Economic Damages from Ecosystem Shocks: Evidence from Aquatic Species Invasions

David J. Lewis
Dept. of Agricultural and Applied Economics
University of Wisconsin-Madison
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Collaborators: Eric Horsch (Stratus Consulting), Bill Provencher (UW-Madison).

Aquatic invasive species

- Invasive species are widely believed to have a large impact on ecosystem services.
  - From a research perspective, an invasion serves as a natural experiment of an ecosystem change.
  - Examples that humans will perceive.
- Minimal research on quantifying the economic damages from invasive species.
- U.S. spends an estimated $120 billion per year on invasive species (Pimentel et al. 2005).

The Issue

- Q: what is the effect of an aquatic species invasion – an ecosystem shock – on quantitative welfare measures for those who use lakes?
- Two possible approaches:
  - Hedonic analysis: how do species invasions become capitalized into land values?
  - Contingent valuation: what is the average shoreline landowner's willingness-to-pay to prevent invasions?

Hedonic Pricing Models – Housing Market

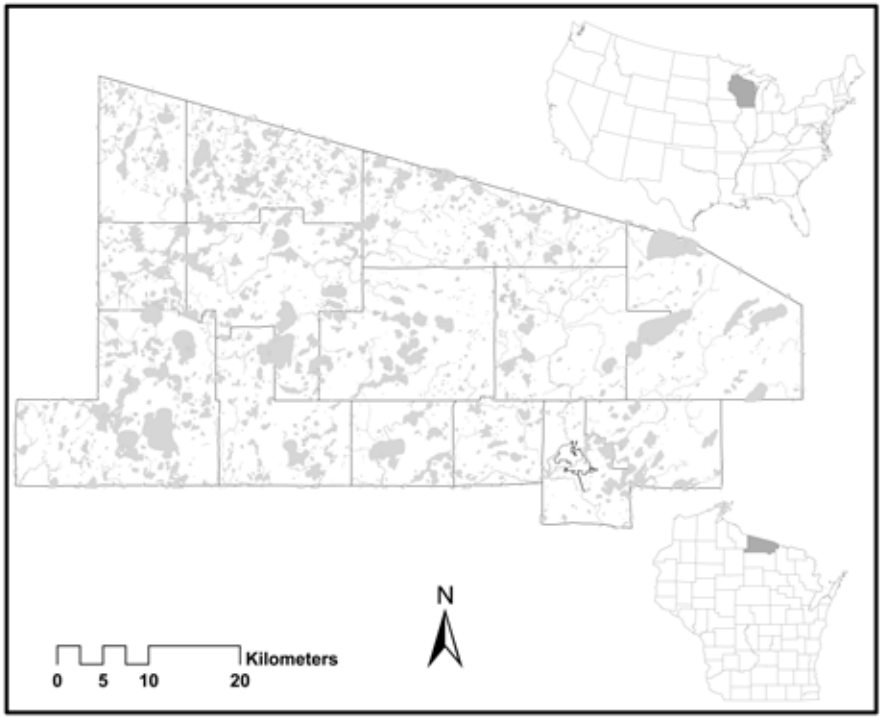
- What determines the value of a house?
  - Site characteristics: lot size, shoreline frontage, number of bedrooms, age of house, etc.
  - Neighborhood characteristics: distance from downtown, quality of schools, etc.
  - Environmental characteristics: noise levels, air quality, scenic views, proximity to dis-amenities (e.g. landfills), etc.
- Using data on property transactions, statistical analysis is used to decompose the price effects of each attribute.

Hedonic Pricing Models – Housing Market

- Competitive land markets ensure that property attributes are capitalized into land values.
  - Prices are bid up for properties with desirable attributes.
  - Prices are bid down for properties with undesirable attributes.
  - Examples from prior research:
    - Air and water quality
    - School quality
  - If AIS are truly undesirable, then property prices on AIS lakes should be bid down relative to prices on non-AIS lakes.

The application

- Lakeshore property owners in Vilas County, WI.
- Over 170 lakes within Vilas County.
- Eurasian watermilfoil (EWM) invasions.
  - A non-native plant.
  - 10% of lakes affected.
  - 21% of recent property transactions on EWM lakes.



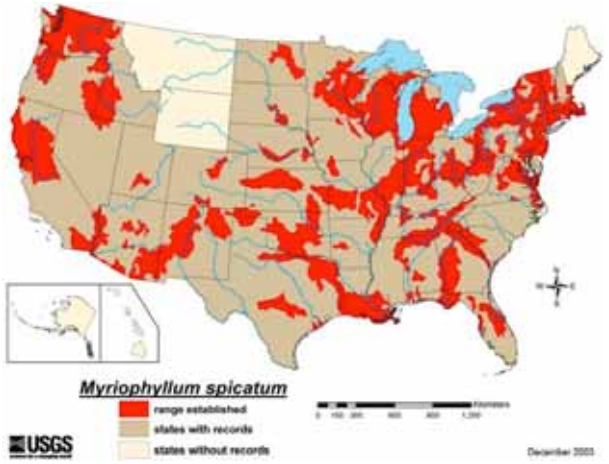
The application

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.

Eurasian watermilfoil (EWM)

- EWM is a widespread problem for freshwater systems.
- As with other aquatic invasive species, EWM's spread is often by humans.
  - Boats
  - Trailers
  - Bait Buckets
  - Motors



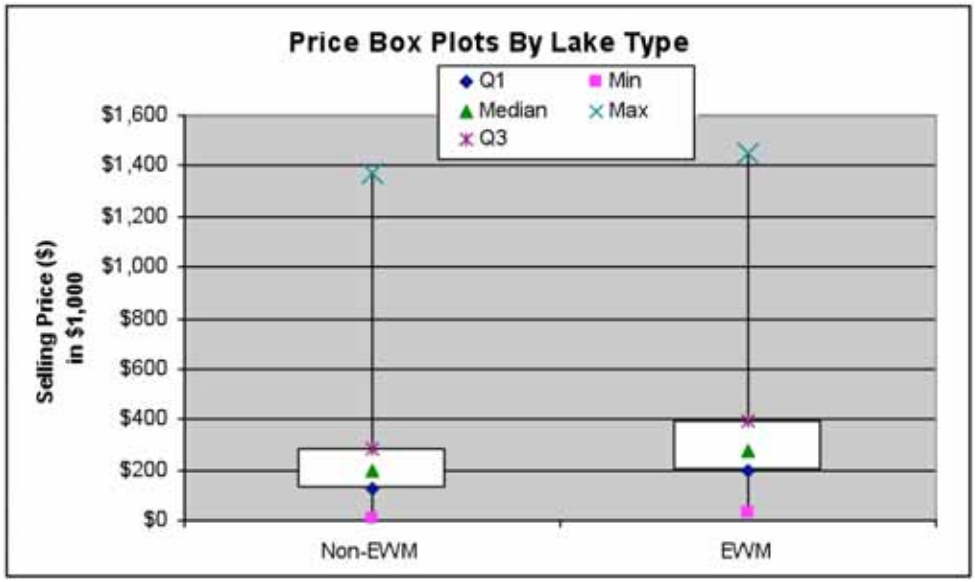
The hedonic application

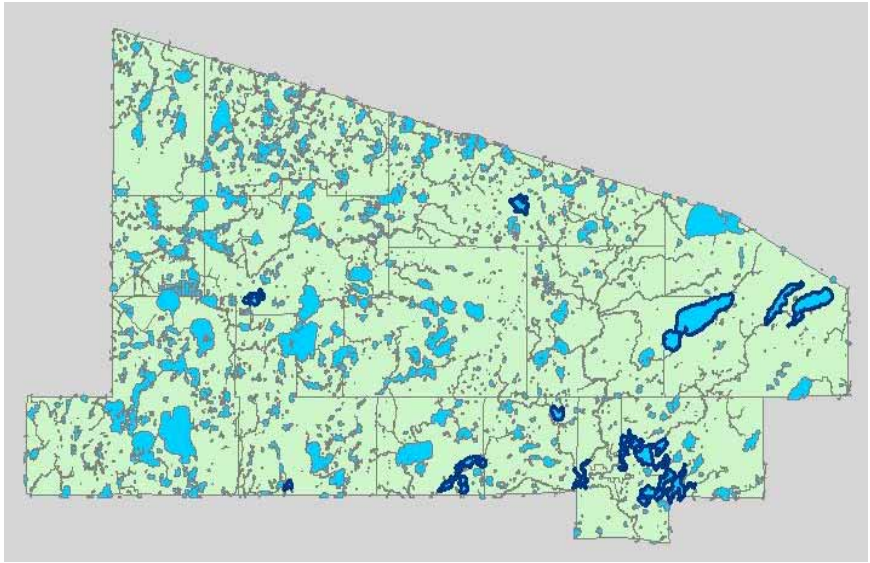
- Arms-length shoreline property transactions (1997-2006): 1,841 sales.
- Available data:
  - Structural: assessed structural values.
  - Parcel characteristics: shoreline frontage, lot size.
  - Lake characteristics: lake size, water clarity, distance to nearest town, shoreline development density, zoning, boat launch, lake association, fishing quality.
  - EWM measures:
    - Presence/absence and year of invasion.
    - DNR surveys of lake-wide relative abundance (available for ’05, ’06 only).

Data sources: WI Bureau of Revenue, Vilas Co. Info. Tech. Dept., Vilas Co. Mapping Dept., Wisconsin DNR, Env. Remote Sensing Center at UW-Madison, Local Fishing Guidebooks.

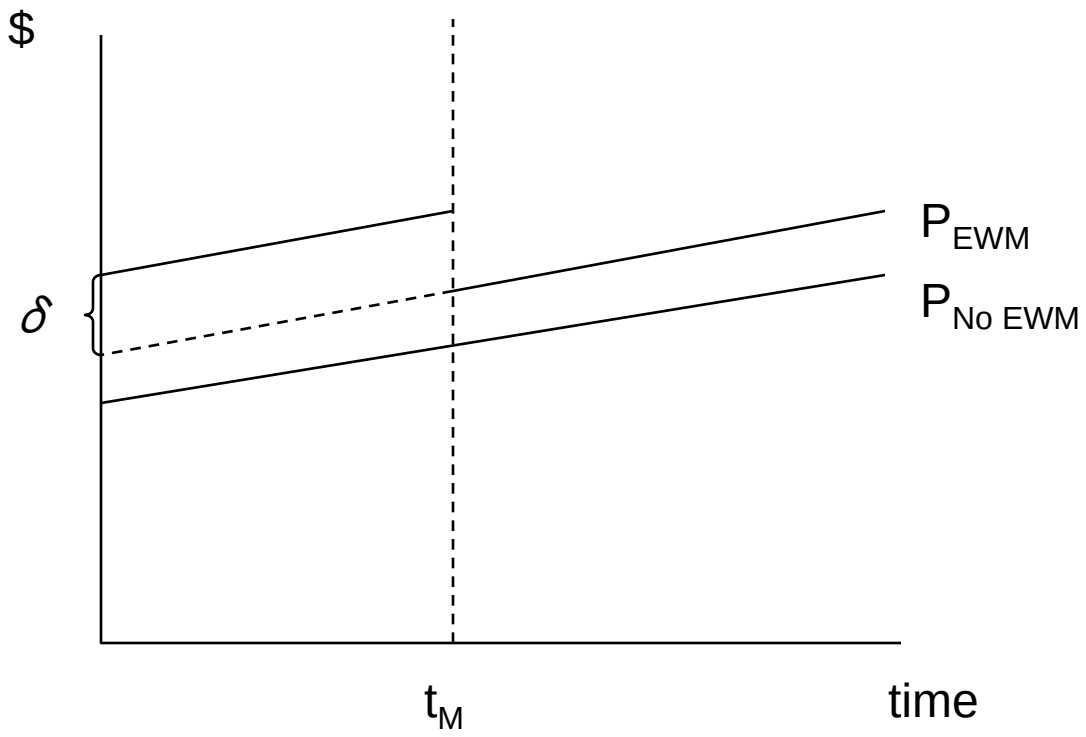
The hedonic application

- Looking at the raw data, properties on lakes with EWM tend to sell for more than properties on lakes without EWM.
  - EWM lakes tend to be larger and have more sport fish such as Musky and Walleye.
  - EWM is more likely to spread to lakes that are popular with boaters; these lakes are also popular with homeowners.





Intuition on statistical (econometric) model



t_M: year of EWM invasion.

δ: drop in price due to invasion.

- The time of invasion is a "natural experiment".
- We estimate a lake-specific premium (P) for every lake that captures all features of a lake that don't change over time: lake size, scenery, etc.
- The lake-specific premium is allowed to vary over time and we test for the effects of the time of invasion.
- Attributes specific to the property (e.g. lot size, frontage, etc.) are separately controlled for.

Hedonic Results (1997-2006)

	Linear Fixed Effects		Non-Linear Fixed Effects	
	Estimate	**Robust Std. Err.**	**Estimate**	**Robust Std. Err.**
Before EWM	$28,294*	9509	$32,087*	14135

- Results indicate that properties on EWM lakes sold for approx. $30,000 more per property before being invaded.
- This is approximately 8% of the average property value, or 13% of the average value of land net of structural values.
- In annual terms, the average homeowner is willing-to-pay approximately $1,400** to prevent an invasion of their lake by EWM.

Single asterisk (*) denotes significance at the 95% level. All standard errors are clustered by lake.

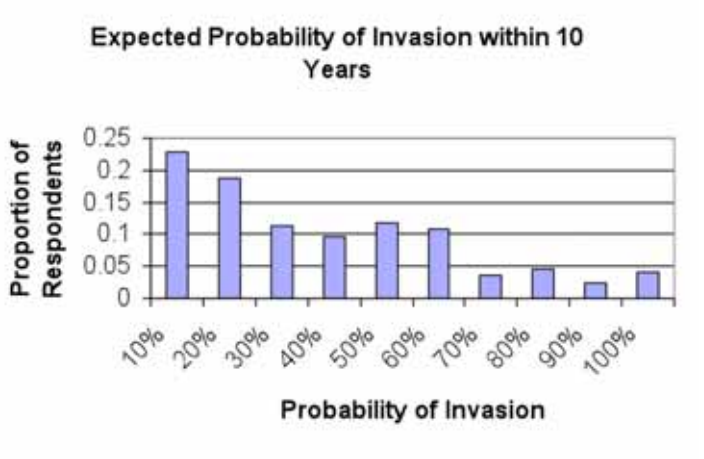
** Assumes a 5% discount rate.

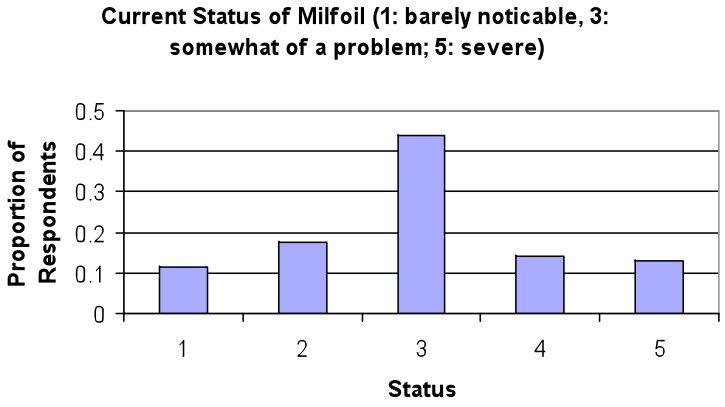
Contingent valuation – An alternative to hedonic modeling

- Contingent valuation (CV) – ask people directly their WTP to prevent environmental damage.
  - Exploits the experimental control of a survey.
  - Common criticism: ask a hypothetical question, get a hypothetical answer.
    - Evidence shows CV does particularly well for goods that provide familiar use values (Carson et al. 2001).
    - People are well aware of EWM.
- We are attempting to verify the hedonic estimates for EWM with a CV study – this work is on-going and not yet complete.

2008 UW-Madison Survey of Vilas County Lakeshore Landowners

- Survey sent to approx. 3000 shoreline property owners.
- 92% of respondents were familiar with EWM invasions before receiving the survey.
- Many respondents expect EWM invasions within 10 years.
- Many respondents claim EWM is at least “somewhat of a problem” on their lake.





Conclusions

- Aquatic invasive species can yield significant economic damages.
  - Eurasian watermilfoil invasion lowers lakefront land values by approximately 13%.
  - Average annual loss for an additional invaded lake is approx. $187,000.
  - On-going survey work aims to check the property value estimates with alternative methods.

More information

- Property value citation:

  Horsch, E.J., and D.J. Lewis. 2009. “The Effects of Aquatic Invasive Species on Property Values: Evidence from a Quasi-Random Experiment.” *Land Economics* (In Press). Copy available as a staff paper at the following website: http://www.aae.wisc.edu/pubs/sps/.
- Survey results of Vilas County shoreline property owners available at the following website :

  http://lter.limnology.wisc.edu/.
  - 2005 survey results available.
  - 2008 survey results will be available by end of summer.
- UW-Madison environmental economics researchers
  - David Lewis: dlewis2@wisc.edu
  - Bill Provencher: rwproven@wisc.edu