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December 17, 2013
UP460: Urban Land Use and Transportation Policy

The Schuylkill River Trail

A Cost-Benefit Analysis of an Urban Trail

Abstract

Urban trails are frequently described in terms of their health benefits to a community, but they also offer other types of benefits: recreation, mobility, and reductions in automobile use, among others. In this analysis, the estimated benefits and costs were compared for the Schuylkill River Trail, a urban trail that passes through northern and central Philadelphia. The benefits outweighed the costs in eight out of nine cost-benefit scenarios, with a benefit-cost ratio of 2.77 in the most likely scenario. Under this scenario, recreation and health accounted for about 95 percent of the total benefits. Though small, the mobility benefit was found to be increasing in importance based on a spatial analysis of bicycle commuting trends.

Introduction and Literature Review

Traditionally located in small towns and rural communities, recreational trails have become popular urban amenities in recent decades. Sometimes referred to as linear parks, urban multi-use trails are often located along rivers or streams or in former rail corridors (Moore & Shafer 2001). These dedicated, often grade-separated facilities provide bicyclists and pedestrians with opportunities for recreation and human-powered mobility that are otherwise unavailable in the urban environment.

Regardless of their popularity, urban trail require funding, often from the same sources that fund streets, highways and public transportation. The costs and benefits of these traditional modes of transportation are relatively easy to quantify, but advocates for active transportation have struggled to frame their arguments in economic terms (Krizek et al., 2007). Where they have done so, they have focused primarily on the health benefits of walking and cycling (Abildso et al., 2012; Starnes et al., 2011; Wang et al., 2004).

Wang et al. (2004) examined the costs of urban trails in Lincoln, Nebraska and annualized these costs over useful lives of 10, 30 and 50 years using discount rates of 3, 5 and 10 percent. They estimated per-mile annual construction and maintenance costs ranging from

$5,735 to $54,017 in 2002 dollars, with an average cost of $35,355 per mile. The average cost per trail user was estimated to be $235. At $622, the annual per-user cost of inactivity was 2.65 times greater than the average per-user cost of the trail.

Abildso et al. (2012) attempted to address some of the perceived shortcomings of the Wang study in their analysis of the costs and health benefits of 8.2 miles of trails in Morgantown, West Virginia. Instead of using raw trip counter data as a proxy for trail users, they multiplied these counts by 0.667 to account for round trips. They also used data from an intercept survey of trail users to adjust the counts for repeat users and to estimate physical activity trends. Using a useful life of 30 years and no discount rate, they estimated an annualized trail cost of $6,721 per mile or $74.08 per repeat trail user in 2011 dollars. Considering only newly active trail users, the cost per user was $329.22. These costs were smaller than most of the published health benefits that they reviewed, which ranged from $205.80 to $905.16 per user per year.

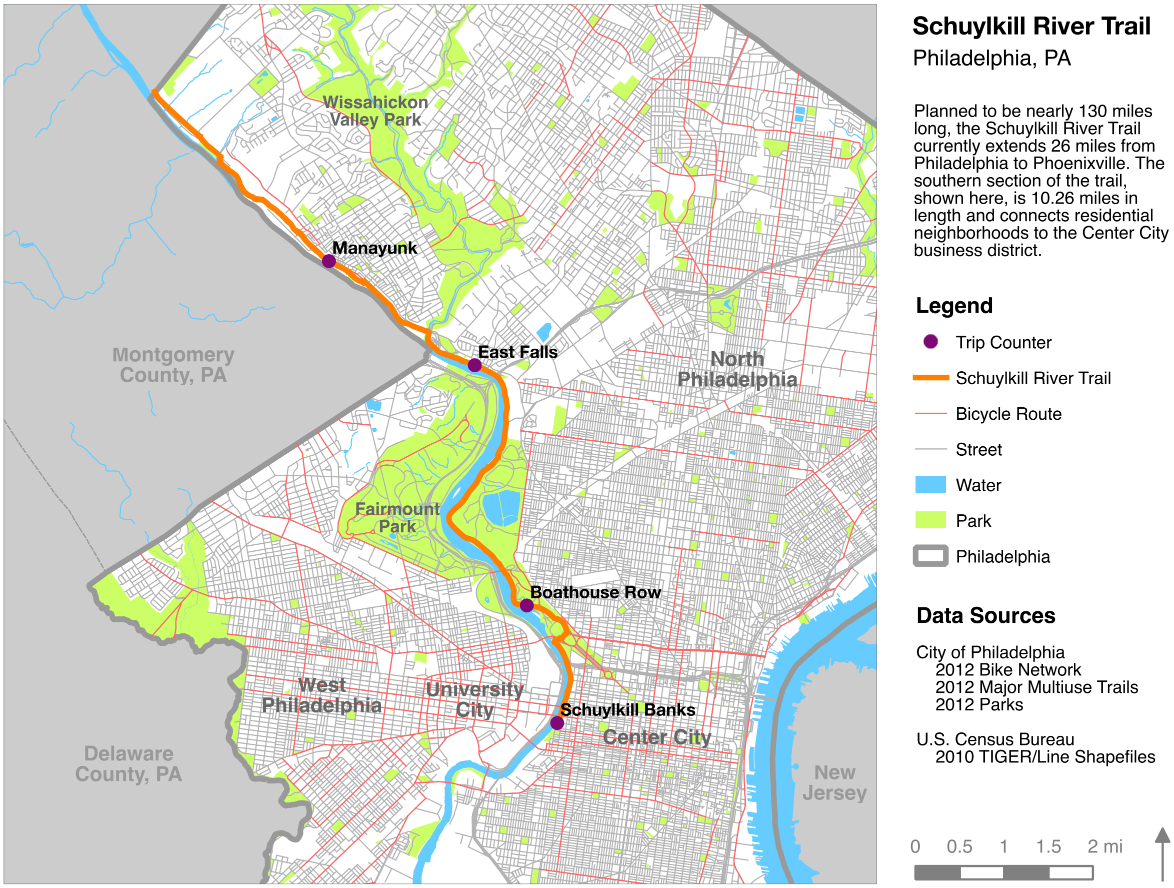
Krizek et al. (2007) described a more comprehensive method for estimating the costs and benefits of bicycle facilities and developed an online calculator based on their research. They identified seven categories of direct and indirect benefits of these facilities: mobility, recreation, health, safety, automobile use, livability and fiscal benefits. These benefits, they suggested, could be used in combination with cost estimates to show the cost effectiveness of bicycle facilities.

This study takes a comprehensive look at the benefits and costs of an urban trail using a framework based on the methods of Krizek, Abildso and Wang. It examines the 10.38-mile section of the Schuylkill River Trail that lies within the city limits of Philadelphia. The trail offers recreational opportunities, and it connects residential neighborhoods to the downtown core. By estimating the benefits and costs of the Schuylkill River Trail, the analysis suggests that the benefits of the trail outweigh the costs under the most likely cost and benefit scenarios.

The Schuylkill River Trail

The Schuylkill River Trail is a regional multi-use trail in southeast Pennsylvania. Planned to cover nearly 130 miles, the trail follows the path of the Schuylkill River. The southern terminus of the trail is currently located at Schuylkill Banks Park near Center City (downtown) Philadelphia. From this origin, the trail extends 26 miles to the northwest to Phoenixville. Of these 26 miles, 10.38 miles lie within the city of Philadelphia (see *Figure 1*). This 10.38-mile segment is the focus of the present analysis.

Figure 1



First built in 1979 as the Valley Forge Bikeway, the Philadelphia portion of the trail has been expanded and upgraded many times (Tomes & Knoch, 2009). The trail passes through four parks: three linear parks and the large East Fairmount Park (see *Table 1*). The Schuylkill River Park segment, which passes by Center City, is below street level with ramps for entering and exiting the trail. The Benjamin Franklin Parkway and East Fairmount Park segments, which follow Kelly Drive through Fairmount Park, consist of a paved sidepath. The Manayunk Canal segment runs along the canal with limited street crossings.

The trail passes through the central business district at its southern end and through high-density residential areas throughout the remainder of the trail. It is entirely off-street except for a 1.3-mile on-street segment just north of Fairmount Park. The majority of the trail is paved with asphalt and concrete, with short segments constructed from dirt, gravel and wood in the Manayunk Canal segment.

Table 1

Trail Length and Area by Characteristics

Schuylkill River Trail, Philadelphia, PA

Park	Length (ft)	Area (sq. ft)[1]
Schuylkill River Park	5,618	56,177
Benjamin Franklin Parkway	1,422	16,549
East Fairmount Park	25,234	240,621
Manayunk Canal	22,541	156,823
Real Estate Type[2]		
Urban Central Business District		112,353
Urban High Density Residential		836,045
Trail Location		
On Street	6,992	
Off Street	47,823	
Trail Material		
Asphalt	39,623	366,214
Concrete	3,614	26,267
Dirt	5,325	26,766
Gravel	4,479	35,832
Wood	1,774	15,090

[1] Area excludes on-street segments of the trail. [2] Real estate areas include a 5-foot buffer on each side of the trail. Data source: City of Philadelphia Streets Department, Bicycle Network Shapefile, November 1, 2012.

Data Sources and Methods

The techniques and assumptions used in this cost-benefit analysis built on the work of Krizek et al. (2007), Wang et al. (2004) and Abildso et al. (2012). The study focused on four of the seven benefits described by Krizek et al. (2007): mobility, recreation, health and automobile use. For an off-road facility like the Schuylkill River Trail, the safety benefit was assumed to be captured in the mobility and recreation benefits. The livability benefit, which examines the value of the trail as it is capitalized into surrounding property values, was excluded from the analysis because it does not represent a unique benefit but instead reflects the value placed on other benefits. The fiscal benefit, which quantifies the value of building a facility sooner rather than later, was also excluded because the trail has been in existence for decades.

The calculation of benefits was based on usage estimates derived from trip counters located along the trail. It also drew on the findings of a trail user survey conducted by the Rails-to-Trails Conservancy in 2009 (Tomes & Knoch, 2009). The year-long paper survey, distributed at trail access points, asked users of the Schuylkill River Trail about the frequency, purpose and spending behavior associated with their use of the trail. Though the survey covered all 57 miles of the trail that were open when it was conducted, 21.1 percent of the 1,223 responses were from residents of Philadelphia.

Costs

Because the Philadelphia section of the trail has existed for more than thirty years and was often extended or improved as part of larger infrastructure projects, it was not possible to obtain actual cost figures. Instead, the replacement cost of the trail was estimated using the online cost calculator developed by Krizek et al. (2007). The calculator was populated using trail material data from the Philadelphia Streets Department and trail features observed in satellite photos. Key assumptions used in estimating the trail cost included:

- For the purposes of real estate and landscaping costs, a five-foot buffer was included on either side of the trail in addition to its width.
- The Schuylkill River Park section of the trail was assumed to run through Urban Central Business District real estate, while the rest of the trail was assumed to fall within the Urban High Density Residential zone.
- Access ramps were estimated as bridge beds using average dimensions observed in satellite photos.
- Because the trail runs along a river and does not require any dedicated underpasses, the cost premiums of extending existing bridges to cover the trail were estimated using the trail width.
- The contingency estimates were assumed to cover expenses like bulkheading of the riverbank, which were necessary for construction of the trail as well as the adjacent parks.

Cost calculations used the calculator's default costs for off-road trail construction in Philadelphia. These costs were derived by Krizek et al. by applying a regional multiplier to costs observed in the calculator's base region. Costs were inflated from the calculator's base year, 2002, to 2013 using the calculator's default inflation multiplier for that period, 1.32. The estimated construction and maintenance costs (C) were then annualized using useful life time periods (t) of 10, 30 and 50-years and discount rates (r) of 3, 5 and 10 percent (Wang et al., 2004):

$$annual\ cost = \frac{r * C}{1 - (1 + r)^{-t}}$$

These annual cost estimates were summarized as three cost scenarios: low (50 years, 3 percent), medium (30 years, 5 percent) and high (10 years, 10 percent). As in the analysis performed by Wang et al. (2004), the medium cost scenario was assumed to be the most likely.

Trail Usage Estimates

The Philadelphia Parks and Recreation department collects usage data at four points along the trail using TRAFx trip counters. These counters record a count every time an infrared beam is broken by a cyclist or pedestrian. Estimates of trail usage were derived from these data using a methodology based on the work of Abildso et al. (2012) and the Rails-to-Trails Conservancy (Tomes & Knoch, 2009).

Counts from three counters—Manayunk, Boathouse Row and Schuylkill Bank—from March 2011 through May 2011 were used to estimate the total number of counts during 2011.[1] These estimates for 2011, the most recent year for which data were available, were used as a proxy for current usage estimates. Though the three-month counts for 2011 were slightly lower than the corresponding counts from 2009 and 2010, the difference was likely due to differences in springtime weather, which is highly variable in Philadelphia. As such, the 2011 estimates represent conservative estimates for current trail usage.

The full year estimates (E) for each counter (c) were used to estimate the number of annual users and trips. The user and trip estimates assumed that:

- Users on the Philadelphia section of the trail pass 1.988 counters (M) on average.
- The infrared counters undercount by about 20 percent (P_u) because of side-by-side crossings and fast-moving cyclists.
- All non-commuting trips start and end at the same location. During these non-commuting trips, which represent 80.89 percent (P_{nc}) of all trips, users pass the same counters twice.

[1] Counts for the fourth counter, East Falls, were unavailable for 2011 and were estimated using 2010 data.

After adjusting for multiple counters, missed counts and round trips, the counts were multiplied by 0.98 (P_a), the proportion of users who were adults 18 years old or older, as estimated from the survey results. Children were excluded from the analysis because the benefits they receive from trail usage are different from those received by adults (Krizek et al., 2007):

$$annual\ trail\ trips = \sum \left(E_c * \frac{1}{M} * \ (1 + \ P_u) * \frac{1}{1 + P_{nc}} * \ P_a\right)$$

Based on survey results for trip frequency, the average user was estimated to make 100 trail trips per year (T_y). As a result, the total number of trips for 2011 (T_t) was divided by 100 to estimate the number of annual users of the trail:

$$annual\ trail\ users = \frac{T_t}{T_y}$$

Trip and User Purpose

Different trail users use the trail for different purposes, and the purpose of a trip impacts the benefits the user receives (Krizek et al., 2007). The 2009 survey asked respondents to classify their primary use of the trail, and the resulting percentages were used to allocate the total number of annual users previously calculated. Commuters were assumed to make ten trips per week for nine months out of the year, or a total of 390 annual trips. Based on this assumption that commuters make 3.9 times more trips than the average trail user, the total number of users previously estimated was allocated among the trip purpose categories.

Mobility Benefit

Mobility benefits describe the value commuters place on using the trail to commute to and from work and were estimated using time premiums for off-road trails. Tilahun et al. (2007) used an adaptive preference survey to determine the time premiums in minutes (M) that a bicycle commuter would be willing to spend to use an off-road trial instead of four comparison facilities. They found that commuters would trade 23.14 minutes of one-way commute time to use an off-street trail if the alternative was a street with parking and no bicycle lane, and 14.21 minutes if the alternative was a street with a bicycle lane and no parking (see *Table 2*). Using an hourly time value (V) of $12.00, these times correspond to $4.63 and $2.84 per one-way commute, respectively. These values were multiplied by the estimated number of commuting trips (T_c) to produce high and low estimates of the annual mobility benefit:

$$annual\ mobility\ benefit = M * \frac{V}{60} * T_c$$

Table 2

Time Value of Off-Street Bicycle Facilities

For One-Way Commuting Trips

Comparison On-Street Facility	Time Value (Min)	Monetary Value[1]
Bicycle lane, no parking	14.21	$2.84
Bicycle lane with on-street parking	16.00	$3.20
No bicycle lane, no parking	18.46	$3.69
No bicycle lane with on-street parking	23.14	$4.63

[1] Assumes an hourly time value of $12.00. Data sources: Kruesi, 2011; Tilahun et al., 2007.

In addition to the monetary benefits of commuting, the spatial distribution of bicycle commuting was examined using 400, 800 and 1,200-meter buffers around the trail, as described by Krizek et al. (2007). Census block groups were assigned to these buffers based on the location of their centroids. Census blocks within or south of Center City and University City were excluded from the analysis because they primarily represent destinations—not sources—of commuting trips made on the trail. The overall bicycle commuting rate was calculated for each buffer using data from the 1990 and 2000 decennial censuses and the 2006-2010 5-year American Community Survey estimates. In addition, logarithmic regressions were performed for each time period to determine the strength of the relationship between the distance from the centroid of the block group to the trail (D) and the bicycle commuting share (S) for that block group:

$$S = f(\ln(D))$$

Recreation Benefit

Recreation benefits describe the enjoyment that recreational users of the trail get from cycling, running and other trail activities. These benefits were estimated based on non-commuting trips using two different methodologies. In the first, employed in a 2008 analysis of Philadelphia parks by the Trust for Public Land (Harnik, 2008), non-commuting trips were allocated among activities such as walking, bicycling and walking a pet based on the trail activities reported by respondents to the 2009 survey. All commuting trips were assumed to be bicycle trips, reducing the number of bicycle trips receiving recreation benefits. Each activity (a) reported by survey respondents was assigned the value (V) specified in the 2008 report, with "other" activities assigned the average value of all "general" and "sports" activities. These per-trip values were multiplied by the estimated number of trips (T) for that activity, yielding the low estimate for the overall recreation benefit:

$$annual\ recreation\ benefit = \sum (T_a * V_a)$$

The high estimate for the recreation benefit was produced using the time value methodology employed by Krizek et al. (2007). Based on the 2009 survey results, the average trip length in hours (H) was estimated to be 1.5 on the Philadelphia section of the Schuylkill River Trail. The average trip length was multiplied by an hourly recreation value (V) of $10 (Krizek et al., 2007) to produce an average trip value of $15. This value was multiplied by the number of annual non-commuting trips (T_{nc}), yielding the high estimate for the annual recreation benefit:

$$annual\ recreation\ benefit = H * V * T_{nc}$$

Health Benefit

Health benefits describe the reduction in direct healthcare costs and other expenses that trail users experience as a result of increased physical activity. These benefits were estimated using two methodologies. The first, used by the Trust for Public Land in its analysis of Philadelphia parks (Harnik, 2008), focused on direct healthcare expenses. It estimated the difference in cost (C) between active and inactive trail users age (a) 18 to 64 and age 65 and above to be $250 and $500 respectively. As in the parks study, these cost differences were assumed to take into consideration the proportion of these age groups that were already active. The cost differences were multiplied by the number of users (U) in each age bracket, as estimated using age results from the 2009 trail user survey. The result was adjusted using a regional multiplier (R) of 1.046 to produce the low estimate for the annual health benefit:

$$annual\ health\ benefit = \sum (C_a * U_a) * R$$

The second methodology, which used an online health costs calculator developed by the Robert Wood Johnson Foundation ("Quantifying the Cost," 2006), included other costs of inactivity in addition to direct healthcare costs. The calculator was populated with the following input data:

- Estimated number of adult trail users
- Estimated number of working trail users based on Philadelphia's workforce participation rate in the 2007-2011 American Community Survey 5-year estimates (59.20 percent)
- Percentage of trail users 65 years or older from the 2009 trail user study (16 percent)
- Estimated percentage of trail users who would otherwise be physically inactive based on the Philadelphia metropolitan area's 2005 inactivity rate calculated by the Centers for Disease Control (41.8 percent)
- Median annual salary for Philadelphia workers from the 2007-2011 American Community Survey 5-year estimates ($28,428)

The calculator yielded estimated savings for medical costs (S_m), workers' compensation (S_{wc}) and increased productivity (S_p). These savings were summed to produce the high estimate of the trail's annual health benefit:

$$annual\ health\ benefit = S_m + S_{wc} + S_p$$

Automobile Use Benefit

The automobile use benefit describes the value of reduced traffic congestion produced by bicycle commuting. Krizek et al. (2007) found that congestion reduction was the only automobile-related benefit of bicycle commuting that could be reliably estimated. They estimated low, medium and high per-mile savings (S) of 1, 8 and 13 cents, respectively. These per-mile rates were multiplied by 3.54 miles, the average bicycle commute length (L) in the 2009 National Household Travel Survey, to produce average per-trip benefits. Low, medium and high annual automobile use benefits were estimated by multiplying the respective per-trip benefits by the estimated number of commuting trips (T_c) per year:

$$annual\ automobile\ use\ benefit = S * L * T_c$$

Cost-Benefit Analysis

The annual mobility, recreation, health and automobile use benefits were added together to produce high, medium and low benefit scenarios. For the mobility, recreation and health benefits, the medium scenario used an average of the high and low benefits. The benefit scenarios were compared to the high, medium and low cost scenarios, yielding a total of nine cost-benefit scenarios. For each scenario, the total, per-mile and per-user net benefits were calculated. The benefit-to-cost ratio of each scenario was also calculated. For the purpose of discussion, the medium cost-medium benefit scenario was assumed to be the most likely.

Results

Costs

The trail cost calculator yielded a total construction cost estimate of $61.9 million and an annual maintenance cost of $58,873 (see *Table* 3 and *Figure 2*). Nearly half of the construction cost, $30.0 million, went toward real estate acquisition, reflecting the high cost of prime land near the urban core. Only $7.5 million of the cost went toward construction materials and labor and $2.6 million toward equipment, primarily street lights. The total construction cost per mile was nearly $6 million.

Table 3

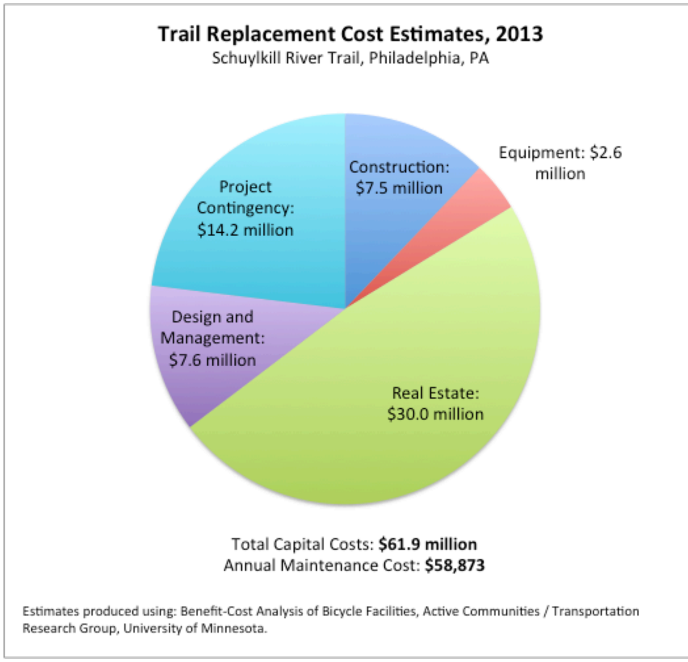
Trail Replacement Costs Estimates, 2013

Schuylkill River Trail, Philadelphia, PA

Construction	**2013 Cost Estimate**
Clearing and Grubbing	$67,315
Pavement and Curbs	$1,312,418
Pavement Markings	$48,244
Landscaping	$1,164,951
Access Ramps and Bridges	$2,970,000
Underpass Premium	$1,267,299
Construction Contingency	$683,022
Construction Total	$7,513,250
Equipment	
Signs and Signals	$50,160
Fencing and Gates	$475,607
Lighting	$2,027,626
Equipment Total	$2,553,392
Real Estate	
High Density Residential	$19,930,833
Central Business District	$5,034,790
Real Estate Contingency	$4,993,124
Real Estate Total	$29,958,748
Design and Management	
Construction Administration	$2,279,866
Construction Planning	$759,956
Design and Engineering	$3,799,776
Field Inspections	$759,956
Project Contingency	$14,287,482
Design and Management Total	$21,887,035
Total	
Total Capital Costs	**$61,912,425**
Cost per Mile	$5,964,588

Estimates produced using: Benefit-Cost Analysis of Bicycle Facilities, Active Communities / Transportation Research Group, University of Minnesota.

Figure 2



The annual equivalent construction cost of the trail ranged from $2.4 million assuming a 50-year useful life and a 3 percent discount rate to $10.1 million assuming 10 years of useful life and a discount rate of 10 percent (see *Table 4*). Adding annual maintenance costs, the cost per mile ranged from $237,488 to $976,381, and the cost per user ranged from $302 to $1,241 (see *Table 5*). The per-mile costs were significantly higher than those estimated by Wang et al. (2004) and Abildso et al. (2012), reflecting the high cost of land and construction in a dense downtown area. The per-use costs were also higher than those found in these studies, but the difference was less pronounced than the difference in construction costs, suggesting that at least some of the cost premium of building in a dense city is offset by higher usage.

Table 4

Annual Equivalent Construction Cost (2013 $)

Schuylkill River Trail, Philadelphia, PA

Useful Life of Trail	3% Discount	5% Discount	10% Discount
10 Years	$7,258,025	$8,017,942	$10,075,962
30 Years	$3,158,726	$4,027,492	$6,567,624
50 Years	$2,406,257	$3,391,361	$6,244,436

Table 5

Annual Cost Scenarios (2013 $)

Schuylkill River Trail, Philadelphia, PA

	Assumptions		Construction Costs		Maintenance Costs		Total Costs		
Cost Scenario	**Useful Life (Years)**	**Discount Rate**	**Total**	**Per Mile**	**Total**	**Per Mile**	**Total**	**Per Mile**	**Per User**
Low	50	3%	$2,406,257	$231,817	$58,873	$5,672	$2,465,130	$237,488	$302
Medium	30	5%	$4,027,492	$388,005	$58,873	$5,672	$4,086,365	$393,677	$500
High	10	10%	$10,075,962	$970,709	$58,873	$5,672	$10,134,835	$976,381	$1,241

Trail Usage Estimates

From March 2011 through May 2011, the four infrared counters on the Philadelphia section of the trail recorded over 700,000 counts, yielding an estimate of 816,717 annual trips and 8,167 annual users (see *Table 6*). Boathouse Row and Schuylkill Banks were the most frequently passed counters, together accounting for nearly 80 percent of the total counts.

Table 6

Annual Bicycle and Pedestrian Trip Estimates, 2011

Schuylkill River Trail, Philadelphia, PA

	Counts and Estimates		Estimates After Adjustments			
Trip Counter	**3-Month Counts**	**12-Month Estimates**	**Multiple Counters**	**Missed Counts**	**Round Trips**	**Adult Trips**
Schuylkill Banks	251,059	822,778	413,872	496,646	274,557	269,066
Boathouse Row	357,852	1,172,762	589,921	707,905	391,346	383,519
East Falls [1]	120,000	393,267	197,821	237,385	131,232	128,607
Manayunk	33,148	108,634	54,645	65,574	36,251	35,526
Adjusted Total						**816,717**

[1] East Falls data were unavailable for 2011 and were estimated using 2010 data. Data source: Schuylkill River Trail TRAFx Counters, April 2011 - June 2011, City of Philadelphia Parks and Recreation Department.

Based on informal observations of trail use, the estimate of 8,167 annual trail users was conservative. This low estimate was likely due to the voluntary nature of the 2009 trail user survey. More frequent users of the trail were more likely to see and respond to the survey, inflating the reported number of trips per user. Still, this estimate of annual users was used in the analysis in order to maintain consistency with other assumptions based on the survey results.

Trip and User Purpose

Exercise and fitness trips made up an estimated 55.5 percent of all trips on the trail, followed by recreation and tourism trips, which accounted for 24.1 percent of all trips (see *Table 7*). Commuting trips and commuting users represented an estimated 19.1 percent and 4.9 percent of trips and users respectively, reflecting the assumption that commuters made an average of 390 annual trips compared to 100 annual trips for the average user.

Table 7

Estimated Annual Adult Users and Trips by Purpose

Schuylkill River Trail, Philadelphia, PA

	Adult Users		Adult Trips	
Primary Purpose	**Percent**	**Annual Users**	**Percent**	**Annual Trips**
Exercise and Fitness	65.2%	5,325	55.5%	453,409
Recreation and Tourism	28.3%	2,311	24.1%	196,802
Commuting	4.9%	400	19.1%	156,075
Other	1.5%	123	1.3%	10,431
Total[1]	99.9%	8,167	100.0%	816,717

[1] Totals do not add up to 100 percent because of rounding in the reporting of survey results. Data sources: Tomes & Knoch, 2009; Schuylkill River Trail TRAFx Counters, April 2011 - June 2011, City of Philadelphia Parks and Recreation Department.

Mobility Benefit

The low estimate, which compared the trail to a street with a bicycle lane and no parking, yielded an annual mobility benefit of $443,564. The high estimate, which compared the trail to a street with no parking and an on-street bicycle lane, resulted in an annual mobility benefit of $722,313. Though both estimates were included in the analysis, the higher end of the range was more realistic for Philadelphia, where narrow streets make dedicated bicycle lanes difficult to implement and dense development necessitates on-street parking in most neighborhoods.

The spatial and temporal analysis of bicycle commuting revealed increased commuting overall, with particular increases in the area surrounding the Schuylkill River Trail (see *Figures 3 – 5*). Between the 1990 Census and the 2006 – 2010 American Community Survey, the bicycle commuting share in block groups 400 to 800 meters from the trail increased slightly, while the rate in block groups 800 to 1200 meters from the trail increased by more than 240 percent (see *Table 8*). Meanwhile, the bicycle commuting share in the city as a whole increased by nearly 190 percent. The bicycle commuting rate within 400 meters of the trail varied widely, but because of the trail's location within parks, it represented a relatively small number of bicycle commuters.

Logarithmic regressions revealed a weak but increasing relationship between distance from the trail and bicycle commuting share (see *Figure 6*). These results suggest that, as the bicycle network in Philadelphia develops, the Schuylkill River Trail is becoming an increasingly important part of that network.

Figure 3

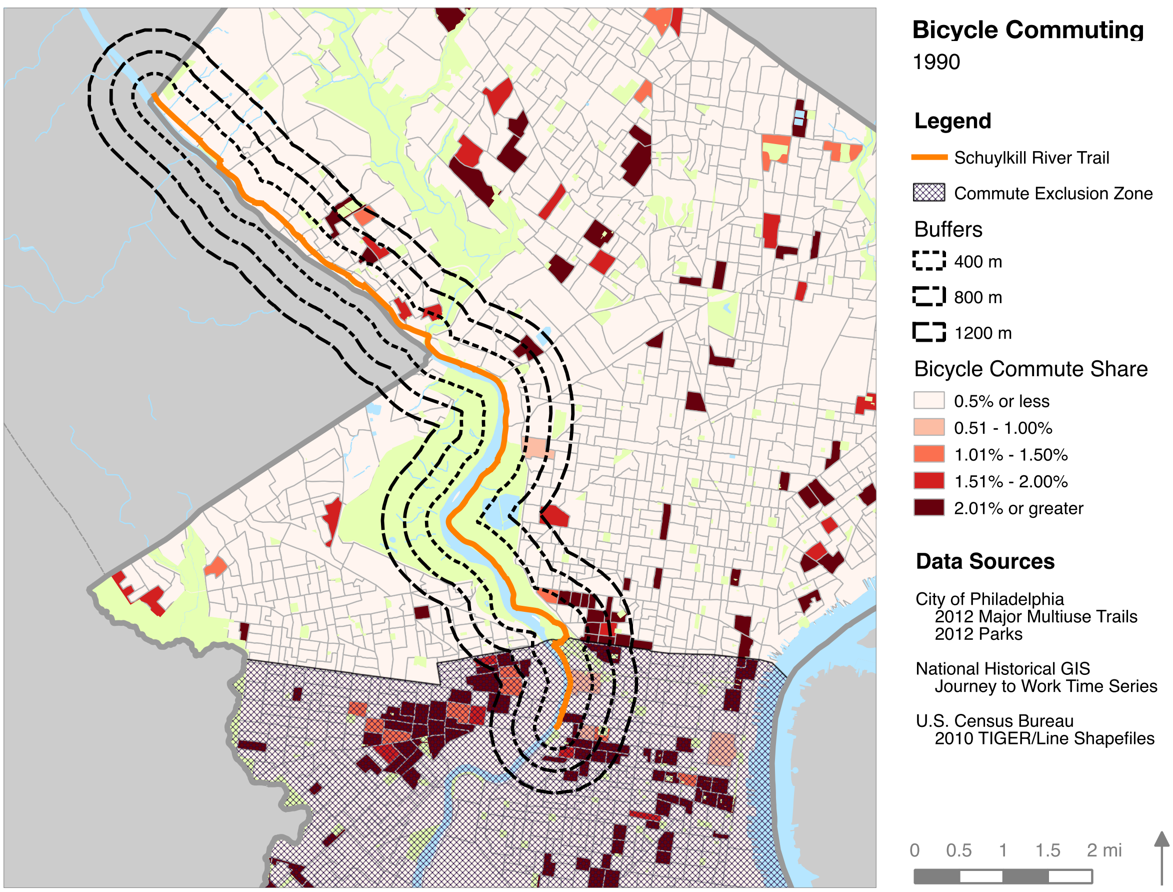


Figure 4

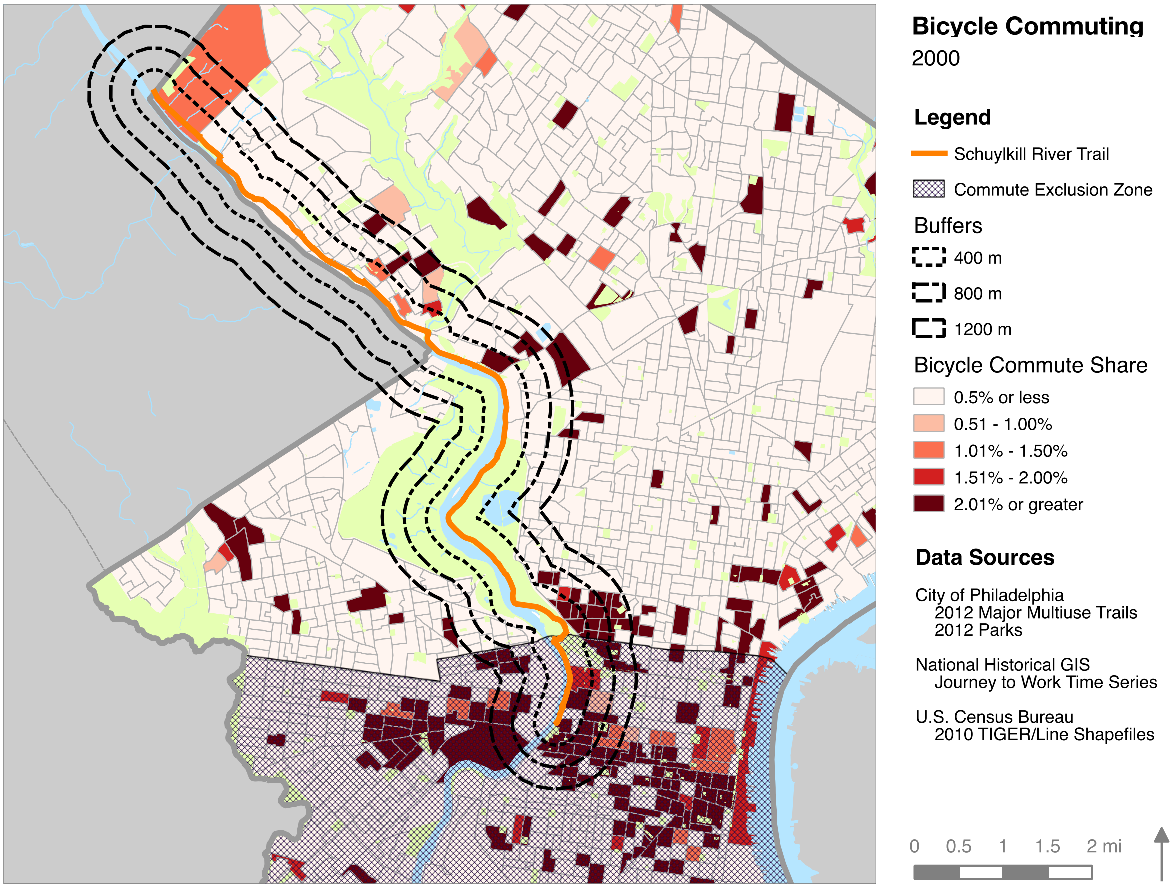

Bicycle Commuting
2000
Legend
Schuylkill River Trail
Commute Exclusion Zone
Buffers
400 m
800 m
1200 m
Bicycle Commute Share
0.5% or less
0.51 - 1.00%
1.01% - 1.50%
1.51% - 2.00%
2.01% or greater
Data Sources
City of Philadelphia
2012 Major Multiuse Trails
2012 Parks
National Historical GIS
Journey to Work Time Series
U.S. Census Bureau
2010 TIGER/Line Shapefiles
0 0.5 1 1.5 2 mi

Figure 5

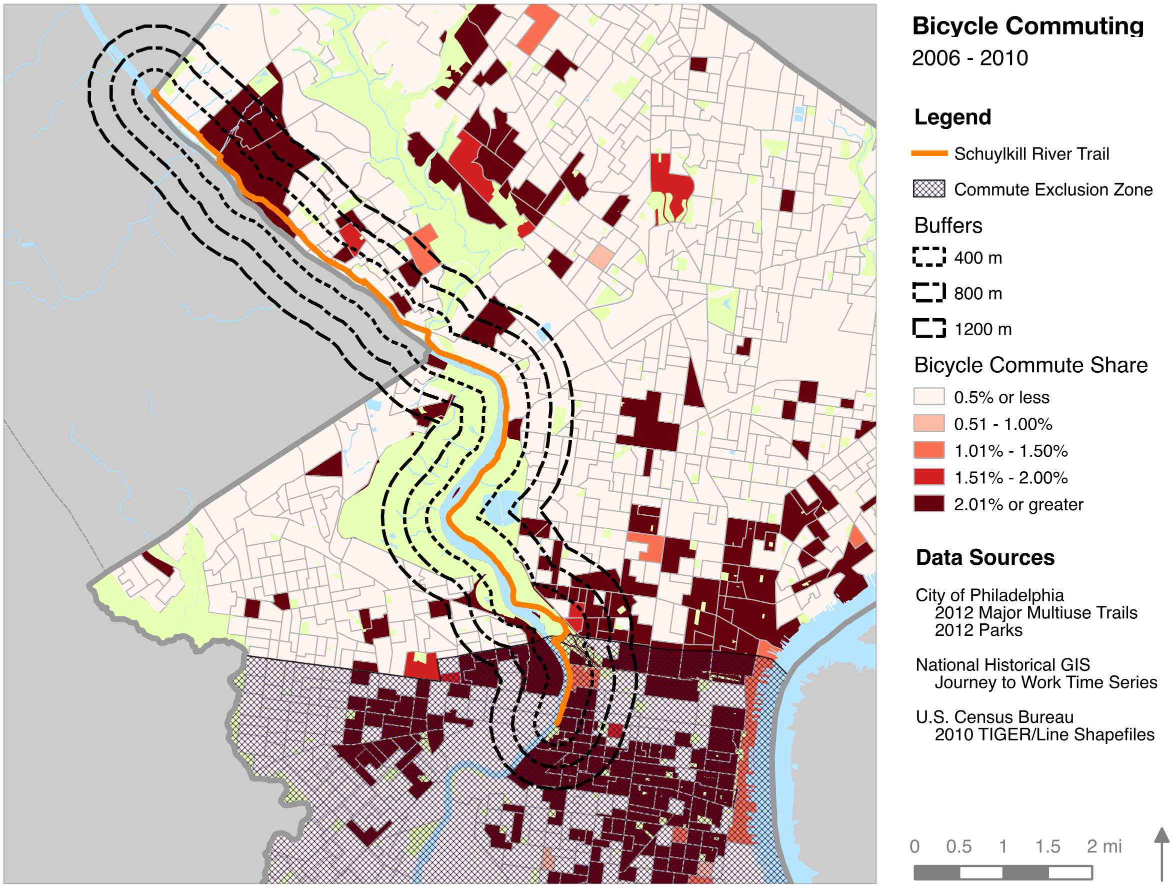


Table 8

Bicycle Commuting Share by Distance from Trail, 1990 - 2010

Schuylkill River Trail, Philadelphia, PA

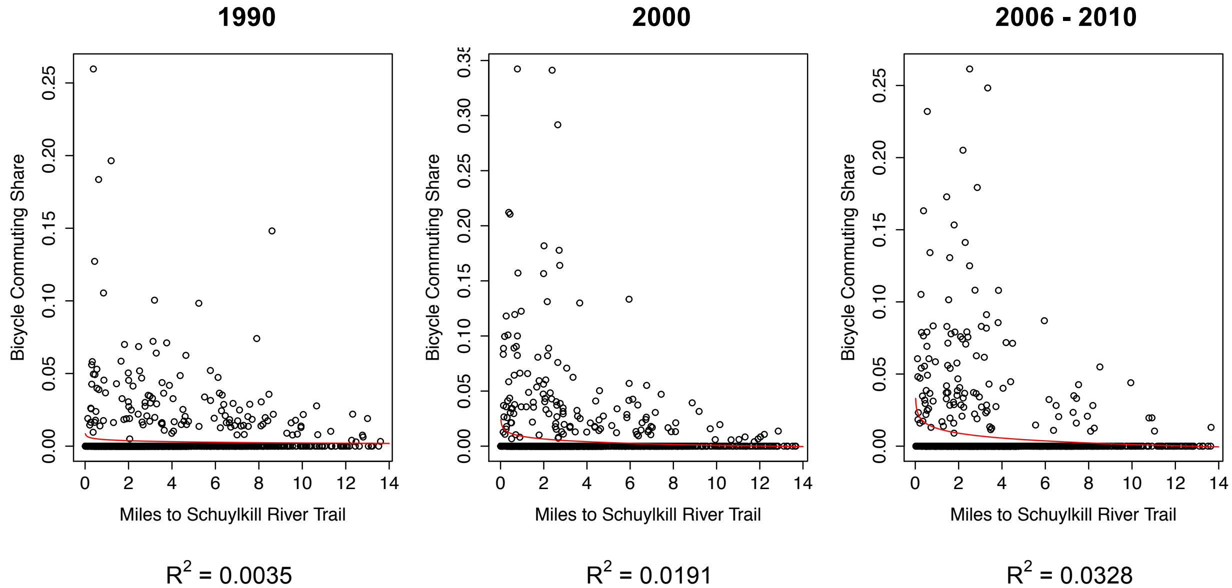
Distance from Trail	1990	2000	2006 - 2010[1]
0 - 400 meters	0.21%	2.12%	1.04%
400 - 800 meters	1.55%	1.54%	2.01%
800 - 1,200 meters	0.53%	1.01%	1.82%
City of Philadelphia	0.57%	0.86%	1.63%

[1] 2006 - 2010 data are based on American Community Survey 5-year estimates. Counts and estimates of bicycle commuters are derived from Census block groups. Block groups are categorized based on the distance from their centroids to the trail. Data source: National Historical GIS, Journey to Work Time Series Table.

Figure 6

Relationship between Bicycle Commuting Share and Distance to Trail, 1990 – 2010

Distance to Schuylkill River Trail from all Census Block Groups in Philadelphia, PA



Recreation Benefit

Estimating recreation benefits by activity yielded a total annual recreation benefit of $1.6 million, the low estimate for this benefit (see *Table 9*). Even after removing bicycle trips from commuting, cycling produced the largest total benefit of any of the trail activities. Running and walking also provided significant recreation benefits. With cycling, these activities accounted for over 85 percent of the total annual recreation benefit.

Table 9

Recreation Value by Activity

Schuylkill River Trail, Philadelphia, PA

	Annual Trips		Monetary Value	
Primary Activity	**All Adult Trips**	**Non-Commuting Adult Trips**	**Per Trip**	**Annual Total**
Walking	220,514	220,514	$1.47	$324,155
Bicycling	359,355	203,281	$3.16	$642,368
Running	130,675	130,675	$3.25	$424,693
Horseback Riding	4,084	4,084	$8.40	$34,302
Walking a Pet	65,337	65,337	$1.32	$86,245
Other[1]	36,752	36,752	$2.40	$88,205
Total	816,717	660,642		$1,599,968

[1] The per-trip value for other activities is based on the average value of visits to Philadelphia parks for all general and sports activities. Data source: Harnik, 2008.

Estimating the recreational benefit by time instead of by activity produced an annual recreation benefit of $9,909,636, the high estimate for the recreation benefit. The difference between this estimate and the low estimate reflects the difference between the assumed recreational value of time and the amount of money users are willing to pay to use a private recreational facility. It also suggests that trips on the Schuylkill River Trail tend to be longer on average than visits to Philadelphia parks, yielding a higher per-trip value when time is considered.

Health Benefit

The Trust for Public Land method, which focuses on direct medical cost savings, yielded an annual health benefit estimate of $2.5 million, or $303 per user (see *Table 10*). Of this annual benefit, over one quarter went to users 65 years old and older. Based on results from the user survey, seniors represented about 16 percent of all trail users.

Estimating comprehensive health benefits using the Robert Wood Johnson Foundation calculator produced an annual benefit of $7.4 million, or $904 per user. At $2.2 million, the annual medical care benefit was similar to the benefit estimated using the Trust for Public Land method and represented nearly 30 percent of the overall health benefit. Benefits from increased productivity represented most of the rest of the annual health benefit estimate, with decreases in workers' compensation contributing less than 1 percent of the total benefit.

Table 10

Annual Health Benefit

Schuylkill River Trail, Philadelphia, PA

Trust for Public Lands Method	Annual Benefit	Percent
Users 18 to 64 Years Old[1]	$1,794,001	72.4%
Users Over 65 Years Old[1]	$683,429	27.6%
Total	$2,477,429	100.0%
Robert Wood Johnson Calculator		
Medical Care	$2,196,690	29.7%
Workers' Compensation	$17,064	0.2%
Lost Productivity	$5,172,532	70.0%
Total	$7,386,286	100.0%

[1] Age-based estimates are for direct medical cost savings only and are regionally-adjusted. Data sources: Harnik, 2008; "Quantifying the Cost," 2006.

Automobile Use Benefit

The annual benefits for congestion reduction as a result of bicycle commuting ranged from $5,525 to $71,826 (see *Table 11*). The $0.13 per mile rate is designed to estimate the benefits in congested urban areas (Krizek et al., 2007), suggesting that the true benefit for Philadelphia is probably near the high end of this range.

Table 11

Automobile Use Reduction Benefit

Schuylkill River Trail, Philadelphia, PA

Benefit Scenario	Per-Mile Benefit	Annual Benefit[1]
Low	$0.01	$5,525
Medium	$0.08	$44,200
High	$0.13	$71,826

[1] Estimates assume an average bicycle commute length of 3.54 miles. Data source: 2009 National Household Travel Survey.

Cost-Benefit Analysis

Combining the annual mobility, recreation, health and automobile use benefits yielded per-mile benefits of $1.6 million to $10.0 million and per-user benefits of $554 to $2,215 (see *Table 12*). These benefits were significantly higher than the estimated per-user costs of $302 to $1,241.

Table 12

Summary of Annual Benefits (2013 $)

Schuylkill River Trail, Philadelphia, PA

	Annual Benefits by Type				Total Annual Benefits		
Benefits Scenario	Mobility	Recreation	Health	Automobile Use	Total	Per Mile	Per User
Low	$443,564	$1,599,968	$2,477,429	$5,525	$4,526,487	$1,605,493	$554
Medium[1]	$582,939	$5,754,802	$4,931,858	$44,200	$11,313,799	$5,799,002	$1,385
High	$722,313	$9,909,636	$7,386,286	$71,826	$18,090,061	$9,981,461	$2,215

[1] For the mobility, recreation and health benefits, the medium scenario is the average of the high and low scenarios.

Net annual benefits were positive in eight out of the nine cost-benefit scenarios (see *Table 13*). Under the medium cost-medium benefit scenario, assumed to be the most likely, the trail produced net annual benefits of $696,285 per mile, or $885 per user.

Table 13

Net Annual Benefits by Scenario (2013 $)

Schuylkill River Trail, Philadelphia, PA

	Total by Benefit Scenario			Per Mile by Benefit Scenario			Per User by Benefit Scenario		
Cost Scenario	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**	**Low**	**Medium**	**High**
Low	$2,061,357	$8,848,669	$15,624,931	$198,589	$852,473	$1,505,292	$252	$1,083	$1,913
Medium	$440,122	$7,227,434	$14,003,696	$42,401	$696,285	$1,349,104	$54	$885	$1,715
High	($5,608,348)	$1,178,964	$7,955,226	($540,303)	$113,580	$766,399	($687)	$144	$974

Benefit-cost ratios for the trail ranged from 0.45 to 7.34 depending on the cost and benefit scenarios (see *Table 14*). Under the most likely scenario, the trail had a benefit-cost ratio of 2.77. Over half of the annual benefits in this scenario came from recreation, while 44 percent of the benefits were from health cost reductions (see *Figure 7*). Mobility accounted for about 5 percent of the annual benefits, and automobile use reduction represented less than 1 percent of the total.

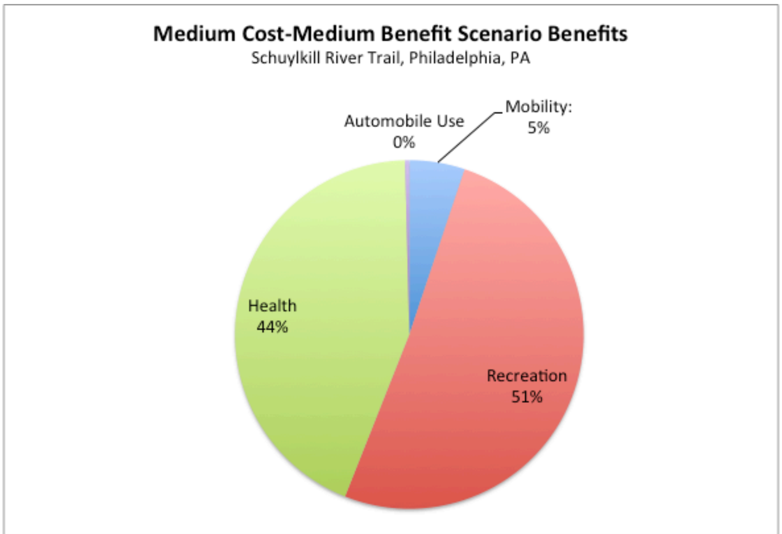
Table 14

Benefit-Cost Ratio by Scenario

Schuylkill River Trail, Philadelphia, PA

	Benefit Scenario		
Cost Scenario	**Low**	**Medium**	**High**
Low	1.84	4.59	7.34
Medium	1.11	2.77	4.43
High	0.45	1.12	1.78

Figure 7



Limitations and Further Research

Though this study provides evidence to suggest that the benefits of Philadelphia section of the Schuylkill River Trail outweigh its costs, further research is needed to address the study's limitations and test its assumptions. One of the key limitations of the current research was its inability to distinguish induced benefits from pre-existing benefits, resulting in an overstatement of the benefits directly attributable to the trail. Future research should estimate the proportion of benefits induced by the trail by comparing recreation and commuting behavior in areas close the trail to the behavior in similar areas further from the trail.

Despite this limitation, the urban form of Philadelphia suggests that the induced benefits are high compared to the pre-existing benefits. Narrow right-of-way and limited off-street parking make the addition of on-street bicycle facilities difficult or impossible in many parts of the city. In addition, many neighborhoods are served only by small parks or squares that are one block in size or less, offering limited recreational opportunities. As a result, the Schuylkill River Trail serves as an important link, both to jobs in Center City and University City and to recreational opportunities in Fairmount Park.

In future studies, assumptions made in this analysis should be confirmed or modified through direct observation of trail users. This is particularly important for assumptions based on the results of the 2009 trail user survey, which many not be representative of all trail users. In addition, direct observation could be used to check the methodology used to derive the number of annual trips from the trip counter data.

Because of the unique geographical features of the Schuylkill River Trail and its integration with complex urban systems, the results of this analysis hold limited potential for generalization outside of Philadelphia. Unlike on-street bicycle facilities, where the user experience is controlled by a limited set of factors, urban trails are highly variable and context-sensitive. Factors such as connectivity to destinations, trail amenities, topography and weather impact both the costs and benefits of trails, making the benefit-cost ratios difficult to generalize. Still, the methods used in this analysis can be applied to any urban trail for which relevant data are available.

In addition, this study can serve as a baseline to track the impacts of expansions of the Schuylkill River Trail. One such expansion, the Schuylkill Banks Boardwalk, which is currently under construction, will extend the trail 2,000 feet south, connecting it to the South Street Bridge

(Glazer, 2013). Because the riverbank in this location is already occupied by freight rail tracks, the expansion is being built on concrete pilings anchored to the riverbed. The boardwalk is projected to cost $10.6 million (Glazer, 2013), more than four times the per-mile cost of the on-land portion of the trail. By connecting the trail to the South Street Bridge, a major east-west bicycle route, it also offers the opportunity to increase the trail's utility as a commuting route. Repeating this analysis after the completion of the boardwalk could help to describe its benefits and, if they outweigh the costs, to build political support for future extensions.

Summary and Policy Implications

A cost-benefit analysis of the Schuylkill River Trail reveals that the costs outweigh the benefits in eight out of nine cost-benefit scenarios. Under the most likely scenario, the benefit-cost ratio is 2.77, and the net annual benefits are $885 per user and $696,285 per mile. In this scenario, about 95 percent of the total benefits come from recreational value and health care cost reductions, with most of the remaining 5 percent coming from increased mobility for bicycle commuters. Though the mobility benefit is relatively small, regression analysis suggests that the trail is increasing in importance as a commuting route.

Though these findings are specific to the Schuylkill River Trail, they have implications for trail-related policies. Since health and recreation represent the majority of the benefits to trail users, the city should pursue policies that increase the number, frequency and length of recreational and fitness-related trips. These policies could include promoting races and other fitness-related programming on the trail; providing additional benches and drinking fountains to encourage longer trips; making the trail fully off-road to improve the recreational experience; and paving gravel sections of the trail to expand recreational choices.

Though small compared to health and recreation, the mobility benefits of the trail are significant for bicycle commuters, particularly in neighborhoods that are poorly served by transit. As cycling becomes a more mainstream commuting mode, the city should plan to maximize the mobility benefits of the Schuylkill River Trail by making the trail a prominent part of its bicycle network. Potential policies include increasing connectivity with on-street bicycle routes; extending the trail into Center City to improve the "last mile" commuting experience; and promoting "bicycle to work" activities on the trail. Policies such as these can help to increase the commuting benefits from a trail that already serves as a valuable recreational amenity.

References

Abildso, C. G., Zizzi, S. J., Selin, S., & Gordon, P. M. (2012). Assessing the Cost Effectiveness of a Community Rail-Trail in Achieving Physical Activity Gains. *Journal Of Park & Recreation Administration*, *30*(2), 102-113.

Benefit-Cost Analysis of Bicycle Facilities. Active Communities / Transportation Research Group, University of Minnesota. Retrieved from http://www.bicyclinginfo.org/bikecost/

Glazer, J. (2013, August 12). Boardwalk hovering over the Schuylkill on track for late 2014. *Daily News*. Retrieved from http://articles.philly.com/2013-08-12/news/41292177_1_schuylkill-county-boardwalk-paved-trail

Harnik, P. (2008). How Much Value Does the City of Philadelphia Receive from its Park and Recreation System? *Trust for Public Land*. Retrieved from http://cloud.tpl.org/pubs/ccpe_PhilaParkValueReport.pdf

Krizek, K. J., Poindexter, G., Barnes, G., & Mogush, P. (2007). Analysing the benefits and costs of bicycle facilities via online guidelines. *Planning Practice and Research 22*(2), 197-213.

Kruesi, F. E. (2011). The Value of Saving Travel Time: Departmental Guidance for Conducting Economic Evaluations. *U.S. Department of Transportation*. Retrieved from http://www.dot.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf

Moore, R. L., & Shafer, C. S. (2001). Introduction to special issue Trails and greenways: opportunities for planners, managers, and scholars. *Journal Of Park & Recreation Administration*, *19*(3), 1-16.

National Historical Geographic Information System, Version 2.0. (2011). *Minnesota Population Center*, Minneapolis, MN: University of Minnesota.

Quantifying the Cost of Physical Inactivity. (2006). *East Carolina University*. Retrieved from http://www.ecu.edu/picostcalc/

Starnes, H. A., Troped, P. J., Kienosky, D. B., & Doehring, A. M. (2011). Trails and Physical Activity: A Review. *Journal Of Physical Activity & Health*, *8*(8), 1160-1174.

Tilahun, N., Levinson, D. & Krizek, K. J. (2007). Trails, lanes, or traffic: The value of different bicycle facilities using an adaptive stated preference survey. *Transportation Research Part A*, *41*, 287–301.

Tomes, P. & Knoch, C. (2009). Schuylkill River Trail 2009 User Survey and Economic Impact Analysis. *Rails-to-Trails Conservancy*. Retrieved from http://www.railstotrails.org/resources/documents/wherewework/northeast/Schuylkill%20River%20Trail%20Users%20Survey_Final_low%20res.pdf

Wang, G., Macera, C. A., & Scudder-Soucie, B. (2004). Cost Analysis of the Built Environment: The Case of Bike and Pedestrian Trails in Lincoln, Neb. *American Journal Of Public Health*, *94*(4), 549-553.