The Economics of Northern Wisconsin Lakes: Lessons Learned from Several Studies

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Four questions (in 75 minutes):

1. What is the value of preventing a Milfoil invasion?
2. What is the effect of open space conservation and minimum frontage zoning on shoreland development?
3. Forecasting Green Frog populations/the value of Green Frogs
4. What is the value of increasing water clarity in northern Wisconsin lakes?

I. What is The Value of Milfoil Prevention?

B. Provencher, D. Lewis, and K. Anderson. "Disentangling preferences and expectations in stated preference analysis: The case of invasive species prevention", working paper 2010.

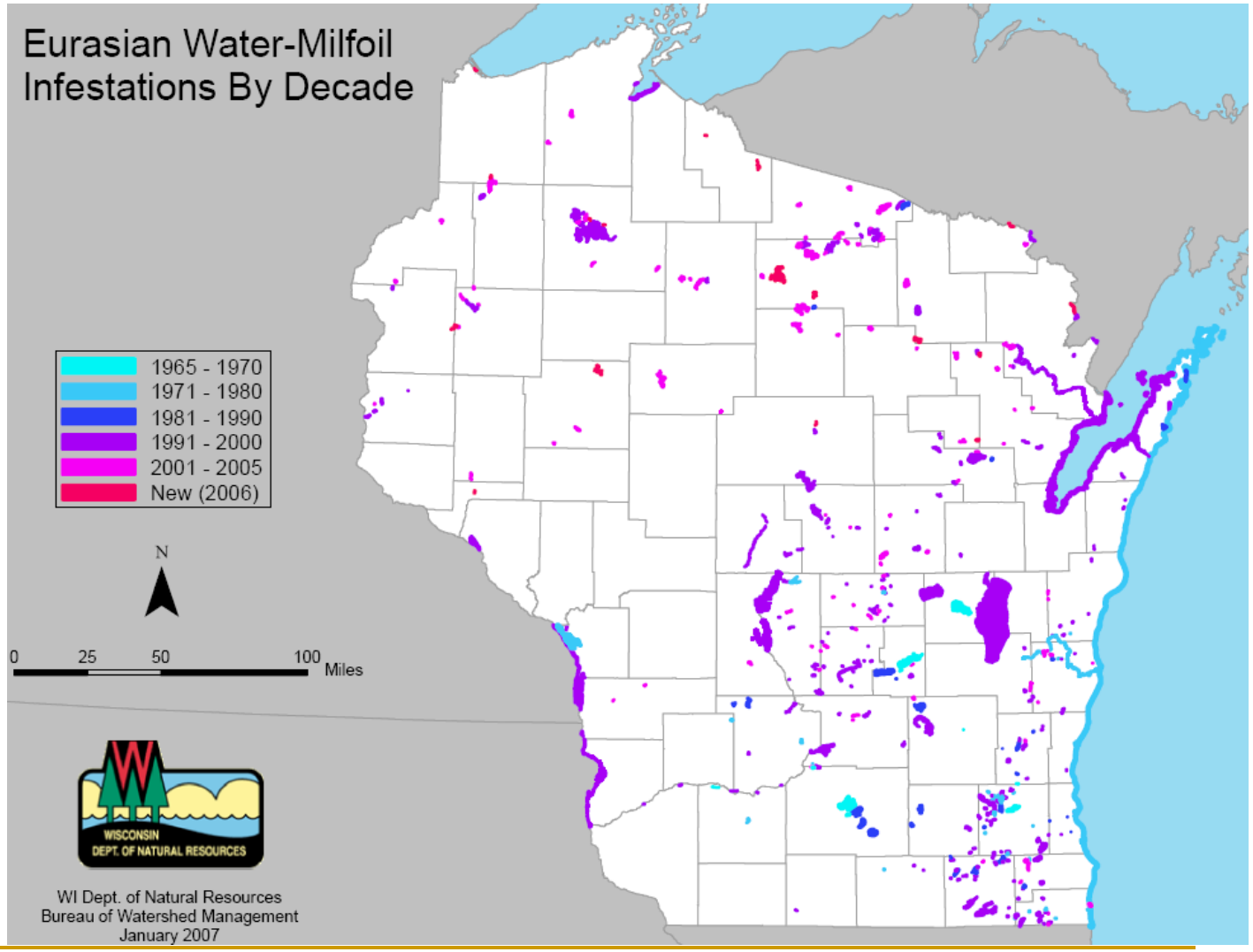
E. Horsch and D. Lewis. "The Effects of Aquatic Invasive Species on Property Values: Evidence from a Quasi-Experiment". Land Economics 85(3):391-409 (2009)

Eurasian watermilfoil (EWM)

- Effects of EWM:
  - Blocks sunlight and competes with native plants.
  - Inhibits predator-prey relationships with fish.
  - Limits human recreation.
  - Quasi-irreversible once established.
- Uncertainty of effects:
  - Can rapidly cover a water body.
  - Sometimes it has minimal effects.
  - Difficult to predict which lakes will be most affected.

Background: the Ecological Issue

Milfoil is spreading through Wisconsin, recently reached the northern lakes



Background: the Ecological Issue

- One of the biggest concerns of shoreline property owners; Some quotes from 2005 survey:
  - "My biggest concern about Fence Lake will be the introduction of Zebra Mussels and weeds which could probably be stopped if lake-hopping fishermen from all over the place would be restricted….

    …I would propose a stop to that fishing lake after lake after lake and would license them to fish only certain lakes per year until the problem is solved. Okay buddy, this year you get to fish Fence Lake and White Sand Lake that's it tell next season….

    …I see fishing as the greatest threat to the spread of these animals and the destruction of lake water quality. Limit the number of lakes each fisherman can visit, that's the ticket.

Background: the Ecological Issue

- My wife and i are members of the lake association here that is already trying to organize involvement to help solve invasive species and lake management issues. We need HELP to deal with these problems, not a public "fix it and pay for it yourselves" attitude…

  …If the State Of Wisconsin/DNR is truly sincere about preserving our lakes, then it needs to stop having "short arms and deep pockets" and put up or shut up!!!
- The government had better wake up and do something about controlling weeds while the costs are relatively reasonable. The alternative is to put a $billion dollar tourism industry at risk not to mention a substantial drop in property values. …

  … When I look at Scattering Rice Lake I think in terms of tranquility, utility and purity with purity being the absence of exotics and infestations of weeds. Without the purity one doesn't have tranquility or utility. And, without the latter much of the recreational and economic base of the North will be destroyed.

Background: the Ecological Issue

- …With the all the huge "starter castles" that everyone is building today, and being taxed on...Just Where The Blazes is all that money being wasted ??? …
- …Perhaps my tax money would be better spent if you stopped spending it on useless projects like this…
- …Is it possible to receive the results of the survey? At a minimum it would be beneficial to share the results with the various Lake Associations in the area.

What is the social cost of a Milfoil invasion?

- Horsch and Lewis (*Land Econ* 2009)
  - Hedonic valuation of shoreline property prices
  - Among the best hedonic studies that I've seen in the environmental economics literature
    - Used natural experiment to identify the effect of Milfoil on property prices
  - Estimated effect on property price… Way too high!

We decide to include Milfoil CV question in 2008 follow-up survey of Vilas County shoreline residents

- Kathryn Anderson will discuss many of the results from this survey on Thursday.
- Primary intention of survey is to examine whether sorting across lakes is correlated with collective/private action to influence lake ecosystem services
- Includes several CV questions concerning these services;
- Why not add questions concerning Milfoil prevention/control?

Our Contingent Valuation Question…buildup

- Web/Mail survey of shoreline property owners in Vilas County
- Two types of Milfoil-related CV questions
  - One for respondents on lakes that already have milfoil
  - One for respondents on lakes that did not have milfoil last summer
- We gave respondents the following info:
  - Consequences of Milfoil on a lake
  - Lake types that are most vulnerable
  - Current status of Milfoil in Vilas County
  - Current status of Milfoil on the respondent's lake according to the WDNR

Our Contingent Valuation Question…buildup

- We describe a prevention program with the following features:
  - As long as the program exists, it is “highly unlikely” that milfoil will become a problem on your lake.
  - The program involves an investment of time and resources on an **annual** basis to prevent the entry of milfoil at public boat launches, and to detect and eradicate milfoil before it is able to establish a foothold on your lake. Examples of possible program activities include…
  - Program costs would be covered by lakeshore property owners and other lake users through a variety of means.

Our Contingent Valuation Question…buildup

- We state that the program will be put to a referendum, and will be enacted only if passed with a majority vote

Now suppose this milfoil prevention/control program is put to a referendum of shoreline property owners on your lake.

The program will take place **only if the referendum passes with a majority vote.**

On the next page of this survey **we ask how you would vote on such a referendum if the annual cost of the program to you was a particular amount**.

- Your vote would indicate the value that you place on the prevention program:
  - You might vote "Yes" on the referendum because you are concerned about milfoil on your lake, and you are willing to pay the specified annual cost.
  - You might vote "No" because you think it is unlikely that milfoil will enter your lake in the absence of the program, or you don't care too much if it does, or you don't believe you can afford the specified annual cost.
- In any case, there is no right or wrong vote. We are interested in how you would likely vote if such a referendum were to actually take place on your lake.

Our Contingent Valuation Question…buildup

- Why go through all this? Why not simply ask, “Suppose a Milfoil invasion is imminent. What would you pay to avoid it?”
  - Large body of literature argues that this sort of simple and direct approach is much more prone to hypothetical bias;

Our Contingent Valuation Question…buildup

- We tell the respondent that responses will be in probability form:

Important Instructions

Please Read Before You Answer the Next Question

- Since you may not know for sure how you would vote on a real referendum, we are asking you to tell us the percent chance that you would vote YES.
- For example, if you check 0-10%, you are saying that you would almost surely vote NO; if you check 70-80%, you are leaning strongly toward voting YES, but still have some doubts.

Our Contingent Valuation Question

- Web-based survey
- Several big advantages to web-based survey:
  - Cheap!
  - Complex skip patterns are possible;
  - Prevent the respondent from reading ahead;
  - **Big one in CV: follow-up question amounts based on initial response.**
- Disadvantage:
  - Nonrespondent bias (individuals who do not have a computer, do not have broadband)
  - Account for this disadvantage with a mail follow-up

Estimation Results: Milfoil Control, Horsch and Lewis

Results of Horsch and Lewis Hedonic Valuation study:

Linear Fixed Effects			
	Estimate	95% low	95% high
Capitalized WTP	**$28,294.20**	**$9,655.76**	**$46,932.64**

Estimation of implied loss from milfoil invasion, from CV prevention question

`	Estimate	95% low	95% high
Annual Loss	**$1,610.93**	**$1,034.32**	**$2,382.29**
Capitalized Loss	**$27,686.06**	**$17,776.19**	**$40,942.99**

	Parameter	SE
Discount rate	**0.06**	**0.03**

Estimated annual WTP for Milfoil control:

	Estimate	95% low	95% high
Avg Annual WTP	**$1,601.53**	**$1,191.71**	**$2,882.42**

Concluding Remarks

- The welfare loss from a milfoil invasion is substantial (Dave was right!)…
- These values apply only to shoreline property owners.

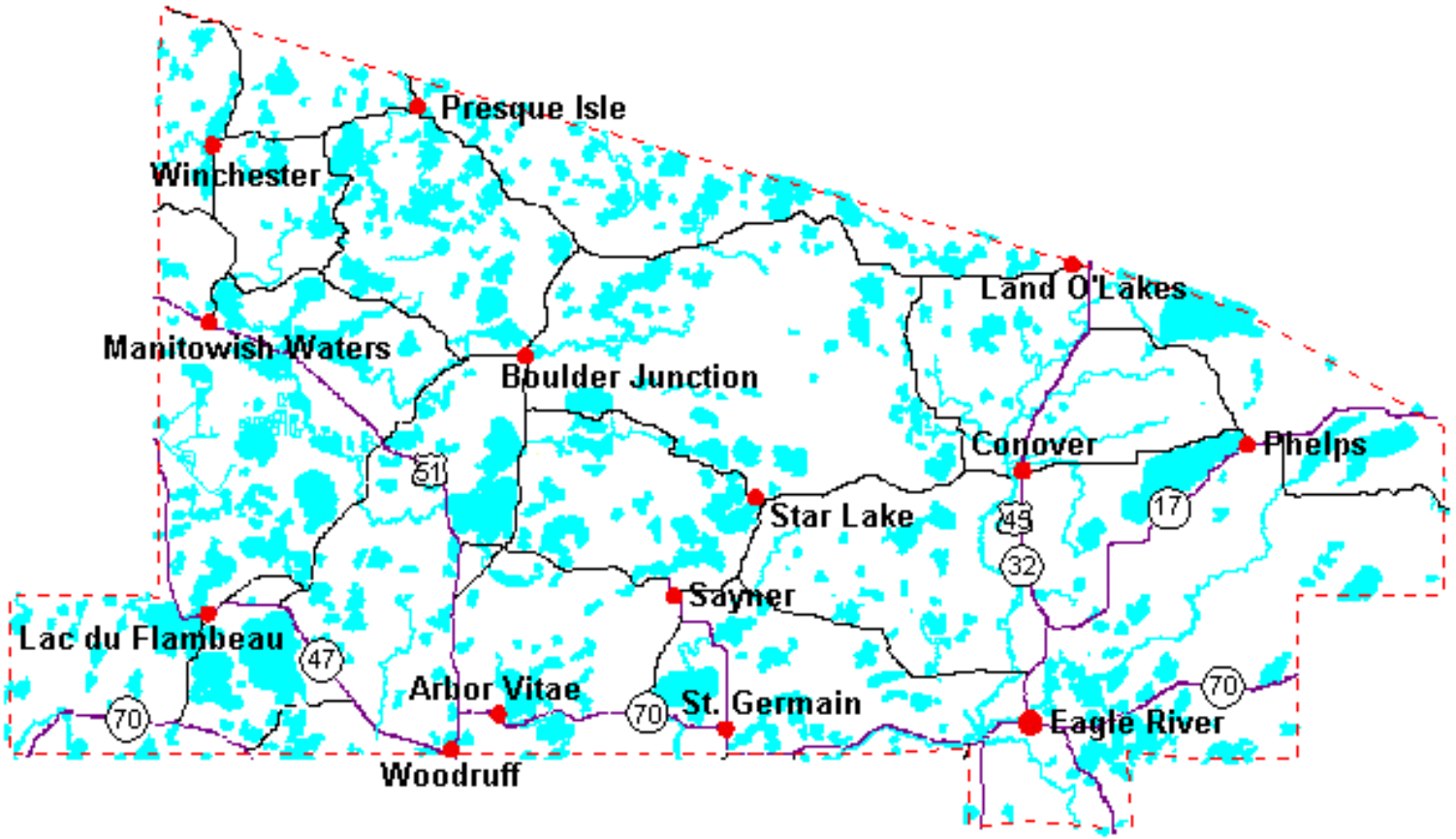
II. What is the effect of open space conservation and minimum frontage zoning on shoreland development?

D. Lewis, B. Provencher and V. Butsic. "The dynamic effects of open-space conservation policies on residential development density". Journal of Environmental Economics and Management Volume 57, Issue 3, May 2009, Pages 239-252.

Why ask this research question?

- Lakefront development results in a variety of ecological consequences:
  - Removal of coarse woody habitat.
  - Reduced growth rates of a variety of sport fish.
  - Reductions in populations of birds and amphibians.
- Many people have a taste for open space.
  - Returns to development tend to be higher near protected open space.
  - Possible for protected open space to **increase** neighboring development.

The study region – Vilas County in Northern Wisconsin

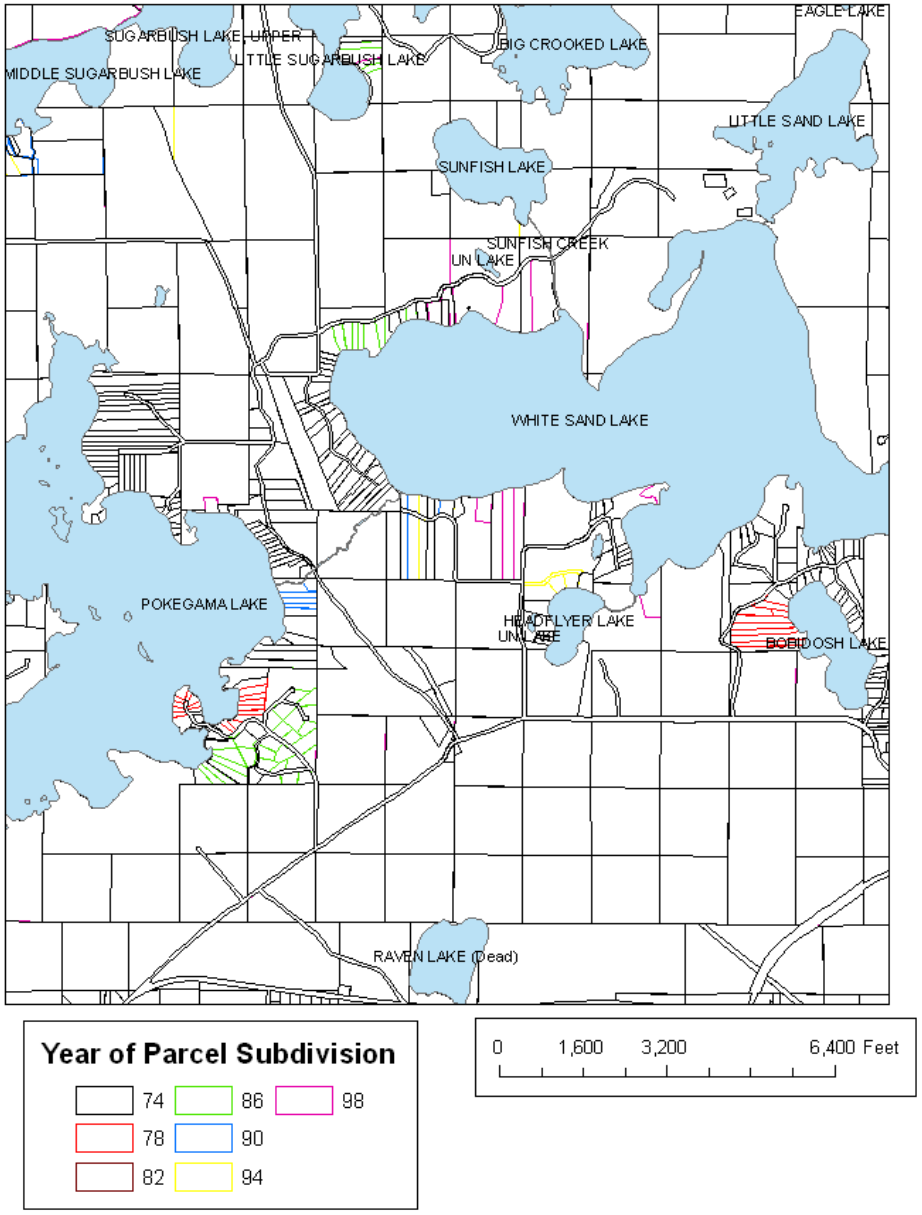


Land conservation in study region

- Shoreline owned as public conservation land.
  - Public land purchased or forfeited in early 20th century.
  - Widespread land abandonment from agricultural failures.
- Minimum frontage zoning (100 foot minimum vs. 200 foot minimum).
  - Zoning set uniformly at township level => each township has dozens of lakes.
  - Pre-1999: 7 of 14 townships had 200 foot minimum, the rest had the state-mandated minimum of 100 feet (non-sewered).

The dataset

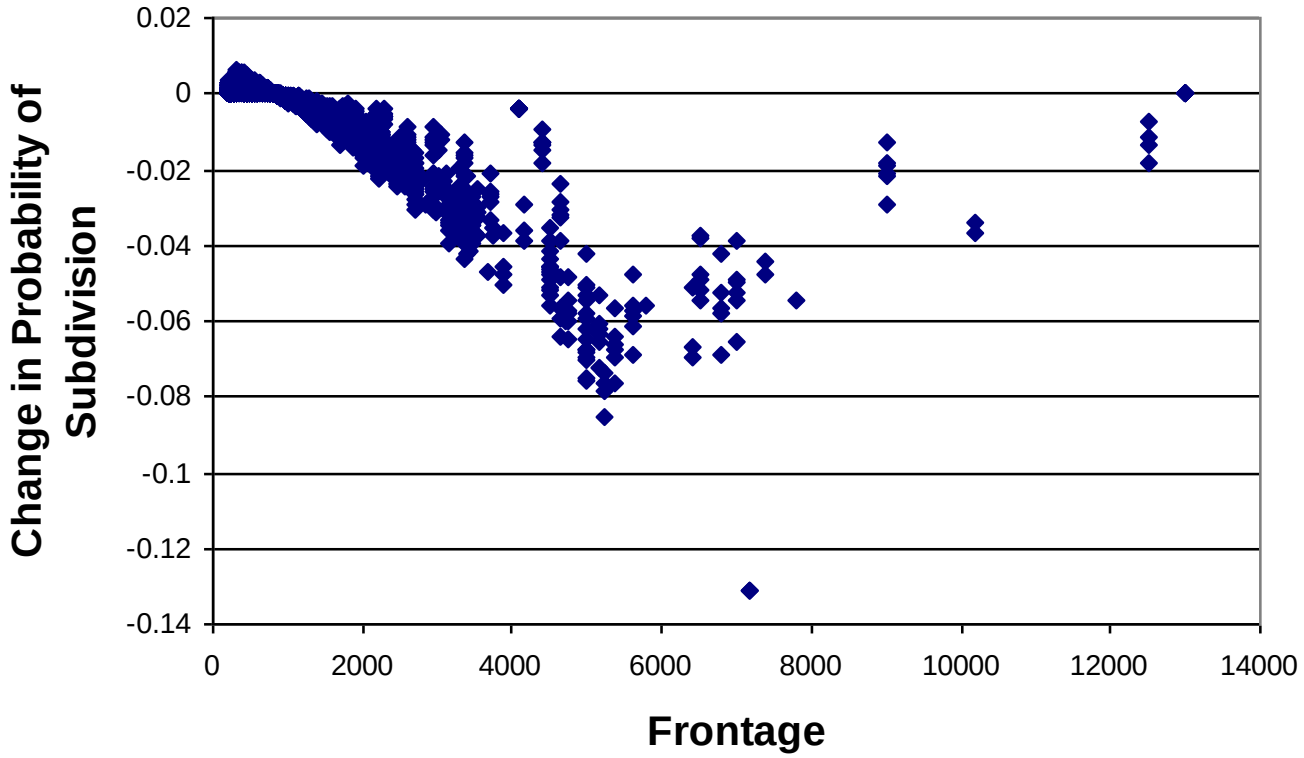
- Estimating land conversion requires time-series GIS data.
- Reconstruction of historical GIS data from paper plat maps linked to current digitized maps.
- Method very applicable to other regions.
- 140 lakes, 1974-1998



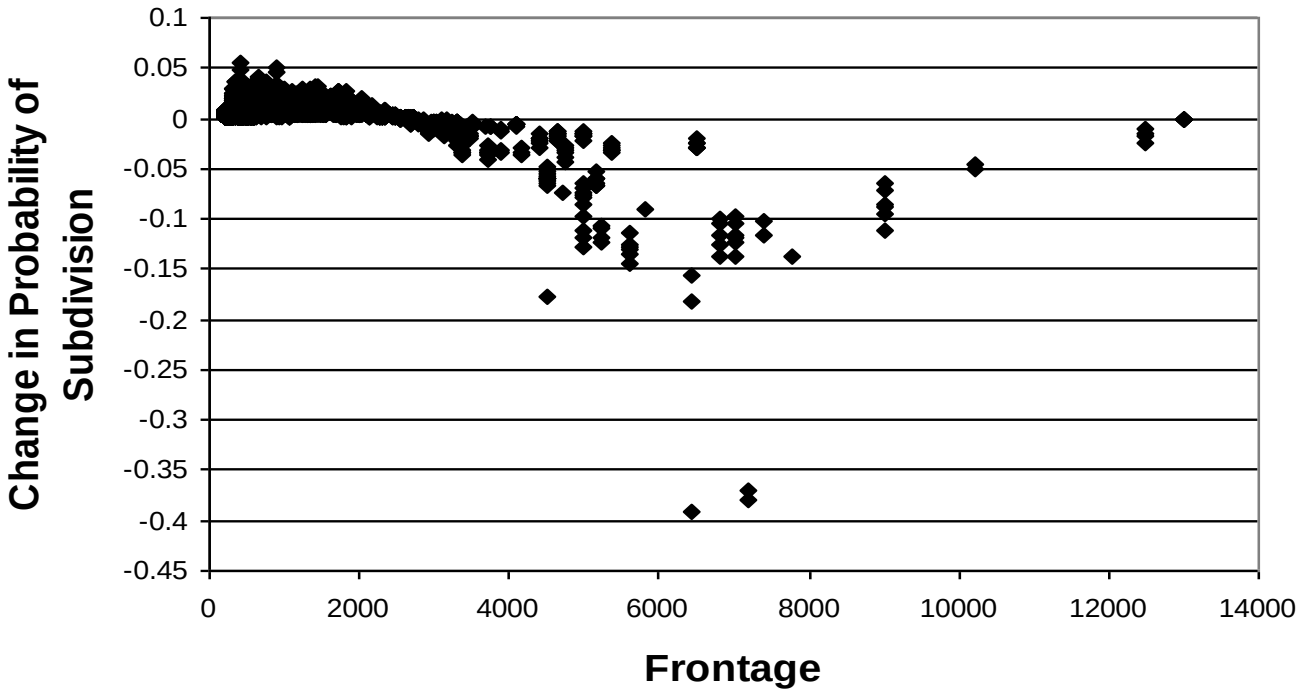
The model

- Statistical model of landowner decisions fit to the dataset
- Two joint decisions by landowners:
  - Probability of subdivision: binary Probit model.
  - Number of subdivided lots: Poisson count model.

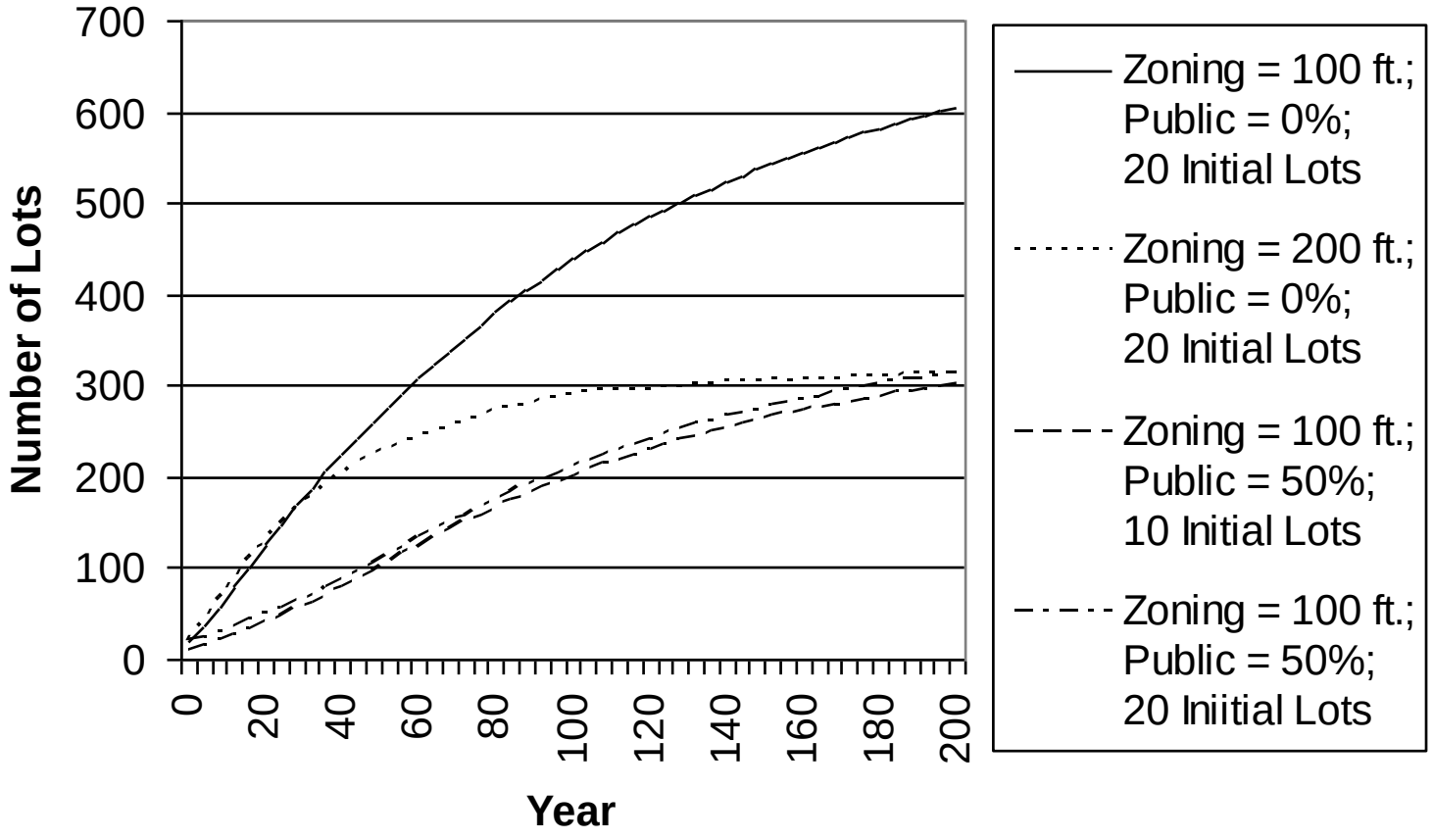
Results – discrete-change effects of a 10% increase in public shoreline



Results – discrete-change effects of 200 foot minimum frontage zoning



Landscape simulation – two conservation policies



III. Forecasting Green Frog Populations; (and) What is the value of Green Frog Conservation?

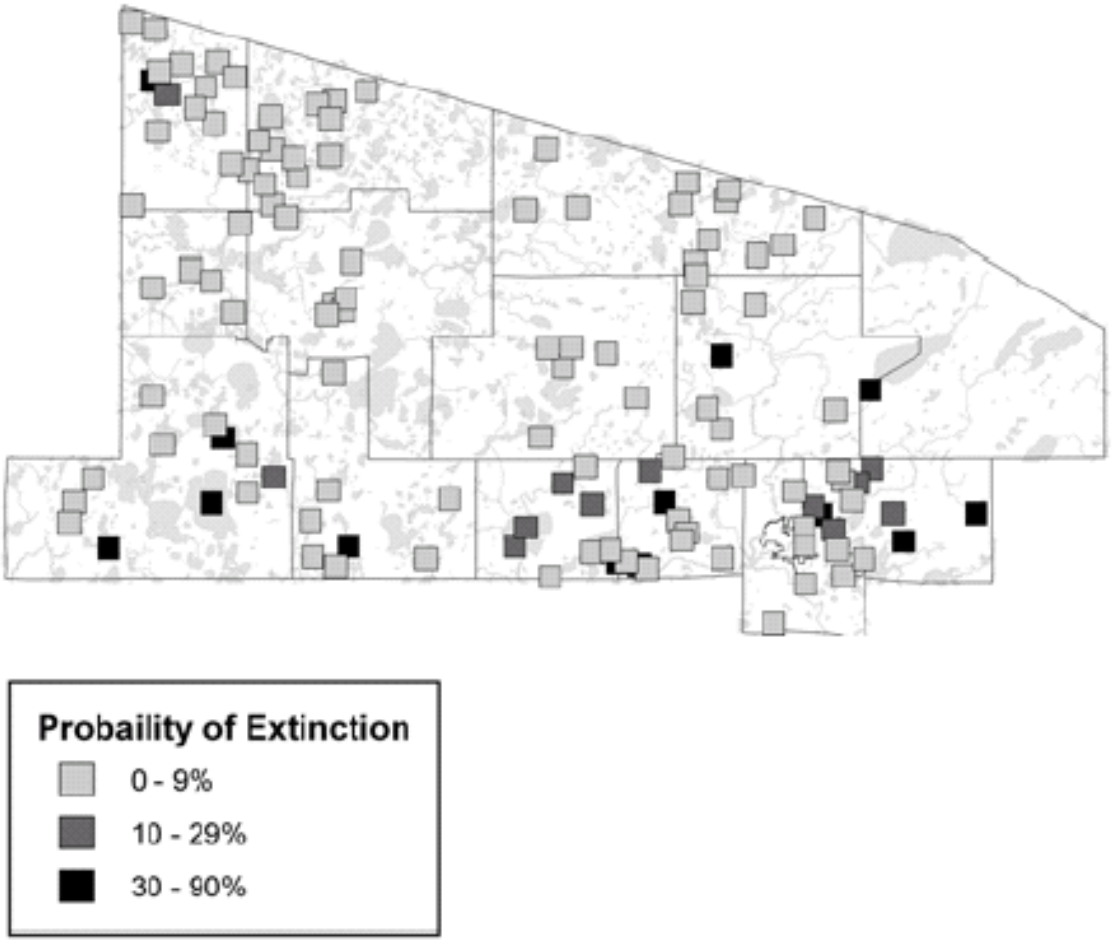
D. Lewis, "An economic framework for forecasting land-use and ecosystem change ", Resource and Energy Economics Volume 32, Issue 2, April 2010, Pages 98-116

B. Provencher and D. Lewis, "Measuring and modeling respondent uncertainty in contingent valuation" (work in progress).

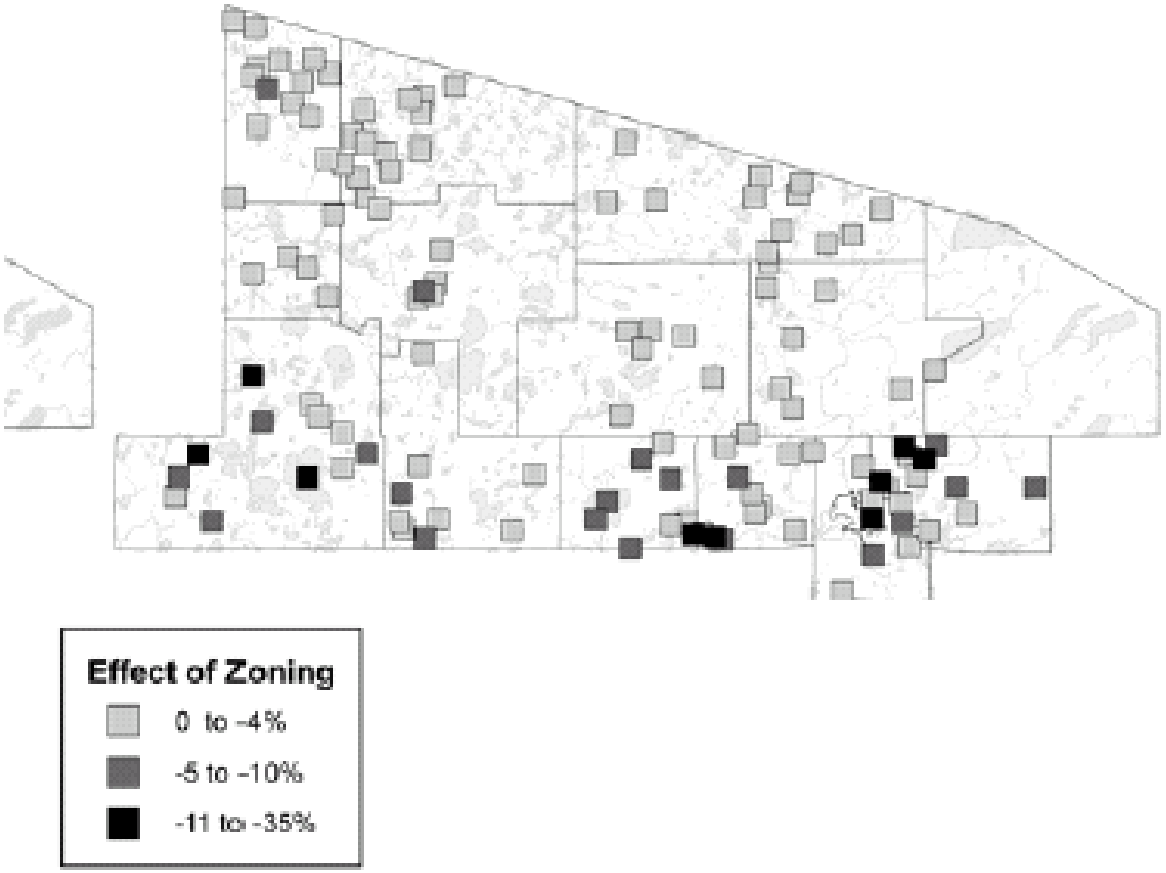
Forecasting Green Frog Populations

- Green Frog biology:
  - Woodford, J.E., and M.W. Meyer. 2003. Impact of Lakeshore Development on Green Frog Abundance. *Biological Conservation,* 110: 277-284.
  - An extinction threshold has been estimated for green frogs on northern Wisconsin lakes at a shoreline development density of approximately 7.9 houses per 1000 feet shoreline (Woodford and Meyer 2003). The Wisconsin state minimum frontage for development is 100 feet, which implies a "build out" density of approximately 10 houses per 1000 feet shoreline
  - Merge this biology model (including its uncertainty) with the development forecasting model (including its uncertainty) to obtain forecasts of Green Frog extinction on Vilas County lakes.

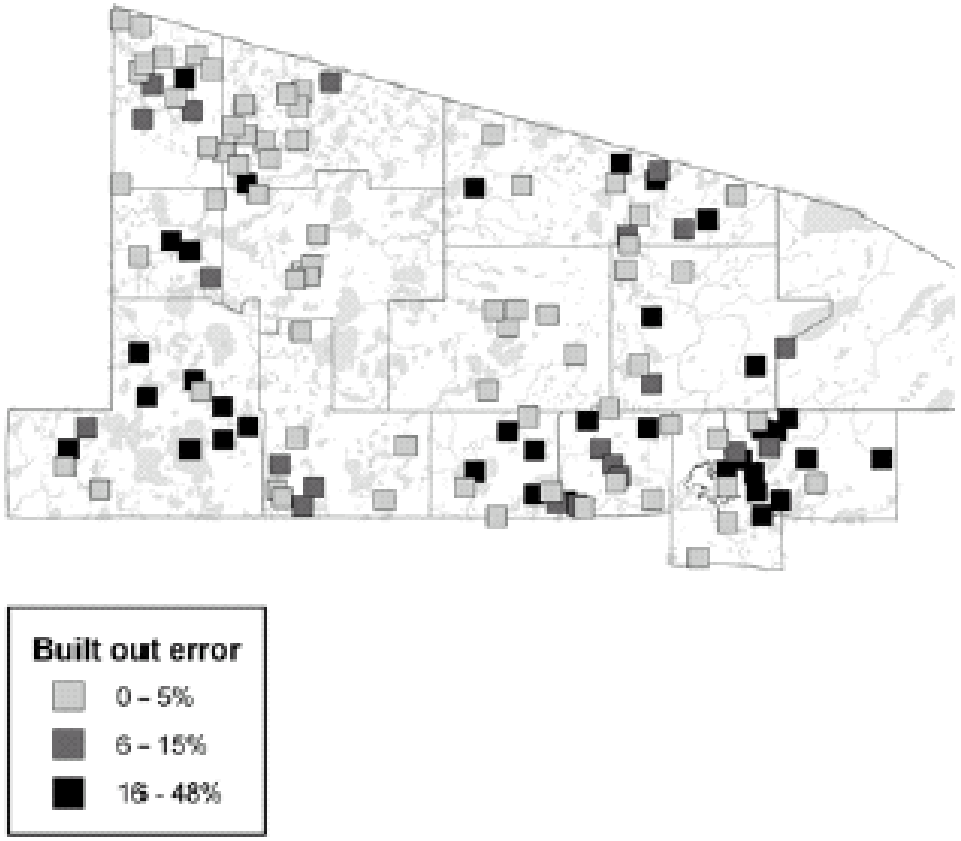
20-year Probability of Green Frog Extinction on Vilas Lakes (pre-1999 conditions)



Change in 20-year Probability of Green Frog Extinction due to the 1999 County Shoreline Zoning Ordinance



Error in 20-year Green Frog extinction probability forecasts embedded in standard build-out models



What is the value of Green Frog conservation?

- **Must use contingent valuation**
  - 2008 University of Wisconsin Lake Resident Survey (same survey as the one used to value Milfoil prevention)
  - "In the remainder of this survey we would like to engage you in two 'thought experiments' intended to get a sense of the value to you of two management activities on your lake. The first management activity concerns controlling an infestation of Eurasian water-milfoil on your lake, and the second concerns maintaining populations of Green Frogs on your lake. As part of each experiment we develop a scenario in which you are asked how you would likely vote on a referendum to either approve or reject the specified management activity."

What is the value of Green Frog conservation? (con't)

- **Describe the species and management issue:**
  - "Green Frogs are a species of frog common in Wisconsin**.** They are greenish-bonze, about 3 inches at maturity, with a call that is a low "gung-gung-gung" - like strumming on a loose banjo string. Typically…"
  - "…Recent research published in the journal *Biological Conservation* indicates that when a lake shoreline becomes fully developed with lots of 100-150 feet of frontage, there is a very high probability that Green Frogs disappear from the lake.

What is the value of Green Frog conservation? (con't)

- **Use the simulation model to provide lake-specific information to the respondent**
  - "Based on current scientific models, the average density of green frog populations on Vilas County lakes is 12 frogs per 1000 yards of shoreline."
  - "By comparison, these models indicate that the average density of green frog populations on YOUR lake is [model estimate] frogs per 1000 yards of shoreline.
  - "Finally, simulation models indicate that the green frog population on your lake will fall by about X% over the next 20 years.

Describe the conservation effort

- **It assures that the Green Frog population on your lake <u>will increase by 25%</u> from the current level and remain stable as long as the program exists.**
- **It involves Green Frog habitat conservation by several property owners on your lake, but NOT BY YOU. These property owners agree to conserve Green Frog habitat on their shoreline with the support and expertise of state conservation organizations. Examples of the habitat conservation activities include:**
  - Planting a shrub layer of Sweet Gale and Leatherleaf along the shoreline;
  - Planting the tree species Tamarack and/or Black Spruce along the shoreline;
  - Placing downed logs at the water's edge;
  - Planting native aquatic plants.

Describe the conservation effort (it will be costly)

- **The program involves annual costs:**
  - Habitat development often involves direct costs, such as planting native shoreline and aquatic vegetation.
  - Staff time of state conservation organizations would be required to develop, monitor, and maintain the new habitat.
  - It may be necessary to pay the property owners in the program because shoreline changes such as placing downed logs at the water's edge may leave their properties less valuable and less attractive.

What is the value of Green Frog conservation? (con't)

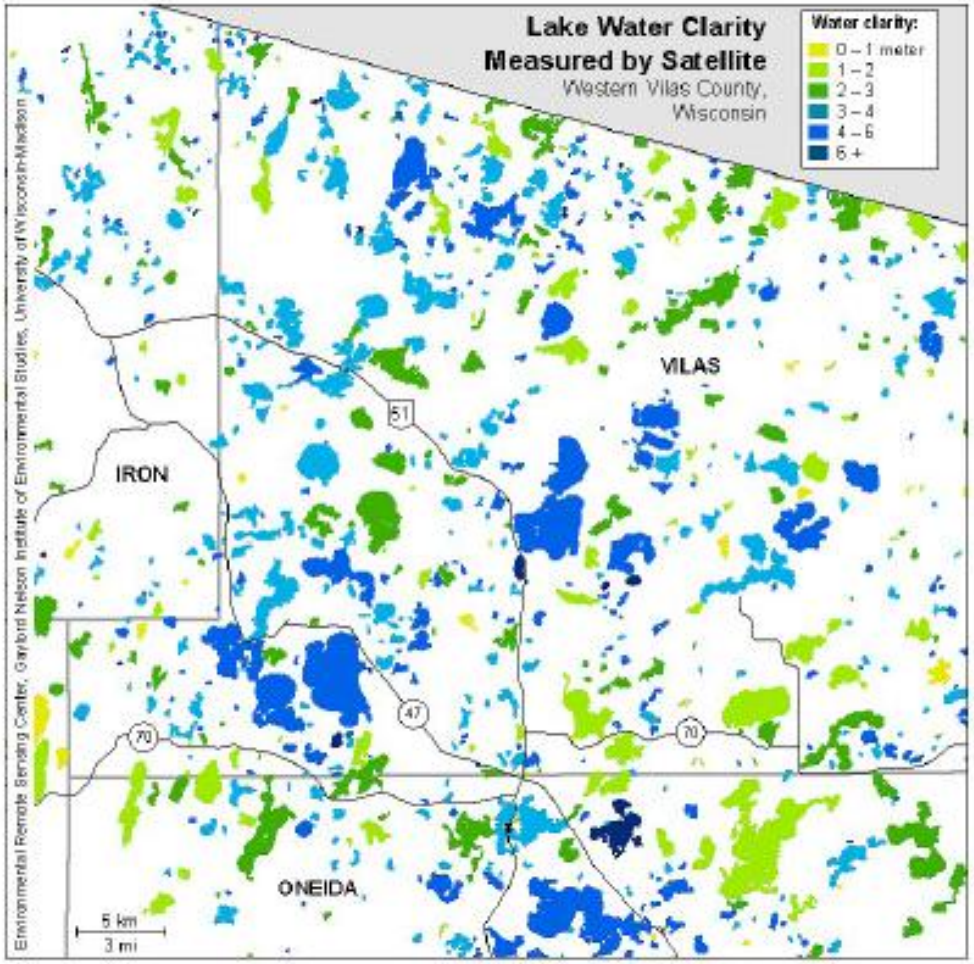
- **Now suppose this habitat conservation program is put to a referendum of shoreline property owners on your lake.**
  - The habitat conservation program will take place **only if the referendum passes with a majority vote.**
  - On the next page of this survey **we ask how you would vote on such a referendum if the annual cost of the program to you was a particular amount**.
  - …In any case, there is no right or wrong vote. We are interested in how you would likely vote if such a referendum were to actually take place on your lake.

What is the value of Green Frog conservation? (con't)

- Average WTP:

n=797			
	Estimate	95% low	95% high
Avg Annual WTP	$30.77	$7.75	$51.94

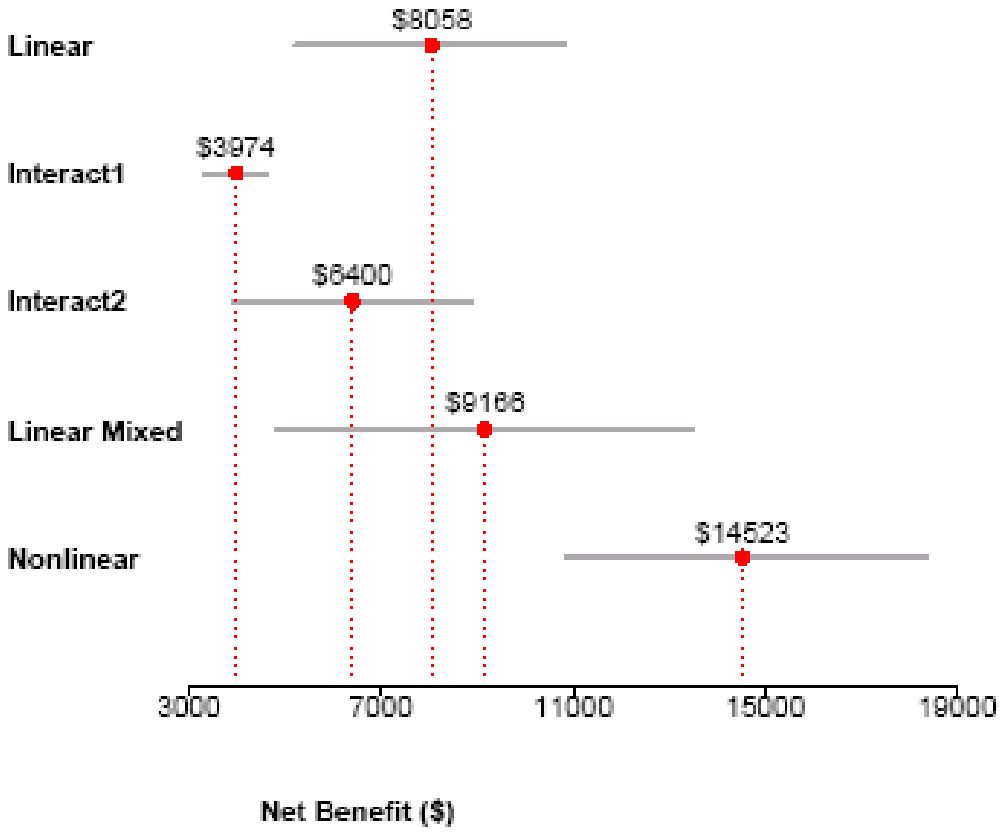
IV. What is the value of increasing water clarity in northern Wisconsin lakes?



Hedonic Analysis of Water Calrity

- **Remote sensing to estimate average lake water clarity in the summer…**
  - Extremely good fit to Secchi measures
  - This allows more lakes than any previous study
  - This allows more properties than any previous study

Hedonic analysis of water clarity



Hedonic Analysis of Water Clarity

Table 1.4: Comparison of Studies Examining Water Clarity

	# Observations	# Lakes	WC Range (m)	Implicit Price $ for marginal 1 meter change in WC ($)
New Hampshire	447	69	4.18 - 5.88	1100 - 9800
Maine[1996]	543	34	1.1 - 8.2	(11 - 200) per ft. frontage
Maine[1999]	249	25	NA	2337 - 12,938
Maine[2001]	348	NA	NA	2600 - 6279
Minnesota	1205	37	1.38 - 6.61	(6 - 2044) per ft. frontage
Wisconsin	1540	169	0.51 - 6.86	6400 - 14,523

Related and On-going Research at UW-Madison

- Hedonic analysis of improvements in fishing quality
- Contingent valuation of improvements in fishing quality
- Valuation of water clarity improvements in Green Bay
- Hedonic analysis of the effect of the 1999 Vilas County shoreland zoning ordinance on shoreline property values
- Contingent valuation analysis of the benefit of the 1999 Vilas County shoreland zoning ordinance
- Hedonic analysis of the effect of small dam removal on property values
- Analysis of the effect of shoreline zoning on near-shore development
- A bioeconomic model of the spread of aquatic invasive species
- The effect of household sorting on long term lake ecology