Edited by Constance T.F. de Brun

The Economic Benefits *of* Land Conservation

THE TRUST *for* PUBLIC LAND

CONSERVING LAND FOR PEOPLE

About The Trust for Public Land

The Trust for Public Land (TPL) conserves land for people to enjoy as parks, community gardens, historic sites, rural lands, and other natural places, ensuring livable communities for generations to come.

TPL's Conservation Initiatives

- *Parks for People*: Working in cities and suburbs across America to ensure that everyone—in particular, every child—enjoys close-to-home access to a park, playground, or natural area.
- *Working Lands*: Protecting the farms, ranches, and forests that support land-based livelihoods and rural ways of life.
- *Natural Lands*: Conserving wilderness, wildlife habitat, and places of natural beauty for our children's children to explore.
- *Heritage Lands*: Safeguarding places of historical and cultural importance that keep us in touch with the past and who we are as a people.
- *Land & Water*: Preserving land to ensure clean drinking water and to protect the natural beauty of our coasts and waterways.

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- *Conservation Vision*: TPL helps agencies and communities define conservation priorities, identify lands to be protected, and plan networks of conserved land that meet public need.
- *Conservation Finance*: TPL helps agencies and communities identify and raise funds for conservation from federal, state, local, and philanthropic sources.
- *Conservation Transactions*: TPL helps structure, negotiate, and complete land transactions that create parks, playgrounds, and protected natural areas.
- *Research & Education*: TPL acquires and shares knowledge of conservation issues and techniques to improve the practice of conservation and promote its public benefits.

Since 1972, TPL has worked with willing landowners, community groups, and national, state, and local agencies to complete more than 3,000 land conservation projects in 46 states, protecting more than 2 million acres. Since 1994, TPL has helped states and communities craft and pass over 330 ballot measures, generating almost $25 billion in new conservation-related funding.

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Cover photos: Jerry and Marcy Monkman

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Foreword

Too often we hear that communities can't afford to create parks, preserve farms, conserve open space, and protect watershed landscapes. But at The Trust for Public Land we know conservation is not an expense, but an investment that pays many dividends, including economic ones.

Government officials and business leaders want to know how conserving land affects a community's finances. And volunteer conservationists are hungry for information that will help them make the case for conservation as a solid economic choice.

How will land conservation affect government revenues and expenses? Is setting aside land for parks and open space good or bad for business and employment? TPL is proud to share research that answers those questions. The five research studies in this report come from acknowledged experts in their fields. Taken together, the papers confirm that strategic land conservation promotes sound economic growth.

This is one of several TPL publications making the case for the many benefits of parks. Please visit our website at www.tpl.org for the very latest reports, information, and publications.

We hope you find this report helpful in your work. Conservation is good for communities in so many ways. Here is specific evidence that, in particular, it is good for the bottom line.

Will Rogers
President, The Trust for Public Land

Preface

Does land conservation protect the bottom line? Leading experts in the field assert that it does. This book presents their quantitative and authoritative research on the economic benefits of land conservation. It brings together for the first time scientists, economists, and researchers from all sectors—academia, government, nonprofits, and industry—to summarize the best current studies, to present new original research, and to suggest areas for further inquiry into the economic benefits of land conservation.

This book grew out of the success of The Trust for Public Land's (TPL) 1999 report, *The Economic Benefits of Parks and Open Spaces,* which offered case studies of how land conservation has helped communities grow smart, attract investment, revitalize cities, boost tourism, protect farms and ranches, prevent flood damage, and safeguard the environment. Eight years later, the report is still the number one downloaded item from our website, as elected officials and citizens demand information on land conservation as a sound investment strategy.

In Chapter 1, John Crompton illustrates that parks and open space generate increased property tax revenue and yield a better return on investment than development. In Chapter 2, Lori Lynch reviews the economic benefits of farmland preservation, including maintaining viable local economies and protecting rural and environmental amenities. In Chapter 3, Caryn Ernst, Richard Gullick, and Kirk Nixon find that forest cover decreases the cost of treating drinking water. In Chapter 4, David Nowak, Jun Wang, and Ted Endreny enumerate the economic value of urban trees, which improve air and water quality. In Chapter 5, John Crompton examines the role of parks and open space in attracting businesses and affluent retirees.

In sum, the contributors to this book demonstrate that a strategy of land conservation is integral to economic health, from maintaining parks and open space to preserving farmland to protecting urban trees and forests around drinking water sources.

TPL gratefully acknowledges the Surdna Foundation, without whose generous financial support this book would not have been possible. I would also like to recognize and thank the following for their invaluable contributions to this project: Ernest Cook, Karen Foster, Kelley Hart, Brian Lehman, Jeremy Morgan, Amy Mullen, Janet Pawlukiewicz, Edith Pepper, Matthew Shaffer, Debra Summers, David Sweet, and Matt Zieper.

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March 2007

Chapter 1

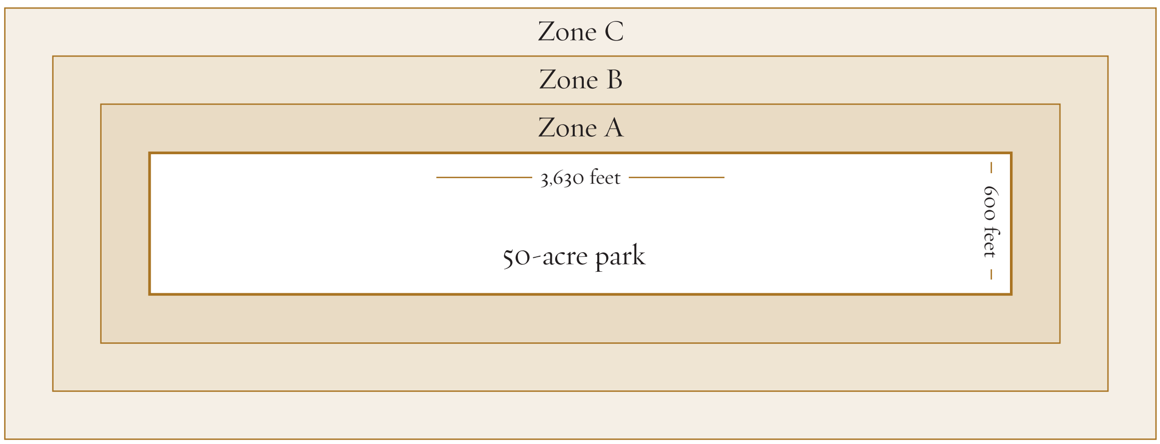
The Impact of Parks and Open Spaces on Property Taxes

John L. Crompton, Texas A&M University

FORMULATION OF THE PROXIMATE PRINCIPLE

The proximate principle states that the market values of properties located near a park or open space (POS) frequently are higher than those of comparable properties located elsewhere. The higher value of these properties means that their owners pay higher property taxes. The increment of those taxes that is attributable to the POS may be used to retire bonds issued to acquire, develop, or renovate it. In some cases, the increment is sufficient to fully meet these debt charges. The proximate principle is illustrated in figure 1.1.

Figure 1.1 Layout of a 50-acre Natural Park



Scenario

1. If properties around the park were 2,000-square foot townhouses on lots sized 60 feet by 90 feet with the 60-feet frontages on the park, then there would be 140 lots in Zone A (60 lots along each of the 3,630-feet perimeters and 10 lots along each of the 600-feet perimeters). Assume there are also 140 lots in Zones B and C. .
2. Assume total property taxes payable to city, county, and school district are 2 percent of the market value of the property.
3. Assume the market value of similar properties elsewhere in the jurisdiction beyond the immediate influence of this park is $200,000.
4. Assume the desire to live close to a large natural park creates a willingness to pay a premium of 20 percent for properties in Zone A, 10 percent in Zone B, and 5 percent, in Zone C. A review of empirical studies (Crompton 2004) suggests these values are a reasonable point of depart

Figure 1.2. Proximate Impact on the Neighborhood

Zone	Market Value of Each Home	Incremental Value Attributed to Park	Total Property Taxes at 2%	Incremental Property Taxes Attributed to Park	Aggregate Amount of Property Tax Increments Given 140 Home Sites
A (20% premium)	$240,000	$40,000	$4,800	$800	$112,000
B (10% premium)	$220,000	$20,000	$4,400	$400	$56,000
C (5% premium)	$210,000	$10,000	$4,200	$200	$28,000
Outside park's influence	$200,000	$0	$4,000	$0	$0
				Total	$196,000

Figure 1.1 shows a hypothetical 50-acre park situated in a suburban community and surrounded by townhouses. It is a natural resource–oriented park with some appealing topography and vegetation. The cost of acquiring and developing it (fencing, trails, supplementary planting, some landscaping) is $20,000 an acre, so the total capital cost is $1 million. The annual debt charges for a 20-year general obligation bond on $1 million at 5 percent are approximately $90,000.

Figure 1.2 develops the annual income stream attributable to the presence of the park that would be available to service the bond debt. The annual incremental property tax payments from the premiums attributable to the presence of the park amount to $196,000, which far exceeds the amount needed to pay the annual debt charges.

In the formative years of urban park development in the United States, from the 1850s through the 1930s, many elected officials authorized this investment of public resources believing that such an investment paid for itself. Officials observed that people frequently were willing to pay a larger amount for a home located close to a POS. This observation was bolstered by empirical evidence provided in the early annual reports published by the Central Park Commissioners in New York City about the change in land values that occurred when the park was constructed. The commissioners reported in 1873 that after paying the annual debt charge of $830,000 for the acquisition and development of Central Park, the city of New York received a net profit of $4.4 million from the increments in tax revenues attributable to the park. These remarkable results were confirmed and reinforced by other anecdotal and empirical evidence in these early years of urban park development.

Landscape architect Frederick Law Olmsted developed Central Park, and his firm subsequently designed 3,000 parks over the next 90 years, so its influence was widespread. The firm's advocacy of the proximate principle was consistent and pervasive. Thus, in 1868, writing to the future developers of Riverside, Chicago, Olmsted spoke of the "vast increase in value of eligible sites for dwellings near public parks" (Miller 2001). More than 50 years later in 1919, his son Frederick Law Olmsted, Jr. continued to espouse the mantra: "It has been fully established that … a local park of suitable size, location and character, and of which the proper public maintenance is reasonably assured, adds more to the value of the remaining land in the residential area which it serves than the value of the land withdrawn to create it" (Olmsted 1919).

Figure 1.3. Early Examples of the Perceived Influence of the Proximate Principle on Property Values

- In Madison, Wisconsin, a citizens committee appointed to investigate and report on the amount of increase in the city's assessed value of property attributable to parks concluded:

  > In our judgment, from ten to fifteen percent of the increase in the value of taxable property in the city of Madison during the period mentioned is attributable to the establishment of parks, drives, playgrounds, and open spaces in and around the city of Madison, by and through the activities of the city, its citizens and the Park and Pleasure Drive Association.

  When translated into dollar terms, the committee concluded that the increased tax revenues the city received from the presence of its parks "are meeting all the expenses of their maintenance, and all interest charges on the investment, and, in addition, are paying into the city treasury at least $10,000 to be expended by the city for other municipal purposes."

- The Hartford Park Commission, Connecticut, reported:

  > A careful examination shows that the parks constructed during the last ten years have increased the ground list by a sum equal to that expended by the city in their purchase and development, and have gone far toward making up that which has been taken from the tax list. This increase will continue for years.

- The park superintendent of Keney Park in Hartford reported: "If the influence of Keney Park is considered to exist only one thousand feet from its borders, then the value of the lands abutting it is probably four times the value they were sixteen years ago."

- The superintendent of parks in Kansas City stated:

  > Any wide awake city can establish its park system without one cent of general indebtedness to the city. In other words, the enhancement in values of benefited lands will be more than sufficient to pay the cost of the acquisition and improvement of the park system. Tills will impress you as being a too optimistic view, yet in our own city it is a fact recognized and not disputed with reference to boulevards, and to a somewhat lesser degree with reference to parks and parkways... . In Kansas City, at least, the effect of park and boulevard improvements has been the enhancement of land values far in excess of the whole cost of the acquisitions and improvements of their park system... . Wherever this work has been properly executed and maintained, it should be considered an investment and not a tax.

Source: Nolen (1913).

In a 1913 article published in Landscape Architecture entitled "Some Examples of the Influence of Public Parks in Increasing City Land Values," a Harvard professor provided multiple illustrations of cities and park commissions, using the proximate principle to justify their investments in urban parks, some of which are reported in exhibit 1.2 (Nolen 1913). Thus, from the 1850s to the 1930s, there was an insistent, almost inviolate conviction in the legitimacy of the proximate principle, not only among park and open space advocates, but also among planners and elected officials.

However, the rudimentary studies that provided the empirical evidence verifying the principle were naive, reflecting the underdeveloped nature of the statistical tools and research designs available in that era. The evidence was limited to simple calculations of increased tax receipts accruing from properties in proximity to parks. This ignored the array of other factors that could have influenced property values in addition to parks.

CONTEMPORARY EVIDENCE

Between the 1930s and the 1970s the proximate principle virtually disappeared from mainstream discussions of parks and open space, in part because of skepticism stemming from an awareness of the naiveté of the early studies that purported to verify the principle. Its resurrection in the last two decades has coincided with the increased capability of computing, which has made feasible more complex analyses enabling the economic contributions of parks and open space to property values to be quantitatively identified and distinguished from those attributable to other possible contributions.

Approximately 20 studies investigating the issue have appeared in the past two or three decades. Most of the results have been published in peer-reviewed journals, which suggests that the studies meet the standards of good social science research. They overwhelmingly verified the legitimacy of the proximate principle. Figures 1.4, 1.5, 1.6, and 1.7 illustrate the results reported by these studies (for a detailed review of them, see Crompton [2004]). The studies demonstrated that the proximate effect is substantial up to 500–600 feet away from the park (typically three blocks). In the case of community-sized parks over, say, 30 acres, the effect may be measurable out to 1,500 feet, but 75 percent of the premium value generally occurs within the 500–600-foot zone. The studies suggested that a positive impact of 20 percent on property values abutting or fronting a passive park area is a reasonable point of departure for estimating the magnitude of the impact of parks on property values. A series of studies (Ernst and Young 2003) conducted in New York City reported that similar positive impacts emerged when substantial capital investment was made in renovating existing parks that had deteriorated.

Figure 1.4. Impact of a Greenbelt on Boulder, Colorado

A frequently cited study examined the effect of greenbelts on property values in three different areas of Boulder, Colorado. A total of 1,382 acres of greenbelt had been purchased adjacent to residential developments. The study's results showed that, other things being equal, there was a $4.20 decrease in the price of residential property for every foot one moved away from the greenbelt. This suggested that if other variables were held constant, the average value of properties adjacent to the greenbelt was 32 percent higher than those located 3,200 walking feet away.

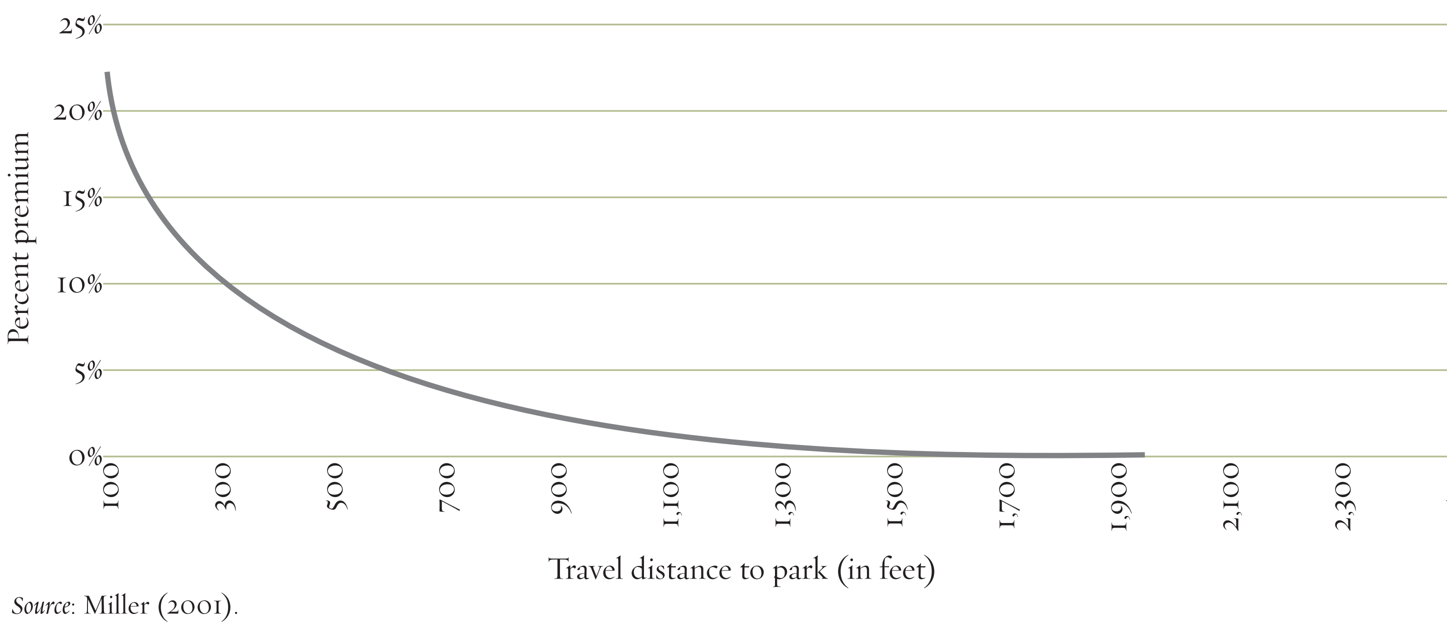
One of the three neighborhoods had been able to take much greater advantage of the open space amenity in its planning than the other two neighborhoods, so the authors initiated further analyses on it. In this neighborhood, price decreased $10.20 for every foot one moved away from the greenbelt. This resulted in

> the aggregate property value for the neighborhood being approximately $5.4 million greater than it would have been in the absence of greenbelt. This increment resulted in an annual addition of approximately $500,000 to the potential neighborhood property tax revenue. The purchase price of this greenbelt for the city was approximately $1.5 million, and thus, the potential property tax revenue alone would allow a recovery of initial costs in only three years.

Source: Correll et al. (1978).

Figure 1.5. Impact of 14 Neighborhood Parks on Adjacent Neighborhoods in Dallas–Fort Worth

The 14 parks were between 2.5 acres and 7.3 acres except for two that were 0.5 and 0.3 of an acre. They were "intermittently maintained" and were selected because of their ordinariness rather than their excellence. The parks were in neighborhoods of single-family houses. The analysis was based on 3,200 residential sales transactions. The price effects compared against home values a half mile from the parks are shown below. Homes adjacent to parks received an approximate price premium of 22 percent relative to properties a half mile away. Approximately 75 percent of the value associated with parks occurred within 600 feet of a park.



Source: Miller (2001).

Figure 1.6. Impact of Open Spaces on Residential Property Values in Portland, Oregon

A study in Portland, Oregon, was based on a sample of 16,747 single-family home sales. Parks were classified into three different categories: urban parks, natural-area parks, and specialty parks/facilities. The results showed that being within 1,500 feet of a natural-area park on average accounted for 16 percent of a home's sale price holding all other factors constant. The impacts of urban parks and specialty parks/facilities were 2 percent and 8.5 percent, respectively. The relatively low premium for the urban parks may be attributable in part to urban parks often having greater variations in quality. When the results are averaged across all parks in the city like this, they do not differentiate between good parks, which people will pay a high premium to live close to, and mediocre parks, which don't attract high premiums.

The impact of distance from each of the three types of area on home values is reported below. For example, a home located 401–600 feet away from a natural area park on average had a $12,621 premium (19.1 percent), while the average premium for a house adjacent to an urban park was $1,926 (2.9 percent). These data suggest that there are relative disadvantages to being located next to the facilities, since the largest premiums for the urban park, natural-area park, and specialty park/facilities were in the 201–400-, 401–600-, and 401–600-foot-distance bands, respectively.

Variations in Proximate Values at Different Distances for Each Open Space Type (1990$)*

Distance Variable	Urban Park	Natural Park	Specialty Park/Facility
≤200 ft.	$1,926	$11,210	$7,396
201–400 ft.	$2,061	$10,216	$5,744
401–600 ft.	$1.193	$12,621	$10,283
601–800 ft.	$817	$11,269	$5,661
801–1,000 ft.	$943	$8,981	$4,972
1,001–1,200 ft.	$1,691	$8,126	$4,561
1,201–1,400 ft.	$342	$9,980	$3,839

*Number of observations: 16,747; average home sale price: $66,198

Source: Lutzenhiser & Netusil (2001)

Figure 1.7. Impact of Greenbelt on Neighborhood Property Values in Austin, Texas

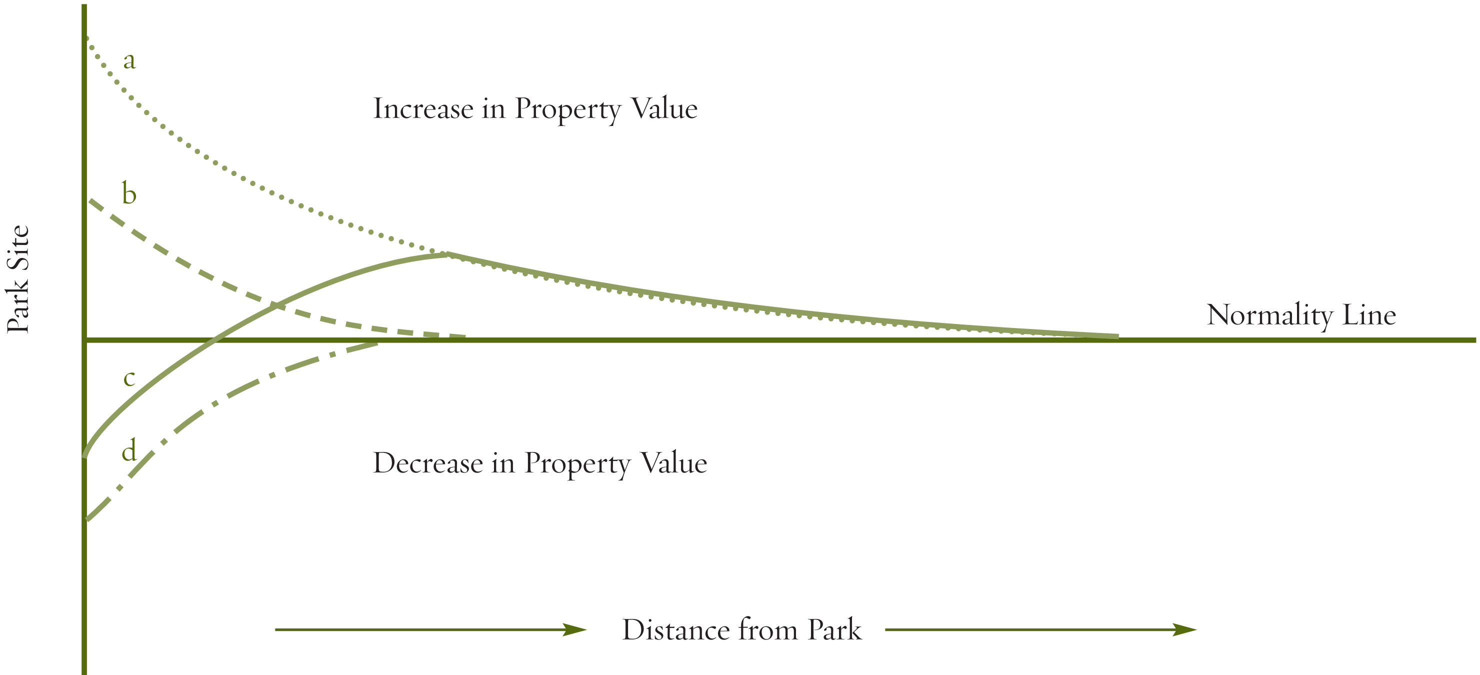
The Barton Creek Greenbelt in Austin, Texas, is a linear 171-acre natural area that stretches for more than seven miles west of downtown. Three neighborhoods abut it: Barton, Lost Creek, and Travis. Single-family home sales of 224, 240, and 236 dwellings, respectively, were used to measure the greenbelt's impact on property values. As shown below, the premium for adjacency to the greenbelt was highest in the Barton neighborhood, representing 20 percent of the average price of all homes in that neighborhood. The comparison criterion is important because all the homes impacted by the greenbelt are included in the average price. If the comparison criterion had been with houses beyond the direct impact of the greenbelt (say, 1,500 feet or more away), then it is likely that the premiums shown would have been substantially longer.

The lack of positive impact in the Lost Creek area was attributed to the different character of the greenway at that point. Homes directly adjacent to the greenway in Lost Creek were located on the edge of deep, thickly vegetated ravines that offered neither recreational access nor attractive views. The vegetation inhibited recreational access, and the views were of other properties across the ravines rather than of the green space. In the Travis area, where the proximate premium was relatively low, the topography of the land did not allow for non-adjacent properties to enjoy a greenbelt vista, so the premium was primarily a reflection of the value accorded proximate access. The last column in the figure shows the decline in value with each foot of distance away from the greenbelt.

Neighborhood	Home Sale Prices			Adjancency Premium	Adjancency Premium %	Decline in Value per Foot from Greenbelt
	High	Low	Mean			
Barton	$550,000	$105,000	$220,000	$44,000	20%	$13.51
Lost Creek	$899,000	$179,000	$356,000	$0	0%	$3.97
Travis	$392,000	$130,000	$233,000	$16,000	6%	$10.61

Source: Nicholls & Crompton (2005a)

Figure 1.8. Alternate Scenarios Reflecting the Range of Impacts That Parks and Open Spaces May Exercise on Property Values



Both positive and negative impacts on property values are possible. The figure shows four alternate scenarios reflecting the range of impacts that parks and open spaces may exercise on proximate property values:

a) A large, high-quality, natural resource-based, signature park that is well maintained to which residents are passionately attached. The measurable positive impact on property value may extend out to 2,000 feet.
b) A smaller high-quality, natural-resource based, community-level park, with some charm and dignity, that is well maintained and regarded with affection by the community. The measurable positive impact on property values may extend out 500 feet.
c) A large, intensively used park with athletic facilities, floodlights, noise, congestion at the entrances, and extensive traffic. These factors lead to negative values on properties in close proximity to the park, but benefits accrue to those living away from the immediate nuisance but within easy access, typically two or three blocks away.
d) A dilapidated, dirty, blighted park with decrepit facilities and broken equipment in which undesirable groups congregate. The community rejects it and regards it with disgust. The negative impact does not extend as far as the positive impact of scenario (a) because people avoid it.

In scenarios (a) and (b) property value benefit increments associated with proximity and accessibility decay as distance from the park increases. Scenarios (c) and (d) suggest that any negative values are likely to be limited to properties in close proximity to the park, and these will decay more rapidly than positive impacts as distance from the park increases—that is, the positive curve is likely to be flatter than the negative curve.

The evidence shows that the type of park also influences the premium: passive parks generate the greatest premium, while properties adjacent to an active park may decline in value. Figure 1.8 presents four alternate scenarios in a generalizable model illustrating the range of impacts that parks and open spaces may exercise on proximate property values.

In addition to the noise and congestion emanating from active-use parks, other conditions that negated any positive impact included (1) poorly maintained parks, (2) lack of visibility from nearby streets, which provide better opportunities for antisocial behavior, and (3) properties whose privacy was compromised from backing onto linear parks.

Like all other goods, the premiums that people are prepared to pay to be proximate to a park or open space are influenced by the available supply. If such amenities are relatively abundant, then the premiums will likely be relatively small or nonexistent. Thus, in rural areas where there is plentiful open space, the incentive to pay a premium to be close to a park is likely to be lower than in densely populated urban areas where open space is rare. Similarly, if homes in an area have large private yards, then it is likely that premiums will be lower than in areas with little private space because privately owned yard space may act as a partial substitute for public park space.

Three additional points are worth noting:

1. If state or federal grants are available to pay for part of a park's construction and development, then the probability increases that the revenue stream from the incremental increases in taxes will cover the local community's capital investment in the park.
2. Incremental property tax income attributable to a park continues to accrue to a community after the debt charges are repaid, at which time the net return to the community will be substantially greater.
3. The proximate principle captures only the "private" benefits that accrue to proximate homeowners. It does not capture the economic value of:
    a) "public" benefits that are received by the whole community such as reduced soil erosion, wildlife habitat enhancement, and improved water quality; or
    b) users of the park who live outside the proximate area whose home prices are, therefore, not influenced by the park..

THE GOLF COURSE ANALOGY

The approximately 1,000 residential golf communities that have been developed in the United States in the last decade offer ipso facto evidence of the proximate principle (Mulvihill et al. 2001). Design and construction of an 18-hole golf course is likely to cost between $3 million and $8 million, but in addition a developer's investment includes lost revenue from lots that could have been sold on the 150–200 acres of land used for the golf course. If the average density of the development is three lots per acre, this means that the developer forgoes the revenue from 450–600 lots, which at, say, $40,000 each amounts to between $18 million and $24 million. Thus, the developer's total investment may be on the range of $20 million to $30 million.

Typically, in golf course communities, approximately 30 percent of households contain a member who plays golf on the course (Nicholls and Crompton 2005b). There may be many reasons why the other 70 percent purchase homes in a golf course community, but a primary factor is likely to be the green space, ambience, and aesthetic appeal the extensive green area of the course offers. Since developers are profit oriented, it is clear that premiums generated from properties in the subdivision exceed the cost of their substantial investment in open space. In this respect, the private market place offers further validation of the legitimacy of the proximate principle.

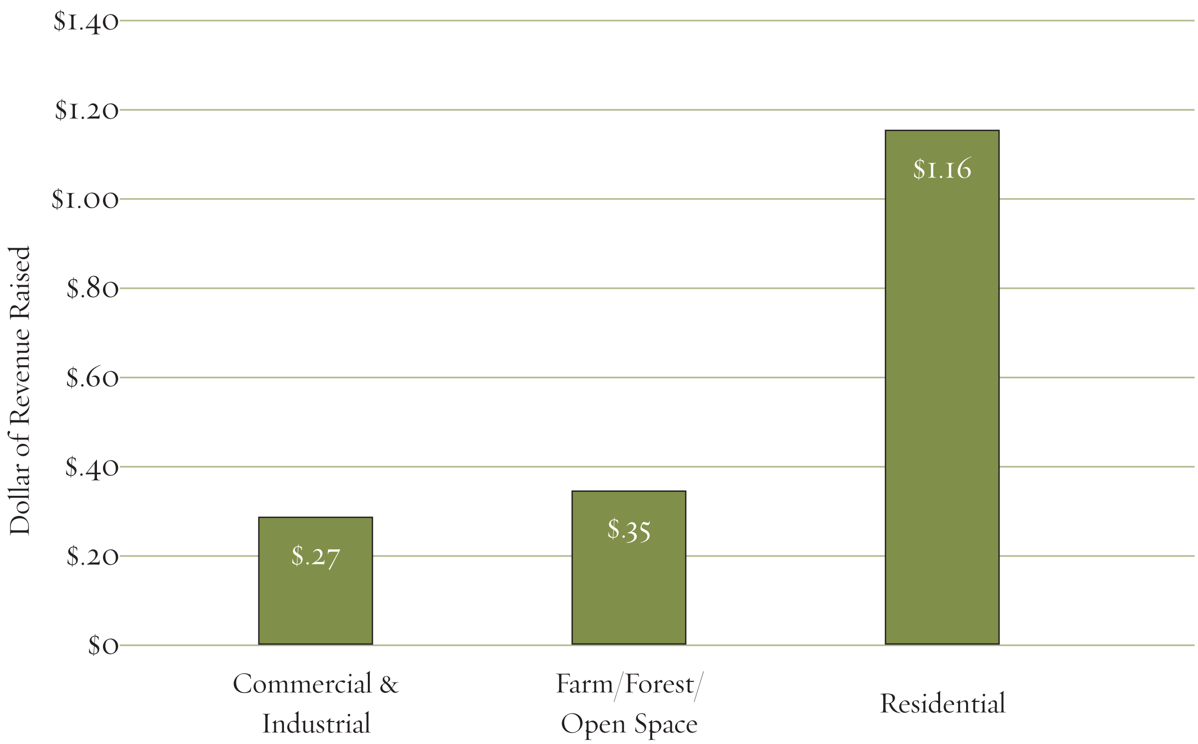
THE ROLE OF PARK AND OPEN SPACE LANDS IN REDUCING TAXES

The empirical evidence overwhelmingly supports the proximate principle. However, in urban/suburban contexts where land is in relatively short supply, the question may not be whether to invest in parks and open space per se, but rather whether such an investment is likely to yield a better return than if the land were to be used for development.

The conventional wisdom among many decision makers and taxpayers is that development is the "highest and best use" of vacant land for increasing municipal revenues. The belief is that development increases the tax base and thereby lowers each individual's property tax payments. Hence, larger property tax revenues are likely to accrue to communities if land is built out with homes rather than used as parks or open space.

In most situations, this conventional wisdom is erroneous. When open space is transformed into homes, the taxes of existing residents invariably increase because while development generates tax revenue, the cost of providing public services and infrastructure to that development is likely to exceed the tax revenue emanating from it. This conclusion emerges from a review (Crompton 2004) of cost of community services studies reported by more than 50 research teams in 21 states.

Figure 1.9. The Median Cost to Provide Public Services to Different Land Uses per Dollar of Revenue Raised*



* n = 98 communities.

Source: Crompton (2004)

Figure 1.9 provides a summary of these results, showing the median cost among almost 100 studies of per dollar of revenue raised to provide public services to each of three different land uses. Thus, for every $1 million in tax revenues these communities received from commercial/industrial uses and from farm/forest/open space uses, the median amount they had to expend was only $270,000 and $350,000, respectively, to provide them with public services. In contrast, for every $1 million received in revenues from residential developments, the median amount the communities had to expend to service them was $1,160,000. The results of these studies indicate that favoring residential development at the expense of open land does not alleviate the financial problems of communities. Indeed, it is likely to exacerbate them.

Figure 1.10. Using Open Space to Reduce Taxes

- The city of Naperville, Illinois was almost built out. The remaining undeveloped area was in the southwest of the city. The city's planners reported that if the area were developed as projected in the existing master plan, then it would attract an additional 7,711 people, of whom 1,820 would be school age. Within this undeveloped zone, the city master plan showed that 125 acres would be parkland or open space.

  The city was concerned about the cost of servicing this new population, especially the costs associated with providing schools for it. Accordingly, the city revised the master plan, expanding the open space acreage to 205 acres. The revised plan projected the school-age population would be 1,104, a reduction of 716 from the original plan. This meant that the residents of Naperville would save the costs of building, staffing, and operating one new school. This cost was much greater than the tax that would have accrued from the additional residences that would have been built in the original plan. The cost of acquiring and maintaining the additional parkland was projected to be much lower than the ongoing net deficit associated with building and operating the additional school.
- Yarmouth, Maine, a community on the state's rugged Atlantic coast, chartered a citizens' committee to examine the pros and cons of developing a parcel of land outside the town. The committee found that (1) if the property were developed, service costs would be $140,000 a year greater than the tax revenue the project would generate and (2) the city could purchase the entire property for $76,000 a year over a 20-year period. As a result, residents overwhelmingly approved a referendum to issue $1.5 million in bonds for open space acquisition.
- In Wayland, Massachusetts, it was found that development of 1,250 acres of open space would cost taxpayers $328,350 a year more than they would receive in added tax revenues from new homes. This represented a $7.75 increase in the tax rate. On the other hand, purchasing the property would only add $4.25 to the tax rate.

Sources: Crompton (2004). Howe and Papst (1997). Todd (n.d.).

The evidence clearly indicates that preserving open space can be a less expensive alternative to development. Hence, a number of communities have elected to purchase park and open space land, rather than allow it to be used for residential development, because this reduces the net tax deficit for their residents, which would occur if new homes were built on that land (figure 1.9). The conclusion is that a strategy of conserving parks and open space is not contrary to a community's economic health, but rather it is an integral part of it.

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Chapter 2

Economic Benefits of Farmland Preservation

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Many people support the preservation of farmland for food security, local economic viability, and amenity benefits. As early as 1977, Gardner proposed four economic benefits that can be derived from the protection of productive agricultural land: (1) a viable local agricultural industry with employment opportunities, (2) protection of rural and environmental amenities, (3) local and national food security, and (4) orderly and fiscally sound development of urban and rural land. Rural and environmental amenities could include views of cows in the meadow or fields of flowing wheat, open fields where rainfall lands to recharge the groundwater, and areas where wildlife can find habitat.

Researchers used surveys to determine which of these benefits were important to individuals and local communities considering a farmland preservation program (figure 2.1). In general, the public favors a mix between agricultural objectives, such as local food production and a rural way of life, and environmental objectives, such as water quality and wildlife habitat. Also frequently mentioned are rural amenities that can incorporate both agricultural and environmental objectives as well as include attributes like scenic quality. Farmland preservation programs themselves have sought to preserve a productive land base for the agricultural economy, preserve the amenity values of open space and rural character, slow suburban sprawl, provide wildlife habitat, and provide an opportunity for groundwater recharge in areas where suburban development is occurring (Bromley and Hodge 1990; Fischel 1985; Gardner 1977; McConnell 1989; Wolfram 1981; Lynch and Musser 2001).

Figure 2.1. Characteristics People Consider Most Important When Preserving Farmland

Papers	Most Important Characteristic of Farmland Preservation
Kline and Wichelns (1996)	Environmental objectives Protecting groundwater Wildlife habitat Preserving natural places Aesthetic objectives Rural character Scenic quality
Krieger (1999)	Local food supply Family farms Control development
Duke and Aull-Hyde (2002)	Agricultural way of life Local food supply Water quality
Bastian et al. (2002)	Land with wildlife habitat Fishing opportunities Scenic views
Nickerson and Hellerstein (2003)	Rural amenities Rural character Scenic beauty Wildlife habitat Food Security Environmental Objectives

Specifically, Kline and Wichelns (1996) found that Rhode Islanders favored environmental objectives, such as protecting groundwater, retaining wildlife habitat, and preserving natural places, and aesthetic objectives, such as preserving rural character and scenic quality. In another paper by Kline and Wichelns (1998), respondents specified that preserving fruit and vegetable farms and woodlands was most important, followed by cropland and land adjacent to water, but the rankings varied according to the objectives of the individual. For example, environmentalists favored forests, rural amenity seekers favored crop and pasture farmland, and agrarian people favored fruit and vegetable farmland.

Krieger (1999) found that people outside Chicago supported farmland preservation to ensure local food supply, protect family farms, and control development. The most important aspect of preserving open space was its role in slowing growth and reducing sprawl. To the Illinois respondents, continued sprawl meant the loss of scenic beauty, increases in air and water pollution, and loss of wildlife habitat.

Duke and Aull-Hyde (2002) found that Delawareans supported maintaining an agricultural way of life, having access to local products, and protecting water quality. People favored growth controls that preserved rural character rather than just controlled growth. Bastian et al. (2002) found that people would be willing to pay more for agricultural land that preserved wildlife habitat, offered angling opportunities, and provided scenic views in addition to agricultural production.

Many of the states mention these benefits when passing the laws to create the farmland preservation programs. Examining these laws, Nickerson and Hellerstein (2003) found that protection of rural amenities such as rural character, scenic beauty, and wildlife habitat is the most frequently mentioned objective, followed by food security and environmental services. The preservation programs ranked soil productivity/traditional agricultural uses and parcel size/contiguity as the most important. Thus, the programs favor preserving cropland, which in principle could provide the rural amenities that the public wants to preserve. While the ranking of objectives may vary from place to place, most individuals indicate the economic benefits outlined by Gardner as important reasons to preserve farmland. So what is the evidence concerning these benefits? Do local communities actually obtain what they think is important when preserving farmland?

A VIABLE LOCAL AGRICULTURAL INDUSTRY WITH EMPLOYMENT OPPORTUNITIES

Preservation does not mean that economic development stops. In fact, farmland preservation programs can signal a commitment to an industry that then stimulates the industry to invest and work to be successful rather than waiting to "sell out." A survey of farmers in four Maryland counties examined the difference in behavior between those who had participated in farmland preservation and those who did not. We found that farmland preservation participants were more likely to have invested in their farm in the last five years—66 percent compared with 55 percent for nonparticipants (figure 2.2).

In addition, the owners of the preserved farms were more likely to attend workshops to learn new technologies and enhance their farming skills (figure 2.3). Sixty percent of those farmers who had preserved their farms had attended workshops at least once compared with 38 percent of nonparticipants.

Seventy-eight percent of participants said they preserved their farm to keep it in the family and 42 percent said they wanted the money for their farm operation. Participants used the money they were paid to preserve their land in ways that may benefit the local economy (figure 2.4). For example, thirty-five percent of farmers used the money to reduce debt, thus making their operation more solvent. Another 28 percent saved the money or invested it in the farm. Eighteen percent used it to finance their farming operation. Twelve percent used the money to finance their retirement instead of selling the land to do so. Some bought additional land or farm equipment for their operation.

Figure 2.2. Investment Behavior of Farmland Preservation Participants and Nonparticipants

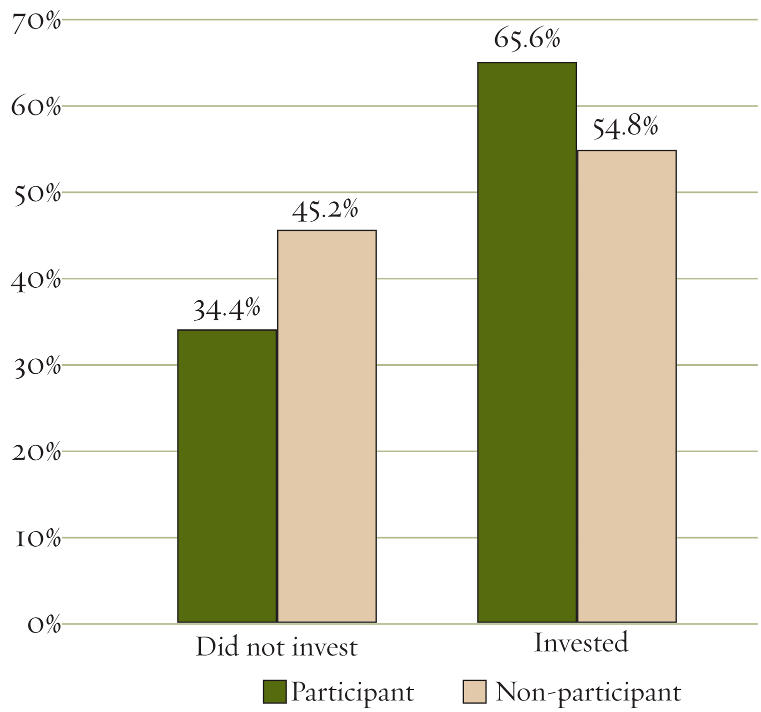


Figure 2.3. Workshop Attendance of Farmland Preservation Participants and Nonparticipants

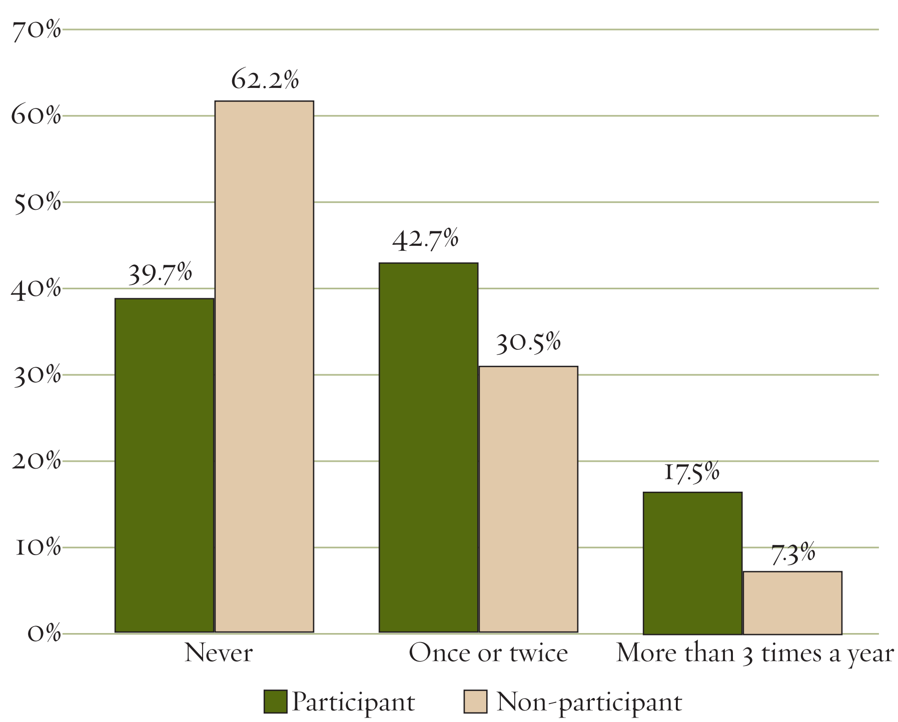
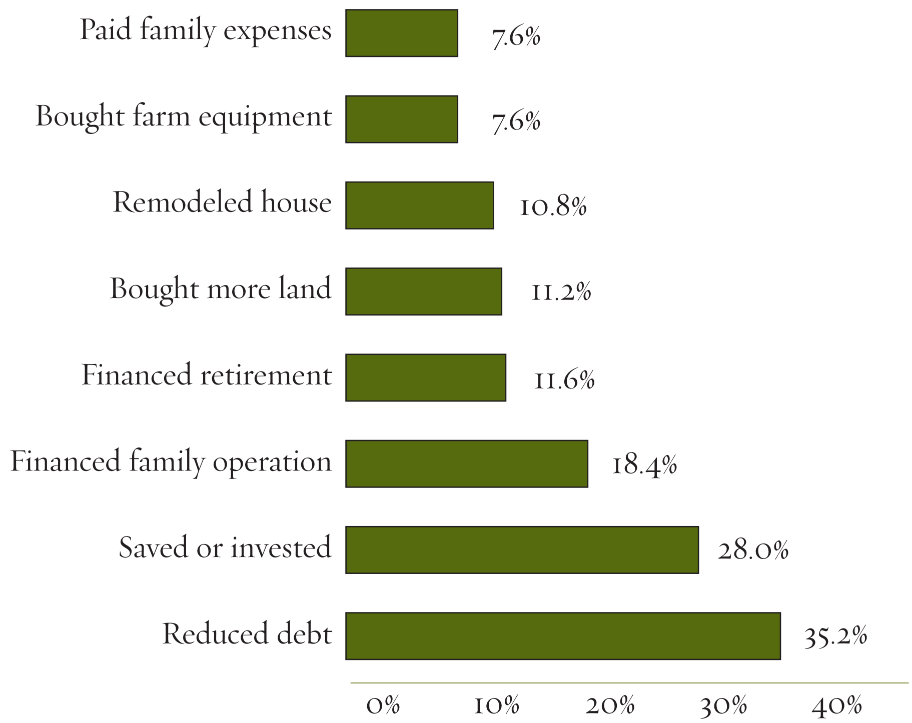


Figure 2.4. How Farmland Preservation Participants used their Easement Payments

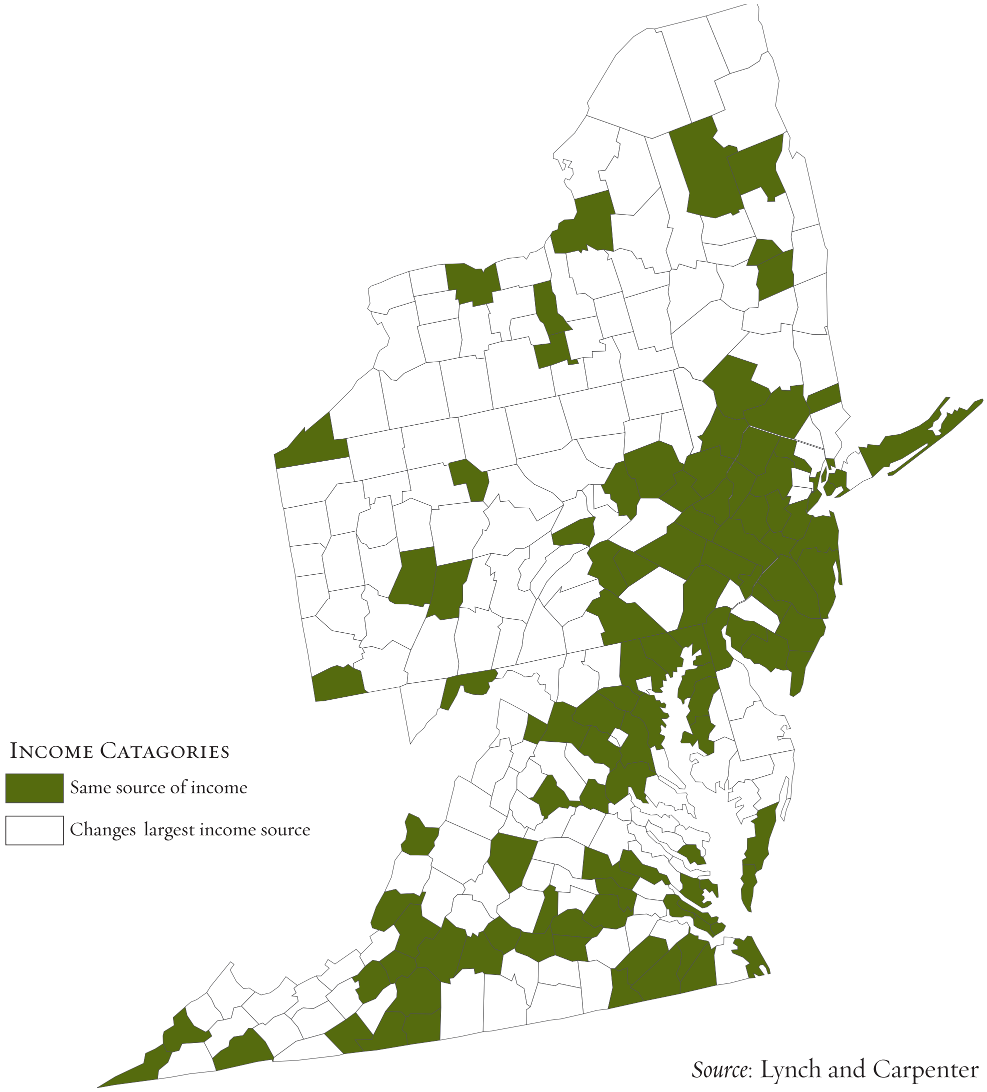


Participants were also most likely to have productive operations and planned to continue farming, according to Lynch and Lovell (2003). Growing crops, owning a larger farm, earning a high percentage of family income from farming, and having a child who plans to continue farming increased the likelihood of enrolling a farm in the preservation program. In more recent research on the mid-Atlantic states, we find that counties with farmland preservation programs have lower rates of farmland loss than similar counties without such programs. Therefore, investment in these types of programs helps to slow the rate of loss and ensures an ongoing industry.

This begs the question of how much land must be preserved to ensure a viable industry; that is, is there a critical mass threshold for the agricultural industry. While Lynch and Carpenter (2003) did not find strong evidence that a critical mass exists, they did find that counties with fewer than 50,000 acres of farmland had an annual rate of farmland loss of 2.36 percent compared with an average rate of 1.57 percent for all counties; counties with between 50,000 and 150,000 acres had a rate of farmland loss of 1.88 to 1.98 percent. They also found that 42 percent of the study's counties derived their largest share of income from a different commodity or animal source in 1997 than in 1949 (figure 2.5). They concluded that some agricultural sectors did not survive as agricultural land was lost but that counties could stem the tide of farmland loss if they adjusted their crop and/or livestock mix.

It is still possible that a critical mass for certain sectors may exist. For example, Adelaja, Miller, and Taslim (1998) indicated that because New Jersey no longer has a critical mass of dairy farmers, it does not offer all the extension programs and services to dairy farmers that the neighboring states provide, which can impact input costs and management quality.

Figure 2.5. Changes in Mid-Atlantic Counties' Highest Income Crop and/or Livestock between 1949 and 1997



Source: Lynch and Carpenter (2003).

In addition, preserving the agricultural industry provides open space attributes and rural amenities that can attract tourists and new residents to an area. Contrary to many communities' concerns that the conservation and preservation policies may have negative effects, Lewis, Hunt, and Plantinga (2002) found that communities that managed land for conservation purposes did not have lower employment growth rates. In fact, they found that when forestlands were managed for preservation uses rather than multiple uses (including extractive uses such as timbering), more people moved into the counties with more conservation land than moved out possibly because of the additional amenities such lands provided, although this effect was relatively small.

Furthermore, Lewis, Hunt, and Plantinga (2003) concluded that preservation policies do not cause the local community to shift from high-wage to low-wage jobs. Wage growth rates were not affected by the amount of land in conservation (nonextractive) uses compared to multiple (including timbering) uses. While these authors do not suggest that preservation or conservation policies are necessarily the best economic development stimulators, they clearly show that the impacts of these policies do not differ from those of resource extraction policies.

Similarly, Duffy-Deno (1997) found no effect from land preservation for wildlife habitat purposes on employment levels or growth rates. Examining 333 nonmetropolitan counties, he found that employment growth after the listing of endangered species and limits on development occurred was similar between counties that had listed endangered species habitat and those that did not.

Lynch and Carpenter (2003) found that the health of the local economy impacted the rate of farmland loss. Healthy local economies (higher employment rates and higher incomes) had lower rates of farmland loss, all else the same.

PROTECTION OF RURAL AND ENVIRONMENTAL AMENITIES

For many economists, rural and environmental amenities are the main reason why local communities might consider farmland preservation programs. Food supply/security and the agricultural economy have markets where goods and services are bought and sold. If people want to have locally grown food and a strong local agricultural economy, then they can patronize local farms and buy local goods to achieve those ends. However, rural amenities are not what we consider market goods—they are not bought and sold. Therefore, to ensure that they are preserved, some type of program or policy may be needed.

To assess how much people are willing to pay for these amenities as a signal for how much land should be preserved, economists use two approaches. One is to ask people directly how much they would be willing to pay to preserve farmland, giving them various scenarios to consider. The other is to evaluate actual housing sales in the market to determine whether the presence of preserved farmland, forest, and cropland increases or decreases the value of a house.

Using the survey method, research has found that the annual willingness to pay varies from $9 to $239 per household per year per thousand acres (Bergstrom, Dillman, and Stoll 1985; Beasley et al. 1998; Bowker and Didychuk 1994; Rosenberger and Walsh 1997; Johnston et al. 2001; McConnell and Walls 2005). Values are higher in areas that are losing agriculture more rapidly—Suffolk County in New York and Alaska as compared with a rural South Carolina county. Figure 2.6 outlines the average willingness to pay from some of these studies as well as the total values for all households in a particular area (2000$).

Halstead (1984) found that Massachusetts residents would have paid $28 to $60 per year to prevent the conversion of farmland to low-density housing and $70 to $176 to prevent high-density housing.

In South Carolina, Bergstrom, Dillman, and Stoll (1985) found lower numbers of households saying they would pay $9 to $16 per year per thousand acres to increase the number of acres preserved (2000$). The authors suggest that the reason for this lower number is that the area studied is predominately rural, so even if some agricultural land is lost that other agricultural land and the associated amenities are still quite close.

Beasley, Workman, and Williams (1986) examined the value to households of preventing the conversion of farmland near Fairbanks, Alaska. Households indicated they would pay $76 per year to avoid moderate development and $144 per year to prevent the conversion of most of the land (1984$). The region's value per acre was $830 (2000 $).

In Bowker and Didychuk's (1994) study, households in eastern Canada responded that they would pay $49 each to preserve 23,000 acres and up to $86 each to preserve 95,000 acres (1991$). The value then computes to $97 average value per acre (1991$).

Ready, Berger, and Blomquist (1997) found that people were willing to pay more taxes to retain land in thoroughbred horse farming in Kentucky. They estimated that the median value of a converted farm is about $0.49 per person per year (1990$). This increases as people perceive that a higher percentage of farms will be lost.

Rosenberger and Walsh (1997) found that households in Colorado will pay $86 to $162 to increase preserved ranchland from 25 percent to 50 percent and from 50 percent to 75 percent (1993$). People in the Rocky Mountains were willing to pay more than those in South Carolina and eastern Canada, similar amounts to those in Alaska but less than those in the urban fringe of Massachusetts.

In a slightly different type of study, Lopez, Shah, and Altobello (1994) found that two of the three studied rural communities in Massachusetts and Alaska had too few acres of farmland relative to the optimum amount suggested by the communities' value for farmland. Given the public's willingness to pay to retain agricultural land, the authors concluded that in highly urbanized areas, the local area would have been better off if more land had been preserved for agricultural uses.

Figure 2.6. Estimated Values to Society of Preserving Agricultural Land

Location (Papers)	Average Willingness to Pay per Household per Year per Thousand acres (2000$)	Measure of value aggregated over Households (2000$)
South Carolina (Bergstrom et al 1985)	$9–16	$23–61
Alaska (Beasley et al. 1998)	$126–239	$830
Eastern Canada (Bowker and Didychuk 1994)	$62–109	$123
Colorado (Ranchland) (Rosenberger and Walsh 1997)	$86–144	
Suffolk County, New York (Johnston et al. 2001)	$40–162	$1,355

Source: Extracted from table 2, "Estimated Values for Open Space Services from Stated Preference Studies" McConnell and Walls (2005).

Many studies (although not all) have found that people will pay more for houses near farmland (figure 2.7). Geoghegan, Lynch, and Bucholtz (2003) found that in two of the three Maryland counties they studied, adjacency to preserved farmland actually increased the value of nearby houses. Irwin (2002) found that people in Maryland are willing to pay more for a house near permanently preserved open space ($3,307) rather than pastureland that could be developed at some point in the future. Irwin suggests that people value open space because it is not development.

A study in Ohio (Irwin, Roe, and Morrow-Jones 2002) found that the value of preserving a single acre as permanent cropland is between $1 and $3 per year and from $12 to $38 per house (about 1 to 4 percent of housing value). Thorsnes (2002) finds that people are willing to pay $5,800 to $8,400 more for a lot or a house to be next to a forest. Sengupta and Osgood (2003) found that hobby ranchers would pay an extra $1,416 for their parcel to be next to greener pastures in the Southwest.

Ready and Abdalla (2005) found that open space within 400 meters of one's house increases its value in Pennsylvania. They also found that forestland increased housing value more than cropland or pastureland and that preserved land increased housing values less than developable land—the reverse of the Maryland studies (Geoghegan, Lynch, and Bucholtz 2003; Irwin 2002)—although forest, preserved land, and developable land all increase housing values. In their examination of the value of open space, McConnell and Walls (2005) concluded that people with higher incomes tend to value open space and will pay more for it.

Figure 2.7. Estimated Values of Agricultural and Forest Proximity

	Marginal Value (as percentage of mean house price)
Backing to forest preserve (Thorsnes 2002)	\$5,800–\$8,400 (19–35% of lot price; 2.9–6.8% of house price)
Conversion of 1 acre of pastureland to:	
Conservation land	\$3,307 (1.87%)
Forest land	-\$1,424 (-0.82%)
(Irwin, 2002)	
1 percent increase in the open space surrounding the house:	
Preserved land	\$0–1,306 (0–0.71%)
Unpreserved and convertible agricultural and forest land	-\$768–0 (-0.39–0%)
(Geoghegan, Lynch and Bucholtz 2003)	

Source: Extracted from table 1, "Estimated Values of Open Space Proximity from Selected Hedonic Price Studies," McConnell and Walls (2005).

PROPERTY TAX REVENUES

If housing prices increase when agricultural land is preserved, farmland preservation programs may actually increase the tax revenues of local communities even when the counties have preferential taxation programs. Geoghegan, Lynch, and Bucholtz (2003) found that preserved farmland increased the value of nearby houses enough to generate sufficient property tax revenues to enroll additional acres of agricultural land into the preservation programs. They concluded that agricultural preservation programs could be self-financing at least in the short term, although this may not hold in rural or predominately agricultural counties. Of course, communities could use the additional taxes for other purposes.

In addition, while the preferential taxation programs may result in agricultural lands paying less property tax than if they were taxed at the land's full market value, cost of community services studies across the United States have found that agricultural lands pay more in property taxes than the cost of the services they use; that is, agricultural land has a net positive benefit in terms of collected property taxes subsidizing residential development.

These programs have been instrumental in slowing the rate of farmland loss. Lynch and Carpenter (2003) found that counties with preferential taxation programs had a farmland loss rate of 0.81 percent, while counties without such a program had a loss rate of 1.58 percent. Counties with preferential taxation programs had farm loss rates almost 0.52 percent lower than counties without programs. Gardner (1994) and Blewett and Land (1988) had similar results. These programs also increase farmers' and landowners' wealth, which could stabilize the financial health of the agricultural operations (Chicoine, Sonka, and Doty 1982).

LOCAL FOOD SUPPLY

According to Fischel (1982) and Dunford (1983), while farmland is disappearing from certain regions, sufficient national land resources remain to ensure the nation's food security. However, many people are demanding and supporting a local source of farm products to obtain fresher products. The most common farmer-to-consumer direct operations are pick-your-own operations, roadside stands, farmers' markets, and direct farm markets. The number of U.S. farmers' markets more than doubled from approximately 1,200 in 1980 to more than 2,800 in 2000 (Festing 1998; Griffin and Frongillo 2003). Similarly, a newer way to obtain local farm produce is through a community-supported agriculture (CSA) group. The number of CSA groups in the U.S. continues to grow from an estimated 635 in 1996 to more than 1,000 in 1999 (Well and Gradwell 2001). In a CSA group, farmers share the economic risks with consumers who pay a preseason subscription to the farm in return for a weekly delivery of produce throughout the growing season. If the farm does well, participating consumers receive a bigger share of local produce, but if the farm has a bad year, they receive less. Preserving farmland helps ensure a continued supply of locally grown produce as a growing clientele of interested local customers helps farmers improve their economic well-being.

CONCLUSION

Farmland preservation can benefit local communities in many ways, resulting in economic viability, better quality of life, possibly positive fiscal impacts, and local produce. As farmland preservation programs mature, we also can learn from their histories how to make them operate more effectively to increase the positive impacts. For example, Lynch and Musser (2001) found that if transfer –of development rights programs allocated rights differently, they would be able to attain more of the programs' objectives.

For those observant readers who question why no mention was made of the impact on development patterns, this author was unable to find high-quality academic studies that addressed this issue well. This is not to suggest that farmland preservation has not had an impact on development patterns. Rather, the lack of research stems from methodological difficulties as well as the complexities of the issue given the multiple land use regulations in the country. More information on this topic definitely would be useful for communities when they confront this issue.

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Chapter 3

Protecting the Source: Conserving Forests to Protect Water

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In 2002, The Trust for Public Land (TPL), in cooperation with the American Water Works Association's (AWWA) Source Water Protection Committee, undertook a study to statistically assess the impacts of declining forest cover on the cost of treating drinking water. The researchers concluded that the cost of treatment for plants using surface water supplies varies depending on forest cover in the source area: the less forest cover, the more expensive the water treatment. The findings were published in the May 2004 edition of AWWA's journal, Opflow, and are reprinted here with the permission of AWWA.

Through a partnership with the U.S. Forest Service, TPL is currently expanding and refining the 2002 study. Information on treatment costs and water quality from approximately 80 drinking water treatment plants will be compared with recent land cover data for each water treatment plant's raw water source drainage areas. Other partners include professors from the University of Massachusetts at Amherst and the University of North Carolina's Institute of Government. Study results will be available by the summer of 2007 and will be disseminated broadly to individuals and organizations interested in this topic. If you have any questions or would like to be included in the distribution, please contact Kelley Hart at (202) 543-7552 or kelley.hart@tpl.org.

More than a century ago, many of America's fastest growing cities, such as Boston and New York, bought land in their source areas to provide lasting protection of water resources critical for sustaining their populations in the future. To this day, these cities, some of the largest in the country, have relatively clean source waters that require minimal treatment.

Advancements in science and technology have enabled water utilities to effectively treat most known contaminants from drinking water sources and to provide American citizens with some of the safest drinking water in the world. However, these advancements have contributed to a movement away from protecting and managing our source areas and to the unfortunate notion that the quality of our raw water supplies is less important.

Treatment alone, although critical to preventing disease, should not be the sole protection of our drinking water. Multiple barriers to disease agents need to be maintained if we are to provide the greatest protection to public health. A multiple-barrier approach to drinking water protection involves several consecutive and interrelated steps, including selection of high¬-quality source water(s), source water management and protection, appropriate treatment, distribution system management, and water quality monitoring.

Current research on the effects of urban and agricultural runoff in raw water sources on public health and recognition of the high costs and limitations of technological fixes has led water supply and watershed managers to revisit two principles that were taken for granted a century ago:

1. The public's water supply should be reasonably clean to begin with.

2. Forests and natural lands are critical to the quantity and quality of water supplies.

Water suppliers and municipalities can build effective partnerships to conserve forested land and protect their source water. A recent study shows the relationship between forests and clean water, and the resulting effects on treatment costs.

WHY PROTECT THE SOURCE?

A major reason suppliers are revisiting the idea of source protection is the growing realization that allowing raw water quality to degrade, in addition to threatening public health, increases treatment and capital costs. Protecting forests—which reduces erosion and sediment, improves water purity, and in some cases captures and stores water—is a cost-effective way to provide clean drinking water, according to Running Pure, a report by the World Wildlife Fund and the World Bank. "For many cities, time is running out," said David Cassells, a World Bank forest specialist. "Protecting forests around water catchment areas is no longer a luxury but a necessity."

Although little research has been done on this issue, a study of 27 water suppliers conducted in 2002 by The Trust for Public Land and the American Water Works Association's Source Water Protection Committee found that water treatment costs for utilities using primarily surface water supplies varied depending on the amount of forest cover in the watershed. Approximately 40 water suppliers were asked to complete a written survey describing their watershed, treatment system, and treatment costs; 33 responses were received, of which 27 were included in the analysis. (Six responses were not used in the final analysis, because either the data were incomplete or the source area or size of the supply was too large to be comparable to the other respondents.) Not all the water utilities were selected randomly, as some were solicited to provide a diverse range of watershed types, and all respondents primarily use surface water.

The survey results indicated that operating treatment costs decreased as forest cover in a source area increased.

- For every 10 percent increase in forest cover in the source area (up to about 60 percent forest cover), treatment and chemical costs decreased by approximately 20 percent.
- Approximately 50 to 55 percent of the variation in operating treatment costs can be explained by the percent of forest cover in the source area.

Not enough data were obtained on suppliers that had more than 65 percent forest cover in their watersheds to draw conclusions; however, it is suspected that treatment costs level off when forest cover is between 70 and 100 percent. The 50 percent variation in treatment costs that cannot be explained by the percent forest cover in the watershed is likely explained by varying treatment practices, the size of the facility (larger facilities pay lower costs per gallon), the location and intensity of development and row crops in the watershed, and agricultural, urban, and forestry best management practices.

Findings show that the more forest cover there is in a watershed, the lower the treatment costs for suppliers drawing from surface water sources. Figure 3.1 shows the change in treatment costs predicted by this analysis, the average daily cost of treatment if a supplier treated 22 million gallons per day, and the average production for surveyed suppliers.

FOREST CONSERVATION AS A BARRIER

Changes in land use can affect source water quality and, thus, treatment costs. Efforts to protect standing forests and natural lands from development or intensive agriculture will help communities avoid future increases in treatment expenditures. Improving land use practices and protecting lands that serve as natural filters for contaminants, such as forests, riparian areas, and wetlands, is critical to reducing pollutants that reach our raw water sources.

Figure 3.1. Water Treatment and Chemical Costs Based on Percent of Forested Watershed

Percent of Watershed Forested	Treatment and Chemical Costs per Million Gallons	Percent Change in Costs	Average Treatment Costs per day at 22 Million Gallons
10%	$115	19%	$2,530
20%	$93	20%	$2,046
30%	$73	21%	$1,606
40%	$58	21%	$1,276
50%	$46	21%	$1,012
60%	$37	19%	$814

A growing understanding of the role that forests and natural lands play in filtering pollutants and maintaining water quantity has led many municipalities and water suppliers, particularly those in growing communities, to consider land protection as part of a multiple-barrier approach to providing safe drinking water. These communities have found that land conservation

- offers permanent protection of critical watershed or recharge land;
- is perceived as equitable by landowners, as it compensates them for the value of their property;
- is broadly supported by voters;
- provides multiple benefits to communities, such as flood control, recreation, and the protection of historic and environmental resources; and
- offers land use control options for communities that do not have regulatory authority in their source area.

Local governments and water suppliers around the country are teaming up with land trusts, community groups, and other stakeholders to protect forests, wetlands, and other natural lands as part of a comprehensive approach to protecting their drinking water sources. This is happening in Austin and San Antonio, Texas, where communities are partnering to protect the Edwards Aquifer.

PROTECTING THE EDWARDS AQUIFER

Austin, Texas

The Edwards Aquifer, on the western side of Austin, is the sole drinking water source for more than 1.5 million people, including residents of San Antonio and Austin. A portion of the Barton Springs segment of the aquifer is surface water, but it is connected to the Edwards Aquifer as it flows below and around Austin. Barton Springs, identified as the most endangered aquifer in Texas, is highly vulnerable to pollution because of its smaller size, high soil permeability, and high recharge capability and because of the region's land development boom.

In 1995 and 1996, a citizens planning committee studied current and future growth patterns in the region and determined that the city's surface water needed protection beyond current regulatory restrictions. Building on that recommendation, the Austin city council designated the most sensitive third of the Austin region—land that drains into Barton Springs and the Highland Lakes—as a Drinking Water Protection Zone. They designated the remaining two-thirds as a Desired Development Zone, which included the urban core, commercial corridors, and the central business district. The new designations made it more difficult to develop in the protection zone and created incentives for building in the development zone.

Even as Austin voters tried to strengthen development regulations, they moved to protect the watershed through land acquisition. A 1991 poll jointly sponsored by TPL and Citizens for Open Space revealed that Austin residents favored open space acquisition, particularly to protect water quality, and would approve increased property taxes to pay for the land. With technical assistance from TPL, the city passed a $20 million bond act for the purchase of a new Barton Creek Wilderness Park, which would protect the most critical areas around the springs.

In 1997, the city's Watershed Protection Department published the Barton Creek Report, which recommended further conservation to protect drinking water quality through the purchase of land and development rights. In 1998, voters approved several land protection funding measures, including a $65 million revenue bond to purchase land and easements within the Drinking Water Protection Zone and a $75.9 million bond to create parks and greenways. Together, they raised a total of $140 million to help meet the community's recreation and drinking water protection goals.

San Antonio, Texas

As the residents of Austin took action to protect the portion of the Edwards Aquifer within their jurisdiction, the residents of San Antonio continued their efforts to protect a sensitive portion of the same aquifer in northern San Antonio. In a May 2000 bond measure, San Antonio voters approved a one-eighth cent sales tax for land acquisition to protect the Edwards Aquifer and to create greenways along sensitive creeks within the city. This measure is expected to raise $65 million over the next three to five years. Of the four bond measures on the ballot in 2000, including measures to increase tourism and attract new businesses, the drinking water protection measure was the only one approved by voters.

Years of public education efforts by the San Antonio Water System (SAWS) had laid the groundwork for the measure by educating residents on community water supply issues. The SAWS efforts to acquire land, which began in 1993 with the acquisition of Government Canyon, highlighted the importance of land protection to the public. The acquisition of Government Canyon was spearheaded by TPL, which structured a cooperative effort with SAWS, Texas Parks and Wildlife Department, and the Edwards Underground Water District (now the Edwards Aquifer Authority). Funding came partially from SAWS, which continues to budget annual funding for the acquisition of both fee-simple purchases and conservation easements over the Edwards Aquifer Recharge Zone.

The final impetus and popular support necessary to pass the bond measure came from grassroots efforts to mobilize voters and educate the public about the threat presented to their water supply by rapid development within the aquifer's recharge zone.

With approximately half of the aquifer's 80,000 acres of recharge zone already developed or planned for development, TPL, The Nature Conservancy, and the Bexar Land Trust work closely with the City of San Antonio, SAWS, and the Texas Parks and Wildlife Department to quickly protect the remaining sensitive lands before further development can take place.

Since 1993, TPL has protected more than 10,000 acres of recharge land over the Edwards Aquifer in the San Antonio area. Most of the land has been conveyed to the Texas Parks and Wildlife Department, and water quality conservation easements on the properties are conveyed to the City of San Antonio. Water quality conservation easements permanently prevent development that could be detrimental to water resources. Some of this land has been purchased by leveraging local bond and sales tax dollars to attract federal Land and Water Conservation Funds.

Chapter 4

Environmental and Economic Benefits of Preserving Forests within Urban Areas: Air and Water Quality

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INTRODUCTION

Forests and trees in urban areas provide many environmental and economic benefits that can lead to improved environmental quality and human health. These benefits include improvements in air and water quality, richer terrestrial and aquatic habitat, cooler air temperatures, and reductions in building energy use, ultraviolet radiation levels, and noise. As urbanization expands within forested regions, trees and forests are replaced with compacted soils, buildings, roads, and cars. This shift from forest to urban land uses changes the local and downwind/downstream environment and consequently impacts local and regional air and water quality.

Poor air quality leads to diminished human health, decreased visibility, and degradation of materials. In the United States, 158 million people live in areas that have not reached attainment for the national eight-hour ozone (O_3) standard; more than 29 million live in nonattainment areas for particulate matter less than 10 microns (PM10); 15 million live in carbon monoxide (CO) nonattainment areas; and about 1 million live in sulfur dioxide (SO_2) nonattainment areas (U.S. EPA 2006).

Poor water quality also affects human health and degrades aquatic habitats, which may also degrade human health and amenities by increasing insect- and waterborne diseases and causing odor and visual degeneration. Although various streams are monitored for attributes of water quality across the nation (U.S. EPA 1998), there is currently no national standard monitoring system in place to assess the wide range of water quality impacts on society (Lombardo et al. 2001). The U.S. Environmental Protection Agency (EPA) expects that state water-monitoring programs will evolve over the next ten years so that states will have a common foundation for such programs. Core indicators have been recommended to monitor water quality that affect aquatic life and wildlife, recreation, drinking water, and fish/shellfish consumption. These indicators include dissolved oxygen, temperature, pH, stream flow, nutrients, sediments, total dissolved solids, nitrates, pathogens, trace metals, and specific pesticides (WEF/ASCE 1998). However, other physical and biological indices are needed (Rogers et al. 2002).

In addition to water quality degradation, other problems associated with changes in stream flows include instability in the drainage system, reduced infiltration of water into soils, and increase peak flows in streams (Herricks 1995; Thorne 1998; FISRWG 1999). Instability in the drainage system can rapidly erode streambanks, damage streamside vegetation, and widen stream channels (Hammer 1972). In turn, this instability will result in lower water depths during nonstorm periods, higher than normal water levels during wet weather periods, increased sediment loads, and higher water temperatures (Brookes 1988).

Preserving or expanding forest stands in and around urban areas is critical to sustaining air and water quality. The objective of this paper is to review the effect and value of urban trees and forest stands on air and water quality.

TREE EFFECTS ON AIR QUALITY

Urban vegetation directly and indirectly affects local and regional air quality by altering the urban atmospheric environment. The four main ways that urban trees affect air quality are (Nowak 1995):

Temperature reduction and other microclimatic effects
Removal of air pollutants
Emission of volatile organic compounds and tree maintenance emissions
Energy effects on buildings

Temperature Reduction

Tree transpiration and tree canopies affect air temperature, radiation absorption and heat storage, wind speed, relative humidity, turbulence, surface albedo, surface roughness, and, consequently, the evolution of the mixing-layer height (height of the atmosphere in which pollutants are mixed). These local meteorological changes can alter pollution concentrations in urban areas (Nowak et al. 1998). Although trees usually contribute to cooler summer air temperatures, their presence can increase air temperatures in some instances (Myrup, McGinn, and Flocchini 1991). In areas with scattered tree canopies, radiation reaches and heats ground surfaces; at the same time, the canopy may reduce atmospheric mixing such that cooler air is prevented from reaching the area. In this case, tree shade and transpiration may not compensate for the increased air temperatures due to reduced mixing (Heisler et al. 1995). Maximum midday air temperature reductions due to trees range from 0.040C to 0.20C per percentage canopy cover increase (Simpson 1998). Below individual and small groups of trees over grass, midday air temperatures at 1.5 meters above ground are 0.70C to 1.30C cooler than in an open area (Souch and Souch 1993). Reduced air temperature improves air quality because the emission of many pollutants and/or ozone-forming chemicals is temperature dependent. Decreased air temperature can also reduce ozone formation.

Removal of Air Pollutants

Trees remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces (Smith 1990). Trees also remove pollution by intercepting airborne particles. Some particles can be absorbed into the tree, though most intercepted particles are retained on the plant surface. The intercepted particle often is resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall (Smith 1990). Consequently, vegetation is only a temporary retention site for many atmospheric particles.

In 2000, estimated annual pollution removal by trees in Atlanta, Boston, New York, and Philadelphia varied from 257 to 1,521 metric tons (figure 4.1). Pollution removal per square meter of canopy cover was fairly similar among these cities (Boston: 8.1 grams per square meter per year; New York: 9.1 grams per square meter per year; Philadelphia: 9.7 grams per square meter per year; Atlanta: 12.0 grams per square meter per year). These standardized pollution removal rates differ among cities according to the amount of air pollution, length of in-leaf season, precipitation, and other meteorological variables..

Figure 4.1. Estimated Pollution Removal by Trees

Pollutant*	Atlanta Removal (metric tons)	Atlanta Value ($ in thousands)	Boston Removal (metric tons)	Boston Value ($ in thousands)	New York Removal (metric tons)	New York Value ($ in thousands)	Philadelphia Removal (metric tons)	Philadelphia Value ($ in thousands)
O_3	672 (158–858)	$4,539 (1,066–5,793)	108 (27–132)	$729 (184–892)	536 (136–722)	$3,622 (920–4,873)	185 (49–239)	$1,246 (332–1,615)
PM10	528 (206–824)	$2,378 ($929–3,716)	73 (29–114)	$330 ($129–515)	354 (138–553)	$1,595 (623–2,493)	194 (76–302)	$872 (341–1,363)
NO_2	181 (93–231)	$1,220 ($628–1,559)	48 (22–61)	$324 ($148–409)	364 (171–507)	$2,459 (1,155–3,421)	93 (46–123)	$630 (312–827)
SO_2	89 (42–149)	$147 ($ 69–246)	23 (11–34)	$37 ($18–56)	199 (106–337)	$329 ($175–557)	41 (22–68)	$67 ($36–112)
CO	39	$37	6	$5	67	$64	10	$10
Total	1,509 (538–2,101)	$8,321 ($2,729–11,351)	257 (94–346)	$1,426 ($484–1,878)	1,521 (619–2,185)	$8,071 ($2,938–11,408)	522 (203–742)	$2,826 ($1,030–3,927)

*Pollutant:
O_3 – ozone
PM10 – particulate matter less than 10 microns; assumes 50% resuspension of particles
NO_2 – nitrogen dioxide
SO_2 – sulfur dioxide
CO – carbon monoxide

Note: The figure shows estimated pollution removal (metric tons) by trees during nonprecipitation periods (dry deposition) and associated monetary value (thousand dollars) for Atlanta (341 square kilometers; 36.7 percent tree cover), Boston (143 square kilometers; 22.3 percent tree cover), New York (799 square kilometers; 20.9 percent tree cover), and Philadelphia (341 square kilometers; 15.7 percent tree cover). Estimates were made using the Urban Forest Effects (UFORE) model (Nowak and Crane 2000) based on tree data collected in the late 1990s and local hourly meteorological and pollutant data from 2000. Numbers in parentheses represent expected range of values (no range determined for CO). Monetary value of pollution removal by trees was estimated using the median externality values for United States for each pollutant (Murray et al. 1994). Externality values for O_3 were set to equal the value for NO_2.

Air quality improvement in these cities from pollution removal by trees during daytime of the in-leaf season averaged 0.6 percent for particulate matter, 0.57 percent for ozone, 0.55 percent for sulfur dioxide, 0.35 percent for nitrogen dioxide, and 0.009 percent for carbon monoxide. Air quality improves with increased percent tree cover and decreased mixing-layer heights. In urban areas with 100 percent tree cover (i.e., contiguous forest stands), short term improvements in air quality (one hour) from pollution removal by trees were as high as 15 percent for ozone and sulfur dioxide, 8 percent for particulate matter and nitrogen dioxide, and 0.05 percent for carbon monoxide (figure 4.2). To estimate pollution removal by trees in numerous U.S. cities, a pollution removal calculator can be found at http://www.fs.fed.us/ne/syracuse/Tools/tools.htm. Pollution removal by urban trees in the United States is estimated at 711,000 metric tons ($3.8 billion value) annually (Nowak, Crane, and Stevens, 2006).

Figure 4.2. Air Quality Improvement by Trees

	Atlanta		Boston		New York		Philadelphia	
Pollutant*	City	Forest	City	Forest	City	Forest	City	Forest
O_3	0.8%	14.8%	0.7%	14.6%	0.5%	11.4%	0.3%	9.4%
PM10	0.9%	8.5%	0.6%	7.3%	0.5%	6.8%	0.4%	7.7%
NO_2	0.5%	8.3%	0.4%	7.4%	0.3%	6.3%	0.2%	5.3%
SO_2	0.7%	14.8%	0.7%	14.9%	0.5%	11.3%	0.3%	9.6%

*Pollutant:

O_3 – ozone

PM10 – particulate matter less than 10 microns; assumes 50% resuspension of particles

NO_2 – nitrogen dioxide

SO_2 – sulfur dioxide

Note: The figure shows the estimated average percentage air quality improvement in cities due to pollution removal by trees during daytime of the in-leaf season (city) and maximum estimated hourly air quality improvement in areas with 100 percent tree cover (forest). Maximum air quality improvement was less than 0.03 percent for carbon monoxide for all cities.

Emission of Volatile Organic Compounds

Emissions of volatile organic compounds (VOCs) by trees can contribute to the formation of ozone and carbon monoxide. However, in atmospheres with low nitrogen oxide concentrations (e.g., some rural environments), VOCs can actually remove ozone (Crutzen et al. 1985; Jacob and Wofsy 1988). Because VOC emissions are temperature dependent and trees generally lower air temperatures, increased tree cover can lower overall VOC emissions and, consequently, ozone levels in urban areas (Cardelino and Chameides 1990).

VOC emission rates also vary by species. Nine genera that have the highest standardized isoprene emission rate (Geron, Guenther, and Pierce 1994; Nowak et al. 2002), and therefore the greatest relative effect among genera on increasing ozone, are beefwood (*Casuarina* spp.), *Eucalyptus* spp., sweet gum (*Liquidambar* spp.), black gum (*Nyssa* spp.), sycamore (*Platanus* spp.), poplar (*Populus* spp.), oak (*Quercus* spp.), black locust (*Robinia* spp.), and willow (*Salix* spp.). However, due to the high degree of uncertainty in atmospheric modeling, results are currently inconclusive as to whether these genera will contribute to an overall net formation of ozone in cities (i.e., ozone formation from VOC emissions are greater than ozone removal). Some common genera in Brooklyn, New York, with the greatest relative effect on lowering ozone were mulberry (*Morus* spp.), cherry (*Prunus* spp.), linden (*Tilia* spp.), and honey locust (*Gleditsia* sp.) (Nowak et al. 2002).

Because urban trees often receive relatively large inputs of energy, primarily from fossil fuels, to maintain vegetation structure, the emissions from these maintenance activities need to be considered in determining the ultimate net effect of urban forests on air quality. Various types of equipment are used to plant, maintain, and remove vegetation in cities. This equipment includes vehicles for transport or maintenance, chain saws, backhoes, leaf blowers, chippers, and shredders. The use of fossil fuels to power this equipment leads to the emission of carbon dioxide (approximately 0.7 kilograms per liter of gasoline, including manufacturing emissions [Graham, Wright, and Turhollow 1992]) and other chemicals such as VOCs, carbon monoxide, nitrogen and sulfur oxides, and particulate matter (U.S. EPA 1991).

Trees in parking lots also affect evaporative emissions from vehicles, particularly through tree shade. In Sacramento County, California, increasing parking lot tree cover from 8 to 50 percent could reduce light-duty vehicle VOC evaporative emission rates by 2 percent and nitrogen oxide emissions when starting a vehicle by less than 1 percent (Scott, Simpson, and McPherson, 1999).

Energy Effects on Buildings

Trees reduce building energy use by lowering temperatures and shading buildings in summer and blocking winds in winter (Heisler 1986). However, trees also can increase energy use by shading buildings in winter and may increase or decrease energy use by blocking summer breezes. Thus, proper tree placement near buildings is critical to achieve maximum building energy conservation benefits.

When building energy use is reduced, pollutant emissions from power plants are also lowered. While lower pollutant emissions generally improve air quality, lower nitrogen oxide emissions, particularly ground-level emissions, may lead to a local increase in ozone concentrations under certain conditions due to nitrogen oxide scavenging of ozone (Rao and Sistla 1993). The cumulative and interactive effects of trees on meteorology, pollution removal, and VOC and power plant emissions determine the overall impact of trees on air pollution.

Combined Effects

Changes in urban microclimate affect pollution emission and formation, particularly the formation of ozone. A model simulation of a 20 percent loss in the Atlanta-area forest due to urbanization led to a 14 percent increase in ozone concentrations for a modeled day (Cardelino and Chameides 1990). Although there were fewer trees to emit VOCs, an increase in Atlanta's air temperatures due to the urban heat island, which occurred concomitantly with tree loss, increased VOC emissions from the remaining trees and anthropogenic sources. This, in turn, altered ozone chemistry such that concentrations of ozone increased.

A model simulation of California's South Coast Air Basin suggests that the air quality impacts of increased urban tree cover may be locally positive or negative with respect to ozone. The net basinwide effect of increased urban vegetation is a decrease in ozone concentrations if the additional trees are low VOC emitters (Taha 1996).

Modeling the effects of increased urban tree cover on ozone concentrations from Washington, D.C., to central Massachusetts reveals that urban trees generally reduce ozone concentrations in cities but tend to slightly increase average ozone concentrations in the overall modeling domain (Nowak et al. 2000). Interactions of the effects of trees on the physical and chemical environment demonstrate that trees can cause changes in pollution removal rates and meteorology, particularly air temperatures, wind fields, and mixing-layer heights, which, in turn, affect ozone concentrations. Changes in urban tree species composition had no detectable effect on ozone concentrations (Nowak et al. 2000). Modeling of the New York City metropolitan area also reveals that a 10 percent increase in tree cover within urban areas reduced maximum ozone levels by about 4 parts per billion, which was about 37 percent of the amount needed for attainment (Luley and Bond 2002).

TREE AND IMPERVIOUS EFFECTS ON WATER QUALITY AND QUANTITY

Human activity can dramatically alter land cover characteristics, impeding water infiltration rates (Hamilton and Waddington 1999; Pitt and Lantrip 2000) and reducing percolation and, consequently, water table levels (Lerner 2002) and stream baseflow regimes

(Faulkner, Edmonds-Brown, and Green 2000). When water is captured in engineered retention or detention basins, rather than infiltrated through forested plots, it undergoes less sorption and is found to pollute subsurface water quality (Thomas 2000; Fischer, Charles, and Baer, 2003) as well as the quality of surface runoff. The result of traditional urban development is to impair important hydrological and watershed recharge and cleansing processes. Research has shown the importance of increasing pervious cover and augmenting subsurface recharge (Argue 1994; Nowakowska-Blaszczyk and Blaszczyk 1997). Removal of forest cover and/or increased impervious area due to urbanization is known to increase stream flow and peak runoff in streams (Leopold 1968; Kidd 1978; Codner, Laurenson, and Mein 1988; Mein and Goyen 1988). These changes in stream flows can lead to flooding, soil erosion, and sedimentation in streams (Anderson 1970; Urbonas and Benik 1995; McMahon and Cuffney 2000; Paul and Meyer 2001; Rose and Peters 2001).

Conventional urban development increases the amount of stormwater runoff generated by the landscape (Chow and Yen 1976; Boyd, Bufill, and Knee 1994; Beach 2002). The principal causes of this effect are impervious surfaces—streets, parking lots, and buildings (Leopold 1968; Schueler 1994)—and compaction of the soil due to construction activities (Hamilton and Waddington 1999; Pitt et al. 2003). Instead of soaking into the ground, rainfall is converted quickly to runoff and then rapidly removed from the site via sewers and manmade channels. As the volume of urban stormwater runoff has increased throughout the United States from the increase in impervious surfaces, the quality of surface runoff has degraded significantly (U.S. EPA 1983).

According to U.S. General Accounting Office (2001), when natural ground cover is present over the entire site, normally 10 percent of precipitation runs off the land into nearby creeks, rivers, and lakes. In contrast, when a site is 75 percent impervious, 55 percent of the precipitation runs off into receiving waters. Runoff from parking lots and other paved areas is estimated at 98 percent of precipitation (USDA NRCS 1986). Water that runs off urban landscapes can no longer recharge groundwater supplies. For communities that depend on locally recharged aquifers, water shortages could limit future development and necessitate sprinkling bans and other restrictions. Increased runoff peaks and decreased lag time (the elapsed time between the onset of a storm and when the peaks occurs) are costly to a city as drainage systems must be designed for peak runoff conditions (Urbonas and Roesner 1993), which can increase downstream flooding.

Water that runs over developed areas, including paved surfaces such as roads and parking lots, before reaching a water body is known as urban runoff and is an increasingly important category of water pollution (U.S. General Accounting Office 2001). Because of impervious surfaces, a typical city block may generate nine times more runoff than a woodland area of the same size (U.S. EPA 1996a). Urban runoff can adversely affect the quality of the nation's waters, and urban stormwater runoff has been identified as one of the leading sources of pollution to rivers, streams, lakes, and estuaries (U.S. General Accounting Office 2001).

Urban runoff is known to be contaminated with numerous water pollutants (U.S. EPA 1983) that are by-products of urban activities, such as automobile use, lawn care, and industrial fallout (WEF/ASCE 1998). Urban runoff and its pollutants from both point and nonpoint sources can cause increases in sedimentation, water temperature, and pathogen levels and decreases in dissolved oxygen levels in bodies of water (Horner 1995; WEF/ASCE 1998).

With regard to water, urban trees can affect both stream flow volume and quality. To date, most of the research has been on the effect of urban trees on stream flow. Trees affect stream flow rates primarily through three mechanisms: rainfall interception, soil water infiltration, and evapotranspiration.

Rainfall Interception

Trees intercept rainfall on leaves and branch surfaces, thereby potentially reducing runoff volumes and delaying the onset of peak flows. Natural forest canopy interception, with subsequent evaporation from a wet canopy, which is affected by tree types and weather conditions, ranges from 11 to 36 percent of annual precipitation in deciduous canopies and from 9 to 48 percent in coniferous canopies (Hörmann et al. 1996). The forest interception fraction is 35 to 40 percent of annual precipitation in the United Kingdom, where annual rainfall exceeds 1,000 millimeters (Calder 1990, 2003). Such findings suggest that deforestation may have a significant effect on runoff generation.

Urban tree interception of precipitation may be different from that of natural forests because both the microclimate and the tree architecture are different. Compared with more rural forests, urban forests have fewer trees per unit area, typically larger tree size, a more diverse mix of species with different phenological patterns, and greater spatial variation in canopy cover (McPherson 1998). In Sacramento, the urban forest canopy is estimated to intercept 11.1 percent of the annual precipitation (Xiao et al. 1998). In summer, tree interception in Sacramento was 36 percent for an urban forest stand dominated by large, broadleaf evergreens and conifers (leaf area index = 6.1) and 18 percent for a stand dominated by medium-size conifers and broadleaf deciduous trees (leaf area index = 3.7). For five precipitation events with return frequencies ranging from 2 to 200 years, interception was greatest for small storms and least for large storms (Xiao et al. 1998). By intercepting and lowering the rainfall rate and intensity impacting the ground beneath the canopy, soil erosion can be reduced and soil water infiltration and percolation to groundwater increased.

Soil water infiltration

In addition to lowering rainfall rates beneath canopies, root growth and decomposition in forested land can increase the capacity and rate of soils to infiltrate rainfall and reduce overland flow. Forests can be used as buffers around water bodies or between impervious areas to naturally filter and infiltrate runoff. Thus, forest buffers reduce not only the quantity of urban runoff, but also pollutants carried with urban runoff through physical, chemical, and biological processes in the soil.

Evapotranspiration

Land cover affects evapotranspiration (ET). ET is a measure of the amount of water evaporated from surfaces or transpired (evaporated) from leaf surfaces and is important in the hydrologic process because it is a means by which liquid water is removed from the groundwater cycle and converted to atmospheric water vapor. Looking at a global average, two-thirds of the precipitation that falls on the continents is evapotranspired. Of this amount, 97 percent is ET from land surfaces and 3 percent is open-water evaporation (Hornberger et al. 1998). Removal of forest cover can increase stream flow as a result of reduced ET. In the interior Columbia River Basin, annual average increases in runoff ranged from 4.2 to 10.7 percent, and reductions in evapotranspiration ranged from 3.1 to 12.1 percent due to decreased vegetation maturity as a result of logging (Matheussen et al. 2000). Evergreen trees usually have the highest actual ET, followed by deciduous trees, shrubs, and grasses, with differences diminished in areas with low mean annual precipitation (Matheussen et al. 2000).

CUMULATIVE EFFECTS ON STREAM FLOWS AND RUNOFF

Relatively little research has been conducted on the effects of urban trees on stream flows and runoff compared to forest areas. In a review of vegetation changes on annual water yields across the world, Bosch and Hewlett (1982) found that, on average, a 10 percent change in tree cover caused an estimated 40 millimeter change in annual water yield for coniferous forest and 25 millimeters for deciduous forest. A complete conversion from grass to evergreen trees on average decreases mean annual runoff by 400 millimeters and vice versa; a conversion from grass to deciduous trees on average decreases mean annual runoff by 250 millimeters and vice versa; and a conversion from grass to shrubs/scrub on average decreases mean annual runoff by 100 millimeters and vice versa. In a study of runoff changes in Victoria, Australia, following the clearing of a forest, the average maximum increase in runoff occurred two years after clearing and was approximately equal to an additional 33 millimeters of runoff per year per 10 percent of area cleared (Nandakumar and Mein 1997). Forests also slow stormwater runoff and provide watershed stability and critical habitat for fish and wildlife (Sedell et al. 2000).

Little research has been conducted on the effects of urban trees on stream flows and runoff. Several estimates of the effects of urban forests on runoff have been calculated using the TR-55 model (Soil Conservation Service 1975). Although these estimates are limited in their capability to accurately estimate effects of urban forests on runoff volume and peak rate due to some important limitations of the model (e.g., Xiao et al. 1998), these studies represent most of the literature on this topic and provide first-order estimates of urban forest effects.

Using this model to simulate urban forest impacts on stormwater runoff in Dayton, Ohio, Sanders (1986) demonstrated that existing tree canopy cover (22 percent) could lower potential runoff from a six-hour, one-year storm by about 7 percent. By increasing tree cover to 50 percent over all pervious surfaces, runoff reduction was increased to nearly 12 percent. A study of Tucson, Arizona, showed that increasing tree canopy cover from 21 (existing) to 35 percent and 50 percent could reduce mean annual runoff by 2 and 4 percent, respectively (Lormand 1988). In Austin, Texas, it was estimated that the existing trees reduce the potential runoff volume by 850 million gallons, or 7 percent of a 5.5 inch, five-year storm (Walton 1997).

Using the HSPF model (Bicknell et al. 1997), Neville (1996) studied the effects of alternative vegetation patterns in the Gwynns Falls watershed (Baltimore, Maryland) as a viable alternative for reducing stormwater discharges. Results indicated that tree canopy cover can have a substantial impact depending on land use. Model simulations revealed that changing tree cover from 0 to 100 percent for the existing conditions would reduce total runoff by about 26 percent. Base flow would decrease by more than 13 percent.

Based on a newly developed model (Wang, Endreny, and Nowak in review), estimates of the effects of urban tree cover in the Dead Run watershed (1,410 hectares) in Baltimore revealed that increasing tree cover over pervious surface from 12 to 24 percent and increasing tree cover over impervious surfaces from 5 to 20 percent reduced total annual runoff by 3 percent (~140,000 cubic meters per year) and decreased peak flow from a 3.6 mm storm on August 13, 2000, by 12 percent. Reducing tree cover over pervious areas from 12 to 6 percent and replacing it with impervious surfaces connected to streams led to a 10 percent increase in total annual runoff (~500,000 cubic meters per year) and a 30 percent increase in peak flow during the 3.6 millimeter storm event. These model simulations illustrate how urban forest management can have a modest influence on runoff volume.

The societal value of runoff reduction in urban streams is difficult to determine. Urban forests can reduce the need for stormwater management infrastructure, particularly at the urban fringe. Some studies have used proxy values related to retention pond costs and suggest that the value of reduced runoff is on the order of hundreds of millions of dollars per year (e.g., Walton 1997). However, further research and evaluation of runoff reduction values are needed before a more certain valuation can be made.

WATER QUALITY EFFECTS

More than a third of our nation's streams, lakes, and estuaries are impaired by some form of water pollution (U.S. EPA 1998). Pollutants can enter surface waters from point sources, such as single-source industrial discharges and wastewater treatment plants. However, most pollutants result from nonpoint source pollution activities, including runoff from agricultural lands, urban areas, construction and industrial sites, and failed septic tanks. These activities introduce harmful sediments, nutrients, bacteria, organic wastes, chemicals, and metals into surface waters. Damage to streams, lakes, and estuaries from nonpoint source pollution was estimated at about $7 billion to $9 billion a year in the mid-1980s (Ribaudo 1986). Point sources of pollution are largely controlled by requirements of the Clean Water Act. However, nonpoint source pollution remains the "nation's largest source of water quality problems" (U.S. EPA 1996b).

Nonpoint source pollution is difficult to control, measure, and monitor because it is diffuse in nature. Forests can reduce nonpoint source water pollution in many ways, helping to ensure a cleaner water supply; they can serve as filters, sinks, or transformers of pollutants. Pollutants are trapped in the forest and are then used by the plants as food for growth or are transformed through chemical and biological processes into nonharmful forms. A continuous litter layer can help maintain a porous soil surface and high water infiltration rates; consequently, overland flow can be minimized in a forest. By decreasing the rate of surface runoff, groundwater recharge from seepage is increased, forest soil nutrients are conserved, and the productivity of the forest is maintained.

Although there is a dearth of research on the effects of urban trees on water quality, data from the EPA's Nationwide Urban Runoff Program reveal that pollutant loadings from runoff in parks and low-density residential areas (areas that typically have higher tree cover and lower impervious cover) are significantly lower than from other urban land uses (U.S. EPA 1999). Research from rural areas also reveals that forests and trees can help improve water quality. Trees divert captured rainwater into the soil, where bacteria and other microorganisms filter out impurities. This bio-filtration can dramatically reduce the sediment, pollutants, and organic matter that reach streams. Important environmental processes for water quality improvement include soil filtration of particles and adsorption of chemicals, nutrient assimilation by plants, and the degradation or volatilization of chemicals by microorganisms (Winogradoff 2002).

One effective management practice in influencing water quality is the construction or conservation of riparian forest buffers along streams, lakes, and other surface waters. These forests can buffer nonpoint source pollution of waterways from adjacent land, reduce bank erosion, protect aquatic environments, enhance wildlife, and increase biodiversity. Through the interaction of their unique soils, hydrology, and vegetation, riparian forest buffers influence water quality as contaminants are taken up into plant tissues, adsorbed onto soil particles, or modified by soil organisms. Riparian forests can affect stream sediment loads and the concentration of nutrients and other contaminants.

Sediments

Sediment refers to soil particles that enter streams, lakes, and other bodies of water from eroding land, including plowed fields, construction and logging sites, urban areas, and eroding stream banks (U.S. EPA 1995). Sedimentation of streams can have a pronounced effect on water quality and stream life, and reduces water clarity. In addition to mineral soil particles, eroding sediments may transport other substances, such as plant and animal wastes, nutrients, pesticides, petroleum products, metals, and other compounds that can lower water quality (Clark 1985; Neary, Swank, and Riekerk 1988). Urban sediment is typically more of a problem during site construction or restoration than during normal use of a site.

Forested lands produce a small fraction of the sediment yielded by more intensive land uses (Patric, Evans, and Helvey 1984; Yoho 1980). In a study of upper Chattahoochee River Basin, Georgia, the greatest suspended sediment yields were from urban areas, compared with forested and agricultural lands (Faye et al. 1980). In Virginia, forestry practices contributed little sediment, agriculture was an important source of sediment, and urban development contributed the most sediment (as well as other pollutants) (Jones and Holmes 1985).

Studies indicate that forest riparian buffers can effectively trap sediment, with removal rates ranging from 60 to 90 percent of the sediment (Cooper et al. 1987; Daniels and Gilliam 1996). Along the Little River in Georgia, riparian forests have accumulated between 311,600 and 471,900 pounds per acre of sediment annually over the last 100 years (Lowrance, Sharpe, and Sheridan 1986). Many factors influence the effectiveness of the buffer in removing sediments from land runoff, including sediment size and loads, slope, type and density of riparian vegetation, presence or absence of a surface litter layer, soil structure, subsurface drainage patterns, and frequency and force of storm events (Osborne and Kovacic 1993).

Nutrients

Nutrients are essential elements for aquatic ecosystems, but in excess amounts, nutrients can lead to many changes in the aquatic environment and reduce the quality of water for human uses (Dupont 1992). Lawn and crop fertilizers, sewage, and manure are major sources of nutrients in surface waters. Industrial sources and atmospheric deposition also contribute significant amounts of nutrients (Guldin 1989). One of the most significant impacts of nutrients on streams is eutrophication, the excessive growth of algae and other aquatic plants in response to high levels of nutrient enrichment (U.S. EPA 1995). In addition, some forms of nutrients can be directly toxic to humans and other animals (Chen, McCutcheon, and Carsel 1994; Evanylo 1994).

Streams draining agricultural watersheds have, on average, considerably higher nutrient concentrations than those draining forested watersheds. Nutrient concentrations are usually proportional to the percentage of land in agriculture and inversely proportional to the percentage of land in forest (Omernik 1977). The highest nitrogen and phosphorus yields typically occur in highly agricultural and urbanized watersheds, and lowest nutrient yields occur in streams of forested watersheds (e.g., Spruill et al. 1998; Hampson et al. 2000).

Forest riparian zones have been shown to reduce between 48 and 95 percent of nitrogen and/or nitrates from runoff (Lowrance et al. 1984; Peterjohn and Correll 1984; Jordan, Correll, and Weller 1993; Snyder et al. 1995). In New Zealand, where subsurface water flows moved through organic soils before entering streams, nitrate levels were reduced by as much as 100 percent. However, mineral soils located along the same streams exhibited little capacity to decrease nitrogen (Cooper 1990). The processes by which soils remove nitrates include denitrification, uptake by vegetation and soil microbes, and retention in riparian soils (Beare, Lowrance, and Meyer 1994; Evanylo 1994).

Plants can take up large quantities of nitrogen as they produce roots, leaves, and stems. However, much of this is returned to the soil as plant materials decay. For example, scientists in Maryland estimated that deciduous riparian forests took up 69 pounds of nitrogen per acre annually, but returned 55 pounds (80 percent) each year in the litter (Peterjohn and Correll 1984). Nevertheless, Correll (1997) suggested that vegetative uptake is still a very important mechanism for removing nitrate from riparian systems because vegetation (especially trees) removes nitrates from deep in the ground, converts the nitrate to organic nitrogen in plant tissues, then deposits the plant materials on the surface of the ground where the nitrogen can be mineralized and denitrified by soil microbes.

Riparian areas can be important sinks for phosphorus but are generally less effective in removing phosphorus than sediment or nitrogen (Parsons et al. 1994). Riparian stands remove 30 to 80 percent of phosphorus (Cooper et al. 1987; Lowrance et al. 1984; Peterjohn and Correll 1984). Some phosphorus may be taken up and used by vegetation and soil microbes, but like nitrogen, much of this phosphorus eventually is returned to the soil. For example, researchers estimated that less than 3 percent of the phosphate entering a floodplain forest in eastern North Carolina was taken up and converted to woody tissue, while scientists in Maryland reported a deciduous riparian forest buffer took up 8.8 pounds per acre per year of phosphorus but returned 7 pounds per acre per year (80 percent) as litter (Brinson, Bradshaw, and Kane, 1984; Peterjohn and Correll 1984). In some riparian areas, small amounts of phosphorus (0.05–2.14 pounds per acre per year) may be stored as peat (Walbridge and Struthers 1993). Riparian forests have been found to be effective filters for nutrients, including nitrogen, phosphorus, calcium, potassium, sulfur, and magnesium (Lowrance, Todd, and Asmussen, 1984; Lowrance et al. 1984).

Metals

Riparian areas may slow the movement of metals and other contaminants to surface waters and increase the opportunity for the contaminants to become buried in the sediments, adsorbed into clays or organic matter, or transformed by microbial and chemical processes (Johnston et al. 1984). The fate of metals in riparian areas is not well understood. However, scientists in Virginia have found significant amounts of lead, chromium, copper, nickel, zinc, cadmium, and tin buried in the sediments in the floodplain along the Chickahominy River downstream of Richmond (Hupp, Woodside, and Yanoksy 1993). Analysis of the woody tissue of the trees revealed that these compounds also are taken up by the trees. Therefore, sediment deposition and uptake by woody vegetation may help mitigate heavy metals in riparian areas.

Pathogens

Pathogens, such as waterborne bacteria, viruses, and protozoa, are the source of many diseases that infect humans, livestock, and other animals (Chesters and Schierow 1985; Palmateer 1992). There is relatively little information on the role of riparian buffers on pathogens. In one study, strips of corn, oats, orchard grass, and sorghum/Sudan grass were all effective in reducing bacterial levels by nearly 70 percent (Young, Huntrods, and Anderson 1980). It was estimated that a buffer 118 feet wide would be required to reduce total coliform bacteria to levels acceptable for human recreational use (Young, Huntrods, and Anderson 1980). Other researchers have demonstrated the ability of grass sod filter strips to trap bacteria from dairy cow manure under laboratory conditions (Larsen et al. 1994). They found that even a narrow (two-foot) strip successfully removed 83 percent of the fecal coliform bacteria, while a seven-foot filter strip removed nearly 95 percent.

Pesticides

Few studies have been made to examine the fate of pesticides in riparian areas. However, where the proper conditions exist, riparian forest buffers have the potential to remove and detoxify pesticides in runoff. Probably the most important process is the breakdown of organic chemicals by soil microorganisms (MacKay 1992). For decades, scientists have observed that soil microorganisms adapt to the presence of a pesticide and begin to metabolize it as an energy source (Fausey et al. 1995). As it is metabolized, the pesticide is broken down to various intermediate compounds and, ultimately, carbon dioxide. In addition, most pesticides have a high affinity for clay and organic matter and may be removed from the soil water as they are bound to soil particles. Once bound, pesticides are often difficult to desorb from the soil (Clapp et al. 1995).

As these studies indicate, riparian forest buffers can reduce the amount of sediment, nutrients, and other contaminants that enter surface waters. However, the studies also suggest that these effects vary from one riparian area to another. The degree to which the riparian buffer protects water quality is a function of the area's hydrology, soils, and vegetation. Riparian forests will have the greatest influence on water quality where field runoff follows direct, shallow flow paths from upland areas to the stream. Riparian forests will have less impact on water quality where surface runoff is concentrated and runs through the buffer in defined channels, or where deep subsurface flows cause groundwater to move below the roots of trees. One significant problem in urban areas is the lowering of the water table and, consequently, the level of base flow. With lowered water tables, the contaminants in water can pass below plant rooting zones and limit chemical uptake by plants. Riparian forests may not be able to provide all of the necessary functions in urban watersheds as a result of numerous channelized sources of runoff in urban watersheds. Therefore, other actions should be taken beyond buffer protection to minimize the effect of urban runoff. These actions would include the reduction of surface runoff, by reducing both the amount of impervious areas and the detention and reinfiltration of any surface runoff generated.

SUMMARY OF EFFECTS OF PRESERVING FORESTS STANDS AND TREE COVER IN URBAN AREAS

The preservation of forest stands in urban areas can lead to many environmental and economic effects related to air and water quality. The magnitude of these effects and values will depend on the amount of forestland or tree cover conserved along with other factors, such as location of the stand relative to urban development or waterways. As much of the research related to urban forest effects on air and water quality is relatively new, the economic values of many of these effects are currently unknown but are very likely quite substantial. Though some values are estimated, there are likely numerous other secondary economic impacts due to cleaner air and water (e.g., increased tourism, business, and/or recreation) that are not accounted for in the value estimate. Continued research is needed on the economic valuation of many of these effects to quantify the economic impact of land conservation at varying scales and locations. The following forest/tree effects related to air and water quality are known:

- Reduced Air Temperatures

  Effect: Through transpiration and shade, trees lower air temperatures and consequently lead to reduced pollution emission and formation, reduced summertime energy use of nearby buildings and consequent pollutant emissions from power plants, increased human comfort, and reduced thermal stress.

  Economic Value: Unknown. However, the cost of reducing a single part per billion of ozone through electric utility nitrogen oxides limitations is estimated at one-half to three-quarters of a billion dollars annually (U.S. EPA 1997). Thus, the economic impact of any temperature reduction effects on reduced pollution formation or emissions will likely be significant as the costs of reducing ozone precursor emissions through other techniques are large.

- Pollution Removal

  Effect: Trees directly remove pollution in the atmosphere through interception of particles and uptake of gases through leaf stomata. Typical removal rates are on the order of 11 grams per square meter of canopy cover per year (ozone, particulate matter less than 10 microns, sulfur and nitrogen dioxide, and carbon monoxide combined).

Economic Value: Average annual value per hectare of canopy cover is about $663 in Atlanta, $447 in Boston, $482 in New York, and $527 in Philadelphia.

- VOC Emissions

  Effect: Although trees emit VOCs that can contribute to ozone formation, integrative studies are revealing that combined effects of trees tend to reduce ozone. In addition, conversion of forest stands to urban development will most likely increase total VOC emissions in the area due to the relatively high VOC emissions associated with urbanization.

  Economic Value: Unknown..

- Energy Conservation

  Effect: Tree cover around buildings can reduce building energy use in summer through shade or reduced air temperatures. Tree cover can increase or decrease building energy use in winter depending on tree locations around a building due to tree effects of shade and blocking of winds. Alterations in energy use will affect pollutant emissions from power plants.

  Economic Value: Savings to homeowners due to altered building energy use from trees in Minneapolis is about $216,000 per year (Nowak et al. 2006a) and about $2.7 million per year in Washington, D.C. (Nowak et al. 2006b). Monetary impact on air quality is unknown.

- Reduced Runoff

  Effect: Trees can reduce runoff through the processes of rainfall interception, evapotranspiration, and increasing soil infiltration. The effects of trees can reduce and delay peak flows, reduce the need for stormwater treatment facilities, and improve water quality.

  Economic Value: Likely in the millions of dollars per year for a city for the entire urban forest.

- Improved Water Quality

  Effect: Trees can improve water quality by reducing runoff and air pollution and, in combination with the soil environment, by filtering, assimilating, adsorbing, volatizing, or degrading many chemicals in the water that flow through the forest. Water quality related to sediments, nutrients, pathogens, pesticides, metals, and other contaminants in forested areas tends to be improved.

  Economic Value: Damage to streams, lakes, and estuaries from nonpoint source pollution was estimated to be about $7 billion to $9 billion a year in the mid-1980s (Ribaudo 1986). Local effects in terms of stream quality and human health are likely substantial.

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Chapter 5

Competitiveness: Parks and Open Space as Factors Shaping a Location's Success in Attracting Companies, Labor Supplies, and Retirees

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With relatively few exceptions, such as the location of military, academic, religious, or political establishments, economic growth is widely believed to be fostered primarily through the presence of businesses. Company start-ups, expansions, and relocations are widely viewed as direct and effective means of enhancing a community's economic development through expanding its existing tax base.

This traditional view has been supplemented during the past decade by a recognition that attracting affluent retirees also offers a viable means of enhancing a community's tax base. Many believe the multiplier effect ensures that the benefits from a new business or from affluent retirees spread throughout a community and extend far beyond the actual dollar value of a firm's initial investment and subsequent payroll, or of retirees' direct spending. This chapter provides an overview of the role of parks and open space in attracting businesses and affluent retirees to a community.

ATTRACTING BUSINESSES

Substantial shifts in American industry have occurred in recent decades with the change from traditional manufacturing to "smokeless" industries. Related to this has been a shift in emphasis from attracting new companies to accommodating the relocation and expansion needs of existing companies. This shift reflects "the mounting evidence that the vast majority of new jobs generated in the United States came from existing companies and new business start-ups" (Kotler, Haider, and Rein 1993).

Many of the smokeless industries may be characterized as "footloose" because they are likely to be less constrained and more flexible in their choice of location than traditional manufacturing companies. They are not tied to raw materials, natural resources, or energy supplies, meaning that cities seeking ways to expand their tax base see them as excellent prospects for relocation. Footloose companies are particularly attractive to communities because they infuse money into a local economy without the adverse effects (e.g., pollution) often associated with traditional manufacturing industries. Their emerging dominance has created a highly competitive environment among communities seeking to expand their tax base.

Research has consistently shown that the elements that are important in location decisions for footloose companies are different from those considered to be important by manufacturing and distribution firms. The success of these businesses frequently is dependent on the caliber of their workforce. This is particularly true of those businesses in the intensely recruited high-technology, research-and-development, and company headquarters categories. Their principal assets are ideas and a skilled workforce, rather than their product inventories and capital equipment. These types of "people-intensive" businesses are information factories whose viability relies on their ability to attract and retain highly educated professional employees.

Today, many such individuals make their decisions on where to work based on "the pursuit of happiness." This phrase of Jefferson's enshrined in the Declaration of Independence is now expressed as "quality of life." The deciding factor for many individuals in choosing where to work is often the quality of life in the geographic vicinity of the business. A vice-president of Dell Corporation in Austin, Texas, the country's largest computer supplier, observed:

> People working in high-tech companies are used to there being

> a high quality of life in the metropolitan areas in which they live. When we at Dell go and recruit in those areas, we have to be able to demonstrate to them that the quality of life in Austin is at least comparable or they won't come. It's about what's the community like where I'm going to live (Crompton 1999).

The importance of quality of life in business location decisions has been repeatedly verified in the literature. It is widely cited as being especially important for high-technology firms or businesses employing highly skilled workers in information or knowledge-based services.

Twenty years ago a review of the company relocation literature (Blair and Premus 1987) concluded that the continued shift to more advanced technologies would lead to an increase in the importance of quality-of-life factors and a relative decrease in the significance of more traditional determinants. This trend continues to gather momentum.

Richard Florida's (2002) discussion of this issue in his book The Rise of the Creative Class captured the essence of contemporary thinking in how communities should approach economic development. He reported that whereas economic growth often used to come at the expense of environmental quality, in the "new economy" environmental quality is a prerequisite for attracting talented workers. Florida reported that environmental quality ranked as the most important amenity in high-technology workers' choices of location, above housing, cost of living, and good schools. He classified all the important factors in the location decisions of "creative class" individuals into a category he termed "quality of place." He suggested that this category has three dimensions. The first was "what's there: the combination of the built environment and the natural environment; a proper setting for the pursuit of creative lives." The other two dimensions were "what's there" and "what's going on."

There is substantial economic literature reporting the need for "disamenity compensation," whereby companies in jurisdictions with a less favorable quality of life have to pay higher salaries in order to attract the same quality worker and vice versa. The overall implication is that firms can reduce the salary levels needed to secure adequate labor (or secure more and better workers at the same price) if they locate in an area whose quality of life is attractive to workers. Quality of life is not only important in relocation, expansion, or initiation decisions, it is also important in employee retention, which has an economic bottom line—it is expensive to go through the recruitment process, particularly for key personnel.

No matter how quality of life is defined, park and recreational opportunities are likely to be a major component of it. There are no great cities in North America or elsewhere in the world that do not have great park and open space amenities. Great is defined not in terms of size, but in terms of people's desire to live there. Great park and open space amenities are synonymous with great cities.

The importance of park and open space amenities was reported in a study of key decision makers (Crompton, Love, and Moore 1997) from 174 businesses that had relocated, expanded, or been launched in Colorado in the previous five years. Small-business decision makers were influenced particularly strongly because they reported that quality of life was their main reason for relocating there. Among six elements that were used to measure quality of life, these small-business decision makers ranked the element of park, recreation, and open space amenities as being most important. They located their businesses where they could enjoy a preferred lifestyle. This finding is especially salient because analysts constantly reiterate that future growth in the U.S. economy is likely to come primarily from small businesses.

It has been noted that many small companies set profit goals for themselves that are not optimum but are merely "good enough." They could earn perhaps higher profits, if they located elsewhere, but this would involve adverse trade-offs for employees and owners in their quality of life. Hence, they "satisfice"; that is, they accept a somewhat lower level of remuneration.

The profound influence that park and open space amenities have on people's preferred living locations can be illustrated by a simple exercise that the author has undertaken with literally hundreds of different groups. First, all members of the group are asked to write down the place where they would like to live given their druthers (i.e., their preferred place, ignoring pragmatic concerns, such as job, family, language, and heritage). After they complete this task, they write in one sentence why they picked that place. When responses to this second task are analyzed, results are invariably similar. More than 80 percent of participants will cite some dimension of park, open space, or ambience in their responses.

For many people, once they attain a threshold level of income, improvements in quality of lifestyle become more important than increases in salary. For example, a $15,000 raise in salary may not be sufficient to persuade a professional who has strong social networks in Place A, where he or she earns $70,000 with a company, to move to a similar company in Place B if the location offers similar lifestyle opportunities. However, the same individual may be enticed to move from the company in Place A to a similar company in Place C for a $5,000 salary increase if Place C offers superior lifestyle opportunities. Because park and open space amenities are important lifestyle elements to many, it is not surprising that many company representatives recognize them as being important in attracting and retaining professional and executive employees.

Strategic economic development involves "designing a community to satisfy the needs of its stakeholders … if small business constitutes the engine of the job generation process, then places should promote those things that facilitate small business growth" (Kotler, Haider, and Rein 1993). Historically, most jurisdictions have been custodially driven rather than benefit driven in their efforts to persuade companies to locate in their communities; they have focused on selling their community as it is, rather than on adapting the community to meet the benefits that relocating companies seek. This approach markedly contrasts with how most viable organizations now operate. In communities seeking to attract footloose companies, especially small businesses, part of a benefit-driven approach is likely to involve investing in park and open space amenities.

Reliance on substantial tax and cash incentives to attract businesses is risky because these incentives are transient. If a community is not an engaging place in which to live, companies are likely to continue looking for the next set of cash and tax incentives and will move on when they are offered. If a community's amenities are of a high standard, it is less susceptible to such "abandonment."

Thus, a strong case can be made that reliance on incentives should be replaced by an alternative strategy that commits to designing a community so that it satisfies the needs of its key constituents (figure 5.1). Advocates of this approach suggest that communities succeed in becoming viable "when stakeholders such as citizens, workers, and business firms derive satisfaction from their community, and when visitors, new businesses, and investors find their expectations met (Kotler, Haider, and Rein 1993).

Figure 5.1. Iowa Strategic Planners Have an Opportunity to Make People the Priority

The Governor's Strategic Planning Council took to the airwaves Monday evening for a statewide town meeting to gather ideas about what Iowans want their state to be like in 2010. It was a valuable exercise that was as interesting for what participants didn't say as what they did. Generally, the comments focused on the need for better education, for keeping young people in the state, for making Iowa more welcoming to newcomers, for a cleaner environment and more cultural and recreational opportunities. Most of the comments could be lumped under a general category of improving the quality of life in Iowa.

Notably missing from the comments—at least from those that made it onto the air—was significant mention of "improving the business climate." Perhaps that's because we've been down that road before, and it led nowhere.

For the last couple of decades, Iowa policy-making has been fixated on improving the business climate. The focus was on incentives to businesses, selective tax cuts for industry, and boasting about Iowa's modest wages and mostly non-union work force. The thinking was that if business could be induced to bring jobs to Iowa, everything else would fall into place.

But it didn't. In almost every measure of economic gain, Iowa is near the bottom among the 50 states. Even among our Midwestern neighbors, Iowa has been bringing up the rear in income and population growth.

Meanwhile, a stagnant Iowa could look around and take note that growth occurring elsewhere wasn't necessarily happening in the states with the most favorable business climates. It was in states that are perceived to have the highest quality of life. Jobs are flowing to regions in which people find it desirable to live.

Iowa bet on the wrong strategy, and lost.

The comments heard by the Governor's Strategic Planning Council might be an indication that Iowans sense the need to change strategies. Things such as parks, recreation, cultural attractions, scenic preservation, strengthening community, cleaner water and air, and other enhancements to the quality of life, no longer can be assigned a secondary priority in Iowa. The quality of life must be the first priority. Iowa must be an inviting state not just to business, but to people. Especially to people.

Source: Lead editorial, *Des Moines Register*, October 27, 1999.

ATTRACTING RETIREES

It has been observed: "There is a new clean growth industry in America today—the industry is retirement migration" (Longino 1995). The appeal of retirees to communities stems from their potential for stimulating local economies. If 100 retired households come to a community in a year, each with a retirement income of $40,000, their impact is similar to that of a new business spending $4 million annually in the community.

From the perspective of economic development investments, targeting resources at recruiting retirees rather than exclusively at corporations has at least two major advantages. First, retirees do not require the economic incentive packages that comprise such elements as tax abatements, low-interest loans, subsidized worker training programs, and infrastructure improvements, which are often standard prerequisites to a corporate relocation. Second, capital improvements made as part of a retiree recruitment effort are likely to focus on such quality of life issues as recreational opportunities, beautification, ambience, or support services, which will also benefit existing residents. In contrast, capital investments targeted at recruiting corporations involve large outlays for such things as developing industrial/business parks, access roads, and utilities. Local residents are likely to receive relatively little direct benefit from these facilities. Hence, the risk associated with recruiting corporations is higher because, if the corporate strategy fails, the community receives a much poorer return on its investment than if the strategy of attracting retirees fails.

Some communities believe that retiree relocations are more desirable than business relocations. Social Security and private pension benefits of retirees are stable so their incomes are steady and not subject to the vicissitudes of economic business cycles. This income comes from outside the community, but retirees spend it locally so it stimulates the economy and generates jobs. Retirees not only increase the tax base, they tend to be positive taxpayers; that is, they characteristically use fewer services than they pay for through taxes. For example, they pay taxes to school districts but do not send children there. Migrating retirees are not likely to strain social services, health care services, the local criminal justice system, or the natural environment since they are likely to be relatively affluent, but they are likely to transfer significant assets into local investment and banking institutions. These assets expand the local deposit base that can be used for commercial and industrial financing. Retirees also provide the community with a pool of volunteers. They tend to be substantial contributors to, and active in, churches and local philanthropic and service organizations.

Figure 5.2. Intrastate Migrants 60 and Over Receiving Social Security or Retirement Income, 1995–2000

	Inmigrants	Outmigrants	Net Inmigrants
"WINNERS"			
1. Florida	354,104	141,831	212,273
2. Arizona	114,104	43,555	71,549
3. North Carolina	64,540	33,733	30,807
4. Nevada	50,017	21,390	28,627
5. Texas	85,477	59,634	25,843
6. South Carolina	38,718	20,036	18,682
7. Georgia	50,655	32,132	18,523
"LOSERS"			
1. New York	47,700	163,289	-115,547
2. Illinois	35,603	83,977	-48,374
3. California	115,616	146,893	-31,277
4. New Jersey	46,089	76,689	-30,600
5. Michigan	31,776	57,157	-25,381
6. Ohio	38,303	58,656	-20,353

Source: U.S. Census Bureau, Population Division (2003).

Most retirees do age in place or remain in the same area where they spent much of their lives. Between 1995 and 2000, however, almost 1.8 million Americans aged 60 and over who were receiving either Social Security or retirement income changed their state of residence. The states that were "winners" and "losers" in this movement are shown in figure 5.2.

These data reinforce the conventional wisdom that Sun Belt states are the primary beneficiaries while northern states are the primary losers. However, the cases of California, Florida, and Texas, all traditionally viewed as Sun Belt states, indicate that more than climate is involved. California, despite attracting the second-highest number of immigrants, is a net loser. At least part of this may be attributable to the extraordinary cost of real estate in California, which encourages retirees to cash in their equity to purchase a much less expensive house elsewhere in the United States and to raise the quality of their retirement lifestyle. Florida, while retaining its traditional position as the leading destination for retirees, was ranked second to New York in the number of outmigrants. Similarly, Texas ranked sixth among the states in number of outmigrants.

Extensive empirical evidence has been reported regarding the propensity of younger, affluent retirees to migrate to areas rich in amenities, and recreational opportunities are prominent among the amenities sought. The central role of recreational opportunities in attracting retirees is consistently reiterated. Among many who have recently retired, there is a desire to initiate a lifestyle change to a more recreation-oriented way of life. These retirees have an image of how they want to live in retirement and seek environments that facilitate that lifestyle. These sentiments are exemplified by the growing number of specialist retirement settlements, such as the Sun City and Leisure World communities, that have emerged in various parts of the country. Such communities invariably emphasize in their promotion the ambience created by open space and the array of opportunities they provide for engaging in recreational opportunities.

Members of this mobile retiree cohort have been termed GRAMPIES (Van der Merwe 1987). The acronym is derived from the first letter of key words in the following statement: There are growing numbers of retirees who are active monied people in excellent shape.

While park and open space amenities are a key ingredient in enticing relatively affluent retires to immigrate to a community, the converse of this also is likely to apply. That is, communities may lose their GRAMPIES if they fail to provide a comprehensive set of recreation opportunities comparable to those in other locations.

This finding was reported in a study of 270 individuals who had retired and migrated to permanently reside in the Texas Lower Rio Grande Valley area within the previous year (Haigood and Crompton 1998). These respondents were presented with 26 items known to potentially "push" people into migrating to another location from their resident community upon retirement. The two items on the list that referred to recreation were ranked second (desire to live a more recreationally enjoyable area) and third (desire to live in a place where recreation opportunities are plentiful) in importance, behind desire to get away from cold weather. This suggests that wealthy retirees are likely to consider moving from communities that fail to provide a comprehensive set of park and recreation opportunities. Data from this study suggest that communities that fail to provide a high number of park and recreation opportunities for retirees are likely to have their tax base eroded by the loss of economic spending power when some of their more affluent retirees leave the community.

There is a strong social element in recreation. Indeed, a primary purpose of participating in park and recreation activities for many people is to facilitate socialization. Thus, encouraging retirees to stay in their home environment where there are extensive existing social networks should be easier for communities than recruiting to the area new retirees who face the formidable challenge of creating new social networks. Thus, if excellent park and recreation opportunities are available in the home environment, one of the primary reasons that retirees leave an area will disappear.

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