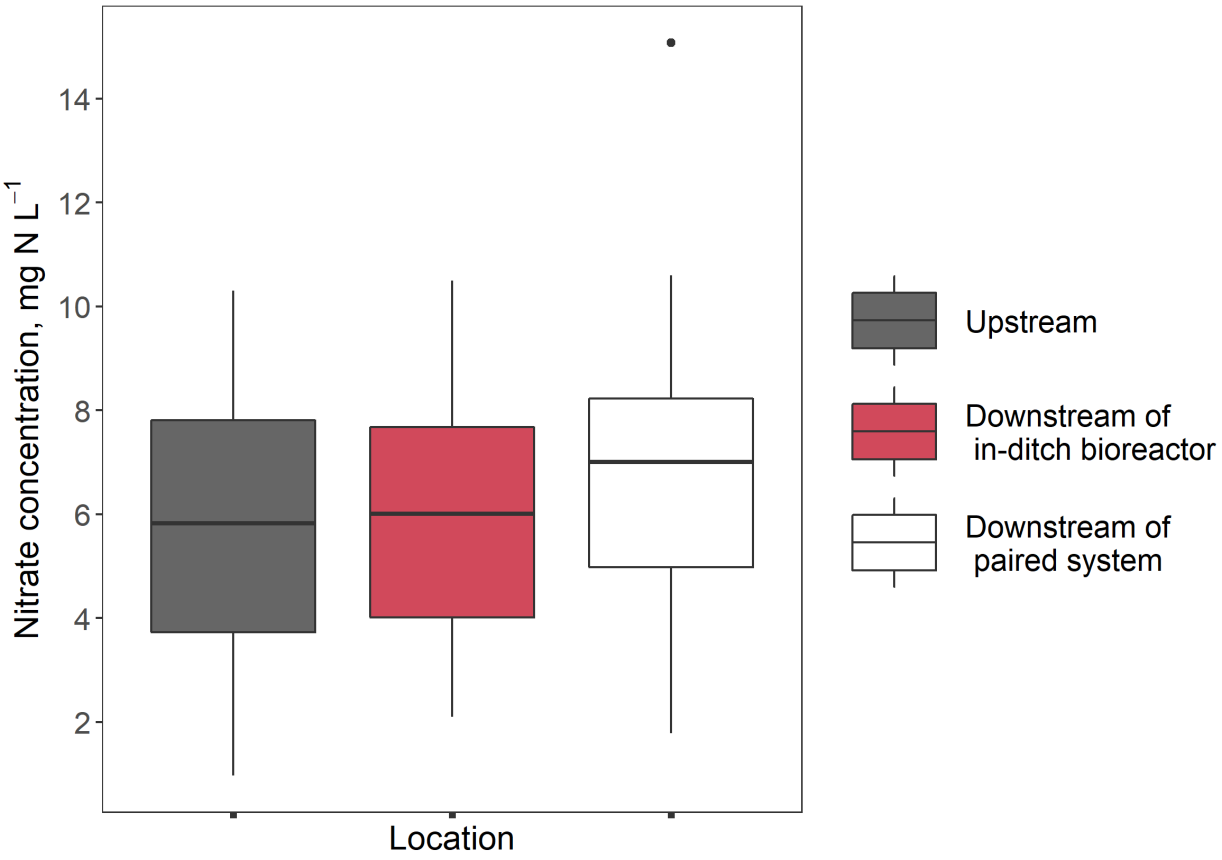

Figure S7. Nitrate concentrations at the upstream cinderblock weir (n = 52, Point A, Figure 1), downstream of the in-ditch bioreactor (n = 47, Point F), and downstream of the outlet of both bioreactors (n = 39, Point G). Box edges indicate 25th and 75th percentiles, whiskers indicate 1.5*interquartile range, points indicate outliers.

Table S1. Composition of soil samples taken from the in-ditch and diversion bioreactor. Mean ± standard deviation are shown (n = 3 for all parameters of both rows other than soil texture, which was not run in triplicate due to sample volume). Different lowercase letters represent significant differences at $p < 0.05$ probability level.

Location	Organic matter	Bray 1 Phosphorus	Potassium	Magnesium	Calcium	Sand	Silt	Clay
	%	---------- ppm ----------				--------- % ---------		
Composite sample of settled soil on top of in-ditch bioreactor	3.4 ± 0.2 a	19.3 ± 0.9 a	151 ± 10 a	547 ± 22 a	2567 ± 94 a	44	27	29
Composite sample of soil cover from diversion bioreactor	2.5 ± 0.5 b	5.3 ± 0.5 b	186 ± 4.6 b	780 ± 28 b	2183 ± 62 b	20	35	45