

# Recovery of Microbial Functional Diversity in Restored Wetlands

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## INTRODUCTION

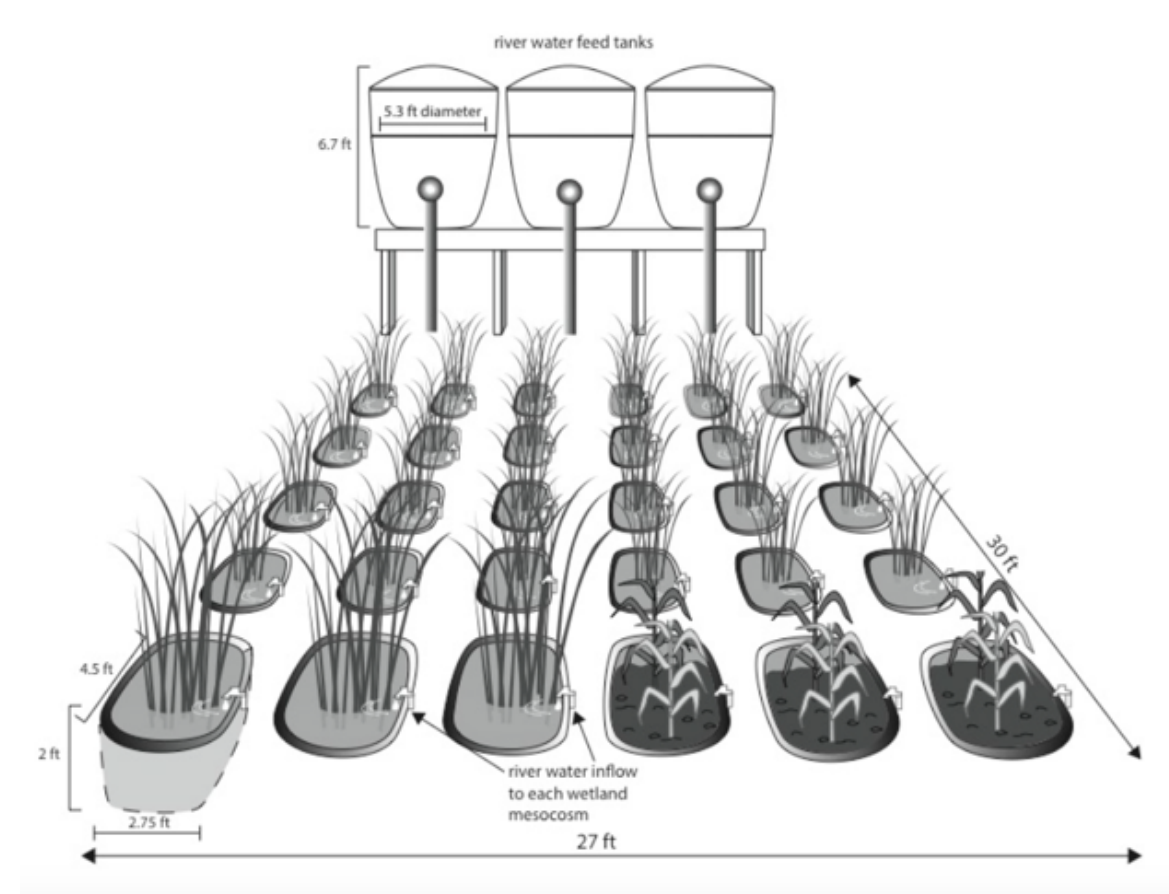
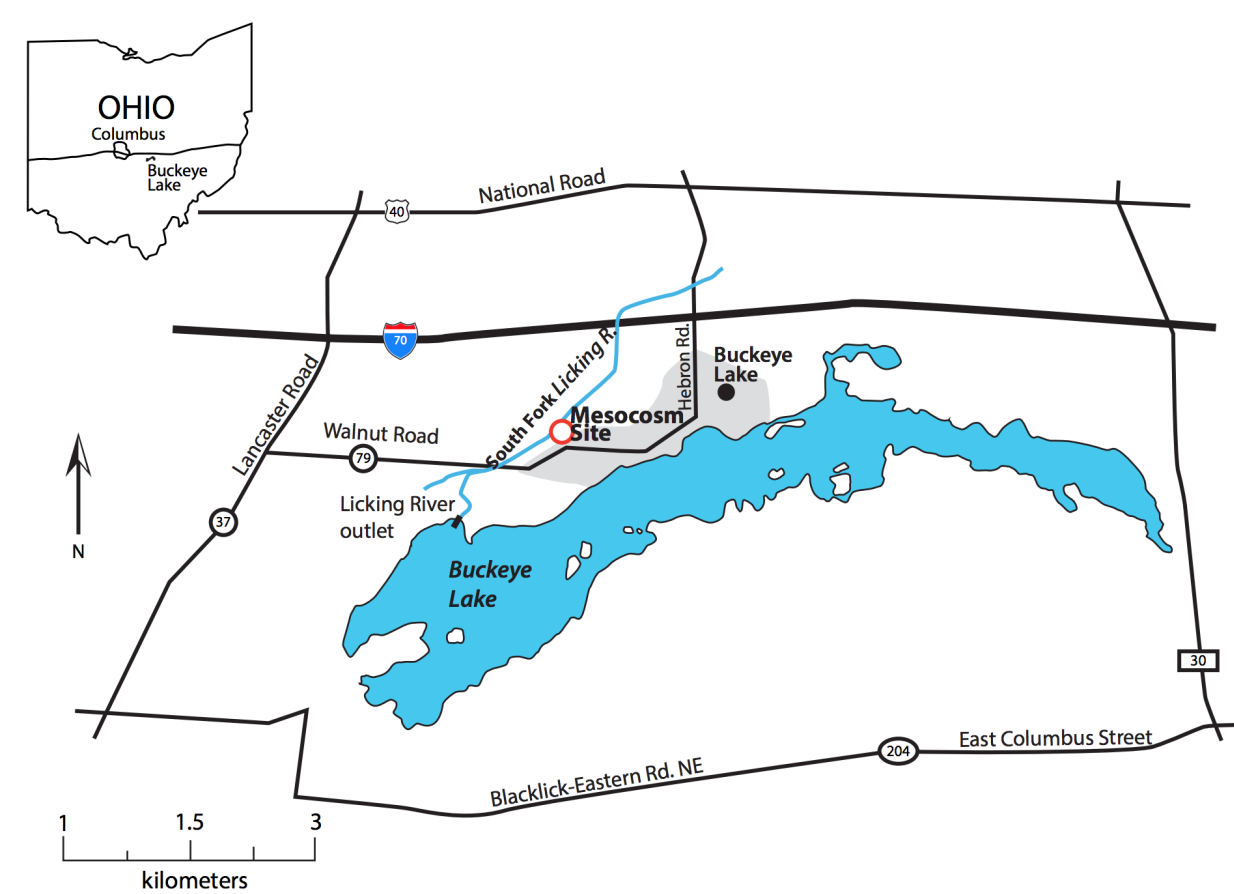
Wetlands play a major role in the water, mineral, and organic compound cycles on earth. They perform important ecosystem services such as supporting biodiversity, storing carbon, mitigating flood waters, and improving water quality. Known as 'nature's kidneys,' they trap and filter sediment, take up excess nutrients, and act as a sink for some toxins.

However, human disturbances such as land use conversion, wetland drainage and the runoff of fertilizers used in agriculture have degraded wetland ecosystem structure and in turn their ecosystem services. One consequence of wetland loss is the chronic degradation of water quality from agricultural runoff. To remedy this, wetland restoration is proposed as a means to recreate these ecosystem services in agricultural landscapes.

The purpose of this experiment is to investigate the effects of hydrology and nutrient loading rates on the establishment of ecosystem services in restored wetlands that lead to nitrogen removal and improved water quality. Many of the processes that create water quality benefits are carried out by soil microbial communities.

Therefore, we assessed levels of microbial functional diversity and its links to denitrification rates, soil respiration, and nitrogen removal efficiency in a system of 30 restored experimental wetland mesocosms.

## METHODS AND MESOCOSMS



30 mesocosm tubs were equipped with a drainage system enabling the manipulations of water levels. Each tub was filled with pea gravel (approximately 8-10 cm) and then with site soil (approximately 30-35 cm). Water levels were monitored and maintained at saturated soil conditions with little standing water. Four treatments were established: high and low water loading rates (10 and 30 cm added depth per week) and deep (15 cm) and shallow (5 cm) water levels.



Biolog EcoPlates were used to quantify microbial functional diversity within each mesocosm. The plates measure 31 carbon sources per assay with three replicates for each source. The carbon sources consist of types of carbohydrates, carboxylic acids, polymers, amino acids, amines/amides. EcoPlates were inoculated with samples from each of the 30 mesocosms. When microbes respire using the substrates, tetrazolium dye that was combined with the carbon source develops a purple color, indicating microbial growth. This response is called a metabolic fingerprint. We read the plates by a microplate plate reader at 530 nm.

## FUNCTIONAL DIVERSITY RESULTS

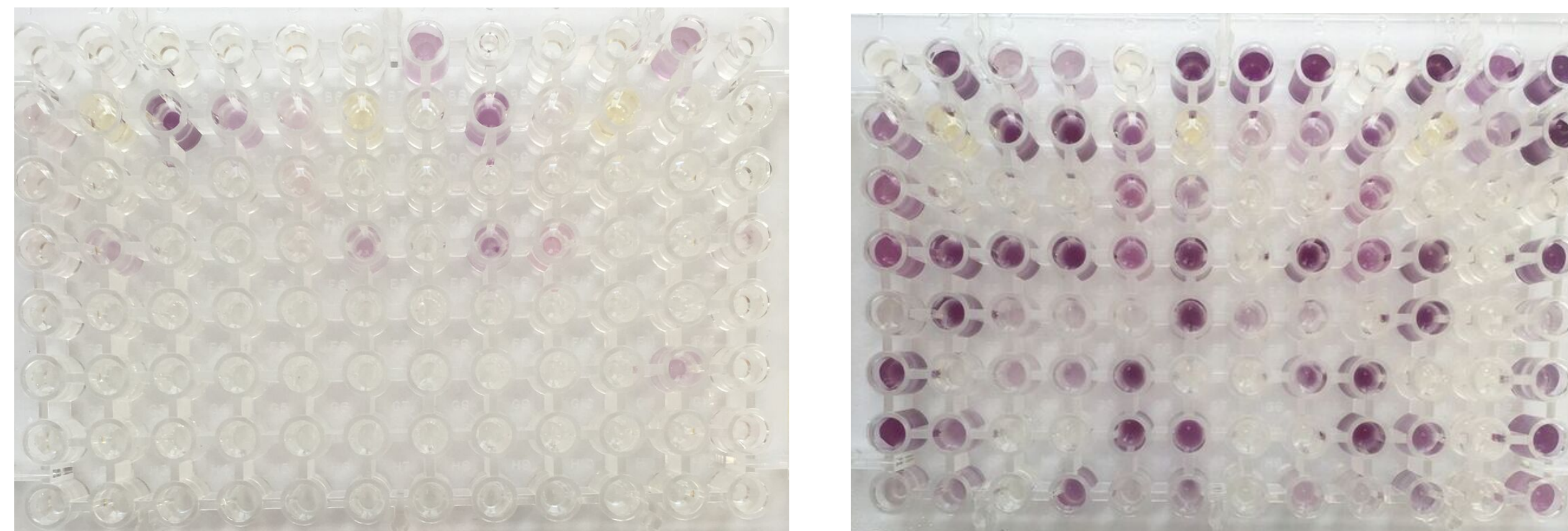


Figure 1. Example of the range in response of the EcoPlates to soil microbial diversity. EcoPlate M14 (low deep treatment) displays low functional diversity (29%) on the left. EcoPlate M27 (high shallow treatment) shows very high functional diversity (74%) on the right.

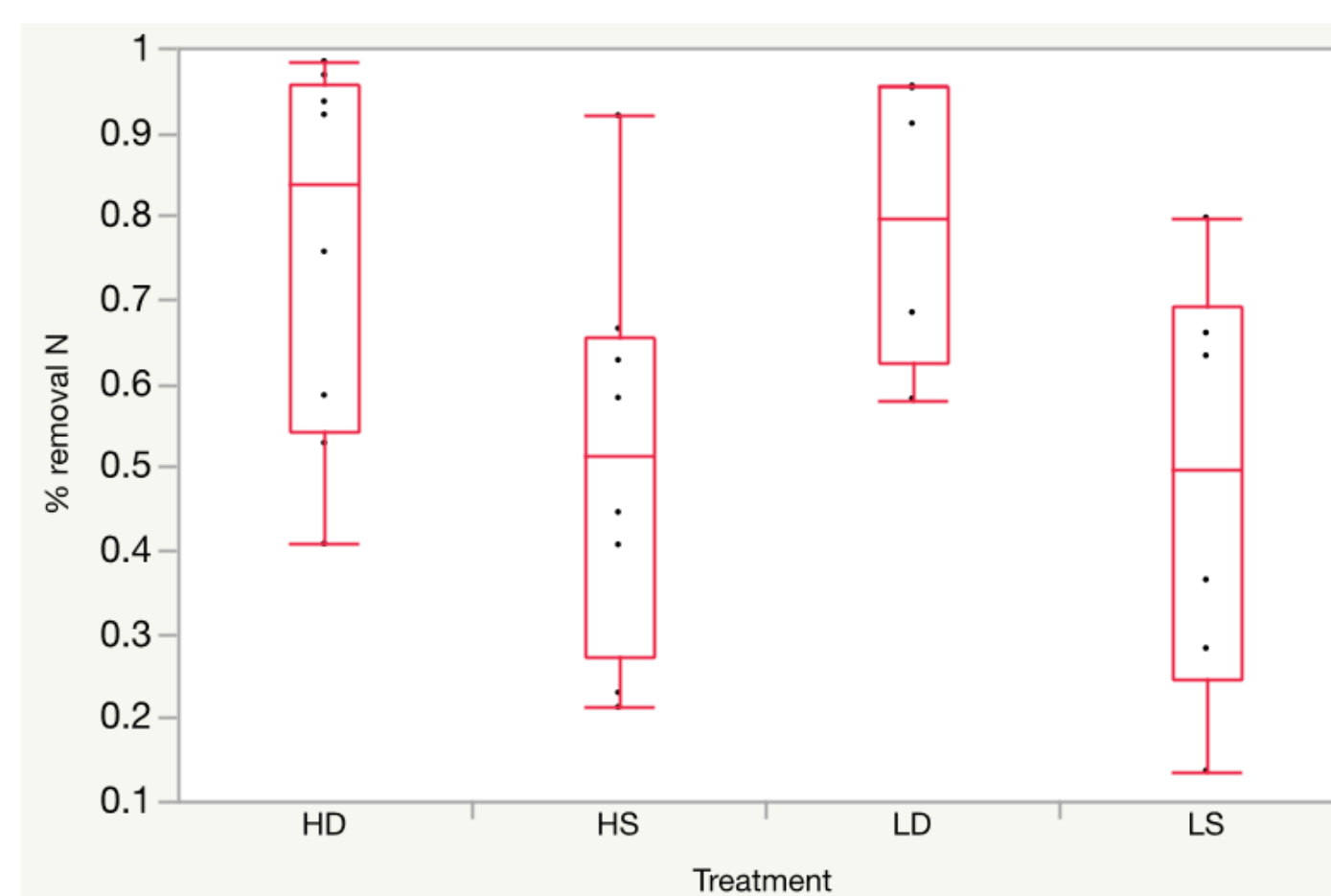


Figure 2. The percent nitrate removal was significantly higher in the deep water treatments, demonstrating water quality benefits ( $p = 0.03$ ).

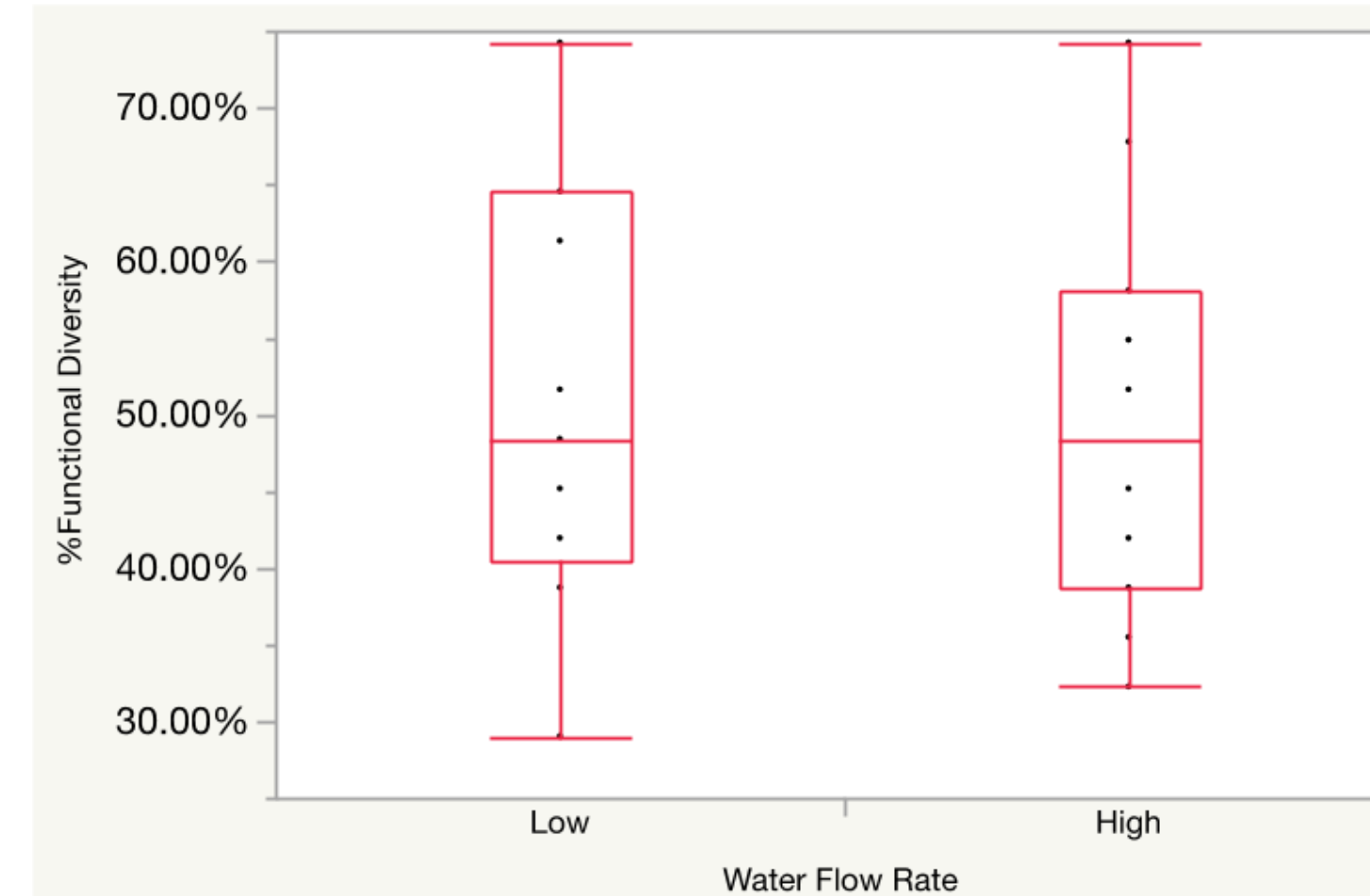


Figure 3. Functional diversity levels showed no significant difference as a function of loading rates ( $p=0.35$ ).

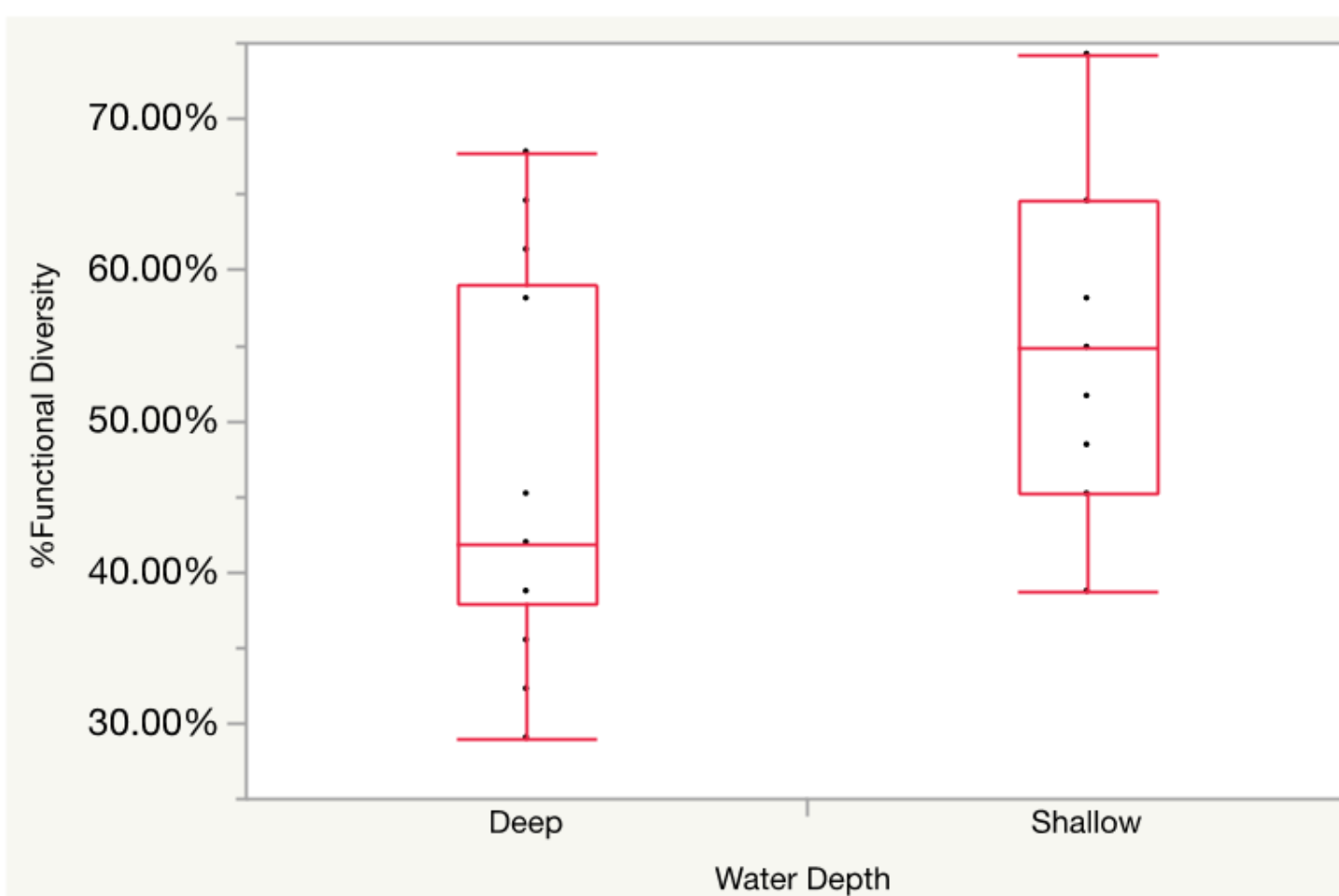


Figure 4. Functional diversity levels were significantly higher in the shallow water treatment in comparison to the deep treatment ( $p=0.03$ ).

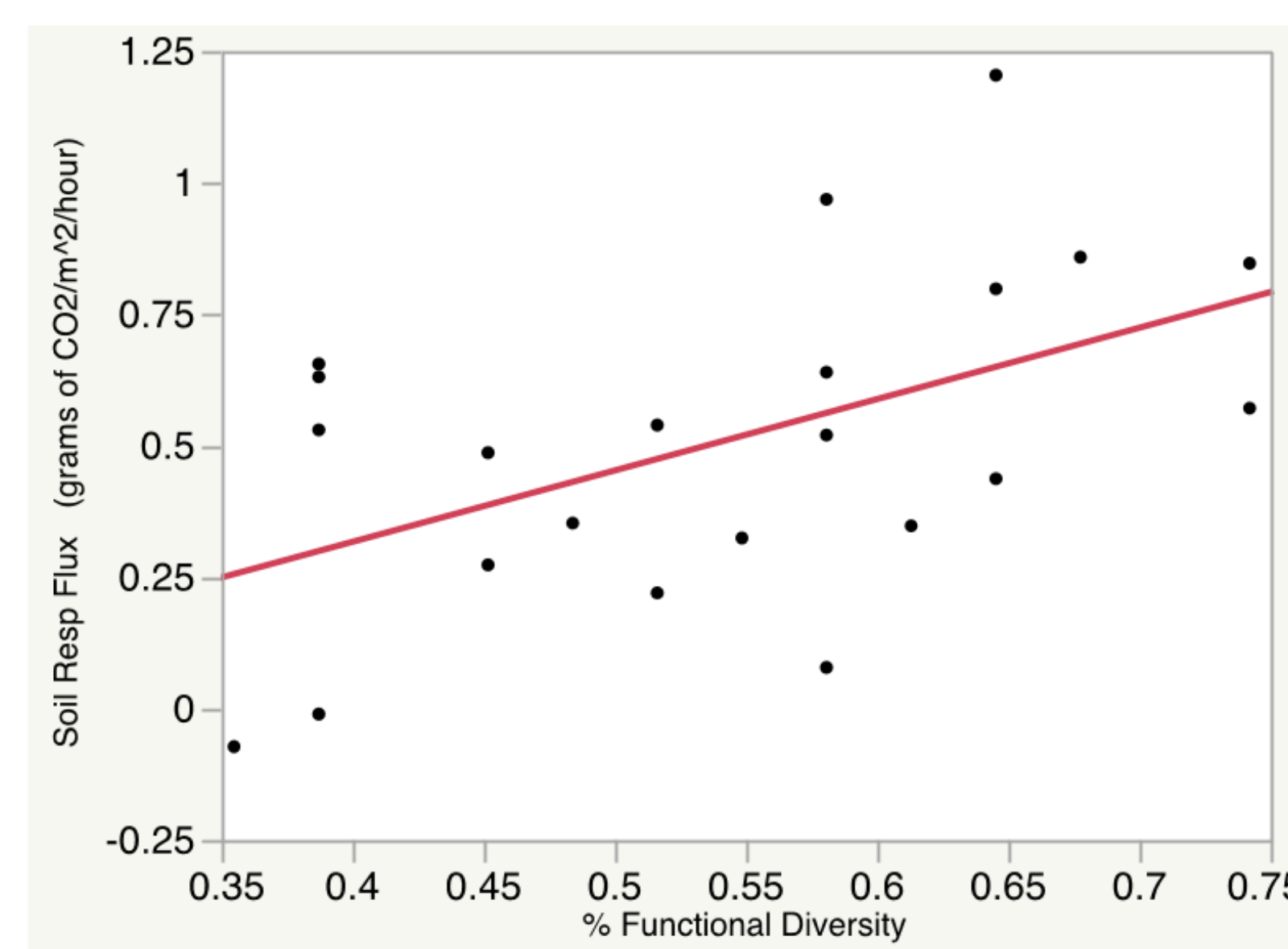


Figure 5. Regression analysis showing relationship of soil respiration rates and levels of soil microbial functional diversity.  $R^2 = 0.259$ ,  $p$ -value = 0.02.

## DISCUSSION

We found higher functional diversity in the mesocosms with shallow water, which we expected. Shallow waters allow for alternating reduction through both aerobic and aerobic respiration. The mesocosms with high loading rates demonstrated greater nitrate removal which was not expected.

We did not see a difference in functional diversity between the high and low loading rates. These differences may develop over time as the ecosystem develops over time since restoration.

Furthermore, soil respiration was higher where functional diversity was higher. Thus lower water levels may lead to more rapid recovery of microbial functions in restored sites.



## FUTURE WORK

We can continue this experiment by studying how the mesocosms change as the ecosystems they represent become established and complexity develops. Microbial functional diversity may increase over time.

We will also compare the functional diversity of experimental wetland mesocosms to natural, preexisting wetlands.

## REFERENCES

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