The Economics of Nutrient Farming

Brian Scott - Visiting Scientist funded by the ARC Economic Design Network and the SIRCA Experimental Economics Laboratory (SEElab), CSIRO, Department of Finance, Economics, and Quantitative Methods, University of Alabama at Birmingham

Jill A. Kostel, Ph.D.,Senior Environmental Engineer, The Wetlands Initiative

Richard M. Peck, Ph.D., Department of Economics, University of Illinois at Chicago

Carol Tallarico, Ph.D., Brennan School of Business, Dominican University

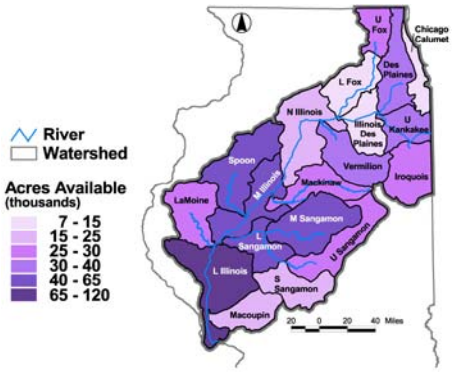
Background

- Illinois River Watershed has high levels of nitrogen and phosphorous
  - Point and non-point sources
- High levels of N and P lead to hypoxia
  - Dumps into the Gulf of Mexico
    - Dead Spot
- USEPA becoming more active in the reduction of N and P in US waterways

Background II

- The Wetlands Initiative (TWI) spearheaded nutrient farming in the Illinois River Watershed
  - Beta test a managed wetland
  - Needed a way to pay for wetland creation
  - Focused on Market Based Solutions
- This is a real life application of a market

http://www.wetlands-initiative.org/



Potential land availability in the 100-year flood zone for nutrient farming in each sub-watershed in the Illinois River Watershed.

Market Attributes I

- Point source emitters for this program (Buyers)
- Managed wetlands (Sellers)
- Polluters need not reduce emissions
  - Credits are produced not created
- Non-temporal program
  - Seasonal
    - No banking or borrowing
- Emissions and land prices higher in North

Market Attributes II

- Total Emissions
  - Ei is an emitter
  - Eij is the amount of emissions from emitter Ei absorbed by wetland j

$$\sum_{j=1}^{m} E_{ij} = \bar{E}_i \quad i = 1,\ldots,n$$

Market Attributes III

- Wetland region (subset)
- Nj is the nitrogen removal capacity for one region – based on land and water flow
- B is a charge/penalty on permits (not price) discussed later
  - Assume it is 1

$$\sum_{i=1}^{n} \beta_{ij} E_{ij} \le N_j \quad j = 1,\ldots,m$$

7

Market Attributes IV

- Objective function
  - cij is the marginal cost to the wetland region j of removing emitter i's emissions
  - Varies on land price and season (productive capacity)

$$\min \sum_{i=1}^{n} \sum_{j=1}^{m} \beta_{ij} c_{ij} E_{ij}$$

8

Market Attributes V

- All emissions must be absorbed
- Wetland regions can't oversell
- Emitters can't have emission "sinks"

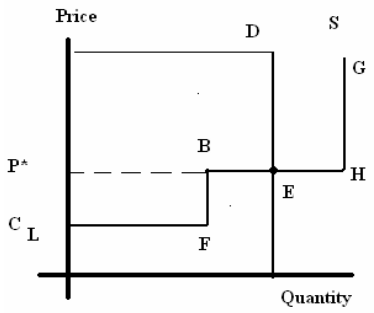
$$\sum_{j=1}^{m} E_{ij} = \bar{E}_i \quad i = 1,\ldots,n$$

$$\sum_{i=1}^{n} \beta_{ij} E_{ij} \le N_j \quad j = 1,\ldots,m$$

$$E_{ij} \ge 0 \quad j = 1,\ldots,m, \quad i = 1,\ldots,n$$

9

Supply and Demand



10

Spatial Distribution

- Emissions are spatial (travel from N to S)
  - Distance traveled effects damage
- Damage is increased the further emissions travel
- Incentive to keep emissions removal close to emission point
- Emissions highest in North
- Land values highest in North

11

Experiment

- Seller or Buyer
- Seller
  - Sell permits for a high price
    - But above the cost of production
- Buyer
  - Buy permits at a low price
    - But below your per unit budget
  - Run experiment

12

Treatments/Market Rules

- Unregulated
- Charge (Bij)
  - Permits charged for buying offsets from wetlands outside your “backyard”, bubbles

13

Assumptions

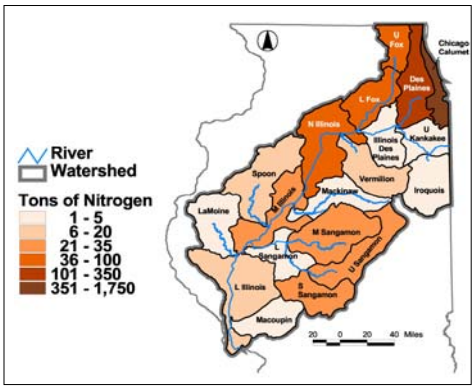
- Marginal cost of traditional method constant
- Marginal cost of wetland production constant
  - Cost variation found in
    - land prices
    - seasons
- Marginal cost of wetland production equal to average cost
- Land values do not change with creation of wetlands
- Two agents in each wetland region (one buyer, one seller)
- Damages are sufficient to support program
  - Refinement?

14

Results

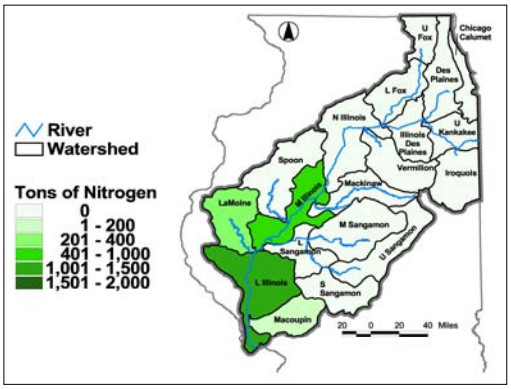
- Treatments
  - Unrestricted < Charge
- Wetland creation has the tendency to be in the South
  - Lower land values
- We don’t have 36 participants

15



The nitrogen credit demand for each sub-watershed in the Illinois River Watershed.

16



Credits traded in the spring months under the “unrestricted scenario” for each sub-watershed in the Illinois River Watershed.

17

Experimental Questions

- What are the effects of the different treatments?
  - Distribution of wetland creation
  - Effect on abatement costs
  - Effect on wealth redistribution
  - Competitive with traditional methods?

18

Experimental Questions II

- What is the tendency of the price?
  - Closer to the…
    - chemical method
    - Marginal Cost of Wetland
  - Implications for profit, viability, and adoption
  - Other Questions
  - Anomalies
- We can implement any kind of market relatively cheaply

19

Future Research

- Combinatorial Auction?
- Phosphorous
- Both N and P
- Intertemporal (trading over seasons)

20