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Influence of purchaser perceptions and intentions on price for forest land parcels: A hedonic pricing approach

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Abstract

A hedonic model was developed to analyze the market for undeveloped forest land in Minnesota. Variables describing in situ conditions, locational characteristics, buyer perceptions and intentions, and transactional terms were tested for their influence on sale price. The independent variables explained 67% of the per hectare sale price variation. Water frontage, road access and density, absentee ownership, future intentions, and financing arrangements had large, positive influences on price. Lack of a real-estate agent and agricultural land in the vicinity of the parcel had negative influences. A parcel's merchantable timber volume was not a significant predictor of price.

JEL classification: Q23; Q25; C51

Keywords: Forest land prices; Forest markets; Hedonic analysis; Forest finance; Price function

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Introduction

Economic forces and societal trends have had a significant influence on the United State's private forests. These trends have brought about changes in the patterns of ownership and the forest resource itself (Birch, 1996; Fleury and Blinn, 1996; Wear et al., 1998; Best, 2002), predominant uses of private forests (USDA Natural Resources Conservation Service, 1999; Sampson and DeCoster, 2000), and land management objectives and attitudes of its owners (Vessels, 1997; Butler and Leatherberry, 2004). These changes, in turn, have also likely contributed to rising prices of forest land (see, for example, Kilgore and MacKay, 2007). Our understanding, however, of whether, how, and to what extent these factors influence forest land prices is minimal. Studies of private forest landowners have repeatedly documented the importance of non-timber property attributes and uses in forest land ownership decision-making. Yet direct evidence of landowner willingness to pay for most of these attributes is scant. Additionally, other factors such as the characteristics of the land transaction, buyer perceptions, and planned uses of the land are thought to influence the price paid for forest land, although empirical evidence is lacking.

The objective of this study was to identify major factors influencing the market prices for undeveloped forest land in northern Minnesota. To do so, a hedonic price model was developed to identify the contribution of a variety of variables on forest land real-estate prices. While a few studies have investigated the factors influencing forest land prices (e.g., Turner et al., 1991; Roos, 1996; Aronsson and Carlén, 2000; Scarpa et al., 2000; Kennedy et al., 2002; Snyder et al., 2007), they have largely focused on parcel characteristics as explanatory variables. We were interested in testing a broader suite of explanatory variables. To accomplish this, we incorporated variables that were developed from a mail survey of recent purchasers of forest land on their intentions for and perceptions of their land and sales transaction characteristics (Donnay, 2005). The inclusion of this survey information with in situ and locational parcel characteristics allowed for a rich analysis of drivers of forest land price.

Literature review

The concept of hedonic modeling is based upon the idea that the price of a house or land parcel is the sum of the unobserved prices of a bundle of attributes associated with that good. Rosen (1974) was the first to postulate that houses, or similar heterogeneous products, could be described as single commodities differentiated by their composite characteristics. When a house is bought, the purchase is, in effect, for a bundle of features of that house that cannot be uniquely acquired. For example, one cannot purchase a view of a lake on its own, but must purchase property that provides a lake view as well as other amenities and disamenities associated with the property. Since markets do not exist for amenities such as this in isolation, economists have sought to estimate the value for such 'commodities' by evaluating purchases of other items that possess such features such as a house or lot. The specification of a hedonic price function is a way to estimate individual's marginal willingness to pay for characteristics of a lot or home. The majority of hedonic pricing applications have linked *housing* sale prices to different amenities and features. Our approach was to link the sale price of undeveloped, forested lots to a variety of parcel-specific and regional features and amenities, as well as buyer perceptions and intentions in an effort to better understand their influence on market prices for undeveloped forest land.

Only a few hedonic studies have examined drivers of forest land price. Turner et al. (1991) evaluated the effect of a number of parcel and regional characteristics on sale price of unimproved forested land (e.g., forest land without structures) in Vermont. Explanatory variables included: size of the parcel, percentage of non-forested area, presence of a frontage road, percentage of parcel with a steep slope, population density, rate of population growth for the surrounding county and town, distances to the nearest major highway and commercial ski area, tax rate, and the month of sale. The authors found that presence of road frontage, presence of non-forested land cover on the parcel, population increases in the county, close proximity to major roads and ski resorts, and lower tax rates all contributed to higher sale price per hectare of forested lots.

Roos (1996) found the price of forested land, classified for timber production, in Sweden was influenced by the size of the parcel, proportion of productive forest land on the parcel, mean standing merchantable timber volume, mean site productivity of the parcels, population density in the county, and month of sale. Agricultural land on the parcel and buyer characteristics were found to be insignificant in the model.

Aronsson and Carlén (2000) examined the impact of a large number of explanatory variables on sale price of forest estates in Sweden. The variables describing physical characteristics included: parcel size, timber stock, site productivity, and moose density as an indicator of hunting potential. Variables describing buyer and seller characteristics were also examined: buyer and seller income levels, age, education levels, household wealth, marital status, owner of other forested estates, and an interaction term between age and wealth. Of the parcel characteristics, parcel size, growing timber stock volume, site productivity, and moose density were all found to have positive influences on sale price. Of the variables describing the seller, income, wealth, age, and higher education were all significant and positive influences on price. Of the variables describing buyer characteristics, only income had a significant influence on purchase price.

Scarpa et al. (2000) developed a hedonic model to estimate the non-timber value of maple-birch forests in Wisconsin. Three categories of explanatory variables were evaluated: ecological stand attributes, locational attributes, and socioeconomic conditions. Nine variables were computed to represent the number of trees on the stand in three species groups (tolerant, mid-tolerant and intolerant), indexed by three size classes (pole, small saw timber, and large saw timber). Shannon's index was used to calculate values for tree species diversity, tree size diversity, and tree color diversity for each stand. Four variables describing site characteristics were computed: site index, distance to water, average percent deviation from the horizontal, and distance to roads. Finally, variables identifying land ownership categories, county population density, and average county household income were calculated. Using a linear hedonic model, the variables describing national forest ownership, intolerant species in all 3 size classes, mid-tolerant species in the two highest size classes, and shade-tolerant species in the two highest size classes were found to be significant predictors of forest value.

Kennedy et al. (2002) explored determinants of forest land prices in northern Louisiana and found that parcel location and tract development potential played important roles in determining forest land value. All of the variables tested in the model were found to be explanatory: presence of a paved access road, length of road frontage, distance to metropolitan areas, value of improvements on the parcel, month of sale, and parcel size.

In Snyder et al. (2007), a hedonic model for undeveloped forest land in northern Minnesota was developed and tested. The analysis focused on the influence of recreational amenities and proximity features associated with the forested parcels. Results indicated that non-timber factors were important drivers of forest land values. Variables associated with recreational and esthetic amenities, such as presence of lake or river frontage and percentage of open water close to the parcel were shown to have a positive impact on forest land sale prices. The method by which forest land sales were financed, road access and density, proximity to population centers, and presence of lake or river frontage had the largest positive influences on per hectare sale prices. Adjacency to public land had an unexpectedly large, negative influence on sale price. A parcel's merchantable timber volume was not found to be a significant predictor of forest land sale price. The research showed that, in general, forest land markets were driven by three major influences: land development pressures, presence of water, and the use of contract for deed financing.

The goal of our research was to determine whether variables developed from survey responses regarding buyer perceptions and intentions could also help explain the variation in forest land sale prices. Specifically, we were interested in investigating the explanatory power associated with the buyers' intentions for the purchased parcels and perceptions of the parcel's characteristics. Several hedonic models have been developed that incorporate survey information on perceptions of water quality and clarity on sales of lakeshore properties (Michael et al., 1996, 2000; Boyle and Taylor, 2001; Poor et al., 2001). Results from these analyses illustrated that purchasers' perceptions of lake water clarity may be different than empirical measures and, as such, important variables to consider in hedonic analyses. To our knowledge, however, no hedonic applications have been developed for forest land that incorporated information on perceptions and intentions.

Another aspect of forest land markets that we wanted to explore was whether transactional characteristics exerted an influence over sale price. In an agricultural study, Perry and Robison (2001) analyzed how transactional characteristics and the means by which buyers learned about properties influenced terms of trade and land prices. Special transactional arrangements such as owner financing, special down payments, desire to keep the land in a family line, and lifetime tenancy were evaluated.

To our knowledge, there have been no hedonic studies focusing on forest land sales that have examined purchasers' perceptions and intentions regarding their forest land, transactional characteristics, along with in situ and locational parcel characteristics. It is the inclusion of this broad suite of explanatory variables where our work makes a new contribution to the analysis of forest land markets. We develop and explore a large set of potential explanatory variables for forest land prices, borrowing from hedonic studies of residential markets, agricultural land sales, and the few forest land hedonic studies. We explore several hypotheses in this paper. First, since many purchasers of forest land have reasons other than timber production for owning forest land, we hypothesized that a parcel's amenity features, more than timber harvesting potential, would be important indicators of forest land price. We also hypothesized that buyer intentions for use of the forest land would influence price with a positive influence if a purchaser intended to develop the land. Finally, we hypothesized that purchaser perceptions about the quality of the forest for game habitat or timber production would influence price.

Data

Minnesota has 6.6 million ha of forest land, 43% of which is privately owned. Of the privately owned forest land, 304,000 ha are owned by forest industry and 248,000 by other corporate entities. The remaining 2.2 million ha of private forest land is owned by individuals, estimated to number 150,000. A characterization of these lands and their owners is that (1) the tracts are small (averaging 26 ha); (2) more than half of the owners do not live on their forest; (3) land tenure is considerable (median ownership length is 23 years); and (4) individuals own forest land for many reasons, the most common being wildlife-related such as habitat or hunting. Timber management ranks low on the list of reasons why Minnesota's forest land is owned by individuals, yet in 2003 over half of the total timber volume harvested in the state came from private forests.

Important trends in Minnesota's forest land sales market over nearly two decades include rising median forest land prices (averaging more than 12%/year), increasing total forest land acreage sold (approximately 0.50%/year), decreasing tract size per sale (averaging more than a 1% decline per year), considerable premiums paid for smaller tracts, and a subtle yet steady increase in the share of the state's private forest land based owned by individuals (Kilgore, 2006; Kilgore and MacKay, 2007).

The instrument used to gather data on buyer intentions and perceptions was a mail-back survey. A questionnaire was mailed to all individuals in the spring of 2004 who purchased unimproved forest land (i.e., forest land without any structures) in St. Louis County, Minnesota in 2001 and 2002. The questionnaire requested information on (1) reasons for acquiring forest land, (2) perceptions about the specific characteristics of the parcel they purchased (tree types and size classes, quality of wildlife habitat), (3) characteristics of the property adjacent to the forest land they purchased, (4) sources of information consulted in acquiring their land, (5) planned uses for the property, and (6) demographic information. The survey was administered following the process described by Dillman (2000) and generated a 77% overall response rate. Tests for non-response bias did not find significant differences between respondents and non-respondents with respect to the size of the parcel purchased or the location of the buyer's residence relative to the parcel purchased.

Surveys were administered to 387 purchasers, with 287 of those returning completed and useful surveys. Twelve of those surveys were removed from consideration for the hedonic modeling because they involved sales between relatives. Our hedonic analysis focused on those 275 arms-length purchases in St. Louis County with completed and useable surveys (Fig. 1).[1] Located in northeastern Minnesota and home to 200,000 people, St. Louis County is the largest county east of the Mississippi River, encompassing nearly 18,000 km^2 (Fig. 1) (St. Louis County, 2005). With over 500 lakes, parts of a national park and national forest, the Boundary Waters Canoe Area Wilderness, and four state parks within its borders, the county is known for its extensive recreational amenities. Duluth, the largest city in the county, is a major seaport on Lake Superior. Outside of Duluth, mining and wood and paper industries dominate.

The information generated from the questionnaire's 28 questions provided a large number of possible explanatory variables that could be used in our model. Given this, we carefully selected only key variables for inclusion in our hedonic model that we thought would be important drivers of forest land prices.

The 275 purchases were unimproved forest parcels (i.e., forest land without any structures) ranging in size from 4.05 to 126.67 ha (10–313 acres). A forested parcel was defined in the study as any undeveloped land with trees as the major vegetation, regardless of land use. To identify such parcels, sales of all land classified for tax purposes by the Minnesota Department of Revenue as undeveloped timberlands and seasonal recreational land were included. The percentage of forested land on the parcels averaged 70%, with wetlands and shrubland making up the largest share of non-forested land cover. Sales of parcels that were smaller than 4.05 ha (10 acres) were omitted from the study due to the likelihood that such parcels were of a different market; that of sale exclusively for residential home site or vacation home development purposes.

The dependent variable used in the model was the sale price per hectare, adjusted by the monthly consumer price index (CPI) (US Bureau of Labor Statistics, 2004). The CPI was used to translate the reported sale price of forest land over the 2-year study period to inflation-free dollars. All sale prices were adjusted to a common date (i.e., January 2001) and, as such, the reported sale price estimates reflect the purchasing power of the consumer's dollar at that time.

Data were gathered from several different sources. From the St. Louis County Assessor's office, Field Card and Certificate of Real estate Value (CRV) data for

[1]The Superior National Forest contains considerable in-holdings and is not a contiguous block of federally owned land. This explains the location of parcel sales located within the boundaries designated as the Superior National Forest in Fig. 1.

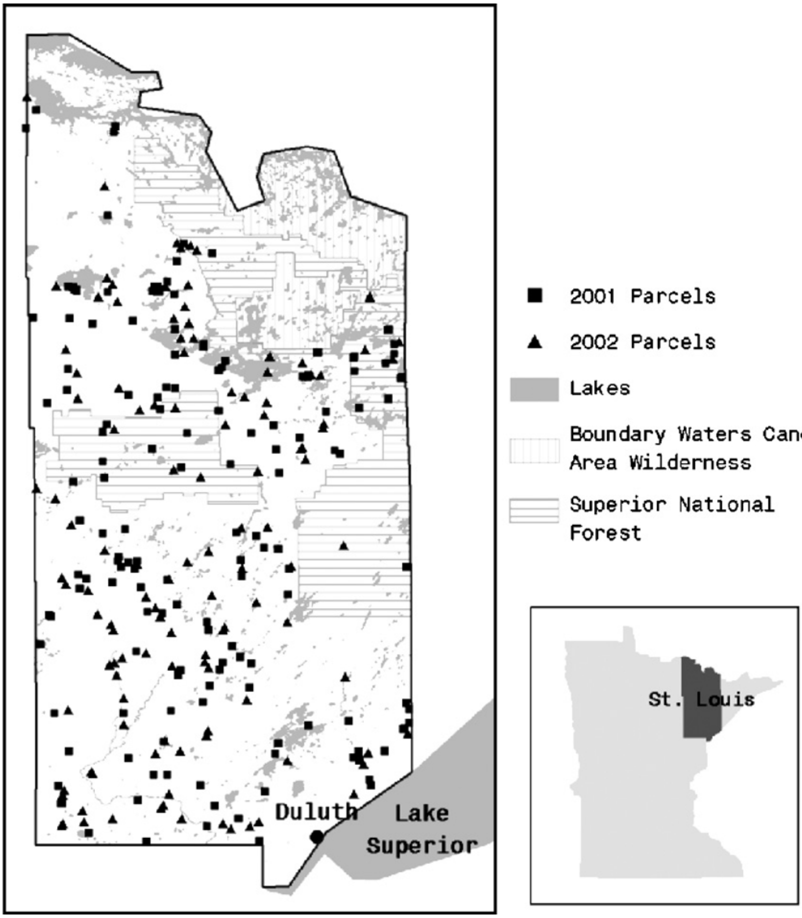

Fig. 1. Location of the 275 Sales Transactions in St. Louis County, MN.

each sale parcel were obtained. By Minnesota law, buyers and sellers of real property must complete a CRV at the time of sale. Data on the CRV include the sale price, acreage, date, legal description, parcel identification number and the buyer, seller and taxpayer names and addresses. It also contained information on how the purchase was financed and the method of conveyance (e.g., warranty deed versus contract for deed). The St. Louis County Assessor's Office Field Cards provide descriptions of various site characteristics (e.g., water frontage, access to parcel) and assessor's notes and opinions on the features of each parcel.

The boundaries of each study parcel were digitized in a GIS (ArcInfo 8.3) using St. Louis County plat books, legal descriptions from St. Louis County Assessor's Office, public land survey polygons (section and townships), and ancillary locational attribute data such as roads, lakes, and railways. Census variables and boundaries were obtained from the US Census website,[2] and road lines were obtained from the Minnesota Department of Transportation. The ownership type of land adjacent to the study parcels was determined using GAP stewardship data. Countywide land and forest cover data were obtained from the Forest Resources Department, University of Minnesota and consisted of classified Landsat satellite imagery from 2000. Data for timber growing stock volume were obtained from Forest Inventory and Analysis Database (FIADB) for the most recent inventory year, which for Minnesota, was 2003.[3]

Model specification

Little theoretical basis exists to guide selection of a functional form for a hedonic price model. However, following Rosen (1974), most researchers choose a functional form that allows price to vary non-linearly as a function of the level of the individual parcel characteristics. Cropper et al. (1988) and Taylor (2003) suggest that the simpler functional forms, such as the linear and semi-log, are usually the most appropriate in empirical applications involving unobserved and 'proxy' variables, as is the case with our study. To evaluate the fit of different functional forms to our data, we used a linear Box–Cox transformation (Box and Cox, 1964) of the dependent variable, as others have done when specifying a functional form for a hedonic model (e.g., Spritzer, 1982; Garrod and Willis, 1992; Faux and Perry, 1999; del Saz-Salazar and Garcia-Menéndez, 2005). In estimating the transformation, a general form for the implicit price function is represented as

$$P^{(\lambda)} = \alpha + \beta X + \varepsilon, \tag{1}$$

where P the price/ha of the parcel, α the intercept, β the matrix of coefficients, X the matrix of explanatory variables, and ε the error term. $P^{(\lambda)}$ is a Box–Cox transformation of the dependent variable which takes the following forms:

$$P^{(\lambda)} = (P^{(\lambda)} - 1)/\lambda, \quad \lambda \neq 0, \tag{2}$$

$$P^{(\lambda)} = \ln P, \quad \lambda = 0.$$

The TRANSREG procedure in SAS 9.1 was used to evaluate a range of lambda values from -3 to 3 and select the one that maximized the log likelihood function. A lambda of one suggests a linear model may provide a good fit for the data. A lambda equal to zero suggests that the natural log of the dependent variable be taken and a semi-log functional form utilized. Other values of lambda suggest more complex transformations be taken, resulting in more difficult interpretations of regression coefficients. The Box–Cox analysis of our data yielded a lambda equal to 0.1. Given a lambda value so close to zero and the ease of interpretation of a semi-log model, we chose to use the semi-log form for our empirical application.

[2] ⟨http://www.census.gov⟩.

[3] ⟨http://www.fia.fs.fed.us/tools-data/data/⟩.

The general model that we estimated is represented by the following equation:

$$P = \alpha + \beta X + \varepsilon, \tag{3}$$

where P is the Natural log of the sales price per hectare of the forested parcel, α the intercept, β the vector of coefficients, X the vector of explanatory variables, and ε the error term that represents the effect of omitted and mis-specified variables, and random error.

Ordinary least squares regression was chosen as the estimation method because an inspection of the residual plot indicated that the residuals were randomly distributed throughout the range of the dependent variable.

Model variables

Table 1 identifies the variables we hypothesized were likely to influence the per hectare sale price of forest land in northern Minnesota.

Buyer intentions and perceptions

Intentions

Several variables were developed based upon respondents' stated intentions for the forest land they purchased. In the survey, respondents were asked to choose their most important reason for purchasing forest land (Donnay, 2005). Two responses that we hypothesized would be important predictors of price were 'purchase to establish a primary or secondary residence' (HOME) and 'purchase as a place to enjoy wildlife' (WILDLIFE), which could include consumptive (hunting) and non-consumptive (bird-watching) uses. Dummy variables were created for these two response categories, and both variables were anticipated to have positive signs since previous studies have documented the high demand for Minnesota forest land for these two purposes (Baughman, 1988; Birch, 1994; Donnay, 2005).

Survey respondents were also asked to estimate the number of days per year that they intended to visit their forest land. A dummy variable was created to identify those purchasers who planned to visit their land 12 days or less per year (VISITS). We hypothesized that the effect of this variable would be negative since purchasers who intended to visit their land infrequently might not be willing to pay high prices for their land relative to those who plan to use this property more frequently.

A binary variable was created that indicated whether buyers purchased their land in order to gain access to adjacent public land for recreational use (ACCESS). We hypothesized that this variable would be positive as buyers might be willing to pay a premium to purchase land that gave them ready access to adjacent public land for recreation.

Table 1. Independent variables tested in hedonic model for effect on price of Minnesota forest land

Variable	Variable description	Expected effect on price/ha
Buyer intentions and perceptions		
Buyer intentions		
HOME	Binary variable (1 if primary reason for land purchase is for construction of a primary or vacation home, 0 otherwise)	+
WILDLIFE	Binary variable (1 if primary reason for land purchase is a place to enjoy wildlife, 0 otherwise)	+
VISITS	Binary variable (1 if purchaser intends to visit the land less than or equal to 12 days/year, 0 otherwise)	–
ACCESS	Binary variable (1 if the property was purchased in order to gain access to adjacent lands for recreational use, 0 otherwise)	+
SUBorSELL	Binary variable (1 if purchaser bought the land with the intention of subdividing and/or selling, 0 otherwise)	–
Buyer perceptions		
GAME	Binary variable (1 if purchaser rated the quality of game habitat on their land as excellent, 0 otherwise)	+
%WET	Estimated percent of non-forested swamp or wetland on the property	–
%SOFT	Estimated percent of evergreens on the property	–
TREE_AGE	Binary variable (1 if the estimated percentage of land with trees greater than 10-year old is at least 50%, and 0 otherwise)	+
Transactional characteristics		
Sales transaction information		
DATE	Year and month of sale (values range from 1 for January 2001 to 24 for December 2002)	+
CONTDEED	Binary Variable (1 if contract for deed financing used, and 0 otherwise)	+
ADJ_OWNER	Binary variable (1 if either the purchaser or a relative owned the adjacent land at time of purchase, 0 otherwise)	+
NO_REAL	Binary variable (1 if purchaser did not use the services of a real estate agent, 0 otherwise)	–
APPRAISER	Binary variable (1 if a purchaser used the services of a land appraiser, 0 otherwise)	–
In situ variables		
Parcel size		
SIZE	Size of parcel in hectares	–

Table 1. (*continued*)

Variable	Variable description	Expected effect on price/ha
Parcel land cover		
%AG	Percent agriculture	–
%SHRUB	Percent shrubland	+
%TAM	Percent tamarack forested area	_
Timber growing stock volume		
VOL	m^3/ha of merchantable timber	+
Water frontage		
LAKE	Binary variable (1 if lake frontage present on the parcel, 0 otherwise)	+
RIVER	Binary variable (1 if river frontage present on the parcel, 0 otherwise)	+
Road access		
ROAD	Binary variable (1 if a parcel has road access, 0 otherwise)	+
Locational variables		
Land cover in 8.05-km buffer		
AGBUF%	Percent agriculture	–
H20BUF%	Percent lake, river, or open wetland	+
Population and land development		
%SEAS	Percent of seasonal homes within 8.05-km radius buffer of each parcel.	+
DELTA_PD	Change in population density between the 1990 and 2000 Census for the 8.05-km buffer	+
Proximity to population centers		
TOWN	Distance in km to the nearest Census designated 'populated place' with 500 or more people	–
RD_DENSITY	Road density: km of road per square km in the 8.05-km buffer surrounding each parcel	+
ABSENT	Binary variable (1 if the purchaser's permanent residence is more than 161 km(100 miles) from the parcel, 0 otherwise)	+

Survey respondents were asked about their long-term intentions for their land purchase; e.g., whether they planned to keep, subdivide, or sell the land. For the hedonic model, we created a dummy variable to indicate whether purchasers planned to either subdivide or sell the land in the near future (SUBorSELL). The effect of this variable was hypothesized to be negative as those purchasers with intentions to subdivide or sell might have purchased the land solely as an investment and as such, might have sought parcels with lower per hectare cost.

Perceptions of parcel attributes

Purchasers were asked to rate the quality of the game habitat on their parcel at the time of purchase. A binary variable was created that indicated whether or not a respondent rated their habitat quality at the highest value (GAME). We viewed this variable as a proxy for good hunting potential on the forest land, anticipating that it would have a positive influence on forest land sale price if the purchaser felt the land's hunting value was high.

Survey respondents were asked to estimate the percentages of their property in different land cover, tree types and ages. Variables included in the hedonic model were the estimated percentage of non-forested swamp or wetland (%WET), the estimated percentage of conifers on their property (%SOFT), and a binary variable indicating whether at least 50% of their parcel was comprised of trees greater than 10-year old (TREE_AGE). Sale price per hectare was hypothesized to be negatively influenced by the percent of non-forest wetland present, as this is often unsuitable land for development, timber harvesting, and many forms of recreation. The expected impact of the conifer variable (%SOFT) was negative since softwoods are inferior to hardwoods for most game wildlife habitat in Minnesota. The TREE_AGE variable was a proxy for forest land that is not cut-over. We hypothesized that the TREE_AGE variable would have a positive influence on purchase price because non-cut-over forest land would be expected to have greater esthetic and wildlife habitat value.

Transactional characteristics

Sales transaction information

A categorical variable (DATE) was created to control for the month and year of sale. This variable was expected to be positive as real forest land prices have increased in Minnesota for over a decade (Kilgore and MacKay, 2007). A dummy variable (CONTDEED) was also included in the model to indicate whether the sale was financed on a contract for deed. Contract for deed is a method of financing in which the seller acts as a bank, providing a loan to the buyer. Featherstone et al. (1993) and Kilgore (2006) found contract for deed financing to have a large and positive impact on sale price of agricultural land and forest land, respectively. We anticipated that this variable would have a positive impact on sale price in our study as well.

Respondents were also asked whether they or a relative owned any of the adjacent land to the parcel they acquired. We created a binary variable for the model from this question (ADJ_OWNER). We hypothesized that sale price might be higher if either a relative or the purchaser owned adjacent land because a purchaser might be willing to pay a premium to add directly onto existing holdings.

Survey respondents were asked a series of questions about the methods they used for gathering information about the properties (Donnay, 2005). A binary variable was created to indicate if a purchaser did not use the services of a real-estate agent in the acquisition of their forest land property (NO_REAL). The effect of this variable was anticipated to be negative since the use of a realtor is likely to include fees and commissions, driving sale prices up.

Along similar lines, respondents were asked about their use of a land appraiser in the purchase process. A dummy variable was created for the hedonic model, which indicated whether a purchaser employed the services of an appraiser (APPRAISER). We anticipated that the sign on this variable would be negative as the use of an appraiser would likely ensure that a purchaser was not overpaying for lower quality land.

In situ variables

Parcel size

Parcel size in hectares (SIZE) was included as an explanatory variable with an expected negative influence on sale price. Previous research has found that price per hectare declines as size of a forest parcel increases (See, for example, Armstrong, 1987; Turner et al., 1991; Kilgore and MacKay, 2007).

Land cover within parcel

Land cover data for each parcel and within an 8.05-km (5-mile) buffer surrounding each parcel were computed using a recent land cover classification of St. Louis County. Categories of land cover that were computed include percent developed area, agriculture, grassland, forest, open water, wetland, shrubland, and non-forested area. The land cover variables for shrubland (%SHRUB) and agricultural land (%AG) were included in the model. We hypothesized that shrubland would function as a proxy for edge habitat associated with forest land. Edge habitat is beneficial for several game (e.g., ruffed grouse) and non-game species (e.g., songbirds). Given that, we hypothesized that this variable could have a positive effect on price, particularly if a purchaser was interested in hunting or wildlife watching. We anticipated that percentage of agricultural land would have a negative influence on the set of sales in this analysis, as this land type may be viewed as being unsuitable or undesirable for recreation or possessing low esthetic quality.

The land cover data described above were further broken down into more specific forest cover-type categories for the portion of each parcel classified as forested. One of the tree species' variables that was tested in the model was percentage of tamarack (%TAM). We used tamarack stands as a proxy for a forested wetland, and as such, expected this variable to be negatively related to price as it might reflect conditions unsuitable for development and recreation, as well as land cover with minimal wildlife habitat value.

Timber growing stock volume

Timber growing stock volume, or merchantable timber, on the parcels was estimated using the USDA Forest Service's Forest Inventory Analysis (FIA) data. The variable (VOL) was measured in m^3/ha and was included in the model as an indicator of the harvesting potential on the parcel. FIA defines timber growing stock volume as the volume of commercial species that meet certain merchantability standards, and does not include rough cull or rotten cull trees. The definition and equation for growing stock volume were determined using FIA documentation. Based on FIA ground plot data, growing stock volume was calculated for each ground plot in our study area. Using ArcGIS Spatial Analyst software, a surface was interpolated from the plot data using an inverse distance weighting function. The location of the center of each study parcel was determined. The growing stock volume of each parcel was then estimated by overlaying the centerpoints of the parcels with the growing stock volume surface layer. We hypothesized that larger values of the VOL variable would be associated with higher sale prices, particularly if a purchaser was interested in owning forest land with the intent to manage for timber.

Water frontage

Given that previous studies (Baughman, 1988; Birch, 1994; Turner et al., 1991; Aronsson and Carlén, 2000) have shown non-timber property attributes, in particular recreational and amenity features, are primary reasons for owning forest land, variables were included to capture the influence of such amenities. Two dummy variables were developed to indicate whether a parcel had lake (LAKE) or river frontage (RIVER). Both variables were anticipated to have a positive impact on parcel price since they represented access to recreational opportunities as well as a degree of insularity from development. Again, it is important to note that the parcels in our dataset were at least 4.05 ha (10 acres), and not of a smaller size that would typically be sold only as cabin or home development lots, which is a different land market.

Road access

A binary variable indicating all-weather road access to the parcel (ROAD) was computed. The sign on this variable was hypothesized to be positive as purchasers are likely to pay a premium for a parcel that can be readily accessed.

Locational variables

Land cover within an 8.05 km (5-mile) buffer

Land cover variables within an 8.05-km buffer surrounding each parcel were generated using the same land cover categories as the in-parcel categories.

The agriculture (AGBUF%) and open water (H20BUF%) land cover buffer variables were included in the model. Sale price per hectare was hypothesized to be positively influenced by the percent of open water in the buffer to reflect a premium for proximity to water sources for its amenity and recreational value. The AGBUF% variable was anticipated to have a negative sign as the presence of agricultural land uses may detract from a forest parcel's esthetic, hunting, and recreational values.

Population and land development

Two variables were created from the 2000 US Census data and measured at the block level, which is the smallest reporting level of Census geography. These variables were included to identify how the intensity of and growth in development surrounding each study parcel impacted sale price. Percent seasonal housing density of the total housing density (%SEAS) was computed for an 8.05-km buffer surrounding each parcel. Change in population density (DELTA_PD) was computed for the same 8.05-km buffer to capture change in growth in the surrounding area between 1990 and 2000. This Census change data was obtained from work by Radeloff et al. (2005).[4] We hypothesized forest land near areas experiencing population growth and containing amenities attractive for seasonal home construction would have a positive impact on forest land sale prices.

Proximity to population centers

A variable was developed that measured the distance in kilometers to nearest populated places as defined by the US Census. Distances were measured as actual road distances versus straight-line distances. This variable measured distance to a populated place of at least 500 people (TOWN). Longer distances to populated places were expected to be associated with lower sale prices, as there is value to being located close to the services and amenities of a town center. Thus, we expected the coefficient on this variable to be negative, as found by Roos (1996) and Kennedy et al. (2002). A variable measuring road density within the 8.05-km buffer of any parcel was created (RD_DENSITY). This was viewed as an indicator of development intensity, with higher densities expected to be associated with higher sale prices.

A binary variable was developed to indicate whether the distance between the purchaser's permanent residence and the parcel was greater than 161 km (100 miles) (ABSENT). The effect of this variable was anticipated to be positive because 'absentee' land purchasers might be willing to pay a higher land price, particularly if they intend to build a vacation residence. Additionally, such purchasers might pay higher prices because they don't have familiarity with or access to current information on forest land prices in northern Minnesota.

[4]This data set contains 1990 housing and population densities adjusted to 2000 block boundaries, so that change estimates from 1990 to 2000 can be made without corruption from changes in block boundaries. ⟨http://silvis.forest.wisc.edu/projects/WUI_Main.asp⟩.

Results

Table 2 contains the mean values and ranges of the variables that were tested in the hedonic model. Table 3 presents the results of the regression analysis of Eq. (3) that was conducted using SAS, version 9.1. Of the 29 variables included in the model, 12 were significant at the 1% level, 6 at the 5% level, and 2 were significant at the 10% level.

Multicollinearity is often an issue with hedonic pricing models (see, for example, Garrod and Willis, 1992; Tyrväinen and Miettinen, 2000; Irwin, 2002). However, no definitive rules exist for determining whether multicollineary is a serious problem in a hedonic application. To address the issue of multicollinearity with our set of independent variables, a correlation matrix was generated to test for relationships among them. The analysis showed no correlation exceeding 0.45 in absolute value. The highest correlation value (−0.45) occurred between the variables RD_DENSITY and AGBUF%. While this indicates some degree of relationship between these two variables, it did not seem great enough to exclude one or the other variables. Correlations between the remaining pairs of variables were considerably smaller. Turner et al. (1991) reported correlations up to 0.45 in the set of explanatory variables used in their hedonic model.

The variance inflation factor (VIF) was estimated for each of the independent variables as another check for multicollinearity (Table 3). Kennedy (1985) suggested that a VIF value greater than 10 is a serious indicator of a multicollinearity problem with a model. The highest value VIF for our model was 3.10 for the RD_DENSITY variable, again suggesting that multicollinearity was not a serious problem with our model.

Buyer intentions and perceptions

Intentions

The variable describing the buyer's intention to build either a primary or secondary home on the parcel (HOME) proved to have a very large, positive influence over sale price per hectare. Buyers paid 41% more per hectare on average if they had plans to build a residence on the parcel over those who had other intended purposes or uses, a premium of $988/ha. Those purchasers who responded that their primary reason for purchase was to own a place in which to enjoy wildlife (WILDLIFE) paid a premium of $631/ha. The positive influence of the wildlife variable (WILDLIFE) might be indicative of the purchasers' desire for hunting or bird watching on the parcel and reflective of the premium they are willing to pay to enjoy such recreational opportunities on private land. While a strong relationship between the GAME and WILDLIFE variables might be expected if purchasers had a desire to hunt on their property and correctly identified high-quality game habitat on their lands, we found a very small, and negative correlation coefficient between the two (−0.0785). This may suggest that even

Table 2. Mean values and ranges of variables in the hedonic model

Variable	Unit	Mean	Minimum	Maximum	Std. dev.
PRICE/HA	$/ha	2436.94	121.75	20,808.29	2,810.68
Buyer intentions and perceptions					
HOME	Yes/no	0.23	0.00	1.00	N/A
WILDLIFE	Yes/no	0.06	0.00	1.00	N/A
VISITS	Yes/no	0.30	0.00	1.00	N/A
ACCESS	Yes/no	0.25	0.00	1.00	N/A
SUBorSELL	Yes/no	0.23	0.00	1.00	N/A
GAME	Yes/no	0.33	0.00	1.00	N/A
%WET	%	17.87	0.00	96.00	22.10
%SOFT	%	42.44	0.00	100.00	29.54
TREE_AGE	Yes/no	0.56	0.00	1.00	N/A
DATE	Month and date[a]	12.08	1.00	24	6.84
CONTDEED	Yes/no	0.10	0.00	1.00	N/A
ADJ_OWNER	Yes/no	0.16	0.00	1.00	N/A
NO_REAL	Yes/no	0.45	0.00	1.00	N/A
APPRAISER	Yes/no	0.18	0.00	1.00	N/A
Transactional characteristics					
DATE	Month and date[a]	12.08	1.00	24	6.84
CONTDEED	Yes/no	0.10	0.00	1.00	N/A
ADJ_OWNER	Yes/no	0.16	0.00	1.00	N/A
NO_REAL	Yes/no	0.45	0.00	1.00	N/A
APPRAISER	Yes/no	0.18	0.00	1.00	N/A
In situ variables					
SIZE	Hectares	19.42	4.05	126.67	16.08
%AG	%	4.96	0.00	78.85	13.48
%SHRUB	%	6.27	0.00	50.54	8.52
%TAM	%	11.49	0.00	72.06	13.24
VOL	m^3/ha	66.15	0.00	234.13	42.74
LAKE	Yes/no	0.09	0.00	1.00	N/A
RIVER	Yes/no	0.06	0.00	1.00	N/A
ROAD	Yes/no	0.84	0.00	1.00	N/A
Locational variables					
AGBUF%	%	5.19	0.12	22.03	4.05
H20BUF%	%	6.37	0.09	44.40	7.85
%SEAS	%	28.58	0.58	81.31	21.12
DELTA_PD	Change in %	0.23	−11.33	12.92	2.57
TOWN	km	16.40	0.76	49.75	9.46
RD_DENSITY	km/km^2	0.61	0.04	1.87	0.32
ABSENT	Yes/no	0.39	0.00	1.00	N/A

[a]Values of the DATE variable, which represented the month and year of sale, ranged from 1 to 24. For example, a sale in January of 2001 would be assigned a DATE of 1.

Table 3. Hedonic model results

Variable	Coefficient	Standard error	Variance inflation factor	Marginal implicit price[a]
Buyer intentions and perceptions				
HOME	0.34037*	0.08555	1.27246	988
WILDLIFE	0.23011***	0.14237	1.15743	631
VISITS	−0.00340	0.07653	1.21503	NA
ACCESS	0.03965	0.08130	1.23490	NA
SUBorSELL	−0.10266	0.08604	1.30153	NA
GAME	0.05822	0.07084	1.09993	NA
%WET	−0.00276	0.00173	1.43505	NA
%SOFT	−0.00208***	0.00115	1.13812	−5
TREE_AGE	0.15950**	0.07919	1.51871	421
Transactional characteristics				
DATE	0.01435*	0.00485	1.11051	35
CONTDEED	0.25397**	0.11106	1.11051	705
ADJ_OWNER	−0.12636	0.09758	1.23672	NA
NO_REAL	−0.14612**	0.07115	1.23585	−331
APPRAISER	0.10663	0.08724	1.09716	NA
In situ variables				
SIZE	−0.00858*	0.00212	1.13827	−21
%AG	0.00709*	0.00274	1.33487	17
%SHRUB	−0.00636	0.00457	1.48763	NA
%TAM	−0.01100*	0.00273	1.28020	−27
VOL	−0.00118	0.00081	1.17800	NA
LAKE	1.36644*	0.12175	1.20608	7119
RIVER	0.57477*	0.14408	1.18533	1893
ROAD	0.38233*	0.09549	1.20666	1135
Locational variables				
AGBUF%	−0.03678*	0.01213	2.36642	−90
H20BUF%	0.01678*	0.00556	1.86879	41
%SEAS	0.00565**	0.00250	2.73257	14
DELTA_PD	0.05368*	0.01428	1.32128	131
TOWN	−0.01066**	0.00465	1.89838	−26
RD_DENSITY	0.45932*	0.17738	3.10087	1119
ABSENT	0.17544**	0.07220	1.21979	467
Intercept	6.81310*	0.24813		
R^2	0.7053			
Adjusted R^2	0.6704			
F-value	20.22*			
N	275			
Mean price/ha	$2437			

*Denotes significance at the 1% level, ** denotes significance at the 5% level, *** denotes significance at the 10% level.

[a]The marginal implicit price is based upon the mean price per hectare.

when forest land is bought for wildlife enjoyment reasons, purchasers are not necessarily or only targeting high-quality game habitat. The VISITS, ACCESS and SUBorSELL variables were all insignificant at the 10% level, although the signs on each were as expected.

Perceptions of parcel attributes

The sign on the variable representing perceived high-quality game habitat (GAME) was positive, as was expected, but the variable was insignificant at the 10% level. This suggests that if purchasers are acquiring land for hunting or wildlife purposes, that they are not differentiating parcels based upon their habitat quality. Or, it could also suggest that purchasers are not aware of what type of landscape provides high-quality game or non-game habitat.

The %WET variable was not significant at the 10% level. We included both the %WET and the %TAM variables in the model as a means of comparing a purchaser's perception of a parcel characteristic with a measured value of it. Both variables had explanatory power in the model, although the coefficient of each was small. A close relationship between these two variables would be expected if purchasers were accurately assessing wetland conditions on their parcels. However, the correlation value between these two variables was −0.26. The negative relationship between the variables was unexpected. This may suggest that on average purchaser's perceptions of wetland areas do not accurately coincide with measured conditions or the use of tamarack forested area is not a good proxy for wetland conditions on forested parcels.

Percentage of coniferous trees (%SOFT) had a significant and negative, albeit small, influence on price per hectare, resulting in a −0.2% change in price per hectare for every additional percentage of softwood on the parcel. This suggests buyers place a slightly higher premium on hardwood or mixed hardwood-conifer forests, possibly for their wildlife habitat quality.

Having at least 50% of the forest parcel in land cover with trees that are at least 10-year old (TREE_AGE) proved to have a large, positive impact on the per hectare sale price, commanding a premium of $421/ha (17%). This effect may be attributed to the fact that purchasers desire more mature trees for esthetic, hunting and habitat purposes, and are willing to pay a premium to obtain forest lands that are not cut-over.

Transactional characteristics

The significance of the DATE variable suggests an upward trend in real per hectare forest land prices over time of approximately 1.4% per month over the 2-year-study period. This is to be expected as Kilgore and MacKay (2007) found that forest land prices have been increasing in northern Minnesota over the past decade.

The use of contract for deed financing, CONTDEED, was found to be an important explanatory variable in the model. Buyers paid, on average, approximately 29% more per hectare than if other financing methods had been used, a premium of $705/ha. Possible explanations of this could be the buyer's inability to access capital markets, high transaction costs associated with market financing, and greater flexibility for both buyer and seller in defining terms for financing the forest land purchase (Kilgore, 2006). Surprisingly, the variable describing the owner of adjacent parcels as either a relative or the purchaser themselves (ADJ_OWNER) was not significant at the 10% level.

Brokering a sale without a real-estate agent (NO_REAL) had a significant negative influence on sale price, as we expected since real-estate agent commissions would not have to be paid. On average, forest land sales without the use a real-estate agent were 14% less per hectare than those with this service. This could suggest that sellers are passing part of the savings onto buyers when a broker is not involved, or that the buyer is capitalizing on the seller's lack of knowledge of the current market. The use of an appraiser (APPRAISER) was not a significant explanatory variable in the model.

In situ variables

Parcel size

The SIZE variable exhibited the characteristically negative relationship between size of parcel and price per hectare, although the impact of parcel size in our model was small. For every 1 ha increase in size, the average price per hectare fell by 0.86%.

Land cover

Price was positively related to the percentage of agricultural land (%AG) in the parcel, which was unexpected. The %SHRUB variable was not significant at the 10% level. The variable associated with percentage of tamarack forest cover (%TAM) was found to hold some explanatory power, although its impact on price was slight. On average, for each percentage increase of tamarack on a parcel, sale price per hectare was 1% lower. Tamarack species are found in boggy, marsh areas and may be an indication of lack of development and/or recreational potential.

Timber growing stock volume

The variable measuring standing merchantable timber volume on the parcels (VOL) was not significant in the model at the 10% level. This could suggest that purchasers are unaware or ambivalent to the value associated with managing the parcel for timber production. It could also indicate that forest land purchasers simply do not differentiate forest land value according to tree size.

Recreational and aesthetic feature

By far, two of the most important determinants of forest land price in our study were presence of lakefront (LAKE) and riverfront (RIVER). Forested parcels with presence of lake frontage commanded a price premium of 292% in price per hectare over parcels without lake frontage.[5] Presence of river frontage increased the average price per hectare by 78%. These results indicate that buyers both highly value direct access to rivers and lakes, but also recognize and hold different values for lake versus river frontage.

Road access

Road access to a parcel (ROAD) was found to be a highly explanatory variable, as would be expected. Road access increased average parcel price by 47%, a premium of $1,135/ha, signaling that purchasers value readily accessible parcels.

Locational variables

Land cover within the buffer

Of the land cover types in the 8.05-km buffer surrounding each parcel, percentage of agriculture (AGBUF%) had a negative relationship with parcel price, while percentage of open water (H20BUF%) was a positive variable. On average, for each percentage increase of agricultural land and open water in the buffer, sale prices per hectare were 3.68% lower and 1.68% higher and, respectively. The marginal implicit price of each percentage increase in open water in the buffer, evaluated at the mean price per hectare, yielded a premium of $41 per hectare.[6] The positive relationship of the open water variable likely reflects a recreational value associated with proximity to a lake or river. The marginal implicit cost of each additional hectare of agricultural land in the buffer was $90/ha. This negative relationship with the amount of agricultural land in the buffer may suggest land uses inconsistent with the

[5]While the percentage impact of a continuous variable is the regression coefficient multiplied by 100, a different calculation must be used for dummy variables in a semi-log equation. According to Halvorsen and Palmquist (1980), the percentage impact of a dummy variable is calculated as ({exp(β)−1}*100), where β is the regression coefficient. For example, the percentage impact of lake frontage on average parcel price is calculated as {exp(1.36644)−1}*100 = 292%. Similarly, the marginal implicit price of a dummy variable in a semi-log form is calculated using the expression ({exp(β)−1} *(mean sale price per hectare)). To illustrate, the per hectare marginal implicit price of lake frontage is calculated as: {exp(1.36644)−1}*$2437 = $7,119.

[6]The marginal implicit price of each continuous independent variable is calculated as the price per hectare multiplied by the regression coefficient. Using the mean sale price per hectare, the marginal implicit 'value' of an additional percentage of open water in the buffer is 0.01678*$2437 = $41. The marginal price of each variable is constant over the range of data in our analysis.

objectives of many forest owners (e.g., lack of tree cover, limited hunting and recreation potential).

Population and land development

The percentage of seasonal housing, %SEAS, had a positive, albeit small influence on price per hectare, commanding a 0.57% premium in sale price for each percentage increase in seasonal housing. Higher prices occurred in regions in which the population, measured as change in population density (DELTA_PD), is growing. Price per hectare increased by 5.4% for every percent increase in population density. Both variables are indicative of growing development pressures in the region.

Proximity to population centers

Distance to a populated place of at least 500 people (TOWN) also proved to be a significant explanatory variable. The sign on the coefficient was negative indicating that there is a declining value (−1.1%) for each additional km that separates a parcel from a population center. This could be a function of forest land availability and higher land prices associated with developed or developing areas, or it could signal a premium that purchasers are willing to pay to be near service centers.

Road density (RD_DENSITY) also proved to have a large, positive influence on forest land prices, again suggesting that in more developed areas, sale prices are likely to be higher due to land development and availability pressures. A one unit (km of road per square km) increase in road density in the 8.05-km buffer in which a parcel was found increased sale price by approximately 46%.

Purchasers who lived more than 161 km (100 miles) from their forest land parcel (ABSENT) paid a premium over their counterparts who lived closer. These purchasers paid $467 more per hectare (19%) than the average price. This could be due to their unfamiliarity with the market for forest land in northern Minnesota, or inexperience in buying forest land parcels. Evidence of absentee buyers paying a premium has also been found in the residential real-estate literature (e.g., Lambson et al., 2004).

Summary and implications

The model results point to several major positive influences on forest land markets in northern Minnesota. First, recreational amenities are major drivers of forest land value. In particular, the presence of either lake or river frontage on the forested parcel, or open water within close proximity, resulted in significantly higher prices per hectare than lands without open water. Parcels that were purchased for the primary reason as a place to enjoy wildlife also commanded price premiums, reflective of the recreational quality that purchasers perceive for activities associated with wildlife.

Secondly, land development pressures around population centers signal another major influence of higher sale prices. As population centers in the county, such as Duluth, continue to spread outward, the supply of undeveloped forest land declines, signaling a premium for forested parcels. The model found several proxies for land development pressures to be important drivers of forest land prices, such as increasing population density and higher road densities.

Third, transactional characteristics held considerable influence over forest land price. The method by which forest land was sold had considerable influence on sale price, with contract for deed financing commanding a substantial market premium. Transactions which did not involve real-estate agents resulted in considerable price discounts for purchasers.

Finally, the results indicate that variables related to buyer intentions and perceptions can be significant indicators of price. In particular, our results indicated that intentions to either develop the land for a home or use the land for enjoyment of wildlife were important explanatory variables. Perceptions about tree cover and age on the parcels were also significant in the model.

In sum, the significant variables in our model fell into four distinct categories: in situ parcel characteristics, locational or regional attributes, buyer perceptions and intentions, and transactional characteristics. Variables in each of these categories held some explanatory power individually and as members of the four categories.[7] This suggests that the price function for forest land is complex and cannot readily be estimated with a small number of explanatory variables.

As with all empirical studies, the possibility of measurement error in the data exists. One source of potential error could be attributed to the time lag between the time of the parcel purchase (2001 or 2002), and the time of the survey administration in 2004. We tried to minimize any problems associated with the time lapse by explicitly asking the respondents to answer the survey with regard to the conditions of their parcel *at the time of purchase*. While this certainly does not eliminate the possibility of misspecification or inaccuracies, we do believe it helped to clarify the conditions of the time point we were seeking. Another potential source of measurement error could be the use of proxy variables, such as our use of percent shrubland (%SHRUB) to represent edge habitat, and the use of percent tamarack (%TAM) to represent forested wetland. Future research could focus on more direct measures of these variables of interest.

[7]To test for the combined influence of the four categories of explanatory variables (i.e., in situ characteristics, locational characteristics, Transactional characteristics, perceptions and Intentions), four restricted models, one for each of the 4 sets of explanatory variables, were run and compared to the original, unconstrained model using *F*-tests. The purpose was to test the null hypothesis that all of the coefficients in each of the four sets were jointly equal to 0 in their respective restricted models. The *F* statistics were as follows: In situ restricted model $F(8,245) = 28.74762$; locational restricted model $F(7,245) = 10.92226$; transactional restricted model $F(5,245) = 4.462438$; perceptions and Intentions restricted model $F(9,245) = 4.104182$. All four *F*-statistics were larger than their respective critical values at the 95% confidence level, allowing us to reject each null hypothesis that the four sets of variables are jointly insignificant.

The results of our analysis have several implications for resource management and policy. First, the results support the contention that non-timber factors are important drivers of forest land values. For example, our variables that approximated recreational and aesthetic conditions (LAKE, RIVER, H20BUF%, WILDLIFE) were shown to have a positive impact on forest land sale prices. This suggests that timber harvesting is not the only reason, and in fact, may not even be a reason at all, for owning forest land parcels. This, in turn, may have implications for long-term timber supply, production and management in the northern part of the state.

Forest land parcel sales less than 4.05 ha (10 acres) were removed from our study at the outset because we assumed that the smaller parcels were purchased exclusively for home site purposes. Based upon our findings, however, it appears that larger forest land parcels are being purchased for home site development in northern Minnesota. Twenty-three percent of the respondents in the Donnay (2005) survey indicated their primary reason for purchase of forest land was for either primary or secondary home development, while only two respondents reported timber production for profit as their primary reason. This finding may signal the potential for increasing fragmentation if forest clearing occurs to accommodate homesite development, as well as reduced potential for forest management across the landscape if owners either are not interested in forest management or think that management is incompatible with their goals for a homesite.

Individuals may be buying forest land with a major intention of enjoying wildlife on their property, in both consumptive (hunting) and non-consumptive ways. However, our results suggest that individuals are not just acquiring parcels with high-quality game habitat. This could be attributed to a lack of understanding of what constitutes high-quality game habitat and/or a limited supply of forest land parcels for sale with this characteristic.

The high premiums that purchasers were willing to pay for lake and river frontage may further indicate intent to use such properties for the development of vacation home sites. If this is true, this could signal increasing rates of subdivision, parcelization and fragmentation of forest land in the region. While our analysis did not focus on how water quality may affect purchaser's willingness to pay for land with access to a river or lake, other hedonic studies have shown that declining water quality translates into lower purchase prices and tax base (Krysel et al., 2003). An additional area for future research would be to assess the influence of the linear feet of river or lake frontage or the lake surface area on parcel price rather than simply presence or absence of water frontage. Finally, our findings should be useful to real-estate appraisers, tax assessors, and lending institutions that are in need of information and means to make accurate assessments of the worth of forest land in an open market for taxation, loan appraisals, and other financial purposes.

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