Evaluation of Nitrogen Reduction Options and the Viability of Nutrient Farming in Minnesota

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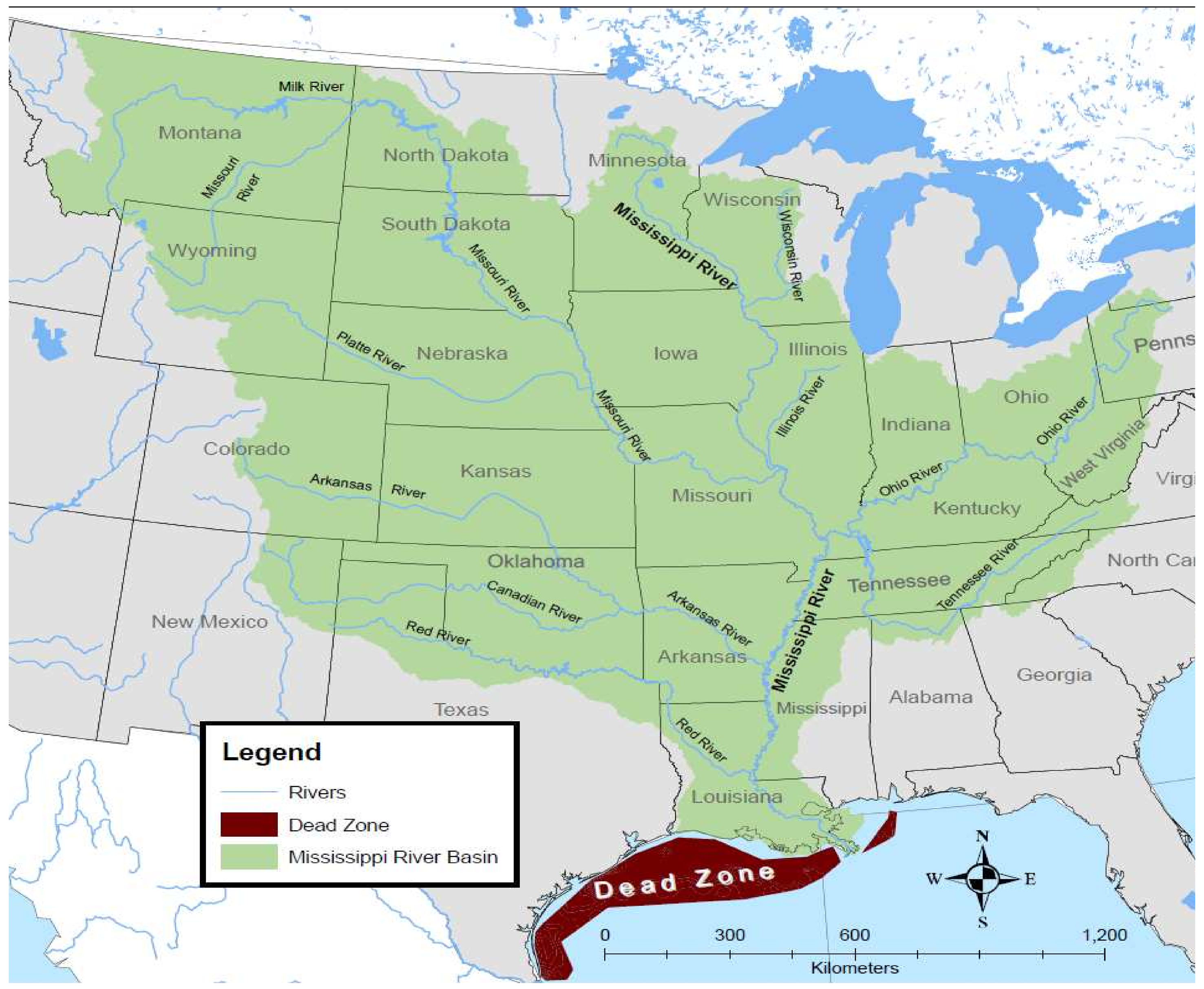
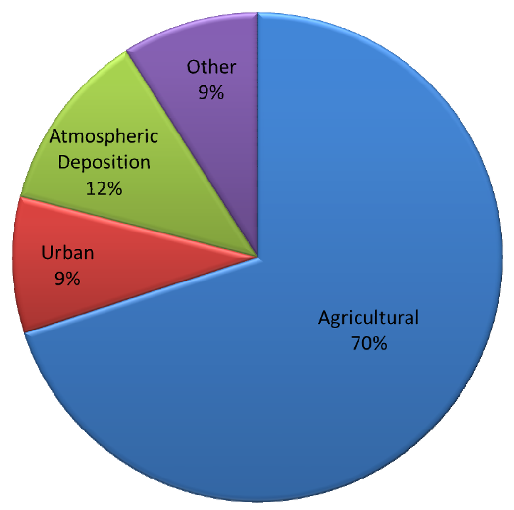
Abstract: Excessive nitrogen (N) runoff, i.e. nutrient loading, is one of the largest problems facing the Mississippi River today. Nutrient loading ultimately causes the dead zone in the Northern Gulf of Mexico and results in unappealing algal blooms, which negatively affect freshwater ecology throughout the Mississippi River Basin (Figure 1). Wetland restoration is one prominent nutrient reduction strategy; the only barrier is finding landowners willing to give up otherwise still productive land for wetland restoration. Nutrient farming is a potential market solution that can motivate landowners to restore wetlands. I conducted a literature review, and interviewed various experts and landowners on the topic of nutrient farming and its feasibility and application for Minnesota. **I conclude that nutrient farming is viable in suite with other options for reducing nutrient loading.** Unlike most other solutions, where landowners or the government provide the funds to implement nutrient reduction strategies, nutrient farming creates a system that makes the dischargers pay for the pollution that they put into waterways, while also paying those who give up land resources for cleaning the nation's waterways.

Nitrogen Loading





(Above) Figure 1. : The Mississippi Basin (MRB) and the 2008 dead zone.

(Left) Graph 1. A pie graph showing the breakdown of nitrogen loading sources.

- The dead zone is caused by eutrophication, which is the decrease of oxygen in an oceanic column. This is due to algae decomposition.
- The growth of algae is heightened by greater nutrient loads. A key nutrient in this process is nitrogen (N).
- The major sources of N-loading are shown in Graph 1. Agriculture is the largest source of N.

Nitrogen Reduction Options

1. Modify Agricultural Practices

Implement management techniques that reduce fertilizer loads

Problems: inability to garner support from farmers

2. Denitrification Bioreactors

Create Bioreactors with purpose of filtering out nitrogen from fields

Problems: degrade over time; expensive

3. Drainage Management

Install "risers" that control the flow of drainage from fields

Problems: high maintenance; expensive

4. Upgrade WWTPs

Upgrade waste water treatment plants to reduce twice as much N-loading

Problems: expensive; unlikely to affect nitrogen loading much, table 1.

5. Restore Wetlands and Riparian Buffers

Wetlands and riparian buffers filter nitrogen and provide other beneficial services

Problems: effectively pulls land, usually farms, out of normal productive service

Comparison of Nitrogen Reduction Options

Option	Potential N-reduction (10^3 metric tons per yr.)	US$ (kg-N^{-1})	Conclusions
Modify Agricultural Practices	900-1400	N/A	Has the greatest potential to reduce N Loading, however it will likely face opposition by farmers
Wetlands: restore 5-13 million acres of wetlands or create 19-48 million acres of Riparian Buffers	300-800	$2.91	Has strong potential to reduce N loading and be implemented as long as funding source are found
Update WWTPs	20	N/A	Unlikely to reduce N loading greatly
Drainage Management	N/A	$2.71	A possible solution of N source "hot spots"
Denitrification Bioreactors	N/A	$2.39-15.17	A possible solution of N source "hot spots"

Table 1. Nitrogen reduction potential comparison conducted by Mistch et al. and the Cost Analysis conducted by Schipper et al.

Nutrient Farming

Large-scale wetland restoration financed by the purchase of nutrient removal credits – either through an open market or through long-term contracts.

- **Background:** In light of the nutrient loading epidemic, the EPA recommends point sources to reduce nutrient discharge by more than 80%. In order for WWTPs (point sources) to meet this, they must upgrade purification systems, which is costly.
- **Solution:** *Nutrient farming* provides a feasible alternative to conventional WWTPs. The cost of using wetlands to provide the same function of WWTPs is less than conventional systems.
- **Case Study:** The Wetland's Initiative (TWI) in Illinois implemented Nutrient Farming for the Metropolitan Water Reclamation District of Greater Chicago. The TWI determined that wetlands providing N and phosphorus (P) reductions could save the MWRD up to twice the cost of upgrading their five WWTPs, Graph 2.

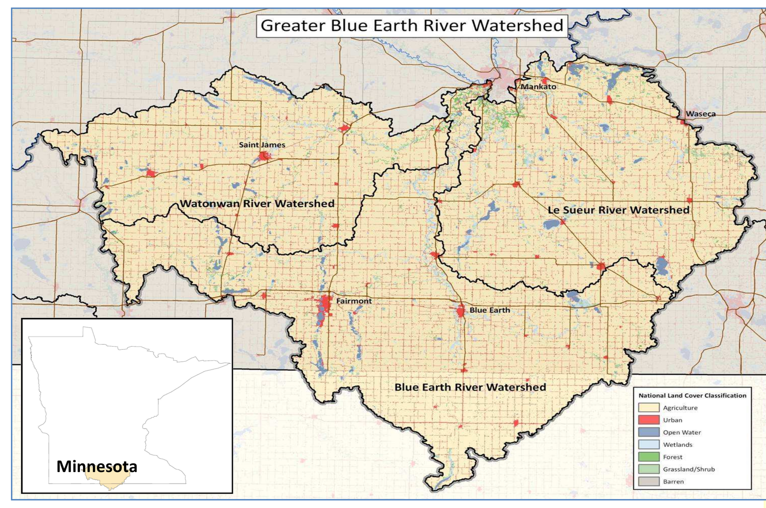
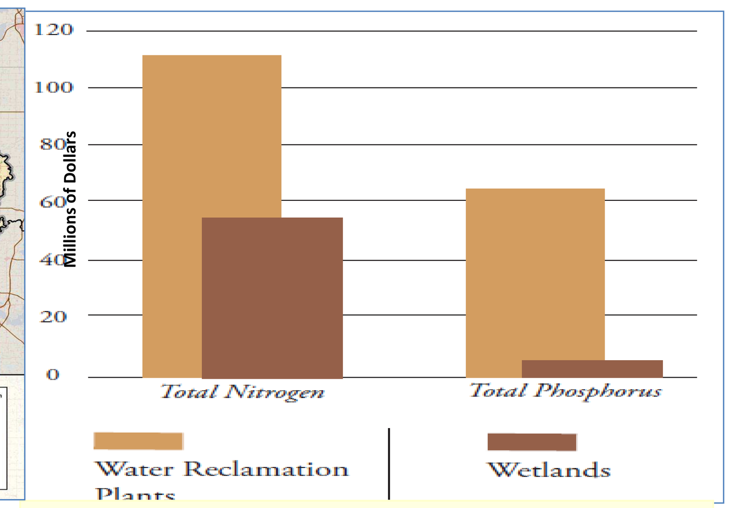


Figure 2. Blue Earth Basin.



Graph 2. Cost comparison of WWTPs and wetlands in N & P reduction; conducted by TWI.

- **In Minnesota:** Minnesota contributes 7% of the N-load that flows into the Gulf. More than half of that N-load stems from the Minnesota River, which includes the Blue Earth Basin, an intensely cultivated region, Figure 2.
- **Potential:** Lansing Sheppard, an author of *This Perennial Lands*, indicated that nutrient farming is a viable option for Minnesota. He also mentioned that the U of M is currently studying treatment wetlands, and are receiving promising results in regards to N reduction. Furthermore Linda Meschke, a partner in the Conservation Marketplace of Minnesota, noted that credit systems for other ecological services are already in place and that eventually nutrient farming may be looked into to reduce N-loading in Minnesota. However, she also stated that current legislation may set environmental laws back for a couple years and that it may be a while before nutrient farming is looked into.

Conclusion: Nutrient farming is a viable strategy to reduce nutrient loading, however it may take a couple years before it takes hold in Minnesota.