The Influence of Spatial Land Use Patterns on Rural Amenity Values and Willingness to Pay for Growth Management: Evidence from a Contingent Choice Survey

by

Robert J. Johnston, Dana M. Bauer, and
Stephen K. Swallow

Department of Environmental and Natural Resource Economics
University of Rhode Island

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Abstract
This paper reports on a contingent choice study in which residents of a rural Rhode Island community were asked to express their preferences for packages of growth management outcomes, where surveys presented both spatial and non-spatial attributes of growth management outcomes. Survey results provide insight on the extent to which estimated willingness to pay (WTP) for marginal changes in specific landscape features or land uses may be influenced by spatial considerations. Results also characterize the potential impact of spatial context on public preferences and WTP for coordinated packages of growth management outcomes.

Keywords
Land Use, Spatial, Contingent Choice, Growth Management, Economics, Valuation

Paper presented at the Annual Meeting of the *American Agricultural Economics Association*, Tampa, FL, July 30-August 2. Address all correspondence to the principal author at The Department of Environmental and Natural Resource Economics, Lippitt Hall, University of Rhode Island, Kingston, RI 02881. Phone: (401) 874-4559. E-mail: rjohnston@uri.edu.

Introduction

Rural growth management strategies often result in distinct spatial patterns of farm, forest, open space, residential and commercial development, and other land uses. As spatial patterns may affect the flow of amenities that specific land uses provide to residents, one might expect that the economic value (positive or negative) of these uses would depend on the spatial patterns in which rural landscapes are arranged (Bockstael 1996). Spatial issues are of particular significance in the management and design of residential developments in rural communities, as such developments may differ across a wide range of spatial and non-spatial attributes (Calthorpe 1993; Arendt et al. 1994). For example, development proposals may differ according to the shape of the developed area, the density of housing, potential preservation of open space, the fragmentation of natural landscapes, and the location of the development relative to roads, viewscapes, and recreational facilities (Calthorpe 1993; Arendt et al. 1994; Grant et al. 1996).

Spatial considerations also play a significant role linking the policy prescriptions of economics to those of other disciplines. For example, it is well established in the conservation biology literature that spatial land use patterns can have significant impacts on the suitability of land as habitat for particular species (Meffe et al. 1997). Accordingly, a narrow 50-acre wooded "buffer strip" along roadways might provide notable scenic attributes, but minimal habitat for particular species valued by residents. Alternatively, a roughly square 50-acre wooded preserve set back from roads and developed areas might provide significant habitat services for valued species, yet minimal scenic attributes. In this context, assessing public preferences for the preservation of "50-acres of wooded open space" without providing information on the spatial context could impose unknown and potentially significant biases on subsequent welfare measurements.

Despite the importance of spatial aspects in assessing implications of growth management and land use change (Bockstael 1996), and despite a variety of available indices that one may use to characterize spatial landscape attributes (Geoghegan et al. 1995; 1997), contingent valuation and contingent choice (CVM) approaches typically estimate public preferences for farm, forest, open space, and other land uses either: i] independent of spatial context, or; ii] in a single spatial context. The resulting WTP estimates may provide misleading estimates of value or willingness to pay (WTP), particularly in cases where a growth management or open space preservation policy would result in spatial land use patterns different from those perceived or expected by respondents. In some policy contexts, a focus on non-spatial aspects of environmental quality may be appropriate. However, in contexts where spatial considerations are relevant, contingent assessments of the social value of growth management outcomes (e.g., open space preservation) may either under- or overstate true values, unless potential impacts and interactions associated with spatial factors are addressed by the survey instrument and subsequent data analysis.

This paper reports on a contingent choice study in which residents of Rhode Island rural communities were asked to express their preferences for packages of growth management, where surveys presented both spatial and non-spatial attributes of growth management outcomes. Survey scenarios addressed hypothetical development and preservation actions on large, previously undeveloped rural parcels, illustrated using simplified maps. Featured land uses included forested open space (protected from development, both with and without public access provisions); undeveloped land; recreation fields; roads; and residential subdivisions. For each featured land use, both the spatial location and layout were varied. For example, respondents were asked to evaluate hypothetical descriptions of residential subdivisions that could vary in terms of density (houses per acre), size (acres), location, proximity to main roads, spatial layout (i.e., shape), proximity to preserved open space, and appearance from main roads, among other factors. Likewise, open space areas, recreation fields, and other land uses were characterized by a range of spatial attributes, including proximity to developed areas and roads. Finally, the survey presented implications of growth management for wildlife habitat, scenic views, traffic, taxes and fees (the payment vehicle), and other attributes identified as important by focus groups.

Based on the results of this survey, this paper provides preliminary findings concerning spatial issues that may complicate the use of non-market valuation methods to assess social values for growth management outcomes. Specifically, we assess whether social values for non-spatial elements of a growth management policy package (e.g., acres of development, acres of open space, etc.) may be influenced by spatial factors of the package (e.g., location, shape, etc.). We also assess the role of spatial attributes in influencing tradeoffs among growth management outcomes. Finally, we discuss implications of model results for future research.

The Contingent Choice Framework

To assess preferences for an environmental policy, contingent choice surveys typically ask respondents to evaluate two or more alternative policy outcomes and to state their preference between them (Mitchell and Carson 1989). In the present context, respondents were asked to consider alternative development options for a hypothetical 400 acre tract of forested land, an area which comprises just over 1% of the land area in the local community. Respondents were provided with two development options, a "current development plan" and an "alternate development plan," where each plan could differ across a set of chosen spatial and non-spatial attributes. These attributes characterized land use features and amenities identified by focus groups and interviews with growth management practitioners, including preserved open space, residential development, recreational amenities, scenic attributes, wildlife habitat, traffic, and taxes.

In accordance with standard discrete choice contingent valuation, utility from a management plan is assumed to be a function of both the non-monetary environmental attributes of the plan and the money cost of the plan to the respondent (Hanemann 1984; McConnell 1990). The preliminary model shown here reflects the representative consumer model, and does not include demographic characteristics in the utility specification (i.e., homogeneous preferences are imposed). We define a simple utility function that includes arguments for both spatial and non-spatial aspects of an growth management plan, and the net cost of management plan to each respondent:

$$U_i(\cdot) = U(X_i, S_i, F_i) = v(X_i, S_i, F_i) + \varepsilon_i \qquad [1]$$

where

X_i = a vector of variables describing non-spatial land-use characteristics resulting from growth management plan i;

S_i = a vector of variables describing spatial land-use characteristics resulting from growth management plan i;

F_i = the change in mandatory taxes under growth management plan i;

$v(\cdot)$ = a function representing the empirically measurable component of utility;

ε_i = a term representing standard econometric error.

If the respondent compares the current development plan (i = A), to the alternate development plan (i = B), then the change in utility (dU) may be modeled conceptually and econometrically as

$$\begin{aligned} dU &= U(X_A, S_A, F_A) - U(X_B, S_B, F_B) \\ &= [v(X_A, S_A, F_A) - v(X_B, S_B, F_B)] - [\varepsilon_B - \varepsilon_A] \end{aligned}$$

$$= dv - \theta \quad [2]$$

The theoretical model assumes a respondent compares the two plans, assesses the difference between utility under the two plans, and indicates the sign of dU by either choosing the current development plan (dU>0) or the alternate development plan (dU<0). If one assumes that θ follows a logistic distribution, the familiar logit model results (Maddala 1983). That is, the probability that the respondent chooses the current development plan (i=A) may be expressed as

$$Pr(A) = \frac{1}{1+e^{-dv}} \quad [3]$$

and the corresponding probability of choosing the alternate development plan as

$$Pr(B) = \frac{e^{-dv}}{1+e^{-dv}} = 1\text{-}Pr(A). \quad [4]$$

The likelihood function follows the standard form illustrated by Maddala (1983).

Although the literature offers no firm guidance regarding the choice of functional forms for *dv*, in practice linear forms are often used. Assuming a linear form, one may specify *dv* as

$$dv = v(X_A, S_A, F_A)\text{-}v(X_B, S_B, F_B) = \beta_x(X_A\text{-}X_B)+ \beta_s(S_A\text{-}S_B)+ \beta_f(F_A\text{-}F_B), \quad [5]$$

where β_x, β_s, and β_f are conforming vectors of coefficients associated with the vectors of attribute differences $(X_A\text{-}X_B)$, $(S_A\text{-}S_B)$, and $(F_A\text{-}F_B)$ (Smith et al. 1995). Although the linear specification does not allow for interactions among development plan attributes, it does provide a simple model for preliminary assessment of spatial issues.

The Survey

The “Rhode Island Rural Land Use” survey was designed to assess rural residents’ preferences for multidimensional growth management packages and tradeoffs among elements of growth management or development plans. The following preliminary analysis is based on surveys returned from Burrillville, RI, a small (36,500 acre) rural town located in the northwest corner of the state. Survey development required over nineteen months and involved background research; interviews with regional experts in various disciplines, policy makers, and local residents; focus groups (Johnston et al. 1995); and extensive pre-testing.

Variables distinguishing management plans (i.e., the current versus alternate management plan) were chosen based on the results of focus groups with Rhode Island rural residents and consultations with growth management practitioners, including state and local government officials. Chosen variables characterized spatial and non-spatial aspects of protected open space, residential development, unprotected undeveloped land, scenic views, wildlife habitat, public access, recreational facilities, traffic, and taxes. The full set of model variables is described by Table 1. Focus groups and pre-tests led to a largely graphical survey format, in which most information was presented on simplified maps of the hypothetical development plans. Legend boxes and other graphics and textual devices were used to further describe the elements of each development plan. Each development plan included a small black-and-white photograph of the "view from the town road," to indicate the impact of the development plan on scenic attributes. Intensive pretesting was conducted on the survey and photographs to ensure that the selected graphical format could be easily understood by respondents, and that respondents shared interpretations of the meaning and implications of survey scenarios (Johnston et al. 1995).

Table 1. Variables Included in the Unrestricted Model (CDP=Current Development Plan; ADP=Alternate Development Plan)

Variable Type	Variable Name	Description	Units and Measurement	Mean (Std. Dev.)
Non-Spatial	*opendif*	The difference between acres of open space preserved in the CDP and ADP.	Acres in CDP minus acres in ADP.	-1.2877 (92.6998)
	sizedif	The difference between acres of residential development in the CDP and ADP.	Acres in CDP minus acres in ADP.	-0.9566 (90.9092)
	densedif	The difference in housing density in the CDP and ADP.	Houses/acre in CDP minus houses/acre in ADP.	0.0053 (0.9818)
	recreate	Difference between dummy variables indicating the presence of recreational (sports) fields in the CDP and ADP.	Difference between dummy variables for CDP and ADP	0.0059 (0.6104)
	lgmam	Difference between habitat quality for large mammals in CDP and that in ADP.	Difference in wildlife habitat quality scale (1=worst; 5=best).	0.0000 (1.2232)
	smmam	Difference between habitat quality for small mammals in CDP and that in ADP.	Difference in wildlife habitat quality scale (1=worst; 5=best).	-0.0161 (1.2165)
	combird	Difference between habitat quality for common birds in CDP and that in ADP.	Difference in wildlife habitat quality scale (1=worst; 5=best).	0.0537 (1.7390)
	unbird	Difference between habitat quality for uncommon birds in CDP and that in ADP.	Difference in wildlife habitat quality scale (1=worst; 5=best).	0.0228 (1.7021)
	taxdif	Difference in additional annual taxes and fees between CDP and ADP (resulting from management plan).	Dollars in CDP minus dollars in ADP.	-1.3981 (155.181)
Scenic	*lowvis*	Difference between dummy variables indicating the presence of development either highly screened or not visible from the main road; in the CDP and ADP. Survey versions included eight different photographs characterizing different development visibility levels; four of these photographs are characterized as low visibility development.	Difference between dummy variables for CDP and ADP.	0.3826 (0.4862)
Spatial	*edgearea*	The difference between the edge-area ratio of residential development shown in the "current development plan" and the edge-area ratio of residential development shown in the "alternate development plan". All ratios are calculated based on edges and areas measured directly from survey maps.	Calculated at a scale of 1 unit = 933.37 ft. (e.g., a 1 unit x 1 unit square block is equivalent to 20 acres or ~871,180 square feet, with an edge-area ratio of 4).	0.0834 (3.7199)
	strip2	Difference between dummy variables indicating the presence of two-sided strip development in the CDP and ADP.	Difference between dummy variables for CDP and ADP.	0.0066 (0.4247)
	cluster	Difference between dummy variables indicating the presence of a cluster development in the CDP and ADP. Cluster developments are defined as developments made up of 4-5 rectangular sub-	Difference between dummy variables for CDP and ADP.	-0.0184 (0.5924)

		development in close proximity.		
	around	Difference between dummy variables indicating the presence of open space located adjacent to either main roads or residential developments, in the CDP and ADP.	Difference between dummy variables for CDP and ADP.	-0.0508 (0.7586)
	onroad	Difference between dummy variables indicating the presence of developments located adjacent to main roads, in the CDP and ADP.	Difference between dummy variables for CDP and ADP.	0.0162 (0.7095)
Traffic	*light*	Difference between dummy variables indicating the presence of a traffic light on the main road, in the CDP and ADP.	Difference between dummy variables for CDP and ADP.	0.0029 (0.7024)

After the presentation of the two hypothetical development plans, respondents were given the choice to vote for the "current development plan" or the "alternate development plan." Additionally, respondents were told that "if you do not vote for either plan, development will automatically occur as shown by the current development plan," thereby specifying the "status quo" that will occur if no choice is made (Adamowicz et al. 1998). This framework was chosen to mimic actual community considerations of development proposals, wherein a landowner already possesses the property rights necessary to permit development; the only uncertainty is *what form* of development will occur, or will be required by town officials. This approach also avoids a variant of "yea-saying" in which respondents might reject *any* plan in which development occurred. Each respondent considered three potential pairs of current and alternate development plans for a hypothetical 400-acre parcel; respondents were instructed to consider each pair independent of previous choices, and to assume that all choices applied to the same 400-acre parcel. In all cases, this parcel was characterized as undeveloped and forested prior to the choice of development options. Prior to presenting respondents with development choices, the survey provided background information on the community and its ongoing development, and reminded respondents of potential tradeoffs implicit in development choices.

Fractional factorial design[1] was used to construct the range of survey questions, given the large number of variables in the model. This resulted in resulting in 128 unique contingent choice questions divided among 43 different survey booklets (three questions per booklet). In most cases, both the current and alternate development plans combined both desirable and undesirable elements, leading to a further reduction in the potential for "yea-saying" among respondents. Surveys were mailed to 1000 randomly selected Burrillville residents in March-April 2000, following the total survey design method described by Dilman (1978). Of 898 deliverable surveys, 528 were returned for a response rate of 59%. The following analysis is based on a subset of 453 of these returned surveys, providing 1359 complete and usable responses to dichotomous choice questions.

Model Results and Hypothesis Tests

For purposes of hypothesis testing, we divide model variables into intuitive groups, as shown by Table 1. Standard "non-spatial" variables are those often found in contingent choice surveys of growth management and open space preservation. These include quantities of various land uses such as undeveloped land, preserved open space, and residential development. Non-spatial variables also characterize the number of houses in a development, the housing density, and the quality of wildlife habitat for particular species groups. "Scenic" variables represent attributes of the viewscape, as represented by photographs of the "view from the town road." In the present case, scenic attributes are represented by a single variable indicating the presence of particular photographs representing "low visibility" development, where photographs were chosen to represent different degrees of visible development intensity. "Spatial" variables characterize the spatial layout, location, and other spatial features of residential development(s), open space, and other development plan attributes. These include the spatial structure of residential developments and the location of developments and open space.

“Traffic” variables represent the presence or absence of particular traffic controls, such as traffic lights.

Model results and hypothesis tests are illustrated by Table 2. Two models are shown. Model one is the unrestricted model including the full set of development plan attributes. Model two restricts the impact of spatial variables to zero (i.e., variables representing spatial factors have been excluded). A log-likelihood ratio test of model one versus model two indicates that the exclusion of the full set of spatial variables (cf. Table 1) has a statistically significant impact on the model at p=0.0001 (χ^2=36.39, *df* = 5). Given this result, model one is chosen as the final model for the analysis of spatial issues. This model is significant at greater than p<0.0001 (-2 Log L χ^2 = 442.16, df = 15), and correctly predicts 80.5% of responses.

Table 2. Logit Model Results

	Model One (unrestricted model)		Model Two (excludes all *spatial* attributes)	
Variable	Parameter Estimate (Std. Error)	Prob. > χ^2	Parameter Estimate (Std. Error)	Prob. > χ^2
intercept	-0.0656 (0.0843)	0.4364	-0.00003 (0.0810)	0.9997
edgearea	0.1490 (0.0.0268)	0.0001	--	--
strip2	-0.3766 (0.1840)	0.0407	--	--
cluster	-0.3826 (0.1367)	0.0051	--	--
around	-0.2588 (0.1043)	0.0131	--	--
onroad	-0.2406 (0.1060)	0.0232	--	--
lgmam	0.1827 (0.0561)	0.0011	0.1321 (0.0537)	0.0139
smmam	-0.0909 (0.0548)	0.0974	-0.0727 (0.0533)	0.1721
combird	0.0962 (0.0383)	0.0112	0.0927 (0.0370)	0.0122
recreate	0.0789 (0.1089)	0.4687	0.1365 (0.1055)	0.1957
densedif	-0.9216 (0.0840)	0.0001	-0.7305 (0.0729)	0.0001
sizedif	-0.00569 (0.000934)	0.0001	-0.00872 (0.000791)	0.0001
opendif	0.00524 (0.000845)	0.0001	0.00354 (0.000695)	0.0001
taxdif	-0.0050 (0.00045)	0.0001	-0.00472 (0.00044)	0.0001
light	0.2227 (0.0954)	0.0196	0.1880 (0.0924)	0.0419
lowvis	0.1244 (0.1379)	0.3670	0.0858 (0.1345)	0.5235
χ^2 for –2 Log L	442.167	0.0001	405.777	0.0001
(df)	15		10	
N	1359		1359	
χ^2 for restrictions	--	--	36.39	0.0001
(df)	--	--	(5)	

Implications and Discussion

The following discussion focuses on the estimated results of the final unrestricted model (model one), although most results are robust to changes in model specification. Parameter estimates for *non-spatial* variables correspond with prior expectations and the results of prior research, where applicable. Respondents prefer development plans characterized by: i] larger areas of preserved open space (*opendif*; p<0.0001); ii] smaller areas of developed land (*sizedif*; p<0.0001); iii] lower housing densities (*densedif*; p<0.0001); iv] improved habitat for large mammals (*lgmam*; p<0.02) and common birds (*combird*; p<0.04); v] lower quality habitat for common small mammals such as squirrels (*smmam*; p<0.06), and; vi] lower annual taxes and fees (*taxdif*; p<0.0001). Perhaps the only surprising result is that the visual intensity of development appeared to have little significant impact on respondents' choices (*lowvis*; p>0.36).

The remainder of the discussion will focus on variables and parameter estimates corresponding to spatial development plan attributes. Given the potential complexity of the impacts of spatial variables on model results and policy implications, the following discussion will be organized around a set of general propositions supported by model results.

Proposition One: *Spatial attributes have a statistically significant impact on the model of respondent choice.*

All five spatial attributes included in the final model are statistically significant at p<0.05. Moreover, the log-likelihood ratio test of model one versus model two suggests that the set of spatial variables has a statistically significant impact on the model of respondent choice. *This combination of individual and joint tests of statistical significance leads to the conclusion that respondents considered spatial factors when choosing between competing development proposals*. If such results apply more generally, contingent assessments of public preferences that suppress spatial attributes may risk either omitted variable bias or methodological misspecification.[2] In cases where spatial attributes vary across choices, *exclusion* of associated spatial variables from econometric models may lead to omitted variable bias, if spatial features are in any way correlated with included non-spatial variables. Alternatively, in cases where spatial attributes are suppressed from the survey entirely, respondents' choices may be partially influenced by unanticipated (by the researcher) assumptions regarding the spatial attributes of survey scenarios, leading to potential methodological misspecification.

Proposition Two: *All else held constant, respondents prefer residential developments: i] with larger edge-area (or edge-interior) ratios, and; ii] in a single contiguous block rather than larger numbers of smaller sub-developments.*

Respondents' choices indicate a strong preference for little or no development. However, where development does occur, relative preferences depend on spatial factors. One of the more notable spatial impacts is that of the edge-area ratio (*edgearea,* cf. Table 1), significant at $p<0.0001$. As the name suggests, the edge-area ratio is the quotient of the perimeter of a two dimensional shape (or set of shapes) and the area of that shape. A high edge-area ratio for a residential development indicates a high degree of "edge" relative to area. A low edge-area ratio indicates a low degree of "edge" relative to area, as might occur in developments characterized by single, nearly-square blocks.

Although uncommon in economics models, such spatial indices are common in ecological models, as they often have critical implications for the suitability of land as habitat for particular species (Meffe et al. 1997). Holding all else constant (including development size), respondents preferred developments characterized by larger edge-area ratios, or greater lengths of edge relative to area. To assess whether *edgearea* was simply capturing some form of curvature in the development size variable, we estimated models including both quadratic and inverse forms of *sizedif* along with *edgearea*. In all cases *edgearea* remained significant at $p<0.01$. The same result holds if one includes the development perimeter alone (*edge*) as an independent variable. In all cases, *edgearea* remained significant at better than $p<0.01$. Hence, the visible edge-area ratio shown on a development map appears to have a strong influence on respondents' choices.

In addition to effects related to development size and edge-area ratio, respondents also had a preference for particular development shapes; respondents preferred development types characterized by single contiguous blocks. Compared to "baseline" developments characterized by single rectangular blocks of varying dimensions, respondents' least preferred development shape was a "cluster" development comprised of four to five distinct sub-developments (*cluster;* p=0.0051). Only slightly more preferred were strip developments comprised of two distinct sub-developments (*strip2;* p=0.0407).

Distilling simple implications of these model results for policy is complicated by an unavoidable degree of correlation among certain spatial variables included in the model. For example, cluster developments (*cluster*=1) tend to have higher edge-area ratios (*edgearea*) than single rectangular developments, *ceteris paribus*. Given the potential for largely unavoidable correlation among spatial variables and a desire to simplify the model, we conduct a hypothesis test to assess whether spatial layout may be adequately represented with a single metric. *Edgearea* is chosen as the metric most likely to serve this role, based on its high degree of statistical significance and ability to characterize a key continuous element of spatial structure.

The assessment is conducted using a log-likelihood test for the case in which all spatial variables describing the shape of residential developments are excluded, except for the edge-area ratio. That is, we compare model one to a restricted version of model one, in which *edgearea* is the sole variable characterizing the spatial layout of residential developments. The log likelihood test indicates the statistical significance of these restrictions at p=0.0109 (χ^2 =9.031; df=2).

These results suggest that a relevant attributes of development's spatial layout (with respect to its impact respondents' choices) may not be characterized by *edgearea* alone, but requires additional variables characterizing development shape.

These results imply that highly simplified, stylized characterizations of the "optimal" spatial attributes for residential developments may be elusive. For example, actual cluster developments are typically characterized by high edge-area ratios (preferred by respondents) and large numbers of small sub-developments (not preferred by respondents). Single large-lot developments (preferred by respondents) are often characterized by low edge-area ratios (not preferred by respondents). Model results suggest that public preferences in such cases will depend on the *specific* spatial attributes of each development, eluding simple characterizations such as "cluster developments are preferred to large lot subdivisions."

Although absolute statements regarding development preferences may be elusive, additional insight may be gained through an assessment of WTP (positive or negative) for various development scenarios. That is, based on the parameter estimates of model one, one may estimate the welfare implications associated with changes in spatial features alone (i.e., holding development size, housing density, and all other factors constant). To provide a simple example, Table 3 illustrates estimated WTP for changes in the spatial characteristics of a 20-Acre, 20 home development. The baseline case from which WTP is estimated is a development arranged in a square block, located adjacent to a main road. WTP is calculated using Hanemann's (1984) well known approach, in which the mean WTP for a marginal change in the *i*th attribute is equal to $-\beta_i/\beta_{taxdif}$, where β_i is the parameter estimate corresponding to the i^{th} attribute, and β_{taxdif} is the parameter estimate corresponding to the money cost of the program (i.e., *taxdif*, the payment vehicle). For non-marginal changes involving more than one variable, WTP may be calculated (given a linear form for dU) as

$$WTP = - \frac{\sum_i (\Delta X_i)(\beta_i)}{\beta_{taxdif}} \qquad [6]$$

where ΔX_i represents the change in the i^{th} variable. Following Poe et al. (1997) and Krinsky and Robb (1986), standard errors and t-statistics for WTP are generated using a simple bootstrap. In this case, we randomly draw 20,000 sets of coefficient estimates from the maximum likelihood estimates and accompanying variance-covariance matrix. Willingness to pay estimates are calculated for each of the 20,000 draws, resulting in an empirical distribution of WTP for each scenario (Poe et al. 1997). This distribution is then used to calculate standard errors and t-statistics.

As shown by Table 3, all six instances of spatial change result in a WTP difference significantly different from zero at $p<0.10$. Accordingly, we conclude that, at least in the illustrated case, changes in spatial attributes alone may result in significant increases or decreases in WTP for growth management policies. Scenarios illustrated by Table 3 suggest that, considering both development shape and edge-area ratio, single square developments are the least preferred by respondents. The most preferred appear to be developments comprised of one or two very narrow rectangular strips. The illustrated cluster developments generate WTP estimates higher than that for a single square development of the same size, but lower than that for narrow rectangular strip developments.

Although it is important to note that this is a preliminary model specification, and that the hypothetical nature of CVM questions often results in inflated WTP estimates (Arrow et al. 1993), model results nonetheless support the hypothesis that spatial factors can play an important role in welfare estimation using contingent choice instruments. Hence, the significant element here is not the absolute value of estimated WTP, but the fact that spatial changes alone can lead to statistically significant WTP changes.

Table 3. Estimated WTP for Changes in Spatial Attributes from "Baseline" Development: 20 Acre, 20 Home Development, Located Adjacent to a Main Road.

Case	Type of Development	Spatial Description[a]	Area[a]	Edge-Area Ratio[a]	Located on Main Road	WTP[b] (SE)	t-statistic (H_0: WTP>0)
Baseline	single rectangle (square block)	1 unit x 1 unit square block	1 sq. unit = 20 Acres	4	yes	--	--
I	cluster (4 part)	cluster of four sub-parts; each 0.5 unit x 0.5 unit (square)	1 sq. unit = 20 Acres	8	yes	42.72 (25.09)	1.70*
II	cluster (5 part)	cluster of five sub-parts; each 0.447 unit x 0.447 unit	1 sq. unit = 20 Acres	8.94	yes	70.76 (27.23)	2.59***
III	single rectangle (narrow strip)	rectangular strip; 2 units x 0.5 units	1 sq. unit = 20 Acres	5	yes	29.82 (5.69)	5.24***
V	single rectangle (narrow strip)	rectangular strip; 4 units x 0.25 units	1 sq. unit = 20 Acres	9	yes	149.15 (28.59)	5.22***
IV	two rectangles (two-sided strip)	two parallel strips; each 2 units x 0.25 units	1 sq. unit = 20 Acres	9	yes	73.75 (35.22)	2.09**
VI	two rectangles (two-sided strip)	two parallel strips; each 4 units x 0.125 units	1 sq. unit = 20 Acres	16.5	yes	297.48 (63.13)	4.71***

[a] Spatial descriptions, areas, and edge-area ratios are calculated at a scale of 1 map unit = 933.37 ft., such that a 1 unit x 1 unit square block is equivalent to 20 acres (~871,180 square feet). This is done to coordinate calculations with scale units used in logit estimation (cf. Table 1 and 2). This convention does not influence estimated WTP.

* Significant at p<0.10 (two-tailed test)
** Significant at p<0.05 (two-tailed test)
*** Significant at p<0.01 (two-tailed test)

Proposition Three: *When selecting locations for residential developments, results suggest that respondents prefer locations off main roads. However, this preference does not appear related to the potential scenic attributes of development.*

Respondents preferred developments located off main roads (*onroad*; p=0.0232). Although not particularly surprising, it is notable that this effect appears independent of the impact of development on scenic attributes. Photographs depicting the visibility of developments from the main road did not have a significant impact on respondents' choices, despite a high degree of variance in the intensity of development illustrated. Based on equation [6], a development adjacent to main roads resulted in WTP estimates $48.17 lower than for identical developments located elsewhere. For a 20-acre square development, this WTP difference is significant at p<0.05, based on a bootstrap-generated standard errors.

The positive value of development locations off main roads combined with the positive value of improved wildlife habitat (cf. Table 1, Table 2) presents a potential tradeoff to rural community officials. Developments located off main roads may have a more significant (negative) impact on wildlife populations, given the potential for increased fragmentation of off-road undeveloped areas. However, habitat values aside, respondents appear to prefer developments located off main roads. These results suggest that potential tradeoffs between spatial location values and habitat values will influence the optimal location of developments in rural communities.

Proposition Four: *All else held constant, respondents prefer open space located at a distance from roads and developed areas.*

The negative parameter estimate for *around* (p=0.0131) indicates that respondents prefer growth management plans in which open space is <u>not</u> located on the edges of residential developments or contiguous to main roads. These results indicate that estimated WTP for open space preservation may depend on the location of open space relative to more intensive land uses such as roads and developments. Note that such effects are independent of public access and wildlife habitat considerations. Where such information is not provided by the survey, CVM scenarios may risk potential methodological misspecification, particularly if respondents make systematic assumptions regarding open space location that are unknown to the researcher.

Conclusion

Model results indicate that spatial factors can influence respondents' preferences and WTP for growth management policies in rural communities. Although the model and results are preliminary and subject to further development, the conclusion that spatial factors influenced respondents' choices among growth management plans appears relatively clear. However, although the impact of spatial factors is clear, policy interpretations of preliminary model results are less obvious. Although the model supports the common conclusions that respondents have a positive WTP for increases in acres of open space, decreases in acres of development, and decreases in housing density, the model does not support many simple generalizations regarding preferences for spatial development layouts. For example, cluster developments may or may not be preferred to roadside strip developments, depending on the specific spatial and non-spatial characteristics of each development. However, certain generalizations are possible. For example, combining the positive value for open space locations off main roads and development with the positive value for wildlife habitat improvements, one could argue that open space should be preserved far from roads and developments, where it will have (potentially) the greatest habitat value for many species.

Although spatial attributes appear to have a significant influence on respondent's choices, the addition of explicit spatial attributes contributes to the complexity of model development and interpretation. As one adds to the spatial realism of the survey instrument, it is necessary to incorporate more complex representations of survey scenarios. Moreover, similar spatial information may be characterized or interpreted in a variety of manners, leading to difficult questions regarding the optimal means to incorporate such information in the data analysis. Although the illustrated models provide one means to represent spatial attributes, the presented model and results are preliminary, and based on only a small proportion of the data which will soon be available for analysis. Moreover, in many cases the variables representing spatial structure are relatively crude; the models could undoubtedly be improved through more refined spatial measures.

In summary, spatial factors appear to play an important role in influencing respondents' preferences for growth management. However, the most appropriate and informative way to model and interpret the associated spatial impacts remains at least somewhat unclear, leaving implications for policy design in some cases ambiguous. Ongoing and future research (based on survey data currently being collected) will seek to address these questions, with the ultimate goal of identifying improved methods to incorporate spatial factors into contingent assessments of land use and growth management policies.

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Endnotes

[1] The factorial design of survey scenarios was completed by Dr. Donald A. Anderson of STATDesign, Evergreen, CO.

[2] Methodological misspecification is defined as a situation in which "the market described by the researcher is formally correct, [yet] one or more elements are inadequately communicated so that the respondents does not perceive them in the way intended by the researcher."(Mitchell and Carson 1989, p. 249, as cited in Johnston et al. 1995).