2006

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Citation Details

Yeakley, J. A.; Ozawa, C. P.; Hook, A. M. 2006. Changes in riparian vegetation buffers in response to development in three Oregon cities. In: Aguirre-Bravo, C.; Pellicane, Patrick J.; Burns, Denver P.; and Draggan, Sidney, Eds. 2006. Monitoring Science and Technology Symposium: Unifying Knowledge for Sustainability in the Western Hemisphere Proceedings RMRS-P-42CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 296-302

Changes in Riparian Vegetation Buffers in Response to Development in Three Oregon Cities

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Abstract—*Riparian vegetation buffer loss was investigated for three cities with contrasting local regulatory controls in urbanizing northwest Oregon. The cities examined were Hillsboro, Oregon City and Portland, all having experienced high rates of population increase in the 1990s. All cities are covered under Oregon's land use law that provides goals for the protection of open space and natural resources. On the municipality level, regulatory controls in Portland included a system of environmental zoning for riparian area protection, while regulatory controls on development in riparian areas in Hillsboro and Oregon City were less stringent. Digital aerial photographs covering buffer areas within 200 m of all permanent streams for these cities were digitized for the years 1990 and 1997 using criteria including minimum inter-patch distance of 5 m for adjacent classes and minimum patch area of 20 m^2. Cover classes were divided into vegetation areas adjacent to stream and total, as well as woody and unmanaged vegetation areas. Banding analysis was performed for these vegetation coverages for several buffer widths out to 100 m from streams. Results for the 1990 to 1997 period showed larger losses for unmanaged adjacent vegetation 100 m from stream for Hillsboro and Oregon City (≥1.5 percent/year) than for Portland (<1 percent/year). For adjacent tree vegetation within a 100 m buffer width, again Hillsboro and Oregon City had higher rates of loss (>1 percent/year), while Portland lost trees in the 100 m buffer at a lower rate (<1 percent/year). Factors explaining these lower rates of riparian buffer loss for Portland may include both a higher amount of riparian area in public ownership and more stringent local regulatory controls on development in riparian buffers. These results also demonstrate that vegetated riparian buffers continue to be lost due to development in growing Oregon municipalities regardless of the level of regulatory protection.*

Introduction

Growing populations exert increasing pressure in urban areas to develop urban land uses, which can create observable impacts on that natural environment that can degrade ecosystem conditions. Our research seeks to better understand the interplay among social systems, regulatory processes, land cover change and ecosystem functions in areas undergoing urbanization (fig. 1). We have focused on a specific ecosystem attribute, vegetated riparian buffers, in urban areas, with the overall goal of clarifying the linkages shown in figure 1. This paper presents results on vegetated buffer loss in three cities that experienced significant population growth over a 7-year period in the Pacific Northwest of the USA, and discusses regulatory and geographic constraints that are likely related to the resource losses observed.

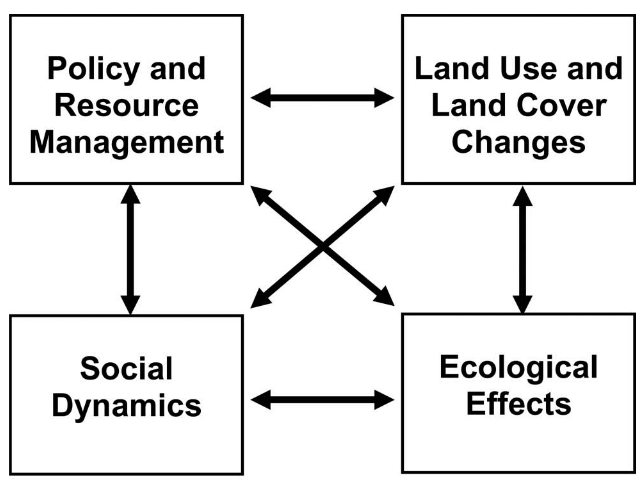


Figure 1. Research Context. Linkages among boxes represent relationships under investigation in this research overall.

Vegetated Riparian Buffers

Generally, riparian buffers can be disconnected, compressed and eliminated by urban development. Riparian areas are particularly susceptible to impacts associated with development (Budd and others 1987). Conservation of riparian zones in urban and industrial areas has usually been limited to narrow borders along streambanks, if at all (Naiman and others 2000). Protection of riparian buffers has been singled out for protective policy in the Portland metropolitan region (Furfey and others 1997). Conditions of the vegetated zone along stream banks are positively related to stream water and wildlife habitat quality. Studies have concluded that minimal buffer widths necessary to maintain stream water quality, native vegetation and wildlife habitat range from at least 20 m to as much as 200 m (Lowrance and others 1984, Castelle and others 1994, Naiman and Decamps 1997, O'Neill and Yeakley 2000, Hennings and Edge 2003).

Regulatory Framework

Oregon is distinguished by its passage of one of the USA's first statewide land use planning laws in 1973. Among the law's 19 goals are provisions to limit the expansion of urban areas and to protect the state's open areas and natural resources. The law sets a framework for local governments to address stream bank protection through comprehensive planning (Abbott and others 1996). The 24 cities and towns and three counties in the Portland metropolitan area (fig. 2) develop comprehensive plans independently, but are expected to act consistently with guidelines set by Metro, the regional planning authority. Considerable discretion with respect to management strategy to protect stream banks remained in the hands of local planners and decision makers until 1998, when Metro assumed a more aggressive stance toward riparian buffers. Through functional plans pertaining to water quality and flood management, Metro set explicit standards to which the region's cities and counties were given a specific period of time to amend their local plans. By 2002, not only were cities expected to be in compliance, but land use changes that resulted from decisions prior to the amendments were expected to have been fully implemented.

Vegetation Losses in Northwestern Oregon

In spite of this relatively progressive regulatory state-level land use framework to curb the degradation of natural and agricultural areas in Oregon, it is becoming clear that enormous losses of vegetated land have yet occurred in urbanized areas of the Willamette Valley over past decades. A study recently concluded by American

Figure 2. Locations and Stream Networks of the Three Study Cities. Shown is the greater metropolitan area of Portland, Oregon, including the urban growth boundary (UGB). Permanent streams and city boundaries are shown for Hillsboro, Oregon City and Portland.

Forests found that tree vegetation in urbanized areas of western Oregon has declined by 56 percent over the period from 1972 through 2000. Clearly such losses are not only occurring in general, but also in critical riparian corridors. While it is likely that increased regulatory measures as described above have slowed the rate of loss of riparian buffers, regulations on the books alone are not sufficient to prevent the degradation of ecosystems in urban areas. For example, during one field visit, we encountered a recent example where the review process failed to enforce the 7.5 m riparian buffer restriction on new development for that municipality. In the planning and permit decision making process, the protection of natural resources is only one among several competing objectives. Therefore, provisions are made for a balancing to occur on a case-by-case basis through the use of "exceptions" or "variances." Such features in the regulatory system indicate that losses of riparian ecosystems will likely continue in spite of increased regulation.

Study Objective

Our overall goal is to better elucidate the linkages among social dynamics, regulatory effectiveness, land cover changes and ecological functions, as shown in figure 1. In this paper we show some of the initial results of our research regarding riparian buffer losses for three Oregon municipalities with varying regulatory strategies over a 7-year period of high population growth.

Approach

Municipalities Selected

We selected three municipalities in the greater Portland, Oregon metropolitan region for intensive study: Oregon City, Hillsboro and Portland. Portland was chosen as the largest city in Oregon and a city with an aggressive approach to protecting natural resources. Hillsboro and Oregon City were chosen due to their comparably rapid population growth rates during the 1990s (table 1), their physical locations that roughly "bracket" the urban growth boundary (UGB) of the metropolitan area (fig. 2), as well as their anecdotal reputations as communities respectively less and more progressive in their attitudes toward resource protection. Regulatory controls varied among the cities. As discussed in Ozawa and Yeakley (2004), by 1990, Portland had instituted a system of environmental zoning (E-zones) for riparian area protection, which depending on location relative to stream, either outright forbid any new building development or only allow construction of structures that follow strict criteria (for example, a low percentage of disturbed area allowed, replacement of vegetation, special construction practices). Hillsboro and Oregon City, however, had far less stringent regulatory constraints on riparian area development. At the county level during the 1990s, Hillsboro riparian areas became subject to a regulation that prohibited development within 7.5 m of streams (although with exceptions that could allow developers to encroach within 4.6 m). Oregon City had no outright restrictions on riparian development from 1990 to 1997; rather development in that municipality was guided by a series of "overlay districts," each relating to specific resources and/or landscape conditions and hazards (for example, water quality, unstable slopes, flood management).

Table 1. Comparative Data for the Three Study Cities.

	Oregon City	Hillsboro	Portland
1990 Population	14,698	37,520	438,802
2000 Population	25,533	69,883	529,121
Population Increase Rate	74%	86%	21%
Municipal Area	22.1 km^2	56.5 km^2	375.6 km^2
Stream Length	34.0 km	63.5 km	475.8 km

Analysis

Our approach for documenting riparian vegetation changes over time in each of the three municipalities consisted of digitizing aerial photographs into four riparian vegetation classes for all permanent streams at two points in time, 1990 and 1997. We then performed a banding analysis where riparian vegetation coverage was measured at several buffer widths out to 200 m from streams and changes over time were compared in the context of differing regulatory strategies. Our data sources included (a) the Metro RLIS database for stream locations and city boundaries (Metro 2002), (b) 1997 color orthorectified aerial photographs at 1.22 m resolution from Metro, and (c) 1990 gray scale photographs at 0.30 m resolution. The 1990 aerial photographs were purchased as raw digital scans and orthorectified to 1997 photos (x and y coordinates) and USGS digital elevation maps (z coordinates) using ERDAS Imagine 8.3 software. For each photo, at least 12 ground control points were used and the total root mean square error was maintained below 1.0. We digitized vegetation using ArcGIS 8.x software, from 0 m to 200 m from permanent streams and wetland features, into four classifications:

- Adjacent woody (= trees and shrubs, within 5 m distance of a stream and/or other adjacent woody cover)
- Adjacent unmanaged (= adjacent woody, plus unmanaged grasses within 5 m distance of a stream and/or other unmanaged adjacent vegetation cover)

- All woody (= adjacent woody plus non-adjacent trees and shrubs)
- All unmanaged (=adjacent unmanaged, plus non-adjacent unmanaged vegetation cover)

We maintained a consistent viewing scale of 1:1500 while digitizing. Our patch delineations followed Schuft and others (1999), and used a minimum inter-patch distance of 5 m for the adjacent classes, and a minimum patch area of 20 m^2 (based on a circular crown diameter = 5 m). We implemented the "adjacent" versus "all" vegetation distinction to track potential changes to riparian corridor habitat quality to account for connectivity (Naiman and DeCamps 1997). We included unmanaged vegetation in the analysis to account for all vegetation changes within our specified buffer widths. We conducted a banding analysis of the digitized vegetation classes (Schuft and others 1999) for the following distances (followed by the corresponding regulatory significance where applicable): 7.5 m (25 ft – Washington County buffer regulation); 15 m (50 ft – proposed Metro Title 3 minimum); 22.5 m; 30 m (100 ft – corresponds to 50x100 ft lot dimension max); 45 m; 61 m (200 ft – proposed Metro Title 3 maximum); 100 m; and 200 m (total). Our quality assurance steps included: (a) alignment of streamline locations provided by Metro were cross-corrected with USGS quadrangles and Metro contour maps; (b) if a stream formed a city boundary, streamline was snapped to the boundary; (c) shadows truncated from photos where determination was possible; (d) field checks were conducted for several dozen ambiguous features; and (e) digitizing interpretations cross-checked between two observers with error < 3 percent. Also, we interpreted 1997 changes while referring directly to 1990 digitized vegetation polygons to minimize interpretation error between years. The analysis was conducted exhaustively for all streams in the three study municipalities (rather than based on a sample or fraction of the streams) to account for all landscape changes in riparian buffers in these cities from 1990 to 1997.

Results

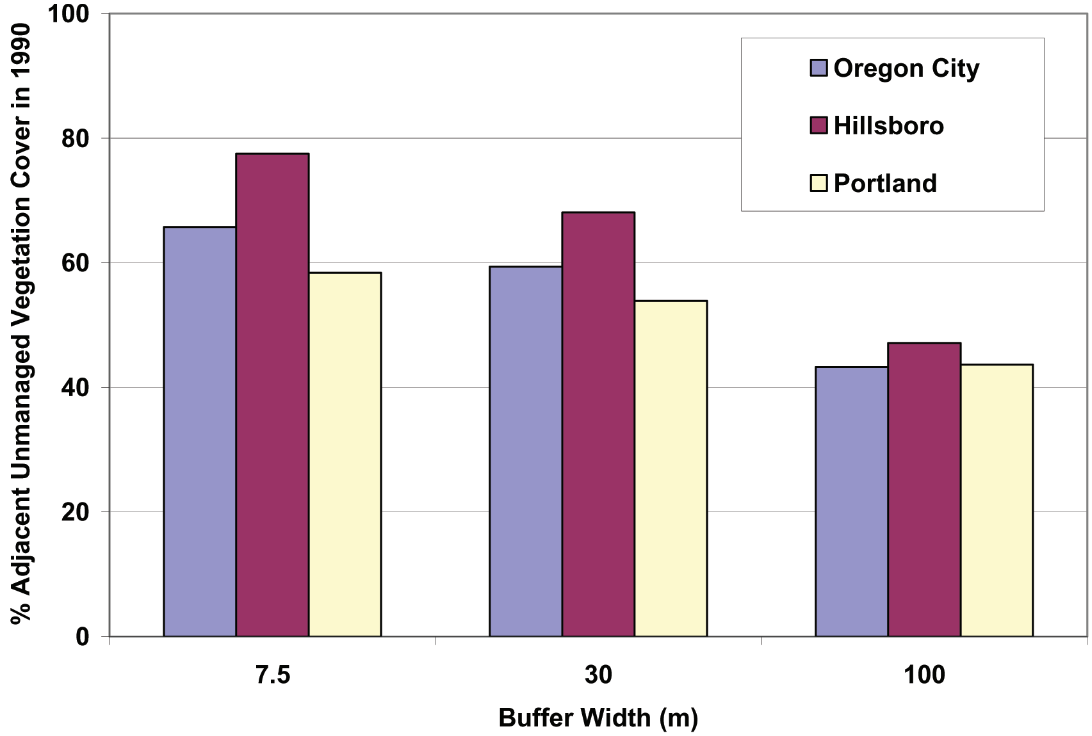
At the beginning of the study period, in 1990, significant portions of adjacent riparian vegetation remained on the landscapes of these three cities (fig. 3). Unmanaged riparian vegetation ranged from approximately 40 percent cover in Oregon City and Portland at 100 m buffer width to nearly 80 percent cover within 7.5 m in Hillsboro. Adjacent riparian tree vegetation resources also remained, ranging from above 30 percent cover at 100 m to 60 percent cover at 7.5 m. It should be noted that these figures do not include historical streams that have been entirely removed and replaced by culverts, as has happened to much of the streams that once existed on the east side of Portland.

For all unmanaged vegetation (trees, shrubs, grasses), losses tracked in this study from 1990 to 1997 ranged from just over 1 percent total in Hillsboro at 7.5 m to over 11 percent riparian cover lost in Hillsboro at 100 m (fig. 4). Losses were slightly higher in adjacent vegetation (fig. 5) compared to all vegetation within the buffer (fig. 4) for most buffer widths examined. For example, in Portland for all buffer widths for both tree and unmanaged vegetation, adjacent losses (fig. 5) were approximately a percentage point higher than for losses of all vegetation in the riparian buffer (fig. 4). Adjacent unmanaged vegetation losses topped 12 percent in Hillsboro at 100 m. Adjacent and all vegetation losses were, however, roughly equivalent in Oregon City for most buffer widths (figs. 4 and 5). On a percentage basis, losses in both adjacent riparian tree and unmanaged vegetation cover within 61 m were highest in Oregon City (figs. 4 and 5). Portland and Hillsboro were roughly comparable closer in, but Hillsboro had the highest losses of all three cities at the largest buffer width (100 m).

At 100 m from stream, larger losses were observed for unmanaged adjacent vegetation for Hillsboro and Oregon City (≥1.5 percent/year) than for Portland (<1 percent/year). For adjacent tree vegetation within a 100 m buffer width, again Hillsboro and Oregon City had higher rates of loss (>1 percent/year), while Portland lost trees in the 100 m buffer at a lower rate (<1 percent/year).

Discussion

Generally, the two cities with lower regulatory stringency experienced larger losses of riparian vegetation at all buffer widths. Oregon City experienced the greatest losses, signaling that their approach of suggestive overlay districts to protect land-based natural resources was not as effective as the more prescriptive approaches of Portland or Hillsboro. Hillsboro was a tale of two types of vegetation loss during the study period. At short distances from streams, Hillsboro experienced the lowest loss of all three cities – in part likely due to a county level ordinance implemented midway through the 1990s that prohibited most development within 7.5 m. At the largest distance from stream, however, Hillsboro experienced the greatest loss, possibly due to its higher construction rates (number of permits relative to total land area) during the 1990s. Portland generally experienced the lowest percentage of riparian loss. There are two potential explanations for Portland's relative success. The more hopeful explanation is that the environmental zoning implemented in



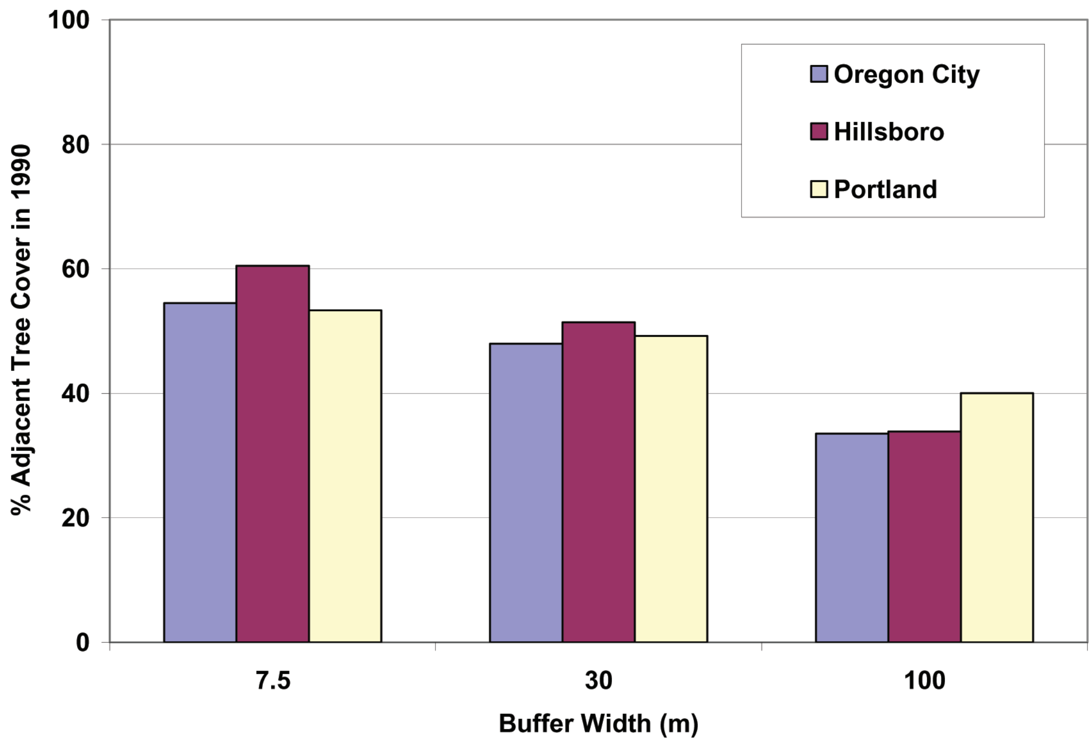


Figure 3. Adjacent Riparian Vegetation Cover in 1990. Shown in the upper graph is percent cover for adjacent unmanaged riparian vegetation cover at 3 buffer widths (or band widths) in 1990. Shown in the lower graph is percent cover for adjacent riparian tree cover at 3 buffer widths in 1990.

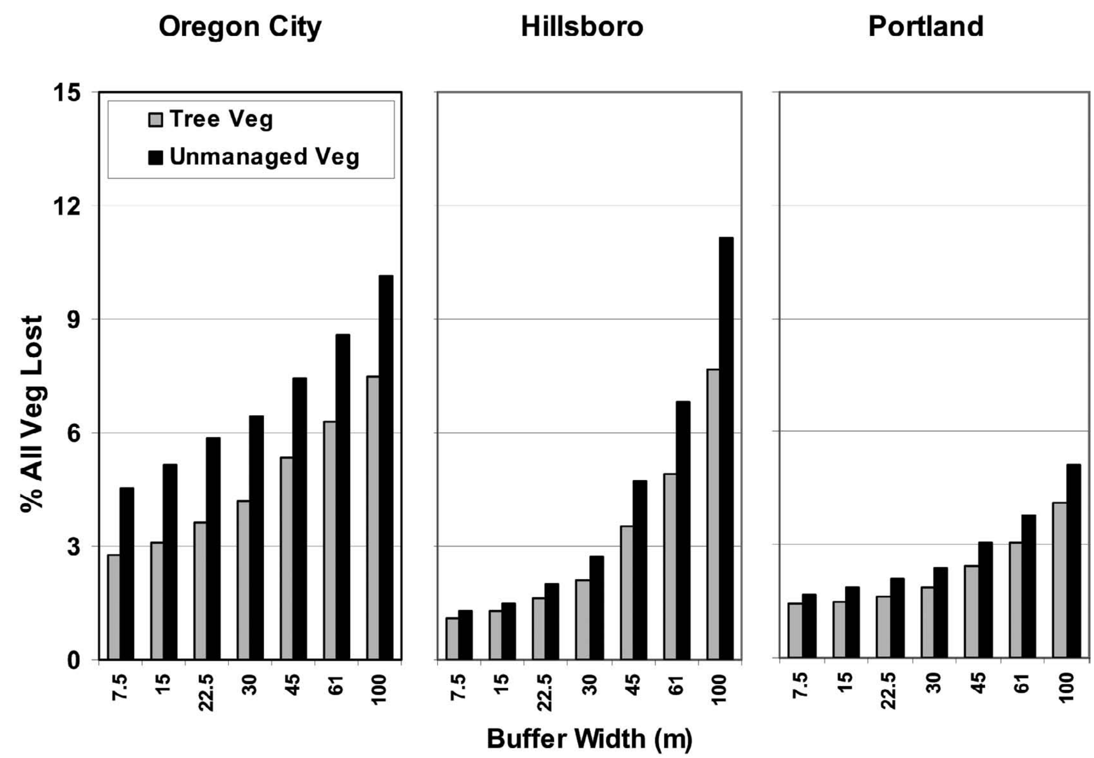


Figure 4. Percent All Riparian Vegetation Lost from 1990 to 1997. Shown in each graph are percent riparian area lost for both all tree and all unmanaged vegetation from 1990 to 1997 for the cities of Oregon City, Hillsboro, and Portland.

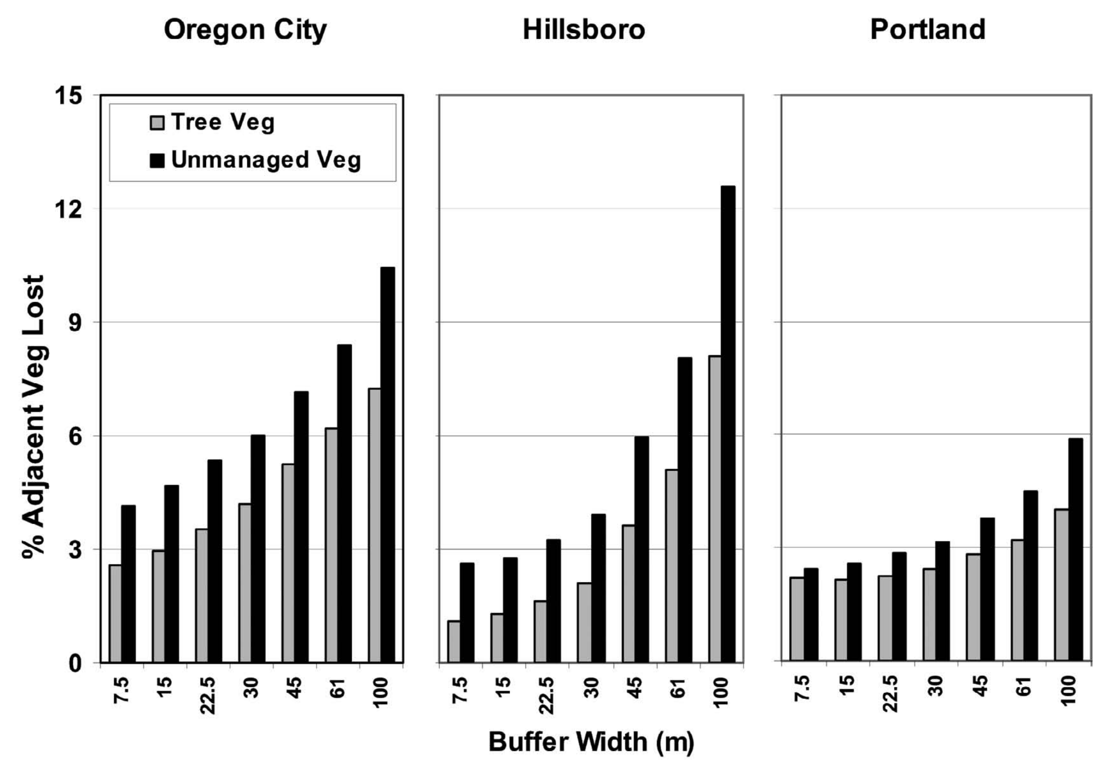


Figure 5. Percent Adjacent Riparian Vegetation Lost from 1990 to 1997. Shown in each graph are percent riparian area lost for both adjacent tree and adjacent unmanaged vegetation from 1990 to 1997 for the cities of Oregon City, Hillsboro, and Portland.

1989 (Ozawa and Yeakley 2004) was actually effective at lowering riparian losses. A secondary possibility is that Portland's streams were protected due to having a large number of streams located on public park land (for example, the ca. 2000 ha Forest Park, located in the northwest part of the city, fig. 2). Further analysis is necessary to determine which factor was more important to Portland's success, but we suggest that both factors (environmental zoning, streams located in public parks) were in play. It should be noted that our analysis does not include streams that have been permanently removed, and here Portland has suffered the most historical loss of streams among the three cities.

While our comparison of the three cities shows differential amounts of loss, an overriding result is that riparian buffer loss occurred regardless of either state or local regulatory efforts. Riparian vegetation loss appears to be an unfortunate consequence of population growth and development activities, and municipalities have yet to factor in the ecological or economic costs of such losses in terms of ecosystem services (Daily and others 1997). We are well underway with an effort to further document losses for these cities from 1997 to 2002, and our preliminary findings indicate that these loss trends have continued. Thus, while Portland shows hopeful signs of stemming the loss of riparian vegetation resources, our results show that the regulatory tools employed to date will likely be only partially successful at best.

Future research that controls for topographic, economic, land use and ownership factors may clarify the relative effectiveness of different regulatory approaches. Additionally, refining our understanding of the types, distribution and patterns of riparian vegetation that satisfy ecological functions, such as habitat connectivity, may enable us to develop more targeted management tools, focus implementation investments, and thereby increase overall effectiveness. Also promising and not to be overlooked are the pro-active efforts of both citizens groups and municipalities to restore riparian vegetation areas. Each of these approaches suggests compelling avenues for research to inform management strategies for preventing riparian resource losses during development.

Acknowledgments

Funding for this research was provided by a grant from Portland State University. Research assistants on the project have included Shannon Axtell, Richard Friday, Jennifer (Shively) Hughes, Melanie Sharp, and Jessica Sladek.

References

Abbott, C.; Adler, S.; Howe, D. 1996. Planning the Oregon way. Corvallis, OR: Oregon State University Press. 328 p.

Budd, W. W.; Cohen, P. L.; Saunders, P. R. 1987. Stream corridor management in the Pacific Northwest: 1. Determination of stream corridor widths. Environmental Management. 11: 587-597.

Castelle, A. J.; Johnson, A. W.; Conolly, C. 1994. Wetland and stream buffer size requirements - a review. Journal of Environmental Quality. 23: 878-882.

Daily, G. C. 1997. Nature's services: societal dependence on natural ecosystems. Washington, DC: Island Press. 392 p.

Furfey, R.; Budhabhatti, J.; Putnam, L. 1997. Policy analysis and scientific literature review for Title 3 of the urban growth management functional plan: water quality and floodplain management conservation. Portland, OR: Metro. 57 p.

Hennings, L. A.; Edge, W. D. 2003. Riparian bird community structure in Portland, Oregon: habitat, urbanization and spatial scale. The Condor. 105: 288-302.

Lowrance, R.; Todd, R.; Fail, J.; Hendrickson, O.; Leonard, R.; Asmussen, L. 1984. Riparian forests as nutrient filters in agricultural watersheds. Bioscience. 34: 274-277.

Metro. 2002. Regional Land Information System (RLIS) data <http://www.metro-region.org.

Naiman, R. J.; Décamps, H. 1997. The ecology of interfaces: riparian zones. Annual Reviews of Ecology and Systematics. 28: 621-658.

Naiman, R. J.; Bilby, R. E.; Bisson, P. A. 2000. Riparian ecology and management in the Pacific coastal rainforest. BioScience. 50: 996-1011.

Ozawa, C. P.; Yeakley, J. A. In press. Keeping the green edge: stream corridor protection in the Portland metropolitan region. In: Ozawa, C. P., ed. The Portland edge: challenges in growing communities. Washington, DC: Island Press.

O'Neill, M. P.;Yeakley, J. A. 2000. Biogeographic variation and riparian plant species diversity in an urbanizing Oregon basin. In: Wigington, P. J.; Beschta, R. L., eds. Riparian ecology and management in multi-land use watersheds. Bethesda, MD: Amercian Water Resources Association: 311-316.

Pauleit, S.; Duhme, F. 2000. Assessing the environmental performance of land cover types for urban planning. Landscape and Urban Planning. 52: 1-20.

Platt, R. H.; Rowntree, R. A.; Muick, P. C., eds. 1994. The ecological city: preserving and restoring urban diversity. Amherst, MA: University of Massachusetts Press.

Schuft, M. J.; Moser, T. J.; Wigington, P. J.; Stevens, D. L.; McAllister, L. S.; Chapman, S. S.; Ernst, T. L. 1999. Development of landscape metrics for characterizing riparian-stream networks. Photogrammetric Engineering & Remote Sensing 65: 1157-1167.