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UNL MESOWheels Program
What is a Floating Treatment Wetland?

BACKGROUND:
The Nebraska Nitrogen Problem:
Nitrate-N is an inorganic form of nitrogen that is often used for plant fertilizer. While nitrate-N is very important for plant growth, overapplication has led to it being prevalent in both groundwater and surface waters in Nebraska. Exposure, specifically drinking water with high nitrate-N can lead to significant health effects (i.e., methemoglobinemia (blue baby syndrome), heart defects). Further, high nitrate-N with phosphate-P can result in toxic algal blooms and enhanced *E. coli* growth in lakes and reservoirs.

Floating Treatment Wetlands (FTWs):
Floating Treatment Wetlands (FTWs), also referred to as floating wetland islands or artificial reed beds, consist of emergent macrophytes growing on a floating mat on the lake water surface in contrast to being rooted in sediment like traditional wetlands[1] (Figure 1). Land is not required for FTW systems, which is often the limiting factor for traditional wetland treatment systems[2]. FTWs have the potential to provide water treatment for total nitrogen, ammonium-N, nitrate-N, total microcystin-LR, E. coli, and total phosphorus (TP)[2–5]. **However, many questions remain about FTW systems, specifically regarding their potential use in the Midwest along with their management and design requirements.**

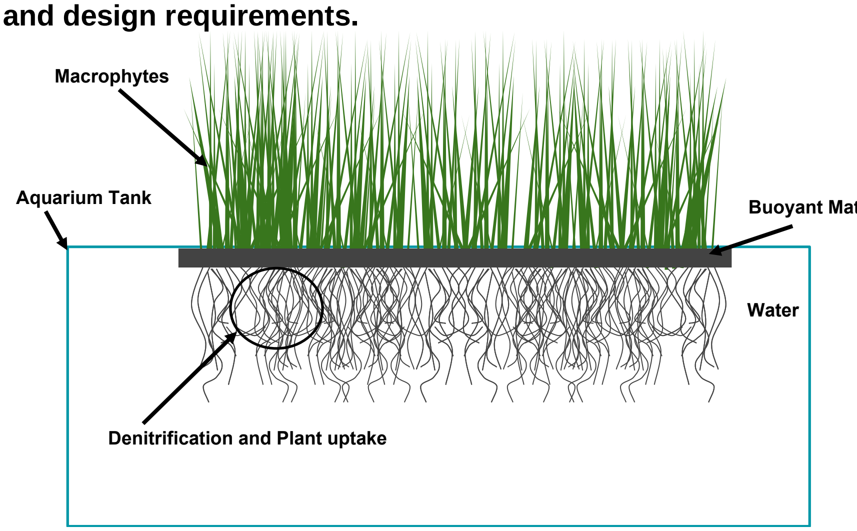

Figure 1: FTW in aquarium tank.

Denitrification versus plant uptake of nitrate-N removal:
FTWs can remove nitrate-N in two primary ways: denitrification and plant uptake (Figure 2). Denitrification is a microbial process in which microbes transform nitrate-N into nitrogen gas that is released to the atmosphere. This results in ***permanently*** removing nitrate-N from the water. In contrast, plant uptake temporarily removes nitrate-N by taking up the nitrate-N and holding it tin the plant tissue throughout the growing season and releasing nitrate-N back into the water as the

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plants die in the fall. This results in a ***recycling*** effect for the nitrate-N into and out of the water. To distinguish between two likeliest forms of removal, water chemistry conditions can be observed. Typically, when conditions favorable for denitrification are present, denitrification will prevail over plant uptake. These conditions include:

1. pH ~ 7
2. Dissolved oxygen <3 mg/L
3. Organic carbon (provided by your mat amendment or plant roots/leaves)
4. Nitrate-N (provided by your fertilizer application)
5. Water temperature > 65° F

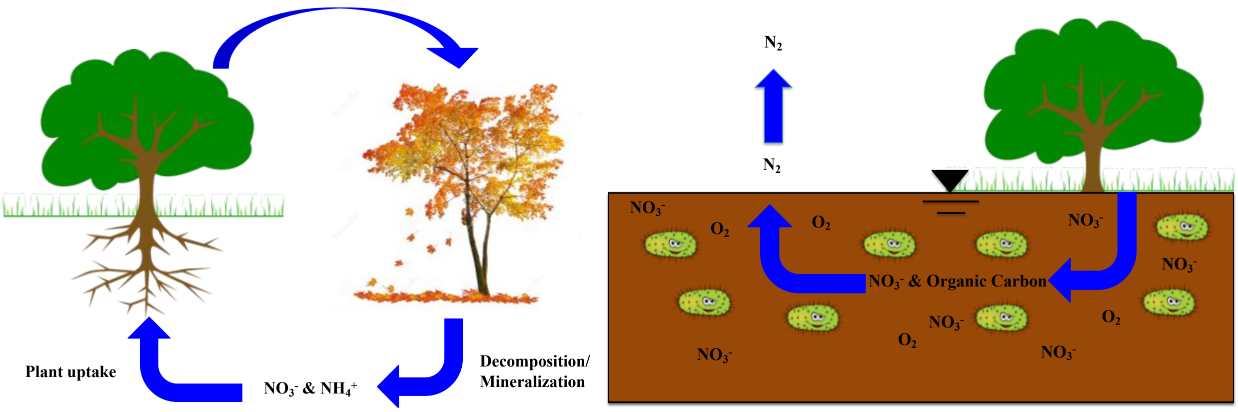

Figure 1: Nitrate-N removal processes in wetlands: (left) plant uptake and (right) denitrification.

OBJECTIVE:

The objective of this exercise is to study the nitrate-N removal of FTWs for nitrate-N (a form of nitrogen fertilizer) removal to prevent algal blooms in lakes and reservoirs. Three treatments will be evaluated:

1. No FTW (control)
2. FTW
3. FTW with mat amendment

MATERIALS NEEDED:

Material	**Cost per Item**	**Total**
3 10-gal aquarium tanks	$15	$30
Beemat	$5	$5
10 Native Wetland Plants	$3	$30
Nitrate Test Strips	$20	$20
pH Strips	$10	$10
Temperature/Dissolved Oxygen sensor	Borrowed from UNL	
Amendment (spent coffee)	$0	$0
Fertilizer (NO_3-N of ~ 10 mg/L)	$5	$5
Total		**$100**

PROCEDURE:

1. Create a miniature floating treatment wetland (See Figure 1):
   a. Add tap water to all 3 aquariums
   b. Leave one aquarium with just tap water
   c. In the other two aquariums place plant plugs in floating mat (allow to establish for at least 2 months) by providing light and fertilizing. Algae may form and can be cleaned or left.
   d. Add an amendment (i.e., coffee, straw) to the surface of one of the floating mats, while leaving the other aquariums with no amendment
   e. Add the fertilizer and mix well into the aquarium to dissolve without disturbing the mats.
   f. Over the next month measure the nitrate-N and pH of the three tanks using the test strips and dissolved oxygen and temperature using the probe every week to 2-3 days as time allows. Do not sample on the first day as sometimes that nitrate-N needs a day or so to be mixed in. Once the nitrate-N concentrations reach 0 or 0.5 mg/L in two of the aquariums, sampling should be stopped.
   g. Record values each time the samples are taken.
   h. At the end of the experiment compare results of nitrate-N removal and changes in the water chemistry.
   i. Using the following equation determine the % removal for each aquarium:

$$\%_{Removal} = \frac{Nitrate_{Day1} - Nitrate_{LastDay}}{Nitrate_{Day1}}$$

$\%_{Removal}$ = percentage of nitrate-N removed in the aquarium
$Nitrate_{Day1}$ = concentrations of nitrate-N on Day 1 of the experiment
$Nitrate_{LastDay}$ = concentrations of nitrate-N on last day of the experiment

DISCUSSION:

1. Which system removed nitrate-N the quickest? Why?
2. Which system removed the most nitrate-N? Why?
3. Were requirements for denitrification present? How did this impact removal rate and quantity?
4. How could you use these practices in your community?