Measuring a test market for nutrient farming

Finding profits in the Illinois River Watershed

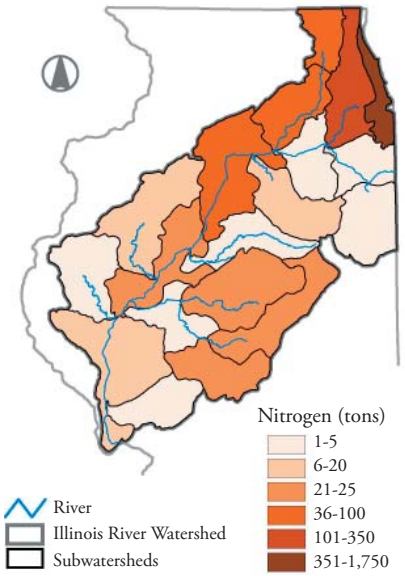
Building upon findings (Hey et al., 2005) that wetland-based treatment would be substantially less expensive than more traditional "concrete and steel" nutrient removal technologies, a nutrient credit market analysis was performed by the University of Illinois at Chicago and The Wetlands Initiative (Kostel et al. 2007). This economic analysis examined the organization, structure, and viability of markets for nutrient credits. For simplicity, the concept was tested using only nitrogen and was applied to the Illinois River Watershed. A linear programming model was developed and used to:

- Examine the potential extent and distribution of total nitrogen credit demand by municipal and industrial dischargers in the Illinois River Watershed;
- Compare the average demand levels to the supply capacity of individual nutrient farms, and;
- Evaluate the relative effects of seasonality under three hypothetical trading scenarios.

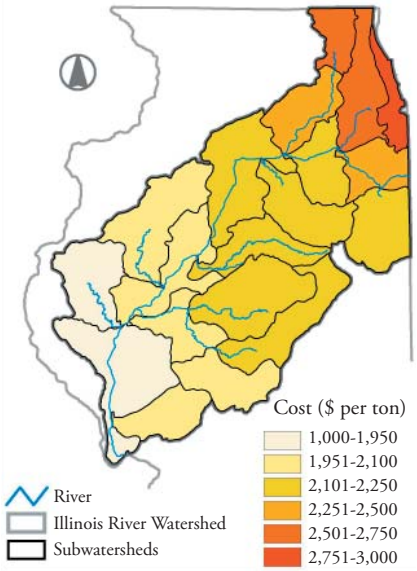
This model was used to simulate an efficient market, or the least costly distribution of wetland-use for a given level of nitrogen removal. The model results indicate which point source discharger should buy credits from which nutrient farm location, or in this case, minor watersheds within the Illinois River watershed. An additional model result is the equilibrium price of a credit, or the prevailing price of a credit at which buyers and sellers are predicted to trade. Predictions of where the most intensive wetland investment will be, revenues returned to these investments, and costs to the point source dischargers are natural model outcomes.

The number of permitted dischargers (290), mass of nitrogen to be removed (2,423 tons/month), and other economic characteristics allowed for estimates of the demand for nitrogen credits. This information was coupled with information about supply of nitrogen, based either on the availability of nitrogen in the rivers or on the

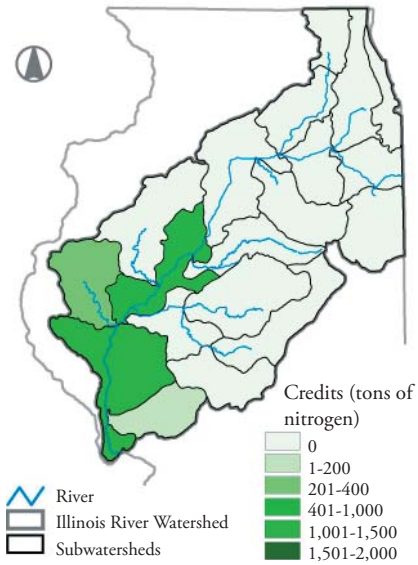
1. Monthly Nitrogen Credit Demand by Municipal and Industrial Dischargers



2. Spring Marginal (Credit) Costs by Subwatershed to Meet Nitrogen Demand



3. Location of Most Cost-Effective Nutrient Farms (Spring, "Unrestricted" Scenario)



The demand for nitrogen removal credits in the Illinois River Watershed would vary greatly (Figure 1) based on the location and the volume of the municipal and industrial dischargers. The subwatersheds near Chicago would have the highest demand. Similarly the cost to use wetland-based nutrient farms in these watersheds would be highest (Figure 2), mainly due to higher land costs. However, if there were no regulatory penalties or restrictions imposed, then the monthly demand would be met most cost-effectively by the subwatersheds in the southern portion of the Illinois River Watershed (Figure 3).

Nutrient Farm Market Parameters Under Three Trading Scenarios

	Trading Scenarios		
	Unrestricted	Restricted Intrwatershed	Accrued 10% Penalty
Total Credits Sold	29,078	29,078	35,781
Total Revenue[1]	$69,925,497	$99,571,889	$121,457,652
Total Cost to Produce Credits	$63,258,006	$66,193,924	$83,288,747
Profit	$6,667,491	$33,377,968	$38,168,905

[1]Assumes all credits were sold at the cheapest cost within the Illinois River Watershed

suitability of nutrient farming sites within the 19 subwatersheds in the Illinois River watershed.

The wetland cost functions utilized for the model nutrient farms were those described in Hey et al. (2005). However, unlike the first study, the marginal cost—or credit price—estimates reflected the differences in land prices throughout the Illinois River Watershed. Since the Illinois River watershed encompasses Chicago and its suburbs as well as downstate farmland, there is considerable variation in land prices and, consequently, considerable variation in marginal cost. In addition, the costs vary by time of year because the level of microbial activity (which drives the denitrification process) varies with water temperature.

Three Regulatory Scenarios

Regulatory agencies may require that dischargers and nutrient farms be located in proximity to each other and will impose "penalties" when the two are not. Thus, for the sake of our analysis, we created three regulatory scenarios: 1) Unrestricted (dischargers purchase nitrogen credits from nutrient farms anywhere in the watershed without regard to location); 2) Restricted intrawateshed (dischargers must purchase credits from nutrient farms within its own watershed before outside trading is allowed); 3) Accrued 10% penalty (dischargers pay an increasing tax on credits purchased in consecutive downstream watersheds). The three regulatory scenarios were analyzed for each of the four seasons. All results are can be found in Kostel et al. (2007) or Scott et al. (in preparation).

Most emissions (89%) come from the three subwatersheds closest to the state's population center, Chicago. This also is the region with the most expensive land values, which drives up the marginal cost of credits in these three subwatersheds. The competitive market solution utilizes downstate nutrient farms with lower costs.

The "unrestricted" scenario is the least expensive because nutrient farms in this scenario are located downstate where land is least expensive. In the other two scenarios spread nutrient farms throughout the 19 subwatersheds, which of course, is the intent of these regimes.

While both the "restricted intrawatershed" and "accrued 10% penalty" scenarios are more expensive than the "unrestricted" case, the "accrued 10% penalty" scenario is the most expensive. While more tons of nitrogen are being removed because dischargers are required to purchase more than one credit for each ton discharged, the effective charge on a ton of emission is inflated by the penalty amount. Therefore, the weighted average price for a ton of emission is on average substantially more than the average price per ton of nitrogen under the "restricted intra-watershed." High prices, of course, can mean that more conventional "concrete and steel" nitrogen removal processes may be competitive.

Considering all of the point source dischargers in the Illinois River watershed, between 29,000 and 36,000 tons TN/year could be removed through nutrient farming under the studied trading schemes (see table). The removal range is a function of the penalties or restrictions imposed on the market by the regulatory agencies. Accordingly, the market revenue would range from $70 million to $121 million/year. This is a sizeable market that could generate substantial profits, from $6 million to $38 million. The return on investment would vary from 5 to 25%.

Imposing additional regulatory conditions on the sale of credits, such as penalties or "restricted intrawatershed" requirements, will make nutrient farming more costly and could threaten to undermine the relative efficiency of nutrient farming. Regulatory regimes will need to be carefully thought out in order to keep nutrient farming competitive.

Nutrient farming was found to be an economically viable means to reduce nitrogen loads in the Illinois River watershed, producing dramatic cost savings, particularly in spring. The revenues of all but the winter "unrestricted" model are large enough to offer economic profit. In the long-run, nutrient farming can provide a rate of return comparable to, or even better than, other investments of land uses. The methods and conclusions can be widely applied to other large watersheds that suffer from nutrient over-enrichment.

Hey, D. L., J. A. Kostel, A. P. Hurter, R. H. Kadlec. 2005. *Comparing Economics of Nitrogen Farming with Traditional Removal.* WERF 03-WSM-6CO. Water and Environment Research Foundation, Alexandria, VA.

Kostel, J.A., Peck, R.M, Scott, B., and C. Tallarico. 2007. The Economics of Nutrient Farming. The Wetlands Initiative Report funded by The Kinship Foundation.

Scott, B., Tallarico, C., Kostel, J. and R. Peck. In preparation. Nitrogen Farming in the Illinois River Watershed: An Environmental Economics Market.

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