

SUMMARY REPORT and WORKING PAPER



The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon

*Prepared for the Portland Bureau of Planning by Dr. Noelwah Netusil,
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TABLE OF CONTENTS

Summary Report	i
<i>The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon</i>	
City of Portland, Bureau of Planning	

Working Paper.....	1
<i>The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon</i>	
Dr. Noelwah Netusil, Associate Professor of Economics, Reed College	

SUMMARY REPORT

The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon

I. INTRODUCTION

Purpose of this Summary

This summary report provides a brief overview of the research study titled *The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon*. The summary provides a general context and background for the study, and highlights the study approach and results. The summary is also intended to help make this research accessible and understandable to the non-technical reader. Complete documentation of this study is found in the following paper.

Project Context and Overview

The purpose of this study is to examine if and how environmental zoning and proximity to environmental amenities (e.g., streams, wetlands, tree canopy, parks and open space) are related to the sale price of single-family residential properties in the city of Portland.

This study, titled *The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon*, was conducted by Dr. Noelwah Netusil, Associate Professor of Economics at Reed College. A review of economic literature yielded few similar studies regionally or nationally. While a number of studies have explored relationships between environmental amenities and property value, only a handful have examines the effect of both environmental regulations and proximity to amenities on property values.

This study is part of Portland's citywide River Renaissance planning effort. River Renaissance involves, among other things, activities that address the relationship between Portland's economy and its environment. For example, the Bureau of Planning is working with the Portland Development Commission and Bureau of Development Services to assess how development goals might be met for high-priority redevelopment sites that have natural resources and environmental zoning. The Portland Harbor Industrial Land Study (PHILS) and the Citywide Industrial Lands Inventory and Assessment will examine priorities and constraints affecting industrial development, including issues related to site-specific natural resources and environmental regulations. The City is also initiating a project to examine how natural resources provide "ecosystem services" with quantifiable economic value in Portland. This project will examine the economic value of environmental goods and services, and will address the benefits and costs associated with different types of management approaches (e.g., restoration, engineering projects).

These activities, and others, will help the City in its efforts to meet goals for both the economy and the environment. They will also inform the development of management tools and strategies to sustain Portland's long-term environmental and economic health.

According to Dr. Netusil, the study results contained in the following working paper should be viewed as preliminary, as this research will be updated for publication in a professional journal. To date, however, the study has illustrated how difficult it is to determine the complex relationships between environmental regulations, environmental amenities and property values. No clear patterns emerge regarding the impact of environmental zoning as an influence on property sale price.

For many parts of Portland, the results indicate that environmental zoning has had no clear impact on property sale price. For a few areas, the study found a negative or positive effect between environmental zoning and property sale price. This may indicate a need to examine additional variables to determine if any key influences on property value were omitted from the analysis.

The study also found considerable variability in how different natural resource and open space amenities seem to have affected property sale price. The results showed variability for both different types of amenities and for different distances from an amenity to a property.

Extensive technical information and input from the community must be considered when evaluating and selecting tools and strategies for managing natural resources. The results of this particular study will provide some specific information to help inform future decisions about the types of tools that will be applied to manage natural resources. However, as with most research, the study raises questions that warrant more evaluation. In addition, there are many issues that this study was not intended to address. Specifically, the project focused solely on single family property values and was not designed to evaluate the effect of environmental regulations and resource amenities on the value of vacant lands, or commercial or industrial lands. These issues and questions are also addressed in section IV. *Future Research Opportunities* of this summary report. The City is exploring options for additional analysis to help answer these remaining questions.

Project Background

In 1988, the Portland City Council established environmental overlay zones to protect and conserve significant natural resources identified as providing benefits to the public. Environmental overlay zones are intended to ensure that approved development will not have significant adverse impacts on those resources. The environmental zoning program is Portland's primary tool for meeting statewide land use planning requirements to protect significant natural resources. Currently environmental zones apply to about 19,000 acres. Approximately 60 percent of this area is publicly owned, while approximately 40 percent of the area is in private ownership.

In November 2001, the Portland Planning Bureau issued an initial proposal to update and expand the existing environmental zoning program. The project, called Healthy Portland

Streams (HPS), is intended to ensure that environmental zoning and non-regulatory tools are effective in conserving significant riparian and wildlife habitat resources. The HPS project is also intended to advance Portland's compliance with Metro's natural resources program and the federal Endangered Species Act and Clean Water Act.

In response to the initial HPS proposal, many property-owners expressed concern that environmental zoning may negatively affect their property values. Property owners expressed concern that environmental zones can constrain development potential and may be perceived as problematic to a prospective buyer. Some residents expressed a belief that environmental overlay zones may positively affect their property values by protecting trees and greenspaces in their neighborhoods.

In light of the questions raised, the Planning Bureau contacted Dr. Noelwah Netusil, Associate Professor of Economics at Reed College, to see if it would be possible to determine the effects of environmental overlay zoning on property values. Dr. Netusil has demonstrated expertise in this area by publishing several studies that examine the relationships between natural resources and property values in the Portland area. She also serves on Metro's Regional Economic Technical Advisory Committee. Based on Dr. Netusil's project proposal and strong qualifications in this area of study, and Reed College's reputation for academic excellence, the City contracted with Reed College to conduct the study. Reed College assigned Dr. Netusil to serve as principal investigator for the project.

The Planning Bureau distributed the project scope to a targeted set of stakeholders for review, including the broad-based Healthy Portland Streams Citizen Review Committee, several staff members from other City bureaus and Metro, and staff of the Association for Portland Progress. Dr. Netusil and Planning Bureau staff briefed Metro's Economic Advisory Committee on the research project. Planning Bureau staff also informed Portland's River Economic Advisory Committee about the project. Staff received some helpful questions and input on the project purpose and scope. Several people expressed interest in the study and asked to be provided the results when the work was completed.

II. STUDY APPROACH

Methodology

Dr. Netusil used the Hedonic Price Method for this study. The Hedonic Price Method allows a researcher to estimate, on average, how specific factors (called "explanatory," or "independent variables") affect the price of a good (called the "dependent variable"), holding other key factors constant. Using the Hedonic Price Method, Dr. Netusil was able to estimate the effect of environmental zoning and resource amenities on the sale price of single-family residential properties.

The results of an analysis involving Hedonic Price Method will be either statistically significant or statistically insignificant. A statistically significant result is sufficiently robust to be interpreted as a definite correlation between an explanatory variable and the dependent variable. A statistically insignificant result is too uncertain to be interpreted as a clear correlation between variables. So, while the estimated effect of an explanatory variable on the dependent variable can take on any value (positive, negative or zero), the result must be statistically significant to be certain that there is an actual effect.

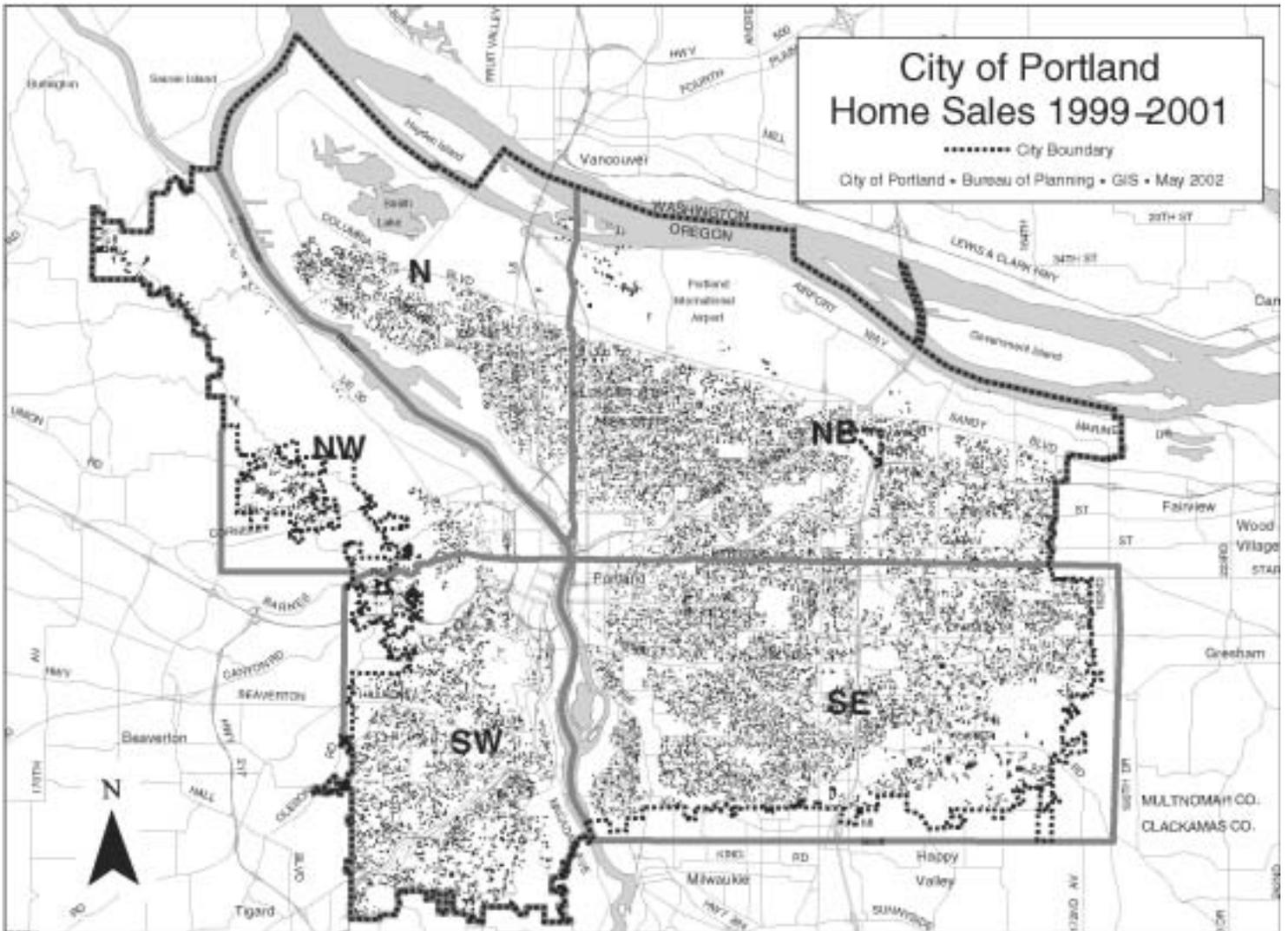
Even when a result is statistically significant, interpretation may be problematic. For instance, if a key variable is inadvertently excluded from analysis, the results may assign an impact on price to one variable when the effect should really be attributed to the omitted variable.

It is important to emphasize that the Hedonic Price Method estimates effects *on average*. For purpose of this study, this means the effect of a variable on property sale price cannot be interpreted to apply to any individual property.

The data developed for this project contains information on 30,071 single-family residential property sales that occurred in the study area (City of Portland within Multnomah County) from January 1, 1999 through December 31, 2001. The Bureau of Planning collaborated with Dr. Netusil in obtaining the data necessary to conduct the study. Property data were obtained primarily from the Multnomah County Assessor's Office. The Bureau of Planning provided Portland zoning information. The amenity data was obtained primarily from Metro's Regional Land Information System (RLIS).

Dr. Netusil divided the city into five areas or "quadrants" (North, Northeast, Southeast, Southwest, and Northwest). This allowed examination of how the results might differ for properties located in different parts of the City. Dr. Netusil also developed and used two models to evaluate the data. The models are described in the following study report.

Figure 1. Home Sales in the Study Area



Source: City of Portland, Bureau of Planning, May 2003

The study paper cites recent literature sources that examine the relationships between a property's sale price and the variables evaluated in this study. Key variables, including environmental amenities, were selected based on the literature review and the researcher's knowledge of the study area.

Structural variables included lot size, home and garage size, number of bedrooms and bathrooms, age, fireplaces, and the number of stories in the home. *Neighborhood variables* included income and race at the census tract level. *Location variables* included distance from the property to the central business district, quadrant, and base zoning. *Environmental amenities* included slopes, tree canopy, rivers and streams, wetlands, several types of parks and open spaces, and trails. The study examined the effects of

amenities when located on a property and near a property (i.e., within 200 feet of the property, between 200 feet and ¼ mile from the property, and ¼ mile to ½ mile from the property). Several variables were combined to explore the potential interactive effects of factors such as slopes on the same property with streams, and streams on the same property with tree canopy.

The regulatory variables established for the study reflect the fact that there are two types of environmental overlay zones– protection zones (p-zones) and conservation zones (c-zones). Each property in the data set fit into one of four regulatory categories: 1) no environmental zone, 2) protection zone only, 3) conservation zone only, and, 4) a mix of protection and conservation zone. Properties with environmental zoning may be partially or fully covered by the overlay zone. An additional variable, “oversize lot,” was generated in hopes of evaluating whether the sales price of lots that could potentially be subdivided is affected by environmental zoning.

Table 1. Summary Statistics for Properties Affected by Environmental Overlay Zones (e-zone)

	p-zone only	p- and c-zone	c-zone only	Total
Number of observations	107	252	669	1,028
Percentage of all property sales	0.36%	0.84%	2.22%	3.42%
Mean % of property in e-zone	27.17%	66.08%	46.94%	NA
Median % of property in e-zone	21.09%	67.53%	42.29%	NA
Minimum % of property in e-zone	0.237%	7.12%	0.145%	NA
Maximum % of property in e-zone	96.25	100%	100%	NA

Source: N. Netusil, April 21, 2003.

Peer Review

Dr. Netusil submitted a draft of the research paper to Dr. Rich Adams, Professor of Agricultural and Resource Economics at Oregon State University, and Dr. Sudip Chattopadhyay, Assistant Professor of Economics at San Francisco State University. Dr. Adams and Dr. Chattopadhyay were selected as peer reviewers because of their extensive experience with the Hedonic Price Method. Dr. Adams is familiar with the Portland area having recently co-authored a paper that applied the Hedonic Price Method to wetlands in Portland. The peer review process was similar to that of a referee report that would be submitted for an article prior to publication in a professional journal. Dr. Netusil incorporated comments and suggestions from the peer-reviewers into a revised version of the paper.

III. STUDY RESULTS - HIGHLIGHTS

One of the special features of this study is that the analysis focused on estimating the separate effects of environmental zoning and resource amenities on single family residential property values. Although the study did not estimate the net or combined effect of environmental zoning and amenities on sale price, Dr. Netusil has emphasized that the impact of environmental zoning on property value must be considered in combination with the effects of resource amenities on or near the property. This is because environmental zoning is applied to conserve important natural resources and landscape features, many of which are protected by environmental zones.

The following summary focuses primarily on those results that were statistically significant. It is important to note that in many instances, the study results were statistically insignificant. In addition, this summary does not distinguish between results generated by the two models used for this analysis since the results from the two models were generally consistent. Additional detail on the study results and the models are presented in the study paper.

Effect of Environmental Overlay Zones on Property Sale Price

- The study showed no clear relationship between the presence of environmental zoning and property sale price. The estimated impacts varied considerably both by category of environmental zoning and by the area in which the property was located.
- The estimated effect of environmental zoning on property sale price was most often found to be statistically insignificant. This means that there was no definite impact from environmental zoning on home sale price in the majority of study situations.
- Statistically significant effects were found in the following situations:

Northwest quadrant properties with protection zoning only were estimated to sell for 10.69% less than properties citywide without environmental zones; properties in the Northwest quadrant with both protection and conservation zoning were estimated to sell for 7.71% less than properties citywide without environmental zones.

North quadrant properties with conservation zoning were found to sell for 22.49% more than properties citywide without environmental zoning.

Southwest quadrant properties with conservation zoning were estimated to sell for 3.31% less than properties citywide without environmental zoning.

Effect of Natural Resource and Open Space Amenities on Property Sale Price

- Like the analysis of environmental zoning, the study showed no clear relationship for the effect of natural resource and open space amenities on property sale price. For a number of amenity scenarios, the results were not statistically significant. Statistically significant results included both positive and negative effects, varying both by amenity type(s) and where the amenity was located relative to the property.
- Slopes - Properties located within 200 feet of steeply sloped areas (more than 25%) such as ravines, buttes, hills, and bluffs were found to sell for up to 2.49% more than properties without sloped areas located close by. Steeply sloped areas within ½ mile of a property were found to have a somewhat smaller but statistically significant positive effect on property sales price.
- Tree Canopy – Tree canopy was estimated to have a positive effect of 1.64% on property sale price when located within 200 feet of a property, but not on it. Conversely, tree canopy was estimated to have a negative effect (up to –1.66%) if located between 200 feet and ½ mile from the property. The data available to support this analysis included only tree canopy areas of at least one acre in size.
- Rivers – Rivers such as the Willamette and Columbia located not on, but within 200 feet of a property, were estimated to increase the sales price of a property by 34.21%. Rivers were also estimated to have a significant positive effect on price if located ¼ to ½ mile from a property.
- Streams – Streams located on or near a property were generally found to decrease a property’s sale price. Properties with streams in the North and Southeast areas were estimated to sell for 21.6% and 15.85% less, respectively, than properties without streams. The presence of streams that are located on private land within 200 feet of a property was estimated to decrease a property’s sale price by 3.59%. The presence of streams that are located on public land this is between 200 feet and ¼ mile from a property was estimated to have a positive effect on the sale price of 1.18%. Alternatively, streams on private property and located between 200 feet and ¼ mile of a property were estimated to reduce the sale price by 2.54%. Streams on private land located ¼ - ½ miles from a property were estimated to positively affect the property sale price by 2.59%.
- Wetlands – Wetlands were found to have a statistically significant effect on home sale price if located between ¼ mile and ½ mile from a property. The estimated effect was found to be –2.42%. The study paper notes that this negative effect may reflect the type of wetland or the fact that 85% of the land classified as wetlands in the study areas are located in North or Northeast quadrants on land with a mix of industrial and open space zoning.

- Slopes and streams combined – The combination of slopes and streams on a property was estimated to have a 12% negative effect on property sales price.
- Streams and Tree Canopy combined - Properties with both trees and streams were found to sell for 9.41% more than properties without a stream and tree canopy.
- Parks and Trails- Specialty parks (e.g., Oaks Park), trails, and cemeteries within 200 feet of a property were found to have a statistically significant effect on a property's sales price. Specialty parks were estimated to increase sales price by 1.75% while trails and cemeteries were estimated to decrease a property's sale by 6.81% and 4.36%, respectively. The report suggests that the negative trail effect might reflect the types of trails included in this study. These were primarily large regional trails, many of which are along rail rights-of-way that are located in or close to industrial areas.

Specialty parks, urban parks, and golf courses located within 200 feet to ¼ mile from a property, were estimated to effect sales price positively, while the estimated effect of trails and cemeteries remained negative.

Located ¼ - ½ mile from a property, golf courses were found to have a positive effect on sales price, while cemeteries were estimated to have a negative effect. Trails are estimated to have a positive effect at ¼ - ½ mile from a property. Natural areas were found to have a negative effect if located ¼ - ½ mile from a property. This finding is counter to previous literature showing that property values are higher for properties located near natural areas (Lutzenhiser, M. and N.R. Netusil. 2001. The Effect of Open Space Type on a Home's Sale Price: Portland, Oregon Contemporary Economic Policy, 19 (1): 291-298).

- Oversize Lots - The sale price of oversize (potentially subdividable based on zoning) lots that have environmental zones was not found to be statistically different than oversize lots that do not have environmental zones.

IV. FUTURE RESEARCH OPPORTUNITIES

The study raises a number of questions that may warrant additional research:

- Why were the effects of environmental overlay zones found to not be statistically significant in most situations, but were found to be significant and strongly negative in Northwest area, and significant and strongly positive in the North area? A study to analyze the effect of views on home sales price could potentially help explain these results.

- Why do the estimated effects of certain environmental amenities vary and why do some of the results of the analysis on environmental amenities differ from findings reported in the existing academic literature?
- Are there any important variables missing from the model such as the influence of views on property sale price? Studies to analyze the quality of amenities such as streams and wetlands could potentially help answer these questions. In addition, the study report recommends analysis of proximity to industrial areas to determine if it is a possible factor influencing the estimated effects of trails and wetlands on property sale price.
- Is the effect of environmental zoning on property sale price related to the amount of overlay on a property or whether the home itself is affected by environmental zoning?

In addition, this study has focused on a particular issue, specifically, the effect of environmental zoning and natural resource and open space amenities on single-family residential property sale price. Questions that would be helpful to explore include:

- How might environmental zoning and amenities affect vacant land?
- How might these factors affect the value of commercial and industrial properties?

Future research could potentially shed light on these questions and others. The City is interested in working with others to explore them further as resources become available.

WORKING PAPER

The Effect of Environmental Zoning and Amenities on Property Values:
Portland, Oregon

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Abstract

This study uses the hedonic price method to examine how environmental zoning and amenities such as tree canopy, streams, wetlands, and open spaces, are related to the price of single-family residential properties sold between 1999 and 2001 in the part of the City of Portland, Oregon that is located in Multnomah County.

The relationship between environmental zoning and a property's sale price is theoretically uncertain. While restricting development may decrease a property's sale price, the preservation of amenities on a property, and in the surrounding neighborhood, may increase a property's sale price.

The impact of environmental zoning on a property's sale price is found to vary with the type of environmental zoning and the property's location. The hypothesis that environmental zoning has an equal impact across quadrants of the City of Portland is rejected for each zoning type. Amenities are found to influence a property's sale price although the effect varies by amenity type and proximity.

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The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon

I. Introduction

In 1974, Oregon adopted statewide goals that provide guidance on how cities and counties should plan land-use. Statewide Planning Goal 5 requires all local governments “to adopt programs that will protect natural resources and conserve scenic, historic and open space resources for present and future generations” (Oregon Department of Land Conservation and Development 1996). To comply with Goal 5, the Portland City Council adopted environmental overlay zones to protect environmentally sensitive areas such as wetlands, riparian corridors, and upland forests (City of Portland, Oregon Bureau of Planning 2001a).

Portland currently has two levels of environmental zoning covering a total of 19,170 acres-- approximately twenty percent of land within the City limits -- the environmental protection overlay zone (p-zone) and the environmental conservation overlay zone (c-zone) (Jortner 2002). Homes on lots affected by environmental zoning may be located entirely or partly within the overlay zone or on portions of the lot completely unaffected by environmental zones.

Properties with a p-zone face the most stringent restrictions since, with a few exceptions, new development is allowed only when there is a demonstrated “public need and benefit.”² Structures and other development such as driveways, patios, and landscaping located on a lot with a p-zone can remain and be maintained although certain changes to structures, such as increasing the footprint or adding a deck, or changes to vegetation such as the removal of certain trees, are prohibited. The c-zone allows development if alternatives have been considered. In addition, when

² For the purpose of this paper, the term property refers to a home and the land on which it is located.

development occurs, it must be undertaken so as to avoid or mitigate adverse impacts on natural resources such as streams and wetlands, streamside/ riparian areas, and upland wildlife habitat. (City of Portland, Oregon Bureau of Planning 2001b)

Theoretically, the effect of environmental zoning on a property's sale price is uncertain. While limiting the ability to expand a home's footprint, changing how a lot can be subdivided, or whether vegetation that is blocking a desirable view may be removed may decrease a property's sale price (the "development" effect), recent research in Portland, Oregon (Lutzenhiser and Netusil 2001; Mahan et al., 2000) concludes that proximity to amenities such as wetlands, natural areas, and streams, many of which are already protected by existing environmental overlay zones, may increase a property's sale price (the "amenity" effect). Empirical work is needed to determine the individual and net impacts of the development and amenity effects on property values in Portland.

This project will use the hedonic price method to examine how (1) environmental zoning, and (2) proximity to environmental amenities such as tree canopy, wetlands, rivers and lakes, streams, and open spaces are related to the sale price of single-family residential properties sold between 1999 and 2001 in the part of the City of Portland, Oregon that is located in Multnomah County. This study also investigates how amenities located on privately owned properties, and in the neighborhood surrounding these properties, are related to a property's sale price.

As with all hedonic studies, the benefits that will be captured are solely private benefits, that is, benefits that are transmitted through the price of a marketed good. Ecosystem services such as improved water quality, reduced erosion, reduced flooding and increased biodiversity, as well as nonuse values, will not be captured using this technique.

II. Hedonic Price Function

The statistical technique used in this study, the hedonic price method, relates a property's sale price to its structural (S), neighborhood (N), regulatory (R) and environmental attributes (E). This technique is based on the theory that the present value of a property's attributes are capitalized into its sale price and that a change in an attribute will be reflected by a change in a property's sale price.

Researchers have used this technique to examine how the sale price of a property is related to air quality (Anderson and Crocker 1971, Beron et al., 2001, Chattopadhyay 1999) and water quality (Leggett and Bockstael 2000). Additional research includes the effects of amenities such as proximity to a golf course (Do and Grudnitski 1995) and views of oceans, lakes, and mountains (Benson et al., 1998) as well as disamenities such as proximity to a smelter (Dale et al., 1999), an airport (Espey and Kaufman 2000) and to highways that are used to transport nuclear waste (Gawande and Jenkins-Smith 2001).

Assuming that housing choices are the result of utility-maximizing decisions and that prices clear the market, the price of the i^{th} property location (P_{hi}) is represented by equation 1.

$$P_{hi} = P_h(S_i, N_i, E_i, R_i) \quad (1)$$

It is generally agreed that the relationship between the price and attributes of a house is nonlinear since many housing attributes cannot be repackaged, for example, two living rooms with six-foot ceilings are not the same as one living room with a twelve-foot ceiling (Freeman 1993, 371).

Researchers have used a variety of functional forms to estimate the hedonic price function including: linear, quadratic, double-log, semi-log, and Box-Cox

transformations (Freeman 1993). The results presented for this study were estimated using a semi-log function with the following specification:

$$\ln P_{hi} = \alpha_0 + \sum_{j=1}^J \alpha_j S_{ij} + \sum_{k=1}^K \alpha_k N_{ik} + \sum_{m=1}^M \alpha_m E_{im} + \sum_{q=1}^Q \alpha_q R_{iq} + u_i \quad (2)$$

where $\ln P_{hi}$ is the natural log of the sale price for property i , S_{ij} represents the j^{th} structural attribute of property i , N_{ik} is the k^{th} neighborhood attribute of property i , E_{im} measures the m^{th} environmental attribute for property i , and R_{iq} is the q^{th} regulatory attribute for property i . A property specific error term (u_i) is also included.

The partial derivative of the hedonic price function with respect to any argument is the marginal implicit price of that characteristic, that is, the additional amount that must be paid for the property to achieve the higher level of the characteristic while holding all other factors constant. In a semi-log model, the coefficients on continuous variables represent proportions and, when multiplied by 100, provide an estimate of the average percentage change in the growth of a property's sale price from a marginal change in a characteristic. The proportional change in the dependent variable from a dummy variable equals $e^{\alpha} - 1$, where α is the estimated coefficient on the dummy variable.

III. Literature

Numerous studies have used the hedonic price method to estimate the relationship between a property's sale price and the amenity types used in this study.

Benson et al., (1998) estimate the value of an ocean, lake, and mountain views for single-family residential properties in Bellingham, Washington. A simple specification of a view variable provides an estimated increase in a property's sale price of 25.6%. A more detailed classification of view gives estimates ranging from 60% for a high-quality

ocean view to 8.2% for a poor partial ocean view. Kulshresththa and Gillies (1993) estimate that a view of the South Saskatchewan River increases the sale price of a property in Saskatoon, on average, by \$11.48 per square foot.

The value of an urban forest is estimated by Tyrvainen and Miettinen (2000) using the hedonic price method and in Tyrvainen and Vaananen (1998) using a contingent valuation study. Tyrvainen and Miettinen (2000) conclude that a 1 kilometer increase in the distance to the nearest forested area leads to an average 5.9% decrease in the market price of a property. A forest view is estimated to increase a property's sale price, on average, by 4.9%. A study conducted by Anderson and Cordell (1988) in Athens, Georgia found a 3 to 5% increase in the sale price of properties with trees in their front yard.

Doss and Taff (1996) and Mahan et al. (2000) provide detailed estimates on the relationship between property values and wetland proximity and type. The Mahan et al. study, conducted in Portland, Oregon, provides coefficient estimates for six wetland types. Proximity to three wetland types was found to have a negative and statistically significant relationship to a property's sale price while proximity to one wetland type was found to be statistically significant and positive. The authors also include distance variables for streams, rivers, lakes, and parks. Proximity to streams and lakes is found to have a positive statistically significant effect, that is, living closer to these areas increases a property's sale price. The coefficients on distance to the nearest park and river were not statistically significant.

The influence of riparian buffers on a property's sale price is investigated in a study conducted in the Mohawk watershed in western Oregon by Mooney and Eisgruber (2001). The authors estimate that a 50-foot treed riparian buffer will decrease the value of the mean property in their data set by approximately 3%. This result is

attributed to a diminished river view. The authors estimate that stream frontage increases property values by 7%.

Studies on the effect of open spaces include Do and Grudnitski's (1995) examination of golf courses in San Diego, California and Lutzenhiser and Netusil's (2001) research on natural areas, urban parks, specialty parks, cemeteries and golf courses in Portland, Oregon. Both studies find a significant and large effect from proximity to golf courses. Lutzenhiser and Netusil conclude that properties located within 200 feet of a golf course experience the largest increase in sale price of all open space types in the study, but this effect drops off quickly as distance from the golf course increases. Natural areas and specialty parks were estimated to have a statistically significant and positive effect on the sale price of properties located up to 1,500 feet (the maximum distance in the study) from these open spaces.

Research on proximity to urban parks shows mixed results. Espey and Owusu-Edusei (2001) estimate a 14% decline for properties located within 300 feet of a small neighborhood park in Greenville, South Carolina while Lutzenhiser and Netusil (2000) find a statistically significant positive effect for properties located up to 600 feet from an urban park in Portland, Oregon.

While these studies have estimated how proximity to an amenity or disamenity is related to a property's sale price, few empirical studies separately identify and estimate the development and amenity effects from zoning (Maser, Riker, and Rosett 1977, Mark and Goldberg 1986, Grieson and White 1989, Spalatro and Provencher 2001).

Spalatro and Provencher (2001) examine the effect of minimum frontage zoning for lakefront properties in northern Wisconsin. While zoning preserves amenities by restricting development (amenity effect) it also restricts the subdivision of properties (development effect). The authors estimate an increase in the average price of lakefront

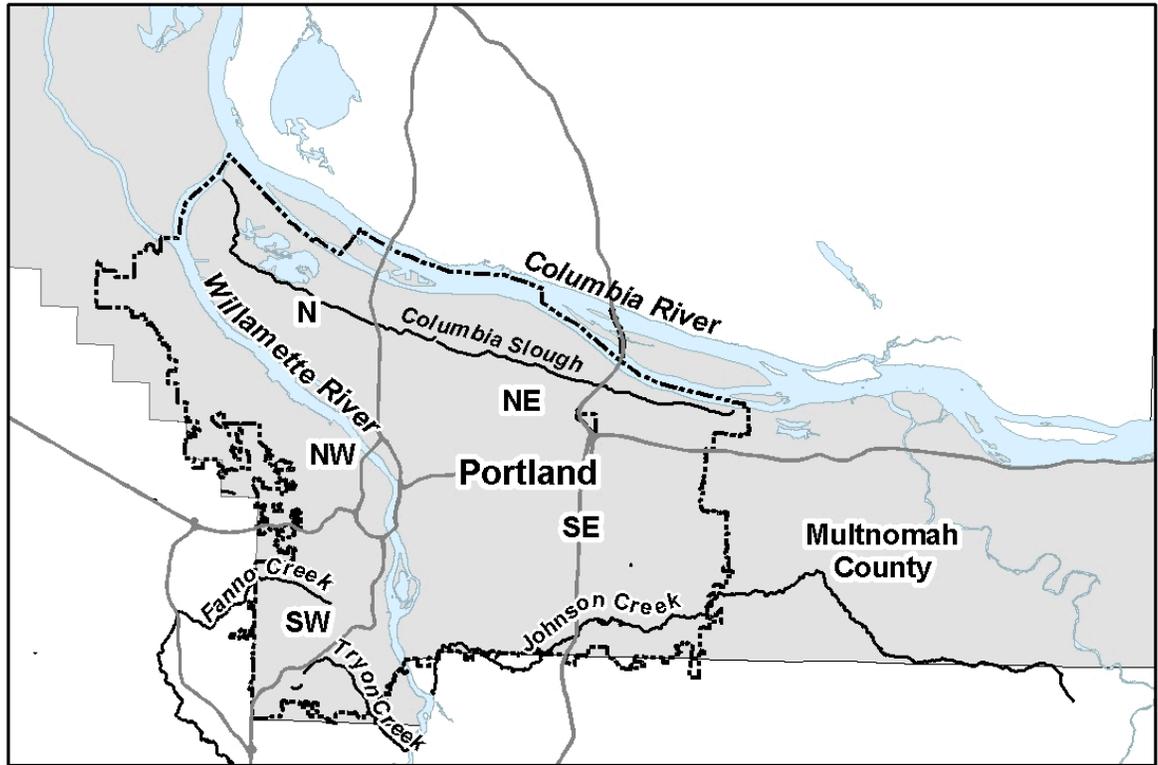
properties from the amenity effect of 21.5% and a negligible economic loss from the development effect. The authors' findings for the development effect are consistent with other studies.

IV. Study Area

The City of Portland, Oregon encompasses approximately 92,850 acres of land. The study area includes the part of the City of Portland located in Multnomah County, an area of approximately 92,150 acres. Approximately 9,395 acres in the study area are in a c-zone and 9,776 acres are in a p-zone (Odenthal 2002); almost 75% of the land in p-zones is publicly held (City of Portland, Oregon Bureau of Planning 2001b).

The city is divided into five quadrants. The Northwest quadrant of Portland is divided by the Willamette River, which flows north into the Columbia River. Streets east of the Willamette are labeled "North" while those west of the river are labeled "Northwest" (Figure 1). The study area has more than 4,500 wetlands and deepwater habitats (Mahan et al., 2000) and approximately 15,000 acres of public and private open space (Odenthal 2003b).

Figure 1: Map of the Study Area



It is estimated that when Portland was first settled there were approximately 200 streams. Many of the smaller streams “have been piped or “culverted” and paved over, obstructing fish passage and, in some cases, entirely eliminating aquatic and riparian habitat” (City Club of Portland 1999, 14). Listings of Willamette River steelhead and chinook as threatened under the Endangered Species Act (NMFS 2002) highlight the connection between Portland’s urban environment and the water quality and healthy spawning and rearing habitat that is needed for salmonid survival.

Johnson Creek, Tryon Creek, Fanno Creek, and the Columbia Slough drain Portland’s major watersheds, which are tributaries to the Willamette River. These creeks and the Columbia Slough currently violate one or more water quality standards while, “[o]ther smaller tributaries within the watershed, although not currently

identified as water quality limited, generally show some impacts to water quality” (City of Portland, Oregon Bureau of Environmental Services 2000, 2-6). Major sources of pollution in the study area include construction activities, vehicular traffic, leaking sewers, fertilizers and pesticides.

V. Data Set

The data set contains sale price, structural, neighborhood, location, zoning, and amenity information for 30,071 arms-length single-family residential property sales in the study area from 1999 through 2001. Sales in Southeast Portland constituted 39.96% of all transactions, 31.93% were in Northeast Portland, 12.62% in North Portland and 12.93% in Southwest Portland. Northwest Portland had the fewest sales with 2.55%. Definitions of the explanatory variables used in this analysis are provided in Table 1.

Table 1: Names and Definitions of Explanatory Variables (Excluded variables are in italics)

Variable Name	Description
<u>Structural Variables</u>	
LOTSF	Lot square footage
LOTSF2	Lot square footage squared
BLDGSF	Total house square footage
GARSF	Total garage square footage
BATH	Number of bathrooms
FIRE	Number of fireplaces
AGE	Year house was sold minus year house was built
ARCH1	<i>Dummy variable: 1 story house</i>
ARCH2	Dummy variable: 1 story house with basement
ARCH3	Dummy variable: 1 story house with finished attic
ARCH4	Dummy variable: 1 story house with finished attic and basement
ARCH5	Dummy variable: 1 story house with unfinished attic
ARCH6	Dummy variable: 1 story house with unfinished attic and basement
ARCH7	Dummy variable: 1 1/2 story house
ARCH8	Dummy variable: 1 1/2 story house with basement
ARCH9	Dummy variable: 2 story house
ARCH10	Dummy variable: 2 story house with basement
<u>Neighborhood Variables</u>	
INCOME	Median income at the census tract (2000)
%WHITE	Percentage of the census tract that is white
<u>Location Variables</u>	
North, Northeast, Northwest, Southeast, Southwest	Quadrant dummy variables, North is the excluded variable
NCBD, NECBD, NWCBD, SECBD, SWCBD	Interactive variable: quadrant multiplied by the distance to the central business district

Zoning Variables

RURAL	Dummy variable = 1 if the property is zoned residential farm/forest (RF) or limited density single-dwelling residential (R20)
LOWRES	Dummy variable = 1 if the property is zoned high density single-dwelling residential (R5), medium density single-dwelling (R7), or limited density single-dwelling residential (R10)
MEDRES	Dummy variable = 1 if the property is zoned low density multi-dwelling residential (R2), townhouse multi-dwelling residential (R3), or attached residential (R2.5)
HIGHRES	Dummy variable = 1 if the property is zoned high density multi-dwelling residential (RH), central residential (RX), medium density multi-dwelling residential (R1), or institutional campus (IR)
LIGHTCOM	Dummy variable = 1 if the property is zoned storefront commercial (CS), mixed commercial/residential (CM), neighborhood commercial 1 (CN1), neighborhood commercial 2 (CN2), office commercial 1 (CO1), or office commercial 2 (CO2)
HEAVYCOM	<i>Dummy variable = 1 if the property is zoned general commercial (GC), or central commercial (CX)</i>
LIGHTIND	Dummy variable = 1 if the property is zoned general industrial 1 (IG1), or general employment 1 (EG1)
HEAVYIND	Dummy variable = 1 of the property is zoned general industrial 2 (IG2), general employment 2 (EG2), heavy industrial (IH), or central employment (EX)
OS	Dummy variable = 1 if the property is zoned open space (OS)
PZONE*Quadrant	Dummy variable = 1 if property is only in a p-zone, broken down by quadrant (quadrants include NW, NE, SE, SW)
PCZONE*Quadrant	Dummy variable = 1 if property is in a c- and p-zone, broken down by quadrant (quadrants include NW, NE, SE, SW)
CZONE*Quadrant	Dummy variable = 1 if property is only in a c-zone, broken down by quadrant (quadrants include N, NW, NE, SE, SW)
OVERSIZELOT	Dummy variable = 1 if the lot size is 1.9 times the maximum allowable zoning density.
LOT_PZONE	Interactive variable, lot size*p-zone

LOT_PCZONE	Interactive variable, lot size*pc-zone
LOT_CZONE	Interactive variable, lot size*c-zone
EZONEOVERLOT	Dummy variable = 1 if a property is in an e-zone and on an oversized lot
EZONEREGLOT	Dummy variable = 1 if a property is in an e-zone, but not on a oversized lot
NEZONEOVERLOT	Dummy variable = 1 if the property is not in an e-zone, but is on a oversized lot
NOEZONEREGLOT	<i>Dummy variable = 1 if the property is not in an e-zone and not on a oversized lot</i>

Area A: Property Amenity Variables

SLOPE	Dummy variable = 1 if the property is sloped
PRVTREE	Dummy variable = 1 if the property has tree canopy
PRVWET	Dummy variable = 1 if a wetland is located on the property
PRSTRM_N	Dummy variable = 1 if a stream is located on the property and the property is in the North quadrant
PRSTRM_NE	Dummy variable = 1 if a stream is located on the property and the property is in the Northeast quadrant
PRSTRM_NW	Dummy variable = 1 if a stream is located on the property and the property is in the Northwest quadrant
PRSTRM_SE	Dummy variable = 1 if a stream is located on the property and the property is in the Southeast quadrant
PRSTRM_SW	Dummy variable = 1 if a stream is located on the property and the property is in the Southwest quadrant
SLOPE_STREAM	Interactive variable = 1 if the property is sloped and has a stream
TREE_STREAM	Interactive variable = 1 if the property has a stream and tree canopy

Area B: Amenity variables on properties located within 200 feet of the lot

B_SLOPE	Dummy variable = 1 if the area within 200 feet of the property has a slope of 25% or greater
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B_TREE	Dummy variable = 1 if the area within 200 feet of the property has tree canopy
B_WET	Dummy variable = 1 if the area within 200 feet of the property has a wetland
B_RIVER	Dummy variable = 1 if the area within 200 feet of the property has a river
B_NATURAL	Dummy variable = 1 if the area within 200 feet of the property has a natural area
B_SPECIALTY	Dummy variable = 1 if the area within 200 feet of the property has a specialty park
B_TRAIL	Dummy variable = 1 if the area within 200 feet of the property has a trail
B_URBAN	Dummy variable = 1 if the area within 200 feet of the property has an urban park
B_GOLF	Dummy variable = 1 if the area within 200 feet of the property has a golf course
B_PRIVSTRM	Dummy variable = 1 if the area within 200 feet of the property has a stream on private property
B_PUBSTRM	Dummy variable = 1 if the area within 200 feet of the property has a stream on public property
C_...	Area C: Amenity variables on properties located within 200 feet and 1/4 mile of the lot Same variables as area B
D_...	Area D: Amenity variables on properties located within 1/4 mile and 1/2 mile of the lot Same variables as area B
MONTH	<u>Time trend</u> Trend variable for month and year the property was sold (1, 2,...36)

Sale price and structural information were obtained from the Multnomah County Assessor's Office (2002). Sale prices were adjusted to 2000 dollars using the Consumer Price Index – All Urban Consumers (Bureau of Labor Statistics 2002). Because the market-determined sale price is preferred (Freeman 1993), properties that sold for less than their assessed land value were eliminated under the assumption that these transactions were not at arms-length. To eliminate undeveloped lots recorded as single-family residential property sales, properties that sold for less than the assessed improvement value were dropped. Observations with missing information, recording errors, and duplicate records were also removed from the data set.³ Summary statistics for the real sale price (in 2000 dollars) for properties in the study area, the real sale price (in 2000 dollars) for properties located in each quadrant in the study area, structural attributes, and neighborhood variables are provided in Table 2.

³ Information about the steps used to clean the data set is available from the author.

Table 2: Summary statistics for real sale price, structural and neighborhood variables

Variable Name	Mean	Standard Deviation	Minimum	Maximum
REALSALE (study area)	175,133	108,629	22,680	2,783,203
REALSALE (N Portland)	125,080	47,438	31,836	1,148,226
REALSALE (NE Portland)	168,892	80,915	36,649	1,045,943
REALSALE (NW Portland)	443,614	202,383	69,892	2,048,781
REALSALE (SE Portland)	152,655	63,746	22,680	871,287
REALSALE (SW Portland)	255,848	165,561	50,904	2,783,203
LOTSF	7,062	7,198	961	324,469
BLDGSF	1,502	691	288	14,720
GARSF	245	205	0	1,800
BATH	1.49	0.66	0.5	9
FIRE	0.83	0.71	0	8
AGE	59	27	0	155
INCOME	45,974	15,445	14,091	111,064
%WHITE	77.79	13.34	29.43	95.71

Neighborhood variables include the median income and percentage of individuals at the census tract level in 2000 that are white (U.S. Census Bureau 2001). The relationship between a property's location and its sale price is captured through a quadrant dummy variable and an interactive variable based on the property's quadrant and the distance from the property to the central business district. A topographic variable was designed to capture features such as ravines, buttes, hills, bluffs, and associated views; this variable equals one if any part of the property has a slope of 25% or greater.

Regulatory variables for each property include the base zoning (single-family residential, commercial, industrial, etc.), the existence and type of environmental zoning on the property broken down for each quadrant in the study area, and a variable that combines environmental zoning and whether the lot is considered to be oversized (City

of Portland, Oregon Bureau of Planning 2002)⁴. Summary statistics for properties located in environmental zones are provided in Table 3. Of the 30,071 properties in the data set, 1,028 properties, representing 3.42% of the transactions, were affected, at least partially, by environmental overlay zones.

Table 3: Summary Statistics for Homes Located in E-zones

	P-zone only	P- and C-zone	C-zone only
Number of Observations	107	252	669
Percentage of All Home Sales	0.36%	0.84%	2.22%
Mean Percentage of Property in e-zone (standard deviation)	27.17% (20.69)	66.08% (24.46)	46.94% (32.61)
Median	21.09%	67.53%	42.29%
Minimum Percentage of Property in e-zone	0.237%	7.12%	.145%
Maximum Percentage of Property in e-zone	96.25%	100%	100%

Table 4 provides information on the distribution of properties with a p-zone, both a p and a c-zone, and with only a c-zone for each quadrant in the study area. No properties located in North Portland in the data set had a p-zone or p- and c-zone designation.

⁴ A property is classified as an oversized lot if the lot size is 1.9 times the maximum allowable zoning density.

Table 4: E-zones and Quadrant

E-zone and Quadrant	Number of Observations
PZONE_NE	1
PZONE_NW	27
PZONE_SE	33
PZONE_SW	46
PCZONE_NE	4
PCZONE_NW	47
PCZONE_SE	49
PCZONE_SW	152
CZONE_N	33
CZONE_NE	52
CZONE_NW	108
CZONE_SE	70
CZONE_SW	406

Dummy variables were created to indicate if a property is sloped, has tree canopy, a wetland or a stream. Dummy variables were also created to capture amenities such as tree canopy, wetlands, rivers, natural area parks, specialty parks, trails, urban parks, golf courses, and streams on adjacent properties or in the surrounding neighborhood. Definitions of the amenity types are provided in Table 5.

Table 5: Amenity Types

Open Space Type	Definition	Source
Slope	Land with a slope that is equal to or greater than 25%	Derived from Metro Data Resource Center 2002a
Tree Canopy	At least one acre of continuous closed canopy	Metro Data Resource Center 2002a
Wetland	National wetland inventory	Metro Data Resource Center 2002a
River	River and water body data layer from the Metro RLIS, which includes major rivers and water bodies (e.g., Willamette and Columbia Rivers), as well as Johnson Creek, the Tualatin River and others of approximately the same size. It also includes Smith & Bybee Lakes, Vancouver Lake and the Multnomah Channel.	Metro Data Resource Center 2002a
Natural Area	More than 50% of the park is preserved in native and/or natural vegetation. Park use is balanced between preservation of natural habitat and natural resource based recreation (e.g., hiking, wildlife viewing, boating, camping). This definition includes parcels managed for habitat protection only, with no public access or improvements. (Waiwaiole 1999)	Metro Data Resource Center 2002b
Specialty Park	Primarily one use at the park and everything in the park is related to the specialty category (e.g., boat ramp facilities). (Waiwaiole 1999)	Metro Data Resource Center 2002b
Trail	Refers to non-road based multi-modal trail which is basically a linear park and may accommodate pedestrian, bicycle, skating, equestrian uses. (Waiwaiole 1999)	Metro Data Resource Center 2002b
Urban Park	More than 50% of the park is manicured or landscaped and developed for non-natural resource dependent recreation (e.g., swimming pools, ball fields, sports courts). (Waiwaiole 1999)	Metro Data Resource Center 2002b
Golf Course	Privately and publicly owned golf courses	Metro Data Resource Center 2002b
Cemetery	Privately and publicly owned cemeteries	Metro Data Resource Center 2002b
Private Stream	Streams that flow through land that is privately owned	Metro Data Resource Center 2002a
Public Stream	Streams that flow through land that is publicly owned	Metro Data Resource Center 2002a

Neighborhood amenity variables include adjacent properties defined as the area within 1 block (200 feet) of the property (Area B) the immediate neighborhood, defined as the area between 200 feet and 1/4 mile of the property (Area C), and the larger neighborhood, defined as the area between 1/4 mile and 1/2 mile of the property (Area D).⁵ Table 6 contains information on the number of properties with amenities on the lot (Area A), the number of properties with amenities at different neighborhood levels, and the number of properties with an amenity on the lot or within 1/2 mile of the property (the union of Areas A, B, C and D).

Table 6: Number of properties in the study area with amenities

Amenities	Area A Properties with amenities	Area B Within 200 feet of the property	Area C Within 200 feet to 1/4 mile of the property	Area D Within 1/4 mile to 1/2 mile of the property	Properties with amenities on the lot or within 1/2 mile
Slope	1,352	3,043	10,219	17,263	17,472
Tree Canopy	2,437	6,216	20,699	28,517	28,753
Wetland	10	36	1,351	5,514	5,655
River		34	350	1,369	1,369
Natural Area		701	4,021	8,087	8,441
Specialty Park		553	7,347	16,417	17,945
Trail		97	1,400	3,910	3,985
Urban Park		1,317	14,369	24,299	25,498
Golf Course		111	1,118	2,958	2,961
Cemetery		136	1,409	3,746	3,933
Private Stream	199	862	5,252	8,291	8,349
Public Stream		157	3,128	6,453	6,564

VI. Results

Two models were estimated to explore the relationship between the sale price of properties in the study area, environmental regulations, and amenities. The first model

⁵ Public rights-of-way and associated amenities were allocated to private property.

includes interactive variables to reflect, for each quadrant in the study area, the presence of a p-zone, p- and c-zone, or just a c-zone on a property. In Model II, these variables are replaced with an interactive variable that combines the lot size with environmental zoning for each quadrant in the study area and variables that capture the effect of environmental zoning on oversized lots. The regressors explain 77 % of the variation of the dependent variable in both models.

Model I

The estimated coefficients for the structural, neighborhood and location variables in Model I conform to intuition and the results from other studies. The three variables that capture lot size, LOTSF, LOTSF2, and OVERSIZELOT, are all significant at the 1% level. Adding a square foot to a lot is found to have a positive effect on a property's sale price, but this effect diminishes as lot size increases and becomes negative at approximately 196,200 square feet.⁶ The dummy variable OVERSIZELOT, which equals 1 if the lot size is 1.9 times the maximum allowable zoning density, indicates that properties on oversized lots sell for 3.00% less than properties that are not on an oversized lot.

Model I - Development Effect

In Model I, the "development effect" from environmental zoning is captured by a series of interactive variables that represent the presence of a p-zone, both a p-zone and a c-zone, or just a c-zone on the property for each quadrant in the study area.⁷ The p-zone coefficient for Northwest Portland is statistically significant and negative at the 5% level. The estimated coefficient implies that, holding all other factors constant, a property with only a p-zone designation in Northwest Portland is estimated

⁶ Eight properties in the data set are larger than 196,200 square feet.

⁷ None of the properties located in North Portland have a p-zone or a p- and c-zone designation.

to sell, on average, for 10.69% less than properties with no environmental zoning. The coefficient for properties in Southwest Portland is negative, but with a p-value of 0.109 the estimated effect is not statistically significant at conventional levels. The coefficients for Southeast and Northeast Portland are positive, but not statistically significant.

The coefficients for properties with both a p- and c-zone show mixed results. The p- and c-zone coefficient for properties located in Northwest Portland is significant and negative at the 5% level, with an estimated impact of 7.71%. The coefficient for Northeast Portland is significant and positive at the 1% level, but only four properties have this designation, so the results must be interpreted with caution. The estimated coefficient for properties in Southeast Portland is positive and for Southwest Portland is negative, but neither coefficient is statistically significant.

If sale prices are affected by the amount of the property with an environmental zone, then the estimated coefficients for properties with both a p- and c-zone should be the largest in magnitude since the average coverage is highest for properties with this designation. The hypotheses that the coefficients for the p-zone only and p- and c-zone variables are equivalent for properties located in Southwest, Northwest, and Southeast Portland could not be rejected.

The third environmental zoning category, c-zone only, is statistically significant and positive for properties located in North Portland at the 5% level and is significant and negative at the 1% level for properties in Southwest Portland. Properties with a c-zone only designation in North Portland are estimated to sell for 22.49% more than properties without any environmental zoning. A c-zone designation is estimated to reduce the sale price of properties located in Southwest Portland by 3.31%. The estimated coefficients for properties in Northwest and Northeast Portland are negative,

while the coefficient for properties in Southeast Portland is positive, but none of these coefficients is statistically significant.

F-tests were conducted to examine whether environmental zoning effects were equal across quadrants in the study area. The null hypothesis of equal effect was rejected for p-zone properties at the 10% level ($F(3, 29,974) = 2.57$; $\text{Prob} > F = 0.0521$), for properties with a p- and c-zone designation at the 1% level ($F(3, 29,974) = 10.65$; $\text{Prob} > F = 0.0000$), and for c-zone only properties at the 5% level ($F(4, 29,974) = 2.70$; $\text{Prob} > F = 0.0288$). These results indicate that the effect of environmental zoning on a property's sale price varies by quadrant.

Model I - Amenities on the Property

Because environmental zoning is a consequence of an amenity located on the property, it is important to consider how amenities on the property, and in the surrounding neighborhood, are related to a property's sale price.

Amenities on a property include slope, tree canopy, wetlands and streams. Three interactive variables were created to explore how the presence of a stream is related to a property's sale price. The first set of interactive variables combine the presence of a stream with the property's quadrant in the study area. The second interactive variable, slope & stream (SLOPE_STRM), captures sloped properties that also have a stream. This variable is expected to be negative since a property with these characteristics may have less land available for development. The third interactive variable is tree & stream (TREE_STRM). Vegetation is an important factor for healthy streams, so the trees & stream variable may serve as an indicator of stream quality.

The coefficients for properties with streams located in North and Southeast Portland and the interactive variable, SLOPE_STRM, are statistically significant and negative. The stream coefficients for properties located in Northeast, Northwest, and

Southwest Portland are not statistically different from zero. The negative coefficient on the stream variables may reflect concerns about flooding since the streams are located on, or adjacent to, the property. An F-test was conducted to test the hypothesis that the coefficients on the stream variables are equal across quadrants. This hypothesis was rejected at the 10% significance level ($F(4, 29,974) = 2.15$; $\text{Prob} > F = 0.0719$) indicating that the effect of a stream on a property's sale price varies by quadrant in the study area.

Model I – Amenities in the Neighborhood

Neighborhood amenity variables include slope, tree canopy, wetlands, river, natural area, specialty park, trail, urban park, golf course, cemetery, privately owned streams, and publicly owned streams. Dummy variables were created for each amenity located within 200 feet of the property (Area B), within 200 feet to 1/4 mile of the property (Area C), and within 1/4 mile to 1/2 mile of the property (Area D).

The variable SLOPE is positive and statistically significant for areas B, C and D. This variable, designed to capture features such as ravines, buttes, hills, bluffs, and associated views, equals one if any part of a property has a slope of 25% or greater. A property with a sloped area within 200 feet is estimated to sell, on average, for 2.49% more than a property without a sloped area, 1.77% more for a sloped area within 1/4 mile to 1/2 mile, and 0.76% more for a sloped area within 1/4 mile to 1/2 mile of the property.

The tree canopy (TREE) coefficient is positive and significant for area B and is negative and significant for areas C and D. The estimated coefficient for area B indicates that a property's sale price is estimated to increase by 1.64% if the area within 200 feet of the property has tree canopy, decrease by 0.53% if the tree canopy is within

200 feet to 1/4 mile of the property, and decrease by 1.66% if the tree canopy is within 1/4 mile to 1/2 mile of the property.

The estimated coefficient on the wetland variable (WET) is positive for Area B, negative for Area C, and negative and statistically significant for Area D. This may be a result of the type of wetland located near residential properties in the study area (Mahan et al. 2000) or a result of omitted variable bias since approximately 85% of the land classified as wetlands in the study area is located in North and Northeast Portland on land with a mix of industrial and open space zoning (Odenthal 2003a).

Two major rivers, the Willamette and the Columbia, are located in the study area. The dummy variable representing the presence of a river (RIVER) is expected to have a positive coefficient. The estimated coefficient for the presence of a river within 200 feet of a property is large in magnitude (34.21%) and statistically significant. The variable becomes negative, but not statistically significant for area C, and then positive and statistically significant for area D.

Neighborhood open spaces are captured by six variables: NATURAL, SPECIALTY, TRAIL, URBAN, GOLF and CEM. Specialty parks, trails and cemeteries within 200 feet of a property (Area B) were found to have a statistically significant effect on a property's sale price. Specialty parks in Area B are estimated to increase a property's sale price by 1.75% while trails are estimated to decrease a property's sale price by 6.81% and cemeteries by -4.36%. The trails variable may be capturing the negative externalities associated with noise and congestion resulting from proximity to a trail, but it may also be capturing a home's proximity to an industrial area since some trails in the Portland area were created from railroad rights-of-way. The majority of trails, as a park type for this study, are on open space, industrial or employment-zoned lands.

In Area C, the coefficients for specialty parks, urban parks, and golf courses, are statistically significant and positive while trails and cemeteries are significant and negative.

The open space variables in Area D are statistically significant at the 5% level with the exception of urban parks. Golf courses remain positive with an estimated impact of 3.60% and cemeteries remain negative with an impact of 3.50%. The coefficient on specialty parks changes signs and is significant, but the estimated impact is small (-0.58%). The trails coefficient also changes sign and is statistically significant – perhaps reflecting the benefit of being within walking distance of a trail without the noise and congestion that may result from proximity to a trail. Natural areas are statistically significant and negative in Area D – an unexpected result that is counter to the literature.

Model I – Stream Variables

Dummy variables were created to capture whether streams located on adjacent properties and in the immediate and larger neighborhood flowed through land that was privately or publicly owned. The private stream variables are significant at the 1% level for all three areas, while the public stream variable is statistically significant for Area C at the 10% level. The location of a private stream within 200 feet of a property is estimated to decrease a property's sale price by 3.59%, within 200 feet to 1/4 mile the decrease is estimated to be 2.54%. The coefficient on private stream is positive for properties located within 1/4 to 1/2 mile of the lot and is estimated to increase a property's sale price by 2.59%. A publicly owned stream within 200 feet to 1/4 mile of a property is estimated to increase the property's sale price by 1.18%.

The negative coefficients on the stream variables for Areas B and C may be capturing negative externalities arising from the activities of private landowners in the

surrounding neighborhood. These activities may include the removal of native vegetation leading to an increased probability of flooding and a decline in water quality due to pesticides, fertilizers, bacteria, and sediment.

Table 7: Regression Results – Model I

Variable Name	Estimated Coefficient	Robust Standard Errors	t-statistic	P-value
<u>Structural Variables</u>				
LOTSF	8.28e-06	7.22e-07	11.47	0.000
LOTSF2	-2.11e-11	3.39e-12	-6.21	0.000
BLDGSF	.0002536	9.36e-06	27.10	0.000
GARSF	.0001498	7.27e-06	20.61	0.000
BATH	.0647696	.0045928	14.10	0.000
FIRE	.0454911	.0031206	14.58	0.000
AGE	-.0011119	.0000827	-13.45	0.000
ARCH1	<i>Excluded</i>			
ARCH2	.0376171	.0041429	9.08	0.000
ARCH3	-.0125682	.0090546	-1.39	0.165
ARCH4	.131587	.0063608	20.69	0.000
ARCH5	.0063168	.0240655	0.26	0.793
ARCH6	.148333	.0084802	17.49	0.000
ARCH7	.0434357	.0222768	1.95	0.051
ARCH8	.1770845	.0108066	16.39	0.000
ARCH9	.1034817	.0063796	16.22	0.000
ARCH10	.2385837	.0100425	23.76	0.000
<u>Neighborhood Variables</u>				
INCOME	2.43e-06	1.58e-07	15.36	0.000
%WHITE	.0060372	.0001626	37.12	0.000
<u>Location Variables</u>				
North	<i>Excluded</i>			
Northeast	.2135092	.0158982	13.43	0.000
Northwest	.4652152	.0270258	17.21	0.000
Southeast	.0889649	.0162133	5.49	0.000
Southwest	.3198498	.0212249	15.07	0.000
NCBD	-6.44e-06	5.76e-07	-11.18	0.000
NECBD	-.0000109	3.40e-07	-32.00	0.000
NWCBD	-.0000179	1.19e-06	-15.06	0.000
SECBD	-7.41e-06	2.37e-07	-31.32	0.000
SWCBD	-.0000172	6.43e-07	-26.78	0.000
<u>Zoning Variables</u>				
RURAL	.0902156	.0475542	1.90	0.058
LOWRES	.1057859	.0337716	3.13	0.002
MEDRES	.0940618	.0340969	2.76	0.006
HIGHRES	.0765969	.0347319	2.21	0.027
LIGHTCOM	.0335066	.0376434	0.89	0.373
HEAVYCOM	-.0238544	.0376614	-0.63	0.526
LIGHTIND	-.1280234	.0833377	-1.54	0.124

<i>HEAVYIND</i>	<i>Excluded</i>			
OS	.2199153	.09291	2.37	0.018
PZONE_NE	.0462383	.0476819	0.97	0.332
PZONE_NW	-.113086	.0457966	-2.47	0.014
PZONE_SE	.0058361	.0289844	0.20	0.840
PZONE_SW	-.0470482	.0293519	-1.60	0.109
PCZONE_NE	.1768589	.0367688	4.81	0.000
PCZONE_NW	-.0802415	.0406876	-1.97	0.049
PCZONE_SE	.0597823	.0500717	1.19	0.233
PCZONE_SW	-.0379908	.0261719	-1.45	0.147
CZONE_N	.2028889	.0833374	2.43	0.015
CZONE_NE	-.030751	.0600926	-0.51	0.609
CZONE_NW	-.0033165	.0287699	-0.12	0.908
CZONE_SE	.0249983	.0320239	0.78	0.435
CZONE_SW	-.0336824	.013021	-2.59	0.010
OVERSIZELOT	-.0304141	.0067752	-4.49	0.000

Amenities on Property

SLOPE	-.0037347	.0099783	-0.37	0.708
PRVTREE	-.0076716	.006868	-1.12	0.264
PRVWET	-.0283615	.0761762	-0.37	0.710
PRSTRM_N	-.2440159	.1083697	-2.25	0.024
PRSTRM_NE	-.0488543	.068183	-0.72	0.474
PRSTRM_NW	.0097148	.0877476	0.11	0.912
PRSTRM_SE	-.1725833	.0887918	-1.94	0.052
PRSTRM_SW	-.0285264	.0486628	-0.59	0.558
TREE_STRM	.0615128	.0542808	1.13	0.257
SLOPE_STRM	-.1379756	.042899	-3.22	0.001

Area B: Amenities on properties located within 200 feet of the lot

B_SLOPE	.0245873	.0068114	3.61	0.000
B_TREE	.0162761	.0044973	3.62	0.000
B_WET	.0077149	.043279	0.18	0.859
B_RIVER	.2942321	.0763002	3.86	0.000
B_NATURAL	.0016511	.011835	0.14	0.889
B_SPECIALTY	.0173687	.0095902	1.81	0.070
B_TRAIL	-.0705391	.0271061	-2.60	0.009
B_URBAN	.0044979	.0060633	0.74	0.458
B_GOLF	.0150284	.024978	0.60	0.547
B_CEM	-.044554	.025772	-1.73	0.084
B_PRVSTRM	-.0365407	.010355	-3.53	0.000
B_PUBSTRM	-.0062207	.0208439	-0.30	0.765

Area C: Amenities on properties located within 200 feet to 1/4 mile of the lot

C_SLOPE	.0175842	.0039578	4.44	0.000
C_TREE	-.0053618	.0032177	-1.67	0.096
C_WET	-.010221	.0079408	-1.29	0.198

C_RIVER	-.0102809	.016	-0.64	0.521
C_NATURAL	-.0045854	.0053906	-0.85	0.395
C_SPECIALTY	.0143845	.0032485	4.43	0.000
C_TRAIL	-.0200117	.0079026	-2.53	0.011
C_URBAN	.0065718	.0028043	2.34	0.019
C_GOLF	.0364635	.0086834	4.20	0.000
C_CEM	-.0324104	.0072432	-4.47	0.000
C_PRVSTRM	-.0257786	.0081098	-3.18	0.001
C_PUBSTRM	.0117759	.006518	1.81	0.071

Area D: Amenity variables on properties located within 1/4 mile to 1/2 mile of the lot

D_SLOPE	.0075265	.0033245	2.26	0.024
D_TREE	-.0167878	.0056557	-2.97	0.003
D_WET	-.0244645	.004852	-5.04	0.000
D_RIVER	.0402384	.0086819	4.63	0.000
D_NATURAL	-.0267	.0039127	-6.82	0.000
D_SPECIALTY	-.0058113	.0028111	-2.07	0.039
D_TRAIL	.0216913	.0054326	3.99	0.000
D_URBAN	-.003572	.0037675	-0.95	0.343
D_GOLF	.035408	.0057537	6.15	0.000
D_CEM	-.035623	.0045516	-7.83	0.000
D_PRVSTRM	.0255629	.0067281	3.80	0.000
D_PUBSTRM	-.0001178	.0068841	-0.02	0.986
MONTH	.0003606	.0001173	3.07	0.002
Intercept	10.74702	.0368536	291.61	0.000

R² = .7777

N = 30,071

Model II

In Model II, the environmental zoning variables were replaced with interactive variables that combine the lot size with environmental zoning for each quadrant in the study area, and with variables that capture the effect of environmental zoning on oversized lots. The lot size variables are used to test whether an additional square foot of land has an impact on properties located in an environmental zone and whether that effect varies by quadrant. The oversized lot variables are used to test whether homes

located on oversized lots in an environmental zone sell for a different amount than homes on an oversized lot, but not in an environmental zone.

The estimated coefficients for the structural, location and neighborhood amenity coefficients for Model II are generally consistent with the results presented for Model I with the exception of the interactive variable, tree and stream. Table 8, includes results for lot square footage, the tree & stream variable, the interactive variables capturing how lot size is affected by environmental zoning for each quadrant in the study area, the oversized lot variables, and the stream variables by quadrant.⁸ The interactive variable, tree & stream (TREE_STREAM), is positive and statistically significant at the 10% level in Model II. This coefficient is appropriately interpreted by combining the estimated effect from this variable (9.41%) with the estimated effect from one of the stream and quadrant variables. For example, properties in Southeast Portland with a stream are estimated to sell for 13.01% less than properties without a stream. The combination of tree canopy and a stream in Southeast Portland decreases the estimated impact to -3.60%.

The interactive variable that captures how an additional square foot in each of the three environmental zone categories is related to a property's sale price is statistically significant and negative for properties with a p-zone in Southeast and Northwest Portland and with a p- and c-zone in Northwest Portland. A statistically significant positive effect is found for properties with a p- and c-zone in Northeast Portland. None of the estimated coefficients for c-zone and lot size were statistically significant.

⁸ The complete set of results is available from the author.

While an additional 1,000 square feet is estimated to increase the sale price of a property in the study area by 0.86%, the negative coefficient on the p-zone variable for properties in Northwest Portland, when combined with the positive coefficient on lot square footage, decreases the estimated impact of an additional 1,000 square feet on the sale price of a property with a p-zone in Northwest Portland to 0.16%.

The OVERSIZELOT variable in Model I was replaced with three interactive variables EZONEOVERLOT, EZONEREGLOT, NOEZONEOVERLOT. A total of 7,206 properties in the data set have an oversized lot and 216 of these properties are located in an environmental zone.

The coefficients on EZONEREGLOT and NOEZONEOVERLOT were statistically significant and negative. The coefficient on EZONEOVERLOT was not statistically different from zero. Properties that are in an e-zone, but not on an oversized lot are estimated to sell for 8.31% less than properties that are not in an e-zone and not on an oversized lot. Properties that are not in an e-zone and on an oversized lot are estimated to sell for 2.91% less than properties that are not in an e-zone and not on an oversized lot. An F-test was conducted to test whether the coefficients on the two oversized lot variables are equal to each other. The null hypothesis of equivalence could not be rejected ($F(1, 29,975) = 2.53$; $\text{Prob} > F = 0.1120$). This means that the estimated coefficients for oversized lots in an e-zone and oversized lots not in an e-zone are not statistically different *from each other*. Further research is required to determine if this effect varies by type of environmental zoning.

Table 8: Primary Regression Results – Model II

Variable Name	Estimated Coefficient	Robust Standard Errors	t-statistic	P-value
<u>Zoning Variables</u>				
LOTSF	8.59e-06	8.08e-07	10.64	0.000
LOT_PZONE_NE	7.77e-07	1.90e-06	0.41	0.683
LOT_PZONE_NW	-7.02e-06	3.76e-06	-1.87	0.062
LOT_PZONE_SE	-2.70e-06	1.49e-06	-1.81	0.070
LOT_PZONE_SW	-2.01e-06	2.34e-06	-0.86	0.391
LOT_PCZONE_NE	.0000194	3.74e-06	5.19	0.000
LOT_PCZONE_NW	-.0000212	3.52e-06	-6.01	0.000
LOT_PCZONE_SE	2.42e-07	1.54e-06	0.16	0.875
LOT_PCZONE_SW	-2.55e-07	1.83e-06	-0.14	0.889
LOT_CZONE_N	.0000106	8.09e-06	1.31	0.191
LOT_CZONE_NE	-3.42e-06	3.11e-06	-1.10	0.271
LOT_CZONE_NW	9.79e-07	2.07e-06	0.47	0.636
LOT_CZONE_SE	1.93e-06	2.22e-06	0.87	0.385
LOT_CZONE_SW	5.89e-07	1.58e-06	0.37	0.710
EZONEOVERLOT	-.0120569	.0173311	-0.70	0.487
EZONEREGLOT	-.0868075	.0344758	-2.52	0.012
NOEZONEOVERLOT	-.0294848	.0072714	-4.05	0.000
TREE_STRM	.0899367	.0525228	1.71	0.087
PRSTRM_N	-.1645676	.0827429	-1.99	0.047
PRSTRM_NE	-.0509772	.0510104	-1.00	0.318
PRSTRM_NW	.0061639	.0921985	0.07	0.947
PRSTRM_SE	-.1393469	.0847179	-1.64	0.100
PRSTRM_SW	-.0660543	.0471292	-1.40	0.161
R ² = .7773				
N = 30,071				

VII. Conclusions and Future Research

The hedonic price method was used to investigate how environmental zoning and amenities are related to a property's sale price. Of the 30,071 arms-length single-family residential property sales that occurred in the study area between 1999 and 2001, 1,028 properties, or approximately 3.42% of the transactions, were for properties with an environmental zone.

The “development effect” of environmental zoning was found to vary by the type of environmental zone and the property’s location. In Model I, the hypothesis that environmental zoning has an equivalent impact on the sale price of properties located in different quadrants in the study area was rejected for each type of environmental zone. In Model II, the hypothesis that the estimated coefficient for homes located on an oversized lot with an environmental zone equals the coefficient for homes on oversized lots without an environmental zone could not be rejected. Future research on the development effect should focus on refining the environmental zoning variables by including information on whether the house is in the environmental overlay zone.

On-property amenities in this study include slope, tree canopy, wetlands, and streams. Prior research has concluded that trees located on a property have a positive and statistically significant effect on a home’s sale price (Anderson and Cordell 1988). While this may also be true in the study area, the tree canopy variable only includes trees that are part of a one-acre, or larger, closed canopy. Future research should focus on an indicator of vegetation at the property-level since other studies have found this to be an important factor in a property’s sale price (Anderson and Cordell 1988, Tyrvaïnen and Miettinen 2000, Tyrvaïnen and Vaananen 1998) and because vegetation is related to water quality – another important determinant of a property’s sale price (Leggett and Bockstael 2000). The statistically significant, positive, and large coefficient for the stream & tree variable suggests the importance of vegetation for properties with streams in the study area.

The negative and statistically significant coefficients for streams located on or adjacent to properties in North and Southeast Portland may result from the actual or perceived risk of flooding, the physical reduction in land that can be developed, or the actual or perceived stream water quality. An indicator of stream quality would allow a

comparison across streams and an analysis of how property values in the study area are affected by stream water quality. Previous research has concluded that poor water quality significantly depresses property values (Leggett and Bockstael 2000) and that restoring streams in an urban area can increase property values (Streiner and Loomis 1995).

The focus of this study has been on the private benefits and costs to homeowners. The benefits to society from preserving trees, wetlands, streams, and the species that depend on these resources should also be acknowledged when evaluating the overall effect of environmental overlay zones. These benefits include ecosystem services, that is, the benefits that society receives from a healthy ecosystem such as flood control, clean water, fisheries, and climate regulation and existence and bequest value from species, such as the Willamette River steelhead and chinook that are listed as threatened under the Endangered Species Act.

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