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OKOBOJI EXPERIMENT: COMPARING NON-MARKET VALUATION TECHNIQUES IN AN UNUSUALLY WELL-DEFINED MARKET FOR WATER QUALITY

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ABSTRACT

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Three techniques to value the non-market commodity of water quality are compared in a notably active and unusually well-defined market: the Okoboji Lakes region of northwest Iowa. The paper compares: (a) a site valuation based on differing property values across lakes; (b) a market valuation by soliciting realtors' interpretations of observed price differentials; and (c) a contingent valuation of willingness to pay for water quality changes. The results obtained are similar in magnitude; the value of water quality ranges from 13 to 23% of the total residence value per square foot of private residence.

INTRODUCTION

It is generally recognized that the comparison of non-market valuation techniques is substantially improved if the commodity in question exists in an active and well-defined market. Individual perceptions and experience evolve over repeated interactions into well-founded implicit values and, thereby, prices for such a commodity. Yet the majority of valuation technique comparisons have suffered from relatively distinct locations and attributes (Schulze et al., 1981), different mixes of health and aesthetic effects (Brookshire et al., 1982), or only partial or incomplete knowledge of the commodity by those revealing preferences (Seller et al., 1985; Smith et al., 1986). The purpose of this note is to describe a recent comparison of valuation techniques (d'Arge and Shogren, 1988) in a notably active and unusually well-defined market for water quality: the Lakes of Okoboji,

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Iowa, U.S.A. The glacial lakes of East and West Okoboji offer a relatively unique set of characteristics for non-market valuation comparisons because the lakes have approximately the same amenities except for water quality, are physically connected and, thereby, have almost limitless and costless substitution possibilities, and there is a high degree of resident awareness of water quality.

Specifically, we compare three valuation techniques: (a) a site valuation based on comparing property values between East and West Okoboji; (b) a market valuation by soliciting realtors' and real estate agents' interpretation of observed price differentials between the lakes; and (c) contingent valuation using a limited sample of site dwellers to examine their willingness to pay or to be compensated for a change in water quality. The results derived from the three approaches are similar in magnitude except for the compensation measure. Although problems existed in obtaining valid compensation estimates, the similarity of the other values is as expected since an active market for water quality through residence site selection has been operating for over 30 years.

SITE DESCRIPTION

East and West Okoboji are part of the Iowa Great Lakes Region (IGL) located in Dickinson County, Iowa, U.S.A. The IGL region is adjacent to the Minnesota border, and is 210 miles (340 km) northwest of Des Moines, Iowa (see Fig. 1). The estimated mid-summer population of the IGL region is 32 332: 7132 permanent residents, 14 700 second-home owners, and 10 500 seasonal renters. The climate is humid-continental: seasonal temperatures range from 110 to $-40\,^{\circ}$F and annual precipitation is 27.69 in (71 cm). The IGL region consists of six principal lakes: Spirit Lake, Minnewashta Lake, Lower and Upper Gar Lake, and East and West Okoboji. The IGL watershed covers 140 square miles (363 km^2), 76% of which is in Dickinson County. Morphometric data indicates that West Okoboji has a maximum depth of approximately 40 m and a mean depth of 11.9 m. West Okoboji has a surface area of 15.40×10^6 m^2 and a volume of 184.0×10^6 m^3. East Okoboji has a maximum depth of 6.76 m and a mean depth of 2.78 m. East Okoboji has a surface of 7.64×10^6 m^2 and a volume of 21.24×10^6 m^3. West Okoboji is more than five times deeper than East Okoboji.

East and West Okoboji offer a relatively unique recreational environment for comparing non-market valuation techniques. The lakes, connected by a shallow canal, are notably similar from a locational and visual perspective. Each offers about the same mix of water-based recreation activities and there is almost unlimited and costless substitution between them except for site advantages. The lakes differ conspicuously, however, in recreation-based

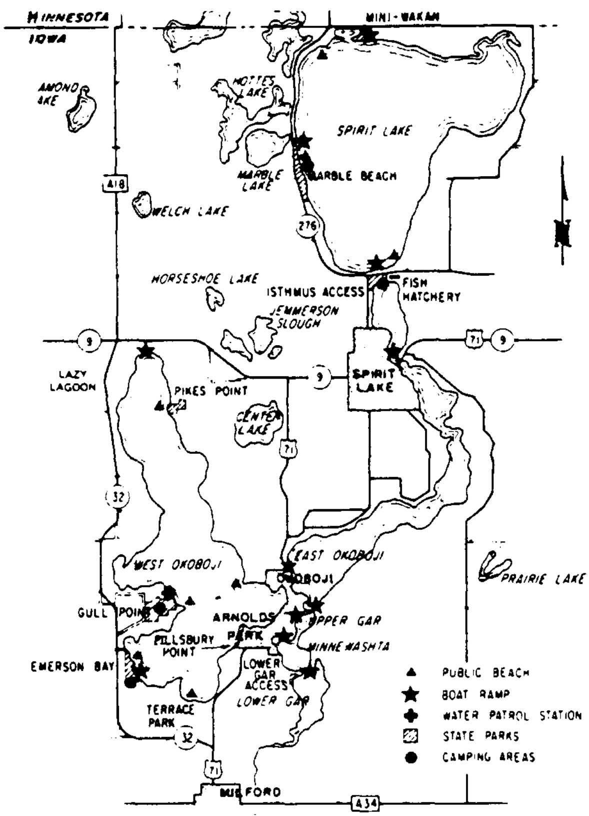

Fig. 1.

water quality. East Okoboji is more shallow and has a relatively greater waste input from agricultural and natural runoff. Consequently, during part of the summer recreational months (typically more than 30 days) East Okoboji supports dense blooms of algae resulting in a lime green color and noticeable odor. Alternatively, West Okoboji rarely (less than five days) has a noticeable algae bloom with turbidity and is typically characterized as clean in summer months. Table 1 summarizes a limited sample of Okoboji residents' perceptions of typical water quality of the Lakes during 100 days in the summer and early fall.

Historically, real estate development has occurred, with substantial second home development, on West Okoboji commencing in the early 1900's and proceeding to the present. East Okoboji developed at a much slower pace. The average assessed valuation per residence for West Okoboji in 1983 was US$161,716; the average size was 2152 sq ft (200 m^2) per residence. For East Okoboji, the average assessed valuation was only US $61,484 and a

TABLE 1

Summary of perception of typical water quality, sample survey, East and West Okoboji Lakes, 100 days in summer and early fall

Level of water quality [b]	Mean of number of summer days perceived [a]	
	East Okoboji Lake	West Okoboji Lake
A	1.50	44.50
B	75.40	50.00
C	20.50	5.25
D	2.10	0.25
E	0.50	0.0
Total	100.00	100.00

[a] Sample size was 20.

[b] Water quality represented by the following scale:

Best water quality 10 A drinkable, swimmable, fishable, boatable
9
8
7 B swimmable, fishable, boatable
6
5 C fishable, boatable
4
3 D boatable
2
1 E no activity recommended
Worst water quality 0

typical residence, 1415 sq ft (131.55 m^2). There is substantial difference in total valuation and value per square foot at the two locations. Given that East Okoboji has been a less desirable location because of water quality, land values have been lower, development occurred at a slower rate, and lower priced housing was erected. Consequently, residents in the Lake Okoboji area have had a very long history of experience with a distinct and identifiable water quality difference which has not varied substantially over many years [1].

[1] One conceptual problem with inter-lake comparisons is that individuals with preferences for higher water quality have located at West Okoboji while those with lesser preferences for water quality or a greater preference for a particular mix of recreation activities have located on the east lake. Consequently, the observed difference in values between the lakes may be partially determined by differences in preferences.

METHODOLOGY

Let us consider the three valuation techniques in more detail. First, the site valuation based on comparative property values is well known and has been frequently used in empirical studies of non-market environmental assets (see for example, Brookshire et al., 1982). The technique is an indirect method to estimate the economic value of a non-market good. The method is indirect in that an implicit price for water quality is assumed to exist in the value of property. A house is comprised of a bundle of assets, one of which is water quality. By comparing property values in two locations where the main difference is water quality, a rent gradient can be estimated. The rent gradient reflects the individual's marginal implicit price for water quality in the housing market (Rosen, 1974; Freeman, 1979). The biggest advantage of the site valuation method is its use of actual market data. The market value of the property can reflect the rational consumer's marginal rate of substitution between water quality and consumption, i.e., the implicit market price of water quality.

Second, the contingent valuation approach is also well known and its use has been expanding rapidly in the economics literature (see for example, Crocker, 1985). The contingent valuation approach estimates the economic value of a non-market asset through construction of a hypothetical market. The hypothetical market creates an auction block in which the asset can be bought and sold. By constructing accurate demand-revealing mechanisms, the economic value is determined through a survey or interview which directly elicits an individual's implicit price for the asset (see Cummings et al., 1986, or Durden and Shogren, 1988, for a description of the demand revealing mechanisms used in contingent valuation studies). Our experiment constructed markets such that both the individual's maximum willingness to pay for increased water quality and minimum willingness to accept compensation for decreased water quality were elicited (the actual survey instrument is available from the authors upon request).

Third, a market valuation by asking a sample of Okoboji realtors and real estate agents to interpret observed price differentials between lakes is a new technique. The technique attempts to incorporate expert's prior information on the contribution of water quality to property values. Although a potential upward bias on value exists, the agents perhaps provide the most knowledgeable opinion on the market for water quality in the Okoboji region.

RESULTS AND DISCUSSION

During the summer and fall of 1984, data were collected for housing-assessed valuations, the contingent valuation experiment, and the realtors and real estate agents response surveys. The sample size for the experiment was relatively small: 66 for housing-assessed valuation (39 for West Okoboji and 27 for East Okoboji—about 10% of the residences in the Lakes region); 20 for the contingent valuation experiment (3% of households); and 17 realtors and real estate agents (15% of total agents). Whether these are adequate samples to represent the area is unclear. Using a single power test suggests that sample size for the contingent valuation method should be 22 (with $R^2 = 0.30$, number of variables 5, and significance level 0.05). For estimating precise benefits of water quality improvements rather than examining methodologies and experimental approaches, probably a larger sample would need to be taken for accuracy in application of the contingent valuation method.

Only residents and dwellings with actual lake front property were considered. By only including residents, we omit consideration of individuals forced to relocate because of higher prices. Therefore, if our sample adequately reflects all dimensions of the resident population then we avoid the truncation and censoring that causes biased parameter estimates using ordinary least squares (OLS) regression analysis (see Smith et al., 1986).

The three data sources revealed three estimates of the rental gradient associated with locations differentiated by the unique level of water quality, and two compensating surplus measures of consumer surplus for differences in value per square foot of housing attributable to water quality. First, the three rent gradient estimates of the difference in value per square foot of housing are the realtors' best estimate of price differentials (US$14.57), comparison of imputed lake frontage prices (US$12.83), and a pooled regression estimated based on assessed valuation (US$13.58). The three rent gradients were derived as follows. First, the realtors' best estimate of US$14.57 per sq ft was derived according to surveyed realtors and real estate agents who attributed an average of 46% of the average difference in housing-square-foot-assessed valuation (US$31.67) to water quality differences. Second, imputed value from regressions of lake frontage were estimated through separate regression equations of housing characteristics for each lake. The difference in regression coefficients in feet of lake frontage equaled US$1009.00 per sq ft. Using the average measure of lake front housing square feet and the realtors' average proportion allocated to water quality, the implied valuation difference per sq ft of dwelling was US$12.83. Third, the pooled regression estimates of housing data for East and West Okoboji compared the differences in housing characteristics. An US$84,189.00 difference was observed net of basic housing characteristics, amounting to a US$39.12 per sq ft difference. Adjusting for realtors' average portion attributable to water quality, the difference in value is US$13.58 per sq ft (see d'Arge and Shogren, 1988). Note, the three estimates are not unique in that part of the realtors' estimate is used in calculations derived from the regression equations.

The two compensating surplus measures are the willingness to pay for increased water quality (US$8.20), and the willingness to be compensated for decreased water quality (US$4.34). The willingness to pay and to be compensated measures of value are based on a limited application of the contingent valuation method. Both the willingness to pay or to be compensated are compensating surplus measures of consumer surplus (Just et al., 1982), and were elicited from a random stratified sample of residents from both lakes. Average willingness to pay bids across lake residents (US$6.29 per US$1000 assessed valuation) were converted to housing value equivalents by using average residence size on each lake (1851 sq ft) and a five percent real rate of discount. The average willingness to pay bid per square foot in present value terms for both lakes equalled US$8.20. The average willingness to be compensated bids per sq ft was determined in a similar fashion as the willingness to pay bids. The average compensation per sq ft in present value terms for both lakes equalled US$4.34. Because of the small number of observations, however, these average estimates must be viewed only as illustrations of the magnitudes of marginal compensation and willingness to pay, not as definite measures (d'Arge and Shogren, 1988).

Table 2 contains a summary of the comparative analysis. One would expect, ex ante, at least five results. First, the three estimates of the rental gradient are reasonably close together, with the realtors' estimate being the highest. This might be anticipated since realtors would have a strategic incentive to overvalue characteristics of the commodity they are selling. Second, we should anticipate the rent gradient estimates to be relatively close given that water quality is well defined to residents and has been for at least 30 years. Third, the rent gradients should be significantly greater than zero in that there should be a substantial difference between the lakes in value per sq ft of housing where water quality had become an accepted and valued commodity. Fourth, as argued by Feenburg and Mills (1980) and Schulze et al. (1981), among others, the rental gradient is expected to exceed the marginal willingness to pay. This expectation is supported in that the average willingness to pay measure (US$8.20) is estimated to be about 56% of the realtors' best estimate (US$14.57), and approximated 60% of the indirect implicit price derived from a pooled ordinary least squares estimate (US$13.58). In comparison, Brookshire et al. (1982) note that marginal willingness to pay was only 34% of the rent gradient. Finally, one should expect that the willingness to be compensated should substantially exceed willingness to pay if this experiment follows recent findings of valuation disparities (see Knetsch and Sinden, 1984, 1987). Note that the estimated compensation is less than either the estimated willingness to pay and the

TABLE 2

Comparison of valuation benefits

Estimate derived from	Difference in value per square foot of housing (1983 US$ per sq ft)	Observed average housing value (%)	Realtors' estimate (%)
Realtors' best estimate	14.57	23	0
Imputed value from regression on lake frontage [1]	12.83	20	88
Pooled regression estimate coupled with realtors' valuation	13.58	21	93
Imputed willingness to pay (average across lakes)	8.20	13	56
Imputed willingness to accept compensation (average across lakes)	4.34	7	30

[1] Adjusted for realtors' proportion attributed to water quality.

rent gradient. It is unlikely, however, that this compensation estimate represents an accurate one. This is due to a 60% refusal rate by respondents to be compensated. Whether this was due to questionnaire design or inherent problems in eliciting responses for compensation is unclear. The true estimate is probably at least several times the US$4.34 calculated here. This result readily confirms Cummings et al.'s (1986) warning that willingness to pay, not willingness to be compensated, should be the surplus measure of choice when utilizing the contingent valuation method.

Given the historical development, substitutability between the lakes, and current community awareness, the Okoboji region offers a unique opportunity to examine non-market valuation techniques. Although tentative, the results suggest that from 13 to 23% of the residence value (per sq ft) is accounted for by water quality increasing from a qualitative boating/fishing level to a qualitative perceived swimming/drinking level. This would yield a sizable benefit if it could be translated to national levels.

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