The effects of ambient water quality and Eurasian milfoil on lakefront property values in the Coeur d'Alene area of Northern Idaho

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Background / Purpose:

- Recreational value of water resources is a major driving force of economic and urban growth in the Coeur d'Alene Lake region of northern Idaho, USA.
- We use spatial econometric techniques in a hedonic pricing framework to estimate the effects of water quality and the presence of Eurasian watermilfoil on lakefront property values.
- Specifically we aim to:
  - gauge the amenity value of lake ecosystems in relation to water quality (clarity) and ecological indicators (± watermilfoil), while minimizing the bias from spatial dependence;
  - investigate the spatial variation of water-quality benefits along the urban-rural gradient, to help demonstrate to lakefront property owners the value of protecting water quality;
  - inform the current local debate regarding the easing of land-use codes along lake shores.

Watermilfoil infestations and housing

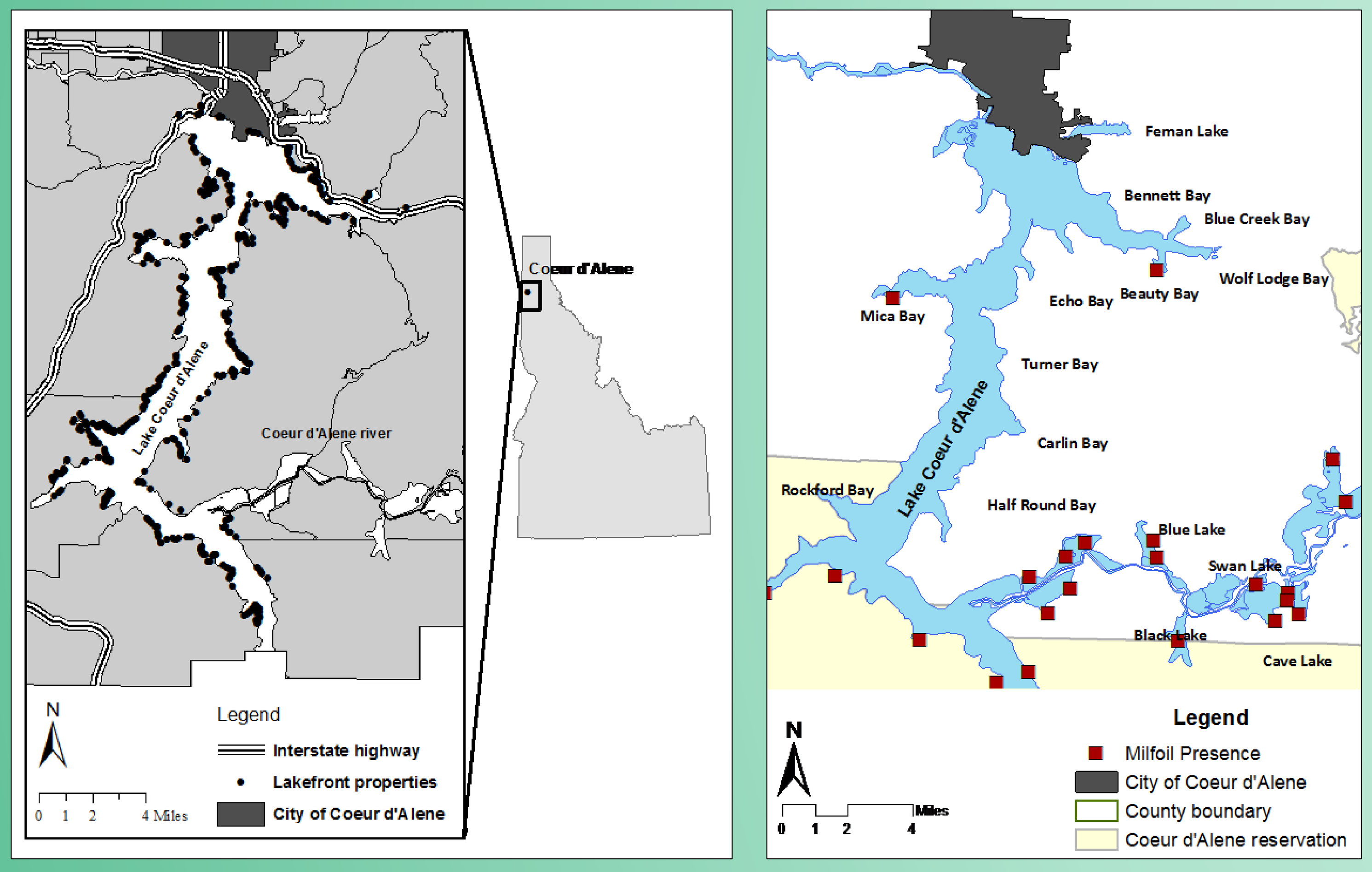


Fig 1. Milfoil presence and lakefront properties; figure on left shows the locations of properties; figure on right shows infestations of milfoil

Hedonic pricing model specifications

The hedonic pricing model (eq.1) takes into account:

$$Ln\,(SP) = \beta_0 + \beta_1(Milfoil) + \beta_2 \ln(\mathrm{WQ}) + \beta_3 ln(WQ) * \ln(Dist2CBD) + r'\mathbf{X} + \delta'\mathbf{T} + \boldsymbol{SF_i}$$

- Structural and locational characteristics of lakefront properties, $\mathbf{X}$;
- Time series dummy variables, $\mathbf{T}$ (2010-2014);
- ln Secchi depths, or ln(WQ), presence of milfoil;
- Eigenvectors to control spatial autocorrelation in residuals, $\boldsymbol{SF_i}$;
- A spatial interaction variable ($ln(WQ) * \ln(Dist2CBD)$) to reflect possible spatially varying influences of water quality on housing prices

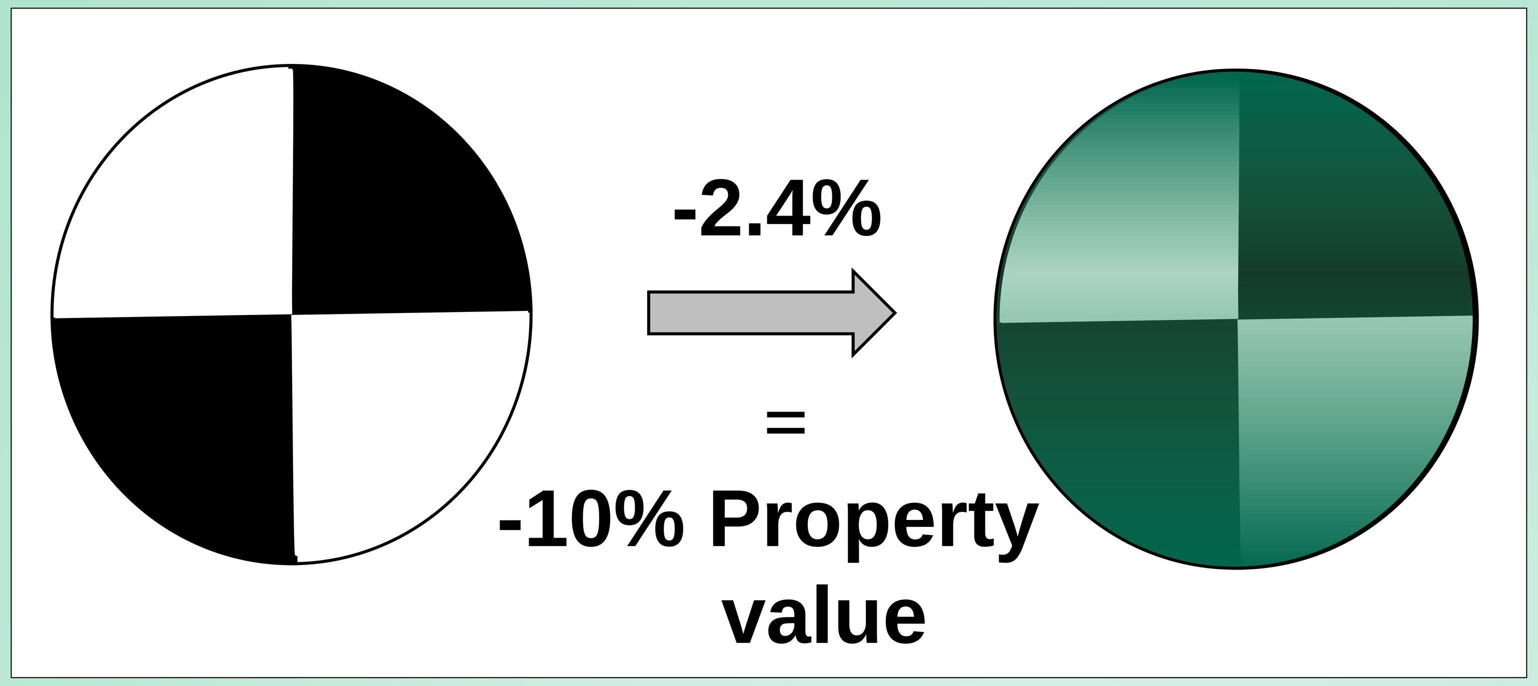
To estimate the performance of eq. 1, models with different configurations were used (Table 2).

Table 2. Model configurations

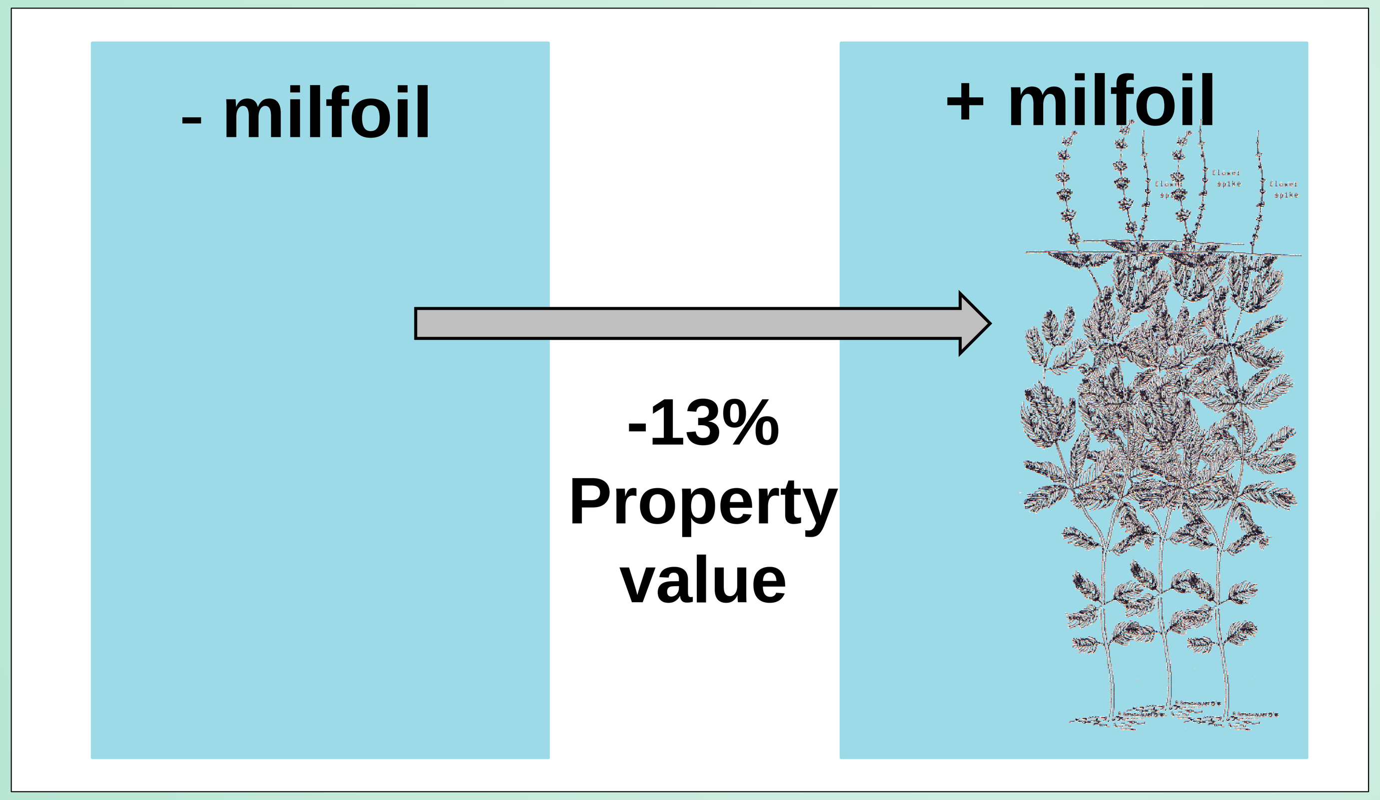
Variables	Model 1	Model 2	Model 3	Model 4	Model1S	Model 2S	Model 3S	Model 4S
$\boldsymbol{X}$	X	X	X	X	X	X	X	X
$\boldsymbol{T}$	X	X	X	X	X	X	X	X
$Milfoil$	X		X	X	X		X	X
ln(WQ)		X	X	X		X	X	X
$\boldsymbol{SF_i}$					X	X	X	X
$ln(WQ) * ln(\mathrm{DISTCBD})$				X				X

Results

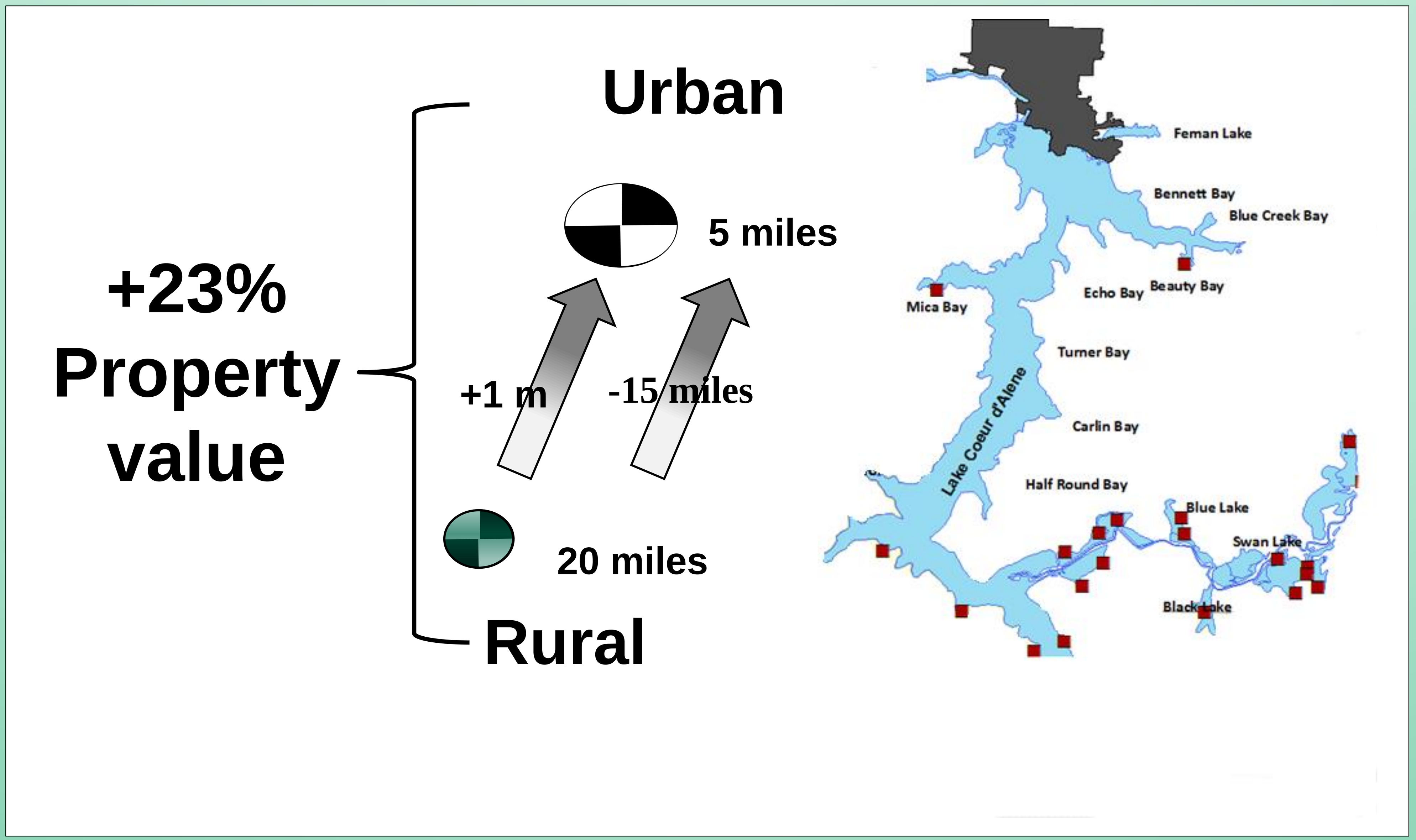
Chi-square statistics demonstrated that spatial filtering models were statistically superior to the OLS models because Moran's *I* index indicated that OLS model residuals were autocorrelated, thus violating assumptions. Breush-Pagan statistics indicated that residuals of spatial filtering models were homoscedastic while the OLS models were heteroscedastic.



Property value in response to decrease in water transparency of 2.4%



Property value in response to presence of milfoil in a nearby bay



Property value in response to increase in secchi depth of 1 m (from 4 meters to 5 meters) and location change of 15 miles along rural to urban gradient (from 20 miles to 5 miles in proximity to downtown Coeur d'Alene)

Results (continued)

Marginal prices for increases in water quality (Secchi depth) ranged from $14,127 to $ 27,096, which corresponded to percentage increases in property values from 2.77% to 5.97% (Table 4).

We used eq. 2 to estimate the implicit value of distance from downtown, the result of which is shown in (Fig 2). For example, for water clarity improvement from 4 to 5 meters, the mean implicit property value increased by 23%, or $8,033 when moving from 32 km (20 miles) to 8 km (5 miles) from the downtown.

$$\frac{\partial Price}{\partial(WQ)} = \frac{Price}{WQ}(\beta_2 + \beta_3 \ln(Distance)) \qquad (2)$$

Table 4. Interpretation of coefficients for all lakefront properties

Water quality attribute	% change at mean property values	Marginal implicit price (in 2010 constant dollars)
Secchi depth (1 meter increase)		
4 meters->5 meters	5.97%	$27,096
5 meters->6 meters	4.32%	$22,033
6 meters->7 meters	3.64%	$18,568
7 meters->8 meters	3.15%	$16,406
8 meters-> 9 meters	2.77%	$14,127
Invasive species		
Milfoil (presence->no presence)	12.53%	$64,444

Note: mean property value equals $509,962, in 2010 constant dollars

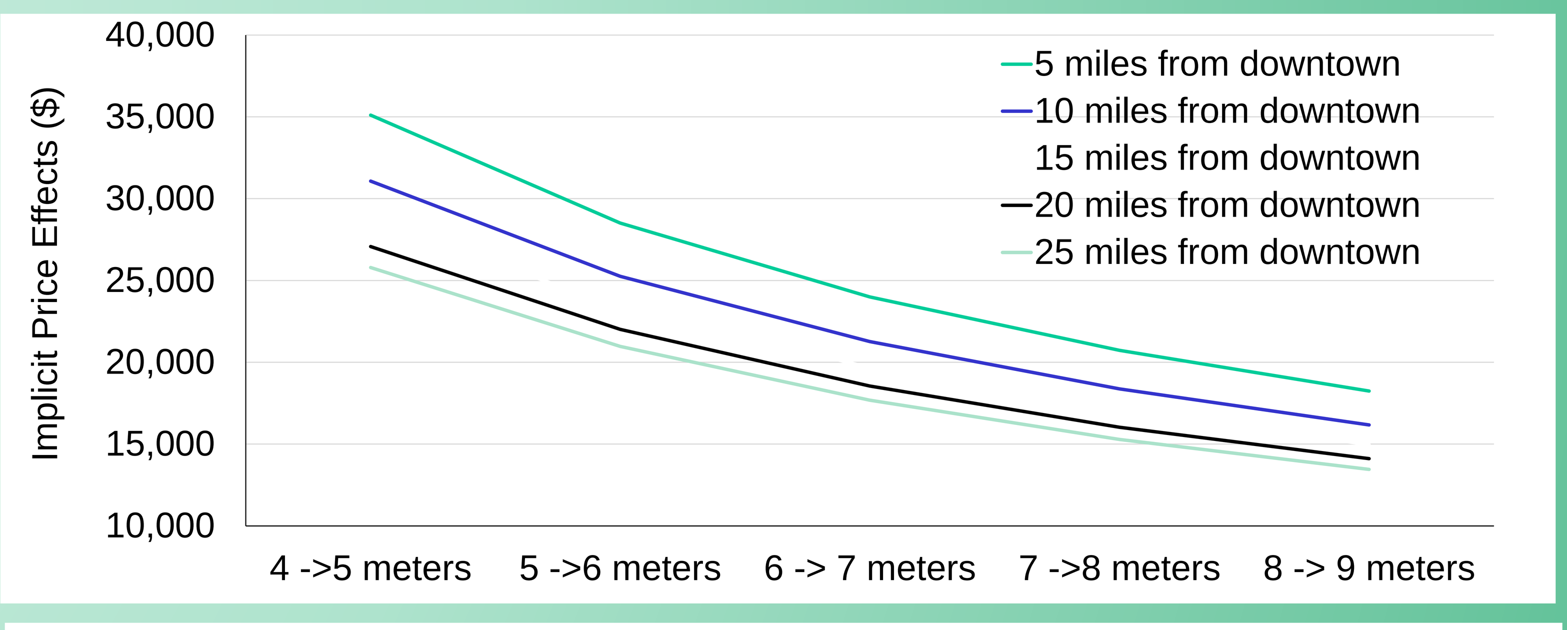


Fig 2. Implicit price of water-quality improvement conditioned upon the urban-rural gradient

Conclusions

1. We used a hedonic pricing model to quantify the impacts of water quality on the lakefront property value in Coeur d'Alene area of Northern Idaho.
2. An implicit positive effect of proximity was found as a result of the spatial interaction between urban-rural gradient and water-quality.
3. Including the economic benefits of maintaining local ecosystem services in land-use planning decisions and stakeholder engagement is critical.
4. Loss of water quality and presence of water milfoil can decrease welfare and net benefits to lakefront property owners.
5. Protection of water quality in the Coeur d'Alene must be integrated into land-use policy and planning, natural resource management, and regional planning to sustain the lake ecosystem.

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