Society and Natural Resources, 19:137–151
Copyright © 2006 Taylor & Francis LLC
ISSN: 0894-1920 print/1521-0723 online
DOI: 10.1080/08941920500394733

Environmental Perception in a Rapidly Growing, Amenity-Rich Region: The Effects of Lakeshore Development on Perceived Water Quality in Vilas County, Wisconsin

RICHARD C. STEDMAN

Department of Agricultural Economics and Rural Sociology,
Pennsylvania State University, University Park, Pennsylvania, USA

ROGER B. HAMMER

Department of Rural Sociology, University of Wisconsin, Madison,
Wisconsin, USA

We explore the relationship between perceived and actual water quality in a rapidly growing, high-amenity rural area (Vilas County, WI) and how this relationship is affected by shoreline development. Although the data on the relationship between shore development and aquatic environs are not conclusive, people express high levels of concern about the environmental impacts of this type of growth. We link databases that include water quality and lakeshore development variables with a mail survey of 1000 local property owners. Although the shoreline development levels are unrelated to water quality variables such as turbidity, chlorophyll levels, and color, we find that lakes with higher levels of development are perceived by respondents as having worse water quality than lightly developed lakes. These findings have important implications for high-amenity rural communities that undergoing rapid development.

Keywords amenity communities, environmental perception, lakeshore development, water quality

This article examines the relationship between perceived and actual environmental quality—using the example of water quality indicators and shoreline development—in a rapidly growing, high-amenity rural area. During the post-World War II era, increased disposable income, leisure time, and transportation improvements have contributed to population growth in nonmetropolitan areas rich in natural amenities such as lakes, coastlines, mountains, forests, and mild climate (Beale and Johnson 1998; Cromartie and Wardwell 1999; Deller et al. 2001; McGranahan 1999; Rudzitis 1999).

As rural communities in many regions shift toward consumption-based economies, land use and the effects of growth on the biophysical environment and quality of

Received 13 April 2004; accepted 1 April 2005.

Address correspondence to Richard C. Stedman, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University, 111-B Armsby Building, University Park, PA 16802-5600, USA. E-mail: rstedman@psu.edu

life become critical issues generating substantial discussion and debate (Green et al. 1996; Jobes 2000; Rudzitis 1996; Smith and Krannich 2000; Warner et al. 1999). Often the challenge facing these communities is how to maintain desired attributes in the face of population growth and its consequences. Some researchers have asserted that managing rapid population growth while protecting social, ecological, and economic values is the most important issue today facing rapidly growing rural communities (Beyers and Nelson 2000; Duane 1999). Maintenance of environmental quality is often touted as of special concern (Gobster et al. 2000). Population growth may harm natural amenities such as forests and lakes (Huang and Stewart 1996; Lankford 1994; Marcouiller et al. 2002; Perdue et al. 1987; Radeloff et al. 2001; Romeril 1989; Rudzitis 1999; Schnaiberg et al. 2002; Wear and Bolstad 1998; Wear et al. 1998).

With respect to the more specific impacts of population growth on aquatic environs, Christensen et al. (1996) found that shoreline development resulted in a large decline of riparian vegetation, hindering the recruitment dynamics of fish (see also Bryant and Scarnecchia 1992). Racey and Euler (1983) found a strong impact of cottage lots on the proportion of disturbed land. Dillon et al. (1994) compared nutrient levels on developed and undeveloped lakes. In 75% of lakes there was a strong relationship between lakeshore development levels and phosphorous. Hendry and Leggatt (1982) found higher levels of fecal coliform and fecal streptococcus bacteria in lakes more heavily developed with cottages. Clark and Euler (1984) found more species of passerine birds in developed lakeshore lots, but a replacement of development-intolerant species like the Canada warbler and solitary vireo with "backyard" species such as junco and chickadee. Meyer et al. (1997) found that housing density was negatively related to vegetation in the terrestrial buffer zone, shrub coverage along the water/land interface, and coarse woody debris. The number of breeding birds did not differ between developed and undeveloped lakes, although the species composition did. There was no effect of development on Bald Eagle or Common Loon distribution and productivity (see also Heimberger et al. 1983).

Although the data on the relationship between development and aquatic environs are not completely conclusive, people express high levels of concern about the impacts of this type of growth, and they tend to couch their opposition to rapid development in language that emphasizes "protecting the environment." In our article, we examine this relationship. Our empirical question is simple: Are lakes with more shoreline development perceived as having worse water quality, independent of the intrinsic geochemical properties of the lakes themselves?

There is no single accepted index of water quality/pollution, despite some efforts to create one (e.g., CEQ 1972). Water pollution remains a concept that is multidimensional (Coughlin 1976) and to a degree site specific (Craik and Zube 1976). Models of water quality perception are often organized around a perceptual-cognitive response (i.e., "awareness"). Although not often articulated as such, this approach fits nicely within a social psychological expectancy-value framework that models attitudes (as summative evaluations) as the sum of beliefs about an object multiplied by the evaluation of each (Eagly and Chaiken 1993). Simply put, overall attitudes toward water quality (e.g., "I love the water in my lake") are determined by a series of beliefs (e.g., "the water in my lake is clear," "the water in my lake has an algae bloom in August") and the values associated with each.

Little systematic research has been conducted using this model: Barker (1971) notes that correlates of perceived pollution include murkiness, weeds, greenness, algae, and odor (these correlate strongly with eutrophication variables such as chlorophyll). Untrained observers had little trouble recognizing nutrient-rich conditions, but missed other measures of water quality that did not emphasize nutrients. Perceptions are also affected by uses. Ditton and Goodale (1973) found that those most involved in the setting (as fishers and swimmers) were more likely to describe the water resource as polluted or dirty (see also Bonaiuto et al. 1996).

Expectancy-value models suggest that overall attitudes are determined by an aggregation of beliefs, weighted by the value judgments associated with each. However, people do not always have adequate information to support each specific belief, particularly concerning harder to observe phenomena such as water quality. In conditions such as these, respondents may use more readily observable phenomena, such as shoreline development or recreational crowding, to help construct their overall attitude, and then "work backward" to fill in missing beliefs that are consistent with the attitude (Bem 1970). This suggests that concerns about other impacts of shoreline development may be also applied to water quality issues. As preliminary support for this claim, we offer findings that scenic quality attributions are generally higher for undeveloped than developed landscapes (Kaplan 1978) and lakes in particular (MacBeth 1989). Stedman (2003) documented that population growth in Vilas County has threatened the "sense of place" or preferred meanings that underpin attachment and satisfaction with the landscape. These meanings, which are predicated on public access to a landscape of high environmental quality, are linked, but are not equivalent to, changes to the physical environment.

Research Questions, Setting, and Methods

We examine the extent to which the relationship between biogeochemical water quality measures and perceived water quality is affected by a lake's level of shoreline development. Consistent with our earlier discussion, we suggest that densely settled lakes will be seen as having worse water quality, independent of water quality measures.

The Northern Highlands Lake District of Wisconsin (NHLD), and particularly Vilas County, the focus of this study, exemplify rapid population growth in ecologically sensitive rural areas. Vilas County is predominantly forested and 14.3% of the surface area of the county is water. Disregarding the 321 ocean and Great Lakes coastal counties, this proportion of surface water ranks the county 21st among the remaining 2789 counties in the 48 contiguous states of the United States.

The permanent population of Vilas County grew from 8894 in 1940 to 21,033 in 2000, an increase of 136% (Figure 1). During the same period, the population of U.S. nonmetropolitan counties grew by just 30%. However, the U.S. Census population does not account for seasonal migration into and out of the county. The number of housing units is a better measure of the changing impact of human settlement than population, since people migrate seasonally but housing units do not. The number of housing units is therefore a reasonable proxy for the number of households during the summer period of peak occupancy. The number of housing units in Vilas County grew from 4836 in 1940 to 22,397 in 2000, a dramatic increase of 363%. During the same period, the number of housing units increased by just 115% in nonmetropolitan counties overall. In 2000, 58% of the housing units were vacant and intended for seasonal occupancy. By comparison, just 3% of housing units

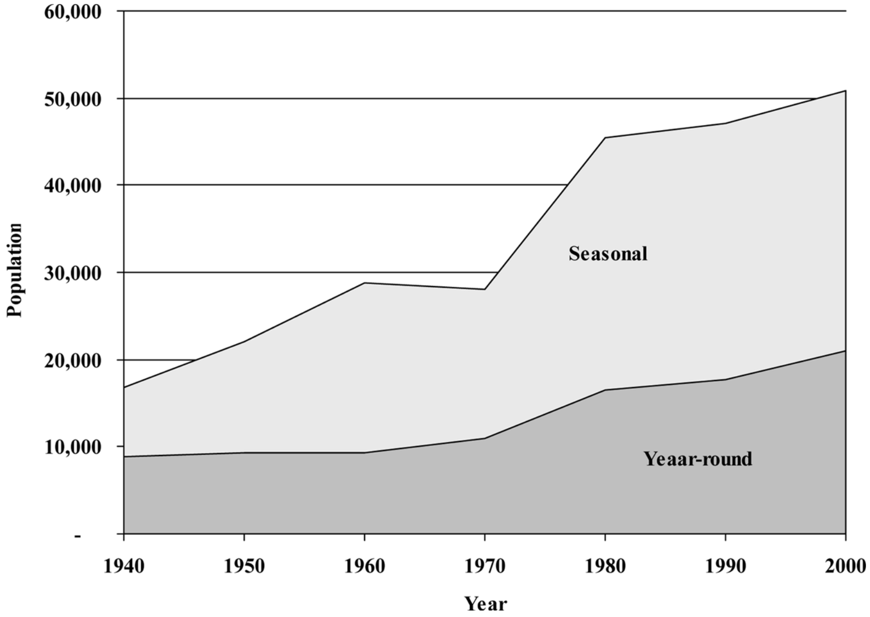

Figure 1. Vilas County, seasonal and year-round population.

nationally were for seasonal occupancy. Although the proportion of housing units that are seasonal declined slightly from 58% in 1990 to 56% in 2000, Vilas County still ranked 10th among all 3108 counties in the contiguous 48 states in terms of the proportion of housing units that are seasonal. By assuming that the number of persons per household in the Vilas County population diverged linearly from the national trend since 1940 and by also assuming that the nonseasonal vacancy rate in the county remained constant during the period, the seasonal and total (i.e., summer) population of the county can be estimated (Figure 1). Although the year-round population of the county, as measured by the decennial Census, grew by 136% during the six-decade period, the estimated seasonal population grew by 280%.

Development pressures have been especially intense around lakes. The Northern Wisconsin's Lakes and Shoreline Study (WDNR 1996a) found a 60% increase in shore development density on selected lakes between 1960 and 1996. New construction has resulted in a dramatic decline in vacant lakeshore property. The loss of shoreline is considered a "priority issue" in the WDNR Northern Initiative (WDNR 1996b). The town of Eagle River (1996) found that clean water, lakes, and woods were most important to quality of life. These amenities are threatened by unplanned sprawl, inadequate shore land zoning, and recreational conflict. Similar results are found in planning documents by local township zoning committees, including those by the Town of Manitowish Waters (1995), Town of Arbor Vitae (1996), Town of St. Germain (1997), and Town of Eagle River (1996).

Methods

Our research integrates survey research on environmental perception with several limnological databases on Vilas County lake attributes. The first database, developed by Vilas County government, includes all lakes in the county over 50 acres in size, 275 lakes in total. Our research used the following variables: lake size (acres), average depth, and shoreline development density (operationalized as the number of structures in the 100-m shoreline buffer per mile of lake frontage), and calculated using 1996 aerial photographs, where visible structures were identified using a stereoscope and mapped on lake GIS (geographic information system) coverages (T. Lyden, personal communication 1999). Using this information, a measure of visible structures per mile of shoreline was calculated.[1] The Long Term Ecological Research (LTER) program also provided data on Vilas County lakes, including the ERL database (collected in the 1980s), which provides information on 171 lakes (Glass and Sorenson 1994). We utilized lake-specific information on water clarity, chlorophyll (or total P), color (light absorption, or dissolved organic carbon as a surrogate), alkalinity, and conductivity (total dissolved solids).

Perceptions of lake quality were explored with a mail survey of a random sample of Vilas County property owners. The instrument asked questions about respondent experiences, perceptions, and attitudes vis-à-vis a particular Vilas County lake.[2] The sampling frame consisted of all Vilas County residential property owners that appeared in the 1998 Vilas County tax records database. One thousand property owners, stratified by gender, were selected for the survey, and a three-contact mailing procedure resulted in a 72.1% response rate.

The data sets were integrated using the WBIC (Water Body Identification Code), a unique identifier for each water body in the state. This number was included in the lake databases described earlier; lake variables were appended to the survey database using the WBIC. Although less than 10% of the county lakes were described in both the ERL and the Vilas County data, lakes that were more likely to appear in these data sets were also more likely to be described by the mail survey respondents. Many lakes with no data are small isolated bog lakes that see little human use (Reed-Anderson et al. 1999).

Results

Respondent Characteristics, Attitudes, Beliefs

Survey respondents provided several types of information: (1) sociodemographic characteristics; (2) experiences and mode of interaction with the lake; (3) perceptions of specific lake attributes; and (4) overall ratings of lake quality. The majority of survey respondents were second home owners (68.4%). Most (74.0%) owned lake frontage. Respondents were fairly advanced in age (mean age = 58.7 years), slightly more likely to be female, and on average owned their current property for 19 years.

Overall, respondent beliefs about "their" lake tended to be fairly positive, with more agreement with positive attributions: for example, the lake is scenic, with many species of wildlife. Accordingly, they disagreed with negative assertions: for example, the lake is crowded, and its water is polluted. However, these statements were hardly unequivocal: Only half agreed that their lake is very peaceful and less than half agreed that their lake has very clear water (Table 1). These assessments were also reflected in overall attitudes toward lake quality. Few rated their lake at the two extreme ends of the scale (poor or perfect), with the vast majority (90.4%) rating their lake from "good" to "excellent."

Table 1. Respondent perception of lake attributes

My lake	% Agree
Is very scenic	64.8
Has many species of wildlife and plants	57.9
Property is very expensive	52.1
Shore is very forested	50.6
Is very peaceful	49.8
Has very clear water	48.0
Has changed a lot over the years	42.5
Has many houses and cabins on the shore	41.4
Has many recreationists using it	41.0
Shore is very developed	33.9
Has a lot of public access	26.5
Is very crowded	22.8
Water is very polluted	16.9
Attitude toward lake condition	
Poor	1.2
Fair	5.9
Good	24.5
Very good	34.1
Excellent	31.8
Perfect	2.5

Water Quality, Shoreline Development, and Environmental Perception

Lakeshore Development and Water Quality. Prior to testing hypotheses about perceptions of water quality, we examine the bivariate correlations between lakeshore development and other lake characteristics (Table 2). Most germane to this article; the level of shoreline development bears no relationship to any of the water chemistry variables: More developed lakes are *not* more turbid ($r = .007$), do not have higher levels of chlorophyll ($r = .030$), and do not differ on their water color ($r = .001$). The reader should keep in mind that there is a great deal of "noise" that may affect these results and that cannot be parceled out using cross-sectional data. For example: (a) Lakes with higher water quality may be initially more attractive for potential development; (b) the effects of new development on water quality may exhibit a temporal lag; (c) property redevelopment that involves demolition of existing structures may not result in increased density of development, but may affect water quality negatively (due to increased impermeable surfaces) or positively (if, for example, old septic systems are replaced with updated systems); and (d) some of these lake characteristics (notably color) are not theorized to be affected by shoreline development density, but are a function of other determinants. However, the finding that there is *no* bivariate relationship certainly counters public expectations that more developed lakes have worse water quality.

Our correlational analysis in Table 2 reveals interesting relationships between lake quality and perception. Lakes with higher levels of chlorophyll are less likely to be viewed as having clear water ($p < .001$) but only slightly more likely to be

Table 2. Lake characteristics and perceptions: Bivariate correlations

	Develop level	Chlorophyll	Water color	Turbidity	"Lake very developed"	"Lake has high rec use"	"Lake water is polluted"	"Lake water is clear"
Develop level	1							
(*n*)	591							
Chlorophyll	.030	1						
(*n*)	291	303						
Water color	–.001	.289***	1					
(*n*)	303	303	318					
Turbidity	.007	.597***	.320***	1				
(*n*)	250	244	259	265				
"Lake is very developed"	.241***	.112*	.094	.147*	1			
(*n*)	548	297	312	261	637			
"Lake has high rec use"	.203***	.140*	.087	.240***	.516***	1		
(*n*)	548	295	310	259	635	637		
"Lake water is polluted"	.113*	.147*	.126*	.090	.176***	.127*	1	
(*n*)	543	293	308	257	630	630	632	
"Lake water is clear"	–.007	–.294***	–.317***	–.230***	–.099*	–.088*	–.363***	1
(*n*)	548	297	312	261	635	635	631	637

Note. Significance: $^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$.

viewed as polluted ($p < .05$). Lakes on the brown end of the color spectrum are also less likely to be seen as clear ($p < .001$), as are lakes with higher levels of turbidity ($p < .001$). Each of these variables is less strongly related to beliefs that the lake is polluted. Lakes with more structures on the shore are perceived as more developed ($p < .001$) and having more recreational use ($p < .001$). In this sense, people "accurately" perceive water quality and increased lakeshore development. Some "crossover" relationships are observed as well, which hint at our analyses to come: Even though there is no relationship between development levels and water quality indicators, respondents on more developed lakes were more likely to agree that their lake is polluted ($p < .05$). A stronger effect is observed for *perceived* shoreline development: Lakes perceived as more developed are more likely to be seen as polluted ($p < .001$) and less likely to be seen as having clear water ($p < .05$). It appears that even though there is no empirical relationship between levels of lakeshore development and water quality variables, this linkage exists in the minds of those using these lakes.

Factors that Affect Perceived Lake Quality. We are also concerned with the relationship of specific perceptual domains to overall assessments of lake quality. We hypothesize independent effects of lake characteristics themselves, respondent attributes, and respondent perceptions. First, we conducted a multivariate analysis that predicted quality ratings from lake characteristics, respondent characteristics, and perceptions. The analysis proceeds by looking at the effects of lake characteristics, then progressively adding respondent characteristics and finally respondent perceptions (Table 3). The predictive ability of the model rises steadily as layers are added (even accounting for the downward effects on adjusted R^2 of adding additional variables). Only 7% of the variation in overall lake quality assessments is predicted by lake characteristics alone; this rises to 19% when human use variables are considered, and to over one-third (34%) when the individual lake perception items are included. In model 1 (lake characteristics only), lakes with less chlorophyll are given higher quality ratings ($p < .01$). No other variables, including lakeshore development, are significant. When respondent behaviors and characteristics are added (model 2), the effect of chlorophyll remains significant. Human characteristics, however, explain far more variance: Men and those who emphasize fishing as their favorite activity give their lake lower quality ratings. When respondent perceptions are added (model 3) chlorophyll is no longer significant, but both of the experience variables remain so. Most of the perception variables are significant: Lakes that are perceived as unpolluted, with clear water, are seen as having higher water quality. While this finding suggests the utility of the expectancy-value aggregated model of environmental perception, lakes that are perceived as being more densely developed are also seen as having worse water quality, net of factors such as actual water quality.

The Coughlin perception model does not allow for the possibility of indirect effects: Lakeshore development may affect perceptions of quality directly, or indirectly through its effects on behaviors (i.e., perhaps more developed lakes are less desired for fishing). Path analysis measures indirect effects of one variable on another, as any relationship between two variables can be decomposed into simple and compound paths (Asher 1983). The model (Figure 2) examines the joint effects of shoreline development, water quality (as indicated by chlorophyll), and respondent characteristics as potential causes of perceptions ("developed" and "polluted") and rating of lake quality.

Table 3. OLS regression models predicting lake quality

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
Lake characteristics only	.307	.094	.070	.921
+ Respondent characteristics	.487	.237	.191	.859
+ Respondent perceptions	.627	.393	.343	.774

Model	S Squares	df	M Square	*F*	Significance
1					
Regression	16.706	5	3.341	3.940	.002
Residual	160.289	189	.848		
Total	176.995	194			
2					
Regression	41.913	11	3.810	5.162	.000
Residual	135.082	183	.738		
Total	176.995	194			
3					
Regression	69.640	15	4.643	7.741	.000
Residual	107.355	179	.600		
Total	176.995	194			

	Unstandardized coefficients		Standardized coefficients		
Model	B	SE	Beta	*t*	Significance
1					
(Constant)	4.463	.219		20.348	.000
Shore development density	–0.006	.006	–.082	–1.170	.244
Access	–0.010	.196	–.004	–.054	.957
Chlorophyll	–0.027	.009	–.270	–2.987	**.003**
Water color	0.003	.004	.060	.814	.417
Turbidity	–0.027	.049	–.052	–.564	.574
2					
(Constant)	4.125	.443		9.310	.000
Shore development density	–0.007	.005	–.087	–1.286	.200
Access	0.067	.184	.025	.364	.717
Chlorophyll	–0.021	.009	–.207	–2.407	**.017**
Water color	0.004	.003	.072	1.009	.314
Turbidity	–0.026	.047	–.049	–.557	.578
Year born	–0.007	.006	–.100	–1.267	.207
Gender	0.438	.135	.223	3.248	**.001**
Own lake frontage	0.224	.154	.110	1.458	.146
Year-round resident	–0.006	.143	–.003	–.041	.967
Years owned property	–0.008	.005	–.122	–1.560	.120
Fishing favorite activity	–0.466	.154	–.215	–3.034	**.003**

(*Continued*)

Table 3. Continued

	Unstandardized coefficients		Standardized coefficients		
Model	B	SE	Beta	*t*	Significance
3					
(Constant)	3.028	.526		5.761	.000
Shore development density	–0.001	.005	–.013	–.200	.842
Access	0.171	.170	.063	1.009	.314
Chlorophyll	–0.014	.008	–.135	–1.717	.088
Water color	0.005	.003	.097	1.481	.140
Turbidity	–0.030	.042	–.057	–.711	.478
Year born	–0.006	.005	–.083	–1.155	.250
Gender	0.335	.123	.171	2.731	**.007**
Own lake frontage	0.157	.139	.077	1.130	.260
Year-round resident	–0.042	.131	–.021	–.319	.750
Years owned property	–0.009	.004	–.145	–2.006	.056
Fishing favorite activity	–0.442	.139	–.204	–3.181	**.002**
My lake is very developed	0.146	.068	.155	2.153	**.033**
My lake has a lot of recreational use	–0.021	.057	–.026	–.365	.716
My lake is very polluted	0.246	.052	.300	4.690	**.000**
My lake has very clear water	–0.128	.053	–.161	–2.403	**.017**

Note. Boldface indicated significance at the $p \leq 0.05$ level.

This analysis demonstrates that increased shoreline development results in perceptions that one's lake is developed (reasonable enough), but also that it is *polluted.* Somewhat ironically, the effect of shoreline development on the perception of polluted water is as strong as that of the lake's actual chlorophyll level. In turn, both perceptions of "polluted" and "developed" are negatively related to lake quality rating, although the effect of the former is much stronger ($p < .001$) than the latter ($p < .05$). Therefore, shoreline development has several effects on lake quality rating: More developed lakes are perceived both as more developed and more polluted, and subsequently of lower quality. There is no significant direct effect of shoreline development on a lake's water quality rating—the effect is mediated through the perceptions just described. There is a somewhat puzzling robust ($p < .001$) direct effect of chlorophyll level on lake quality rating: Lakes with more chlorophyll are seen as being of lower quality, even net of any effects of chlorophyll on perceptions, at least those measured here.

Summary and Conclusions

In response to previous thinking that considers the impacts of rapid development on concerns about environmental degradation of high amenity rural settings, this project examines human response to increased shoreline development in northern

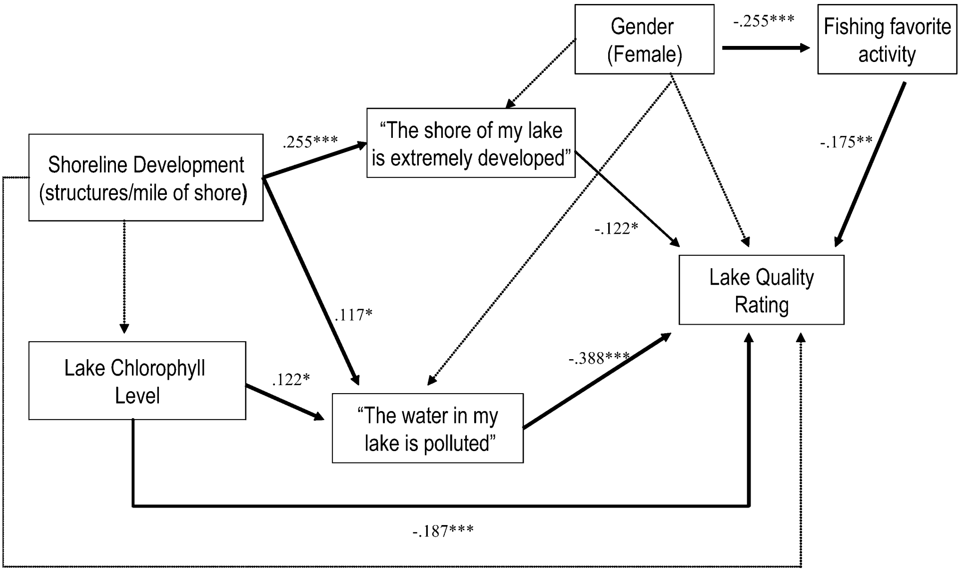

Figure 2. Predicting perceived lake quality.

Wisconsin. Population increase, particularly in seasonal residents, has led to rapid loss of vacant lakeshore areas and concomitant public concern. This concern has been articulated as concerns about maintaining environmental quality, particularly in lake environs. Our results challenge the expected linkage between population growth and environmental impacts: We have examined the relationship between shoreline development and water quality variables and have found no effect, although longitudinal analysis on a lake-by-lake basis might reveal a relationship. In contrast, it is clear that increased shoreline development is strongly associated with human *perceptions* of decreased water quality.

Traditional models of attitudes and beliefs can contribute to our understanding of this apparent paradox, and perhaps shed light on similar issues in other high amenity rural communities. Expectancy-value models suggest that overall attitudes are determined by an aggregation of beliefs, weighted by the value judgments associated with each. However, people often do not have adequate information to support each specific belief, particularly concerning harder to observe phenomena such as water quality. In conditions such as these, respondents will use more readily observable phenomena, such as shoreline development, to help construct their overall attitude, and then "work backward" to fill in missing beliefs that are consistent with the attitude. Under this logic, the overall dislike of increased shoreline development and all it entails (i.e., loss of solitude, loss of recreational access, and a host of other potential factors) may drive more specific beliefs (e.g., "I'm sure it is hurting water quality as well"), rather than the other way around. Those who seek to build models of environmental perception might do well to consider this possibility.

We believe that these Vilas County findings, and the use of the expectancy value model more generally, have important implications for other high-amenity rural areas that struggle with the challenges posed by rapid population growth. Such growth is often predicated on a high-quality natural environment. Accordingly, concerns about the impacts of development are often articulated in terms of impacts on the natural environment. Our findings that there is little relationship between perceived water quality and biogeochemical water quality indicators may have potentially critical ramifications if residents (for example) primarily oppose development on the grounds of preserving environmental quality. This strategy may be risky business. Also, development proponents might be tempted to conclude that all that is required to allay public opposition to shoreline development (or other manifestations of population growth) is to either demonstrate that there is no relationship between the phenomena (i.e., "educate the public"), or to engineer development projects in such a way to ensure that water quality can be shown conclusively to not be harmed. We believe that such conclusions are premature and even misleading. In this, as in other high-amenity settings, people may be deeply concerned about the impacts of rapid population growth on aesthetics, quality of life, or sense of place (Stedman 2003). The environmental impact discourse may be more often invoked as it is easier to articulate (one need not explain or defend water quality in the same manner as might be required for sense of place). Environmental concerns also have the tacit backing of "real science" and hence may be seen as more defensible. Finally, environmental quality concerns may be seen as potentially less selfish than issues of preserving quality of life.

One final note concerns the importance of interdisciplinary research. Understanding the linkage between population growth, environmental change, and human attitudes is only possible with high-quality data in all three areas. Our research suggests the utility of integrating landscape, water, demographic change, and human perception data to understand a particular phenomenon. Survey researchers, demographers, and natural scientists need to be talking more to each other to develop an integrated understanding of responses (environmental impacts, human perception, and human behavior) to social change of the type described here. Despite decades-old calls for better interdisciplinary research (e.g., Heberlein 1988), such integration continues to be relatively rare; far more common are approaches that, while nominally bringing together social and biophysical scientists, allow each group to conduct "business as usual." True integration is not easy: We have pointed out several places where our data may not be completely adequate for the task at hand—longitudinal data at a much finer scale may capture lake by lake changes in development, water quality, and attitudes. Researchers ought to begin to seek these understandings. Social scientists in particular might do well to emulate scientists collecting long-term lake data by systematically monitoring the beliefs, attitudes, and behaviors of those using the lakes. Such approaches should prove valuable to those who wish to understand both environmental and social change in high amenity rural areas.

NOTES

1. This variable reflects the total number of *structures* in the shoreline buffer, rather than the number of housing units. For example, a lakeshore home that also had a detached garage and boathouse would be recorded as three structures rather than one. Thus, there is a conversion that needs to be made from structures to dwellings, but as long as the ratio is constant across lakeshore properties, there is no need to do this. This assumption is followed in the research—there is no reason to assume, for example, that lakeshore property owners on a given lake are systematically more likely to have a different "building to dwelling" ratio than on any other lake. Another factor to consider is that 1996 data are a bit

dated, given the rapid pace of change in Vilas County. Also, the "within 300 feet" designation corresponds to the area covered by county shoreland zoning, and includes some property that does not actually border the shore. Again, this is assumed to be a constant rather than variable source of error.

2. If the respondent had lakefront property, he or she was asked to respond for the particular lake that his or her property bordered. If the respondent owned off-lake property, the person was asked to pick a lake that was close to his or her property, that he or she visited often, or that was otherwise important to the person.

References

Asher, H.B., 1983. *Casual Modeling*. Newburg Park, CA: Sage Publications.

Barker, M. L. 1971. Beach pollution in the Toronto region. In *Perceptions and attitudes in resource management*, eds. W. Sewell and I. Burton, 71–80. Ottawa, ON: Information Canada.

Beale, C. L. and K. M. Johnson. 1998. The identification of recreational counties in nonmetropolitan areas of the USA. *Population Res. Policy Rev.* 17:37–53.

Bem, D. 1970. *Beliefs, attitudes, and human affairs*. Monterey, CA: Brooks-Cole.

Beyers, W. and P. Nelson. 2000. Contemporary development forces in the non-metropolitan West: New insights from rapidly growing communities. *J. Rural Stud.* 16:459–474.

Bonaiuto, M., G. M. Breakwell, and I. Cano. 1996. Identity process and environmental threat: The effects of nationalism and local identity upon perception of beach pollution. *J. Commun. Appl. Social Psychol.* 6:157–175.

Bryant, M. D. and D. L. Scarnecchia. 1992. Species richness, composition, and abundance of fish larvae and juveniles inhabiting natural and developed shorelines of a glacial lake. *Environ. Biol. Fishes* 35:329–341.

Christensen, D. L., B. R. Herwig, D. E. Schindler, and S. R. Carpenter. 1996. Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. *Ecol. Appl.* 6(4):1143–1149.

Clark, K. L. and D. L. Euler. 1984. Vegetation disturbance caused by cottage development in central Ontario. *J. Environ. Manage.* 18:229–239.

Coughlin, R. E. 1976. The perception and valuation of water quality: A review of research methods and findings. In *Perceiving environmental quality*, eds. K. H. Craik and E. H. Zube, 205–228. New York: Plenum.

Council on Environmental Equality. 1972. National Assessment of Trends in Water Quality. Washington, DC: Council on Environmental Equality.

Craik, K. H. and E. H. Zube. 1976. *Perceiving environmental quality*. New York: Plenum.

Cromartie, J. B. and J. M. Wardwell. 1999. Migrants settling far and wide in the rural West. *Rural Dev. Perspect.* 14(2):2–8.

Deller, S. C., S. T. Tsung-Hsiu, D. W. Marcouiller, and D. English. 2001. The role of amenities and quality of life in rural economic growth. *Am. J. Agric. Econ.* 83(2):352–365.

Dillon, P. J., W. A. Scheider, R. A. Reid, and D. S. Jeffries. 1994. Lakeshore capacity study: Part I—Test of effects of shoreline development on the trophic status of lakes. *Lake Reservoir Manage.* 8:121–129.

Ditton, R. B. and T. L. Goodale. 1973. Water quality perception and the recreational users of Green Bay, Lake Michigan. *Water Resources* 9:569–579.

Duane, T. P. 1999. *Shaping the Sierra: Nature, culture, and conflict in the changing West*. Berkeley: University of California Press.

Eagly, A. and S. Chaiken. 1993. *The psychology of attitudes*. New York: Harcourt Brace Jovanovich.

Glass, G. E. and J. A. Sorenson. 1994. *USEPA ERLD-UMD acid deposition gradient–susceptibility database*. US EPA Environmental Research Laboratory–Duluth and University of Minnesota at Duluth.

Gobster, P. H., R. G. Haight, and D. Shriner. 2000. Landscape change in the Midwest: An integrated research and development program. *J. For.* 98(3):9–14.

Green, G. P., D. Marcouiller, S. Deller, D. Erkkila, and N. R. Sumathi. 1996. Local dependency, land use attitudes, and economic development: Comparisons between seasonal and permanent residents. *Rural Sociol.* 61(3):427–445.

Heberlein, T. A. 1988. Improving interdisciplinary research: Integrating the social and natural sciences. *Society Nat. Resources* 1:5-16.

Heimberger, M., D. Euler, and J. Barr. 1983. The impact of cottage development on common loon reproductive success in central Ontario. *Wilson Bull.* 95:431–439.

Hendry, G. S. and E. A. Leggatt. 1982. Some effects of shoreline cottage development on lake bacteriological water quality. *Water Resources* 16:1217–1222.

Huang, Y.-H. and W. P. Stewart. 1996. Rural tourism development: Shifting basis of community solidarity. *J. Travel Res.* 34(4):26–31.

Jobes, P. C. 2000. *Moving nearer to heaven: The illusions and disillusions of migrants to scenic rural places*. Westport, CT: Praeger.

Kaplan, R. 1978. The green experience. In *Humanscape: Environments for people*, eds. S. Kaplan and R. Kaplan, 186–194. North Scituate, MA: Duxbury Press.

Lankford, S. V. 1994. Attitudes and perceptions toward tourism and rural regional development. *J. Tourism Res.* 32(2):35–43.

MacBeth, E. J. 1989. *The relationship of shoreland zoning elements to the aesthetics of developed lakeshores in Wisconsin*. MS thesis, Water Resources Management, University of Wisconsin–Stevens Point.

Marcouiller, D. W., R. Kedzior, and J. G. Clendenning. 2002. Natural amenity-led development and rural planning. *J. Plan. Literature* 16(4):515–542.

McGranahan, D. A. 1999. *Natural amenities drive population change*. Agricultural Economics Report 718. Economic Research Service, USDA.

Meyer, M., J. Woodford, S. Gillum, and T. Daulton. 1997. *Shoreland zoning regulations do not adequately protect wildlife habitat in northern Wisconsin*. Final Report, USFWS State Partnership Grant P1W, 17.

Perdue, R. R., P. T. Long, and L. Allen. 1987. Rural resident tourism perceptions and attitudes. *Ann. Tourism Res.* 14(3):420–429.

Racey, D. and D. Euler. 1983. An index of habitat disturbance for lakeshore cottage development. *J. Environ. Manage.* 16:173–179.

Radeloff, V. C., R. B. Hammer, P. R. Voss, A. E. Hagen, D. R. Field, and D. J. Mladenoff. 2001. Human demographic trends and landscape level forest management in the northwest Wisconsin Pine Barrens. *For. Sci.* 47(2):229–241.

Reed-Anderson, T., E. Bennet, B. Jorgensen, G. Lauster, D. Lewis, D. Nowacek, J. Riera, B. Sanderson, and R. Stedman. 1999. Distribution of recreational boating across lakes: do landscape variables affect recreation use? *Freshwater Biol.* 41:1–10.

Romeril, M. 1989. Tourism and the environment—Accord or discord? *Tourism Manage.* 10(3):204–208.

Rudzitis, G. 1996. *Wilderness and the changing American West*. New York: John Wiley and Sons.

Rudzitis, G. 1999. Amenities increasingly draw people to the rural west. *Rural Dev. Perspect.* 14(2):9–13.

Schnaiberg, J., J. Riera, M. G. Turner, and P. R. Voss. 2002. Explaining human settlement patterns in a recreational lake district: Vilas County, Wisconsin, USA. *Environ. Manage.* 30(1):24–34.

Smith, M. D. and R. S. Krannich. 2000. Culture clash revisited: Newcomer and longer-term residents' attitudes toward land use, development, and environmental issues in rural communities in the Rocky Mountain West. *Rural Sociol.* 65(3):396–421.

Stedman, R. C. 2003. Is it *really* just a social construction: The contribution of the physical environment to sense of place. *Society Nat. Resources* 16(8):671–685.

Town of Arbor Vitae. 1996. *Northwoods character: Design review standards for commercial, multifamily and industrial development*. Eagle River, WI: University of Wisconsin–Extension.

Town of Eagle River. 1996. *Eagle Town River Area Vision 2020 survey report*. Eagle River, WI: University of Wisconsin–Extension.

Town of Manitowish Waters Zoning Committee. 1995. *Town of Manitowish Waters community planning survey report*. Eagle River, WI: University of Wisconsin-Extension.

Town of St. Germain Comprehensive Master Planning Advisory Committee. 1997. *Town of St. Germain Community Planning survey report*. Eagle River, WI: University of Wisconsin–Extension.

Warner, M. E., C. C. Hinrichs, J. Schneyer, and L. Joyce. 1999. Organizing communities to sustain rural landscapes: Lessons from New York. *J. Commu. Dev. Society* 30(2):178–195.

Wear, D. N. and P. Bolstad. 1998. Land-use and change in southern Appalachian landscapes: Spatial analysis and forecast evaluation. *Ecosystems* 1:575–594.

Wear, D. N., M. G. Turner, and R. J. Naiman. 1998. Land cover along an urban–rural gradient: Implications for water quality. *Ecol. Appl.* 8(3):619–630.

Wisconsin Department of Natural Resources. 1996a. *Shoreline protection study: A report to the Wisconsin state legislature*. PUBL-RS. Madison: Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources. 1996b. *Northern Wisconsin's lakes and shorelands: A report examining a resource under pressure*. Madison: Wisconsin Department of Natural Resources.