Landscape and Urban Planning 124 (2014) 14–21

Contents lists available at ScienceDirect

Landscape and Urban Planning

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

Research Paper

Valuing green infrastructure in Portland, Oregon

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HIGHLIGHTS

- A property's sale price increases as distance from a green street increases.
- A facility's age, size, and amount of tree canopy affects a property's sale price.
- Census block or tract is the appropriate scale for measuring green street abundance.

ARTICLE INFO

Article history:
Received 3 June 2013
Received in revised form
29 December 2013
Accepted 1 January 2014
Available online 14 February 2014

Keywords:
Green streets
Hedonic price method
Low impact development
Stormwater
Portland, Oregon

ABSTRACT

This study uses the hedonic price method to examine if proximity, abundance, and characteristics of green street facilities affect the sale price of single-family residential properties in Portland, Oregon. Different methods for measuring proximity and abundance are explored with distance based on street network, and abundance of green streets at the census tract and census block level, producing statistically significant results. A property's sale price is estimated to increase as distance from the nearest green street facility increases although the magnitude of this effect is small. Facility type does not have a statistically significant effect on a property's sale price, but characteristics such as facility size, proportion of the facility covered by tree canopy, and design complexity are estimated to influence sale price.

1. Introduction

In 2000, approximately 80% of the U.S. population lived in urban areas—a number that is expected to reach 90% by 2050 (United Nations, 2008). Urbanization puts pressure on urban ecosystems resulting in changes in the amount, timing, and quality of stormwater runoff, loss and fragmentation of native habitat, and increased vulnerability to invasive species. The amount and placement of just a few key landscape features — such as trees, shrubs, and impervious surfaces — can influence the type of wildlife that can survive in urban areas and the quantity and quality of ecosystem services (Hennings & Soll, 2010).

While research is ongoing to examine the impact of landscape features on urban ecosystems (Nelson et al., 2009), the value of land cover (Kadish & Netusil, 2011), water quality (Leggett & Bockstael, 2000; Poor, Pessagno, & Paul, 2007), wetlands (Mahan, Polasky, & Adams, 2000), and trees (Donovan & Butry, 2010; Netusil, Chattopadhyay, & Kovacs, 2010) have been estimated for urban areas. One area that has not been well studied, however, is the impact of green infrastructure — green streets, ecoroofs (or green roofs), green walls, rain gardens and pervious surfaces — on the sale price of single family residential properties.

Green infrastructure projects are being embraced by many U.S. and European cities as a cost-effective way to control urban stormwater (U.S. Environmental Protection Agency, 2010, 2011) among other challenges. The potential impact of green stormwater systems on biodiversity, traffic accidents, and other city attributes is currently unknown, so valuing the effect of these facilities is germane to policy discussions that attempt to link city greening efforts with quantifiable measures that can be incorporated into the decision making process (Nelson et al., 2009).

In this study we examine one city — Portland, Oregon — and the effect of proximity, density and characteristics of green infrastructure, in the form of 'green street stormwater facilities' on the sale price of single family residential properties. Our study area provides an ideal case study for several reasons. First, Portland is ranked as the most sustainable city of the fifty largest cities in the United States (Revkin, 2008), so its policies may offer insights into improving the process of urban growth and how growth impacts

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0169-2046/$ – see front matter
http://dx.doi.org/10.1016/j.landurbplan.2014.01.002

the social and biophysical conditions of other cities. Statewide land use planning goals, combined with policies implemented by the city of Portland and Metro — the only directly elected regional government in the United States with regulatory power — have produced innovative programs that may serve as models for cities throughout the country and the world.

Second, Portland also struggles, as many cities do, with serious environmental challenges: the main water body in Portland, the Willamette River, has a Superfund site and Steelhead Trout, Coho, and Chinook Salmon, which use the Willamette River to reach spawning grounds, are listed as threatened under the Endangered Species Act (NOAA Fisheries Office of Protected Resources, 2010). While combined systems were state of the art when constructed, by 1993 even a moderate rainfall exceeded the Portland system's capacity, triggering combined sewer overflows (CSOs) of dilute, untreated sewage through 55 outfall points into the Willamette River and Columbia Slough (Oregon Department of Environmental Quality, 2006).

Finally, over the past 20 years Portland has invested $1.4 billion in physical infrastructure projects to reduce combined sewer overflows. These projects, which were completed in December 2011, reduced the number of CSOs to the Willamette River from fifty to an average of four times each winter and once every third summer (Environmental Services City of Portland, 2011). Projects are funded, in large part, by Portland's combined sewer/water bills, which are amongst the highest in the country (Frank, 2011). Further rate increases to fund large capital projects may not be politically feasible, so in 2008 the city launched a new strategy, the $55 million "Grey to Green" program to control stormwater runoff. Program goals include planting 33,000 yard trees and 50,000 street trees, adding 43 acres of ecoroofs, controlling invasive plant species, purchasing over 400 acres of natural areas, and constructing 920 new green street facilities (Environmental Services City of Portland, 2010a).

Green streets, which is a term used by the City of Portland and the Environmental Protection Agency, refer to low-impact development techniques that use "vegetated facilities to manage stormwater runoff at its source" and include curb extensions, street planters, and rain gardens as well as "simple" green streets, which involve changes to existing planting areas between curbs and sidewalks (Environmental Services City of Portland, 2008). Additional benefits attributed to these facilities include increased property values (Wise et al., 2010), traffic calming (Ewing & Dumbaugh, 2009), better bike access and enhanced pedestrian safety (Maas et al., 2009), and added green space and wildlife habitat (Kazemi, Beecham, Gibbs, & Clay, 2009). These facilities "are more cost-effective than piping stormwater to a treatment plant" (Environmental Services City of Portland, 2010b) and are increasingly being promoted by city managers as an effective means for controlling stormwater runoff. Cities such as San Jose, California, Chicago, Illinois, Philadelphia, Pennsylvania, and Seattle, Washington are expanding green street programs (Environmental Protection Agency, 2010a) and a low impact development ordinance, which includes green street facilities, passed in Los Angeles, California (City of Los Angeles Stormwater Program, 2011) and as a statewide ordinance in Washington State (State of Washington Department of Ecology, 2012).

Although cities are moving forward with green street facilities, many questions remain, including whether these facilities affect the sale price of nearby houses. While green space and wildlife habitat have been estimated to increase the sale price of single-family residential properties (Donovan & Butry, 2010; Mahan et al., 2000; Netusil, 2006), literature examining the relationship between green street facilities and the sale price of single-family residential properties is extremely limited. Ward et al. (Ward, MacMullan, & Reich, 2008) estimate that properties located in low-impact development project areas in Seattle, Washington sold for 3.5–5% more than properties in the same zip code located outside project areas. Williams and Wise (2009) reach the opposite conclusion finding that lots in Gainesville, Florida with low-impact development stormwater systems are valued less than lots that use conventional approaches.

Our research contributes to this nascent literature by combining a data set of single-family residential properties sold within the city of Portland, Oregon from January 1, 2005 to December 31, 2007 with detailed information about green street facilities collected by project researchers. We explore the following questions: First, is a property's sale price influenced by its distance to the nearest green street facility and is Euclidean ("straight line") or street network the preferred distance measure? Second, does the abundance of facilities near a property affect its sale price and what is the appropriate scale for measuring abundance? Third, do green street characteristics such as facility type, size, the proportion of the facility covered by tree canopy, and other design features affect a property's sale price? When addressing these questions we examine how our results might contribute to the current debate about green infrastructure and the extent to which implementation can help to mitigate current challenges facing cities.

2. Methods

2.1. Study area

The study area is the part of the city of Portland, Oregon located within Multnomah County. Portland is divided into five quadrants: North (N), Northeast (NE), Southeast (SE), Southwest (SW), and Northwest (Fig. 1). Northwest is excluded from our data set because only one green street facility existed in that quadrant during the study period. The remaining quadrants had 4297 (N), 9232 (NE), 12,594 (SE), and 3589 (SW) single-family residential home sales between January 1, 2005 and December 31, 2007.

2.2. Data

The data set includes sale price, property characteristics, location, land cover, and green street information. Sale price and property characteristics were obtained from the Multnomah County Assessor. Observations were screened to make sure that transactions occurred at arms length and were free of recording errors; duplicate transactions were dropped with the most recent transaction retained for the analysis. Sale prices were converted to 2007 dollars using the Consumer Price Index-Urban (Bureau of Labor Statistics, 2011). Table 1 contains summary statistics for price, structural, property, and neighborhood variables for the 29,712 single-family residential property transactions used in the analysis.

Green street facilities were identified using a map from the City of Portland Bureau of Environmental Services (2010) that contains georeferenced coordinates for all publicly built facilities. Green street variables were created using information about publicly built facilities that existed in the year a property sold, for example, homes sold in 2006 were associated with green street facilities built in 2006 or earlier. Additional data sets from Metro were used to determine the number of facilities for each census block, census tract, and neighborhood in the study area (Metro Data Resource Center, 2009). In 2007 there were 614 green streets in the study area. These facilities are sometimes built close together in "clusters," so only a subset — 318 facilities using Euclidean distance and 262 facilities using street network — are the closest facilities to the properties in our data set. Street network calculations use the street grid