SUPPLEMENTARY MATERIAL

Restoration practices and soil properties influence potential denitrification in agricultural floodplain wetlands

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Online Resource 1

Dissolved gas analysis

Dissolved concentrations of N_2, O_2, and Argon (Ar) in water samples were determined using a Membrane Inlet Mass Spectrometer (MIMS). Each gas was analyzed according to its atomic mass-to-charge-ratio as follows: N_2 at *m/*z 28, O_2 at *m/z* 32, and Ar at *m/z* 40. Standards for dissolved gas were prepared by continuously stirring deionized water to make sure that the gas concentrations were in equilibrium with the atmosphere. The deionized water was kept in a 1 L round-bottomed flask and placed in a water bath set at 24°C.

To determine the concentration of each gas, the thermodynamically expected concentration at 24°C, which was adjusted for atmospheric pressure (Weiss, 1970) was divided by the average *m/z* signal obtained from triplicate standard measurements. The slope between each set of standards was used as a calibration factor to adjust m/z signal of N_2, O_2, and Ar in each sample before calculating concentrations of each gas. The Ar ratio method in R (*mimsy* package) was used to correct for physical effects on N_2 and O_2 concentrations (Kelly, 2020). Because Ar only changes due to physical processes, while O_2 and N_2 respond to both physical and biological processes, the effects of physical changes on the measured gas concentrations can be corrected using Ar ratio as follows:

$$[BG]_{sample} = \left(\frac{uncorrected[BG]_{sample}}{[Ar]_{sample}} \times [Ar]_{expected}\right)\left(\frac{[BG]_{expected}/[Ar]_{expected}}{[BG]_{standard}/[Ar]_{standard}}\right)$$

where,

$[BG]_{sample}$ = corrected concentration of biologically active gas (N_2 and O_2),

$uncorrected[BG]_{sample}$= concentration of N_2 and O_2 before Ar ratio correction,

$[Ar]_{sample}$ = Ar concentration in the same sample,

$[Ar]_{expected}$ = thermodynamic Ar concentration at 24°C,

$[BG]_{expected}/[Ar]_{expected}$ = thermodynamically expected N_2: Ar and O_2: Ar measurements at 24°C, and

$[BG]_{standard}/[Ar]_{standard}$ = N_2: Ar and O_2: Ar measurements averaged over three triplicate standards.

The output gas concentrations from MIMS were expressed as mg L^{-1} of N_2 and O_2 and the areal flux for each sediment core was expressed as mg m^{-2} h^{-1}.

Soil properties

Approximately half of the homogenized soil sample from each 0-10 cm soil core was used for nutrient analysis. Soil samples were dried in an oven at 60°C and ground to pass a 2 mm mesh screen. A subset of ground soil was transferred to fill 20 mL scintillation vials and shipped to the Soil Testing Laboratory at Kansas State University where TC, TN, and extractable P were analyzed. Total C and TN were analyzed by dry combustion (Wright & Bailey, 2001), while Mehlich-3 extraction and colorimetry (Mehlich, 1984) were used to determine "plant-available" P (orthophosphate). Soil nutrient concentrations were reported as mg g^{-1} dry weight.

Soil moisture was measured using the thermogravimetric method, which involved weighing a fresh sample before and after oven drying (Evett et al., 2008). A 30 g fresh homogenized subsample from each 0-10 cm soil core was oven-dried at 105°C. Soil moisture was reported as g g^{-1} of dry soil. Assuming uniform pore size for each core, the moisture loss from the 30 g sample was used to calculate moisture loss for the total soil mass of 456.04 cm^3 (volume of the acrylic tube). Bulk density was reported as g cm^{-3}.

Soil pH was measured using a handheld pH meter in a 1:2 fresh soil-to-water ratio after a 30-minute equilibrium (Reddy et al., 2013), with three-point calibration (pH 4, 7, and 10 buffers). A 10 g homogenized soil subsample was mixed with 20 ml deionized water in a 50 ml beaker. The suspension was stirred for 10 seconds every 5 minutes over a 30-minute period. After settling for 30 more minutes, the pH was measured by immersing the electrode in the supernatant and recording the value once stabilized (usually within 1 minute).

Table S1 Soil properties mean ± 95% CI for 21 easements and 5 restoration practices. The soil properties include O_2 flux, soil moisture (SM), bulk density (BD), pH, total carbon (TC), total nitrogen (TN), and extractable phosphorus (P). Means associated with different lowercase letters are significantly different by post hoc analysis

Restoration practices	**Natural regeneration (n=7)**	**Remnant forest (n=16)**	**Shallow water-dry (n=15)**	**Shallow water-wet (n=18)**	**Tree planting (n=17)**	**All practices (n=73)**
24 h O_2 (mg m^{-2} h^{-1})	-78.26 ± 4.57^{a}	-48.75 ± 6.19^{b}	-56.12 ± 9.78^{bc}	-61.81 ± 8.62^{abc}	-64.70 ± 6.37^{ac}	-60.03 ± 3.80
48 h O_2 (mg m^{-2} h^{-1})	-103.13 ± 11.44^{a}	-88.99 ± 5.49^{b}	-91.49 ± 5.92^{ab}	-93.99 ± 5.66^{ab}	-97.99 ± 5.08^{ab}	-94.23 ± 2.64
SM (g g^{-1})	0.46 ± 0.29^{ab}	0.41 ± 0.10^{b}	0.52 ± 0.13^{ab}	0.71 ± 0.10^{a}	0.35 ± 0.08^{b}	0.50 ± 0.06
BD (g cm^{-3})	1.01 ± 0.15^{a}	0.99 ± 0.06^{a}	1.02 ± 0.12^{a}	1.00 ± 0.06^{a}	1.09 ± 0.09^{a}	1.03 ± 0.04
pH	5.46 ± 0.61^{a}	5.40 ± 0.22^{a}	5.32 ± 0.31^{a}	5.80 ± 0.27^{a}	5.34 ± 0.17^{a}	5.47 ± 0.12
TC (mg g^{-1})	19.95 ± 4.91^{ab}	22.48 ± 4.72^{a}	16.68 ± 3.87^{ab}	14.52 ± 2.97^{b}	18.01 ± 4.01^{ab}	18.04 ± 1.78
TN (mg g^{-1})	1.92 ± 0.39^{a}	2.12 ± 0.37^{a}	1.71 ± 0.34^{a}	1.56 ± 0.25^{a}	1.70 ± 0.29^{a}	1.78 ± 0.14
P (mg g^{-1})	0.05 ± 0.01^{a}	0.05 ± 0.01^{a}	0.04 ± 0.01^{a}	0.04 ± 0.01^{a}	0.04 ± 0.01^{a}	0.04 ± 0.004

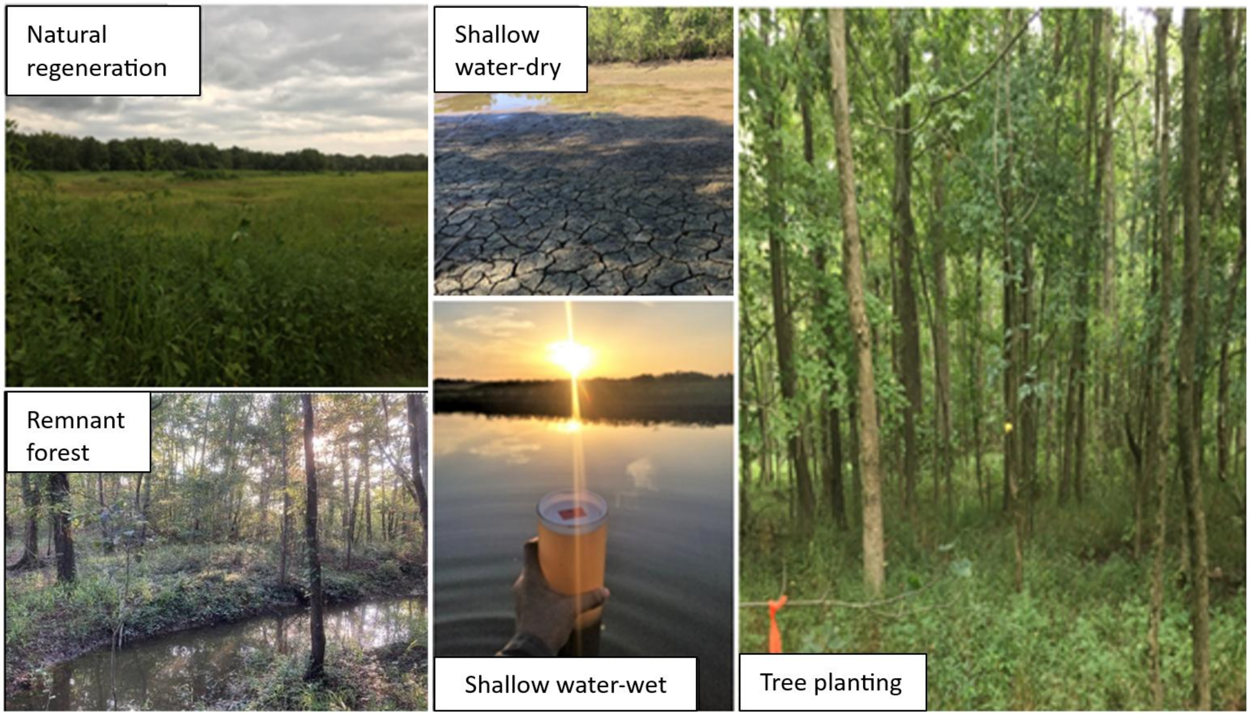

Fig. S1 Examples of each restoration practice sampled in the study sites

Fig. S2 Welded steel corer assembly (top) and paired soil function and soil structure cores (bottom)

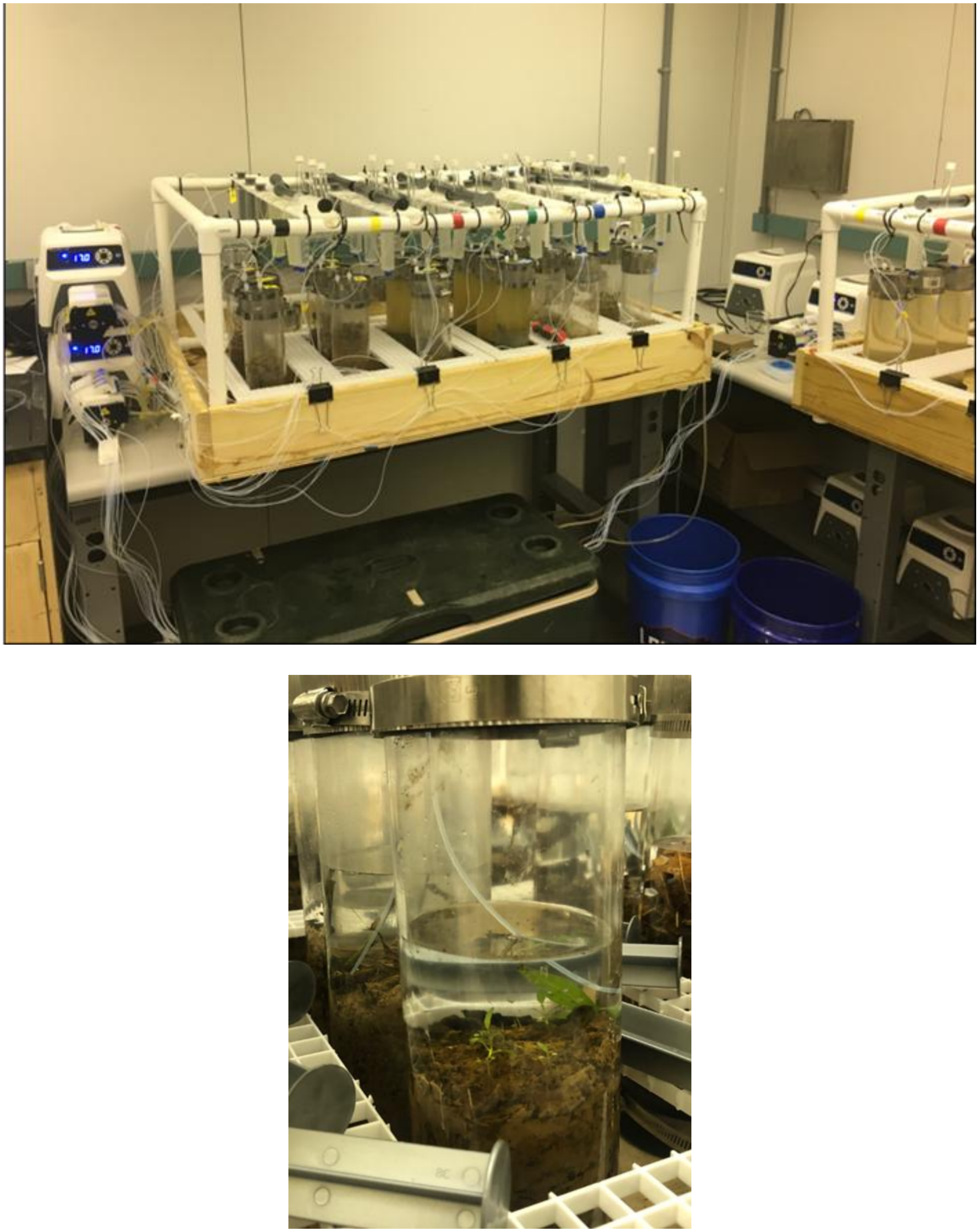

Fig. S3 Flow-through incubation setup in an environment chamber with peristaltic pumps and the recirculating system (top) and a close-up image of incubation cores (bottom)

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