Landscape and Urban Planning 104 (2012) 59–65

Contents lists available at SciVerse ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Valuing vegetation in an urban watershed

Jonathan Kadish[a], Noelwah R. Netusil[b,*]

[a] Pomona College, Department of Economics, 425 N. College Avenue, Claremont, CA 91711, USA
[b] Reed College, Department of Economics, 3203 SE Woodstock Blvd., Portland, OR 97202-8199, USA

ARTICLE INFO

Article history:
Received 16 November 2010
Received in revised form 2 September 2011
Accepted 24 September 2011
Available online 26 October 2011

Keywords:
Hedonic price method
Tree canopy
Non-market valuation
Portland
Oregon

ABSTRACT

This study uses the hedonic price method to examine if land cover types-trees, shrubs, water and impervious surface areas-affect the sale price of single-family residential properties in Multnomah County, Oregon. We combine detailed structural and location information for 36,753 single-family residential property sales with the percentage of land cover on each property and within three buffers surrounding each property. Trees contribute positively to a property's sale price, but the estimated increase may be less than the costs of planting and caring for trees. Benefits received by nearby property owners may justify actions by government agencies to expand canopy coverage.

1. Introduction

Oregon is known for its innovative land use planning, abundant natural resources and, for western Oregon, a rainy season that lasts for eight months. Oregon's nineteen statewide land use planning goals address issues such as urbanization, natural resource protection, and air, water and land resources quality (Oregon Department of Land Conservation and Development, 2008). Goal 14, urbanization, requires each city, county and regional government in the state to create and maintain an urban growth boundary (UGB). This has resulted in dense development and impervious surface areas inside UGBs often exceeding 10%, a widely accepted tipping point past which water quality diminishes rapidly (Booth, Hartley, & Jackson, 2002; Metro, 2008).

The Portland metropolitan area's UGB is managed by Metro, a regional government whose jurisdiction includes Portland and 25 other cities. The Willamette River flows north through the Portland metropolitan area before discharging into the Columbia River. Water quality in this section of the Willamette River is characterized as "poor" to "very poor" based on Oregon's Water Quality Index with mercury, temperature and bacteria listed as major pollutants under the Willamette Basin Total Maximum Daily Load program (Oregon Department of Environmental Quality, 2009). Water quality is compromised, in part, by Portland's combined sewer system which discharges untreated sewage and stormwater into the river almost every time it rains. To address this problem, the City is spending an estimated $1.4 billion on projects that are expected to reduce discharges by more than 94% when completed in 2011 (Portland Bureau of Environmental Services, 2009).

In addition to investing in infrastructure, local and regional governments are seeking innovative ways to improve water quality. The Clean River Rewards program, for example, provides city utility bill (water/sewer) discounts for commercial and residential property owners who take such actions as planting trees or installing ecoroofs to decrease stormwater runoff. Other initiatives include regulations on development, local and regional bond measures to purchase ecologically important natural areas, and educational programs to promote natural landscaping.

The ecological benefits from protecting and enhancing vegetation in the study area are clear (Metro, 2008, 2009). However, whether residential property owners will participate in incentive-based and/or voluntary programs to increase vegetation, or plant the type of vegetation at levels needed to have an impact on water quality is uncertain since the existing literature finds mixed results about the relationship between vegetation and property values.

The goal of this paper is to examine if land cover types – trees, shrubs, water and impervious surface areas – on single-family residential properties, and in the areas surrounding these properties, affect their sale price. Our method allows us to estimate the effect on a property's sale price from replacing impervious surface areas with vegetation and to compute the level of vegetation that maximizes a property's sale price. In addition, we use a more detailed vegetation map, providing more insight into homeowners' overall vegetation preferences than previously published research in the study area that focuses on the effect of individual street trees

* Corresponding author. Tel.: +1 503 517 7306; fax: +1 503 777 7776.
E-mail addresses: jonathan.kadish@gmail.com (J. Kadish), netusil@reed.edu (N.R. Netusil).

0169-2046/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.landurbplan.2011.09.004

(Donovan & Butry, 2010) and the effect of large patches of tree canopy (Netusil, Chattopadhyay, & Kovacs, 2010). We test whether different kinds of vegetation on a property, and in the areas surrounding a property, have a different influence on sale prices and if the effects of vegetation vary with distance from a property.

This paper is structured as follows. The next section reviews relevant literature on valuing vegetation using the hedonic price method. Section 3 provides an overview of the study area, and Section 4 discusses and summarizes the data used in our analysis. Models and empirical results are described in Section 5. The final section concludes with policy recommendations.

2. Literature

Numerous studies use the hedonic price method to estimate the relationship between vegetation, both on and around a property, and a property's sale price. While most studies find a positive effect from trees (Anderson & Cordell, 1988; Dombrow, Rodriguez, & Sirmans, 2000; Donovan & Butry, 2010; Mansfield, Pattanayak, McDow, McDonald, & Halpin, 2005) and other green vegetation (Kestens, Theriault, & Des Rosiers, 2004), some find that dense vegetation and woodlands have a negative effect (Des Rosiers, Theriault, Kestens, & Villeneuve, 2002; Kestens et al., 2004; Netusil et al., 2010), especially when blocking a view (Mooney & Eisgruber, 2001).

Anderson and Cordell (1988) were the first to investigate the impact of trees on a property's value. They find that trees in Athens, Georgia increase the sale price of single-family residential properties by 3.5–4.5%. More recently, Dombrow et al. (2000) estimate that the existence of mature trees on a property increases its value by 1.9% and Mansfield et al. (2005) estimate that increasing tree cover on a property by 10% adds $800 to its value. Donovan and Butry's (2010) analysis of street trees in the east side of Portland finds that street trees in front of a house add $8870 to its sale price (3% of the median sale price) and also have a positive effect on the value of surrounding properties.

In addition to using a survey of trees on each property, the Mansfield et al. study utilizes a normalized difference vegetation index (NDVI), which is monotonically related to the density of green leaves and frequently used to approximate vegetation density (Tucker, 1979). Higher mean NDVI on a parcel has a statistically significant negative effect on sale price after controlling for many key variables, including the proportion of the lot that is forested, which has a positive effect on sale price. The authors also find evidence that property owners substitute between mean NDVI on their parcel and distance from a private forest.

Kestens et al. (2004) also use NDVI to approximate vegetation density by calculating the mean NDVI within a 40 m radius of properties. Higher mean NDVI within 40 m has a positive and significant effect on sale price, suggesting that people like vegetation immediately around their properties. However, the authors also determine that increasing woodlands within 1 km and increasing concrete surfaces within 100 m of a property decreases its sale price. Des Rosiers et al. (2002) similarly find that sale prices are lower for properties from which highly dense vegetation is visible. A possible explanation is that woodlands and dense vegetation block views. Mooney and Eisgruber (2001) estimate that although stream frontage increases the value of the mean property in western Oregon by 7%, a 50 ft treed riparian buffer decreases sale price by about 3%, probably due to diminished view.

Kestens, Theriault, and Des Rosiers (2006) and Des Rosiers, Theriault, Kestens, and Villeneuve (2007) interact socioeconomic and landscaping variables in their spatial expansion hedonic models. Key findings from Kestens et al. (2006) include evidence of a negative effect once the number of trees on a property exceeds a specific number and a positive effect, across model specifications, for mature trees within a certain distance (100 m and/or 500 m depending on the model) of a property. Several vegetation and socioeconomic interaction variables are statistically significant in both papers providing evidence that the marginal implicit price of vegetation depends on a buyer's characteristics.

Open space, a zoning classification that is generally densely vegetated, is commonly valued using the hedonic price method. Geoghegan, Lynch, and Bucholtz (2003) determine how permanent easements in Maryland, which create open space, affect property values. Their results suggest that open space increases the sale price of adjacent properties, but too much open space can diminish property values. Lutzenhiser and Netusil (2001) show the varying impacts on property sale prices of five different types of open space in Portland, Oregon. With the exception of cemeteries, all open spaces have a significant and positive effect on sale price. Holding other factors constant, natural area parks have the greatest impact on sale price, increasing sale price, on average, by $10,648 in 1990 dollars (approximately 16% of the mean sale price).

Another study focusing on the Portland area is Mahan, Polasky, and Adams (2000), which estimates the value of wetlands. Wetlands provide important water filtration services and are generally home to diverse and ecologically important flora and fauna. The authors find in their first stage analysis that increasing the size of the nearest wetland by one acre increases sale price by $24, and moving a property 1000 ft closer to the nearest wetland increases sale price by $436; a second stage hedonic price function was estimated, but the results were unreliable. Netusil et al. (2010) successfully estimate the benefits of large patches of tree canopy in Portland, Oregon by combining results from a first stage hedonic model with a survey of property owners' preferences and socioeconomic characteristics in a second stage model. The first stage provides evidence of diminishing returns to tree canopy with some parts of the study area experiencing negative marginal implicit prices. Per-property benefit estimates in the second stage decline in one specification once tree canopy exceeds 35% of the area within 1/4 mile of a property.

While the literature on the relationship between vegetation and property values is extensive, and several studies using the hedonic price technique exist for the study area, no study to date has explicitly looked at how individual property owners in an urban area value high structure vegetation, such as trees, and low structure vegetation, such as shrubs and lawns, in comparison to impervious surface areas, such as driveways, patios and rooftops. Additionally, the quality of the vegetation layer and the number of buffers used in the analysis – 200 ft, 1/4 mile and 1/2 mile – represent an improvement over previous research.

3. Study area and data

The study area includes the part of Multnomah County, Oregon within Metro's jurisdiction – an area of approximately 140,687 acres. The majority of the study area, 34.78%, is classified as impervious surface, followed by 29.87% high structure vegetation, 25.57% low structure vegetation, and 9.78% open water (Metro Data Resource Center, 2007a). As shown in Fig. 1, the study area includes the majority of the city of Portland, which is divided into five quadrants (North, Northeast, Northwest, Southwest and Southeast) and parts of six other cities: Gresham, Lake Oswego, Milwaukie, Troutdale, Wood Village, and Fairview. Transactions in the last three cities, which are located in the northeastern part of the study area, were grouped together as the Outer Northeast category for our analysis. Our data set includes only one observation in Milwaukie, which was grouped with SE Portland.