How Much Value Does the City of Boston Receive from its Park and Recreation System?

A Report by The Trust for Public Land's
Center for City Park Excellence

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THE TRUST for PUBLIC LAND

Executive Summary

The parks and park programs of Boston – from the Common to Franklin Park to the broad reach of Boston National Historical Park to every playground in between – provide Bostonians with so many joys and benefits that many residents would not want to live in the city without them.

Although the system was not created specifically as an economic development tool, there is a growing realization that the parks of Boston are providing the city with hundreds of millions of dollars of value. This value, for the first time, is being defined. Not every aspect of a park system can be quantified – for instance, the mental health value of a walk in the woods has not yet been documented and is not counted here; and there is no agreed-upon methodology for capturing the carbon sequestration value of a city park – but seven major factors are enumerated – *clean air, clean water, tourism, direct use, health, property value and community cohesion*. While the science of city park economics is in its infancy, the numbers reported here have been carefully considered and analyzed.

Two of these seven factors provide some of the citizens of Boston – as distinct from their government – with individual wealth. The first is increased property value due to park proximity, even though that doesn't become realized until such time as a dwelling is sold. The other is profit income from tourism spending.

These two factors also provide Boston with direct revenue to the city's treasury. The increased property value results in increased property tax. This value came to almost $8.3 million in fiscal year 2007. The second is tourism spending by out-of-towners who came to Boston primarily because of its parks. This value came to $1.9 million.

Three other factors provide Boston residents with direct savings. By far the largest is via the human value of directly using the city's free parkland and recreation opportunities instead of having to purchase these items in the marketplace. This value came to more than $354 million in 2007. Second is the health benefit – savings in medical costs – due to the beneficial aspects of exercise in the parks. This came to $78 million. And third is the community cohesion benefit of people banding together to save and improve their neighborhood parks. This "know-your-neighbor" social capital, while hard to tabulate, helps ward off all kinds of anti-social problems that would otherwise cost the city more in police, fire, prison, counseling and rehabilitation costs. This value came to just under $3.9 million in 2007.

The last two factors also provide savings, but of the environmental sort. The larger involves water pollution reduction – the fact that the trees and soil of Boston's parks retain rainfall and thus cut the cost of treating stormwater. This value came to $8.7 million in 2007. The other concerns air pollution – the fact that park trees and shrubs absorb and adsorb a variety of air pollutants. This value came to just over $550,000.

The park system of Boston thus provided the Boston city government with income of over $10 million and cost savings of over $9 million in 2007. In addition it provided residents with savings of over $436 million in that year. Finally, it added to the general wealth of citizens by more than $730 million.

The Annual Value of the Boston Park and Recreation System	
Summary	
Revenue Producing Factors for City Government	
Tax Receipts from Increased Property Value	**$8,264,000**
Tax Receipts from Increased Tourism Value	**$1,917,000**
Total, Revenue Producing Factors	***$10,181,000***
Cost Saving Factors to Citizens	
Direct Use Value	**$354,352,000**
Health Value	**$78,042,000**
Community Cohesion Value	**$3,858,000**
Total, Cost Saving Factors to Citizens	***$436,252,000***
Cost Saving Factors for City Government	
Stormwater Management Value	**$8,675,000**
Air Pollution Mitigation Value	**$553,000**
Total, Cost Saving Factors for City Government	***$9,228,000***
Wealth Increasing Factors to Citizens	
Property Value from Park Proximity	**$724,929,000**
Profit from Tourism	**$6,711,000**
Total, Wealth Increasing Factors to Citizens	***$731,640,000***
Center for City Park Excellence, Trust for Public Land, March, 2008	

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Background

Cities are economic entities. They are made up of structures entwined with open space. Successful communities have a sufficient number of private homes and commercial and retail establishments to house their inhabitants and give them places to produce and consume goods. Cities also have public buildings – libraries, hospitals, arenas, city halls – for culture, health and public discourse. They have linear corridors – streets and sidewalks – for transportation. And they have a range of other public spaces – parks, plazas, trails, sometimes natural, sometimes almost fully paved – for recreation, health provision, tourism, sunlight, rainwater retention, air pollution removal, natural beauty, and views.

In successful cities the equation works. Private and public spaces animate each other with the sum greatly surpassing the parts. In unsuccessful communities, some aspect of the relationship is awry: production, retail or transportation may be inadequate; housing may be insufficient; or the public realm might be too small or too uninspiring.

Methodology

Based on a two-day colloquium of park experts and economists held in October, 2003 (see Appendix), the Center believes that there are seven attributes of Boston's park system that are measurable and that provide economic value to the city. What follows is a description of each attribute and an estimate of the specific economic value it provides.

1. Removal of Air Pollution by Vegetation

Air pollution is a significant and expensive urban problem, injuring health and damaging structures. The human cardiovascular and respiratory systems are affected with broad consequences for health-care costs and productivity. In addition, acid deposition, smog and ozone increase the need to clean and repair buildings and other costly infrastructure.

Trees and shrubs have the ability to remove air pollutants such as nitrogen dioxide, sulfur dioxide, carbon monoxide, ozone and some particulate matter. Gases are absorbed by leaves, and particulates adhere to the plant surface, at least temporarily. Thus, vegetation in city parks plays a role in improving air quality, helping urban residents avoid costs associated with pollution.

In order to quantify the contribution of park vegetation to air quality, an air pollution calculator was designed at the Northeast Research Station of the U.S. Forest Service in Syracuse, N.Y. to estimate pollution removal and value for urban trees. This program, which is based on the Urban Forest Effects (UFORE) model of the U.S. Forest Service (*see Attachment 1*), is location-specific, taking into account the air pollution characteristics of a given city. (Thus, even if two cities have similar forest characteristics the park systems could nevertheless generate different results based on differences in ambient air quality.)

First, land cover information for all of a city's parks was obtained through analysis of aerial photography. (While every city has street trees and numerous other trees on private property, this study measures only the economic value of trees on public parkland.) Of 4,755 acres of parkland, 52.1 percent was found to be covered with trees.

Boston's Park Trees	
Total Parkland (acres)	4,754.5
Forested Parkland (acres)	2,475.7
Percent Forested	**52.1%**

Then the pollutant flow through an area within a given time period (known as "pollutant flux") was calculated, taking into account the concentration of pollutants and the velocity of pollutant deposition. The resistance of the tree canopy to the air, the different behavior of different types of trees and other vegetation, and seasonal leaf variation are taken into account by the calculator.

The calculator uses hourly pollution concentration data from cities that was obtained from the U.S. EPA.[i] The total pollutant flux was multiplied by tree-canopy coverage to estimate total pollutant removal by trees in the study area. The monetary value of pollution removal by trees is estimated using the median U.S. externality values for each pollutant. (The externality value refers to the amount it would otherwise cost to prevent a unit of that pollutant from entering the atmosphere.) For instance, the externality value of preventing the emission of a short ton of carbon monoxide is $870; the externality value of the same amount of sulfur dioxide is $1500.

The result of the Air Quality Calculator for the park system of Boston *(see Appendix 1)* is an economic savings value of $553,000.

2. Reducing the Cost of Managing Urban Stormwater

Stormwater runoff is a significant problem in urban areas. When rainwater flows off roads, sidewalks and other impervious surfaces, it carries pollutants with it. In some cases (cities with systems which separate household sewage from street runoff) the rainwater flows directly into waterways, causing significant ecological problems. In other cases (cities with combined household and street systems), the rainwater runoff is treated at a pollution control facility before going into a waterway. However, if a storm is large, the great amount of runoff overwhelms the combined system and flows untreated into rivers and bays.

Parkland reduces stormwater management costs by capturing precipitation and/or slowing its runoff. Large pervious (absorbent) surface areas in parks allow precipitation to infiltrate and recharge the ground water. Also, vegetation in parks provides considerable surface area that intercepts and stores rainwater, allowing some to evaporate before it ever reaches the ground. Thus urban green spaces function like mini-storage reservoirs.

A model has been developed by the Western Research Station of the U.S. Forest Service in Davis, Calif., to estimate the value of retained stormwater runoff due to green space in the parks. *(See Attachment 2.)* Inputs to the model consist of geographic location, climate region, surface permeability index, park size, land cover percentages, and types of vegetation. Because of numerous data challenges, the model has not been perfected yet and thus gives only a preliminary indication of value for the park system of the City of Boston.

First, land cover data -- trees, open grassy areas, impervious surface, etc. -- was obtained through analysis of aerial photographs. This analysis reveals that the park system of Boston is 76.7 percent pervious. The rest consists of impervious roadways, trails, parking areas, buildings, hard courts, and also water surface. (While the model was developed with the sensitivity to distinguish between the different effects of such vegetation types as conifers, palms and shrubs, the sensitivity of the aerial photographs was not great enough to make that kind of determination.)

Boston Parkland Perviousness

Type of Cover	Acres	Percent
Pervious	3,637.5	76.7%
Impervious	669.4	14.1%
Water	437.6	9.2%
Total	4,754.5	100.0%

Source: Mapping Sustainability, 2007

Second, the same photographs were analyzed for the amount of perviousness of the *rest* of the City of Boston – in other words, the city without its parkland. It was determined that Boston (without its parks and not counting surface water) is 34.9 percent pervious. The pervious land consists primarily of residential front and backyards as well as private natural areas such as cemeteries, university quadrangles and corporate campuses.

City of Boston Perviousness (Without Parkland)

Type of Cover	Acres	Percent
Total Pervious	9,726.3	37.8%
Impervious	15,876.1	61.7%
Water	139.1	0.5%
Total without Water	25,602.4	

Source: Mapping Sustainability, 2007

Third, the amount and characteristics of rainfall were calculated from U.S. weather data. Boston receives an average of 40.78 inches of precipitation per year with the characteristic coastal New England mix of fog, drizzle, showers, downpours and snow.

The model, which combines aspects of two other models developed by researchers with the U.S. Forest Service, uses hourly annual precipitation data to estimate annual runoff. Then, the reduction in runoff is calculated by comparing the modeled runoff with the runoff that would leave a hypothetical site of the same size but with land cover that is typical of surrounding urban development (i.e., with streets, rooftops, parking lots, etc.).

The final step in determining the economic value of a park system's contribution to clean water is calculating what it costs to manage stormwater using "hard infrastructure" (concrete pipes and holding tanks). This turns out to be a very difficult number to ascertain and is not known by the Boston Water Department. The Department does know, however, that its annual budget for water treatment is approximately $128 million. Thus, by knowing the amount of rainfall the city receives it is possible to make an educated guess about the cost of treatment. This come out to be $0.0637 (6.37 cents) per cubic foot.

Cost of Treating Stormwater in Boston
(per cubic foot)

1	Rainfall per acre per year	148,016	cu. ft./acre
2	Acres of impervious surface	15,940	acres
3	Rainfall on impervious surface (line 1 * line 2)	2,359,309,932	cu. ft.
4	Annual expenditure on water treatment	$128,000,000	
	Cost per cubic foot (line 4/line 3)	**$0.0637**	

By plugging these rainfall, parkland, imperviousness and treatment cost factors into the formula, an annual Park Stormwater Retention Value of $8,675,000 is obtained for Boston.

It should be noted that there is another possible methodology for determining stormwater savings due to parkland. Instead of looking at annual rainfall and the annual operating costs for the system, we could look at the one-time capital costs associated with constructing the system to handle single large storms. This may be more relevant considering that the U.S. Environmental Protection Agency is tightening its regulations and requiring more construction for clean water. We are presently seeking to analyze this different approach.

3. Hedonic (Property) Value

More than 30 studies have shown that parks and open space have a positive impact on nearby residential property values. Other things being equal, most people are willing to pay more for a home close to a nice park. Economists call this phenomenon "hedonic value." (Hedonic value also comes into play with other amenities such as schools, libraries, police stations and transit stops. Theoretically, commercial office space also exhibits the hedonic principle; unfortunately, no study has yet been carried out to quantify it.) The property value added by a park, incidentally, is separate from the direct use value gained; property value goes up even if the resident never goes into the park. (*See Attachment 3.)*

Hedonic value is affected primarily by two factors: distance from the park and the quality of the park itself. While proximate value ("nearby-ness") can be measured up to 2,000 feet from a large park, most of the value, however – whether the park is large or small – is within the first 500 feet. In the interest of being conservative we have limited our valuation to this shorter distance. Moreover, people's desire to live near a park depends on characteristics of the park. Beautiful natural resource parks with great trees, trails, meadows and gardens are markedly valuable. Other parks with excellent recreational facilities are also desirable (although sometimes the greatest property value is a block or two from the park rather than directly adjoining it, depending on issues of noise, lights and parking). However, less attractive or poorly maintained parks are only marginally valuable. And parks with dangerous or frightening aspects can reduce nearby property values.

Determining an accurate park-by-park, house-by-house property value for a city is technically feasible but it is prohibitively time-consuming and costly. Thus an extrapolative methodology was formulated to arrive at a reasonable estimate. Using computerized mapping technology known as GIS, all residential properties within 500 feet of every significant park and recreation area in Boston were identified. ("Significant" was defined as one acre or more; "park" included every park in the city, even if owned by a county, state, federal or other agency.) According to records of the Assessment Office, there are 79,176 residential properties in the city of Boston. (A residential property consists of a property that is owned; thus, a single-family house is one property, a 100-unit apartment building is one property, and a 100-unit condominium building is 100 properties.) Using GIS, we determined that there are 27,383 residential properties within 500 feet of the park and recreation land in the city. And these properties had a combined assessed value of just under $14.5 billion. (Note that many of these properties are multi-unit rental apartment buildings.)

Unfortunately, because of data and methodology problems, it has not been possible thus far to determine which of Boston's parks are "strongly positive," "slightly positive" and "negative" – i.e., adding significant value, slight value or subtracting value to surrounding residences. We are continuing this line of research, but thus far -- despite interviews with park professionals, park users, realtors, assessors and after extensive analysis of crime data – we have not been able to make justifiable judgments on park quality. While new methodologies are being tested, we have chosen to assign the conservative value of 5 percent as the amount that parkland adds to the assessed value of all dwellings within 500 feet of parks. (This number is an average of the high, medium and low values of 15 percent, 5 percent and negative 5 percent that will be used when park quality can be established.[ii]) The result for 2006 was $724.9 million in value due to park proximity.

We then used the residential property tax rate to determine how much extra tax revenue was raised by the city of Boston based on the extra property value due to parks. Using an effective millage rate of $1.14 per $1,000 in assessed value, the result of the Property Value Calculator for the city of Boston is $8,264,000.

It is also important to recognize that, while the tax millage brings in actual dollars to the city, the overall increased value of the near-park properties is a different kind of "real" number. Thus, because of parks, there is an increase in aggregate "property wealth" of Bostonians of $724.9 million.

[Note: It is worth emphasizing that this hedonic estimate is conservative for three reasons. First, it does not include the effects of small parks (under an acre) although it is known that even minor green spaces have a property value effect. Second, it leaves out all the value of dwellings located between 500 feet and 2,000 feet from a park. Third, it does not include the potentially very significant property value for commercial offices located near downtown parks.]

4. Direct Use Value

While city parks provide much indirect value, they also provide more tangible value through such activities as team sports, bicycling, skateboarding, walking, picnicking, bench-sitting and visiting a flower garden. Economists call these activities "direct uses." (*See Attachment 4.*)

Most direct uses in city parks are free of charge, but economists can still calculate value by determining the consumer's "willingness to pay" for the recreation experience in the private marketplace. In other words, if parks were not available in Boston, how much would the resident (or "consumer") pay for similar experiences in commercial facilities or venues? Thus, rather than income, the direct use value represents the amount of money residents save by not having to pay market rates to indulge in the many park activities they enjoy.

The model used to quantify the benefits received by direct users is based on the "Unit Day Value" method as documented in Water Resources Council recreation valuation procedures by the U.S. Army Corps of Engineers. The Unit Day Value model counts park visits by specific activity, with each activity assigned a dollar value. For example, playing in a playground is worth $3.50 each time to each user. Running, walking or rollerblading on a park trail is worth $4.00, as is playing a game of tennis on a city court. For activities for which a fee is charged, like golf or ice skating, only the "extra value" (if any) is assigned; i.e., if a round of golf costs $20 on a public course and $80 on a private course, the direct use value of the public course would be $60. Under the theory that the second and third repetitions of a park use in a given period are slightly less valuable than the first use (i.e., the value to a child of visiting a playground the seventh time in a week is somewhat lower than the first), we further modified this model by building in an estimated sliding scale of diminishing returns for heavy park users. Thus, for example, playground value diminished from $3.50 for the first time to $1.93 for the seventh time in a week. We also estimated an average "season" for different park uses, ranging from 40 weeks for activities like walking to only 8 weeks for sledding. (Although some people walk in parks 365 days a year, we chose to be conservative and eliminate seasons where participation rates drop to low levels.)

The number of park visits and the activities engaged in were determined via a professionally-conducted telephone survey of 600 residents of the city of Boston. (The random-digit-dialed survey had an accuracy level of plus or minus 4 percent). Residents were asked to answer for themselves; for those adults with children under the age of 18, a representative proportion were also asked to respond for one of their children. (Non-Boston residents were not counted in this calculation; the value to the city of non-resident uses of parks is measured by the income to local residents from what these visitors spend on their trips. This is covered under income from out of town visitor spending.)

The result of the Direct Use Calculator for Boston for the year 2007 is $354,352,000.

While it can be claimed that this very large number is not as “real” as the numbers for tax or tourism revenue, it nevertheless has true meaning. Certainly, not all these park activities might take place if they had to be purchased. On the other hand, Bostonians truly are getting pleasure and satisfaction – all $350 million worth – from their use of the parks. If they had to pay and if they consequently reduced some of this use, they would be materially “poorer” from not doing some of the things they enjoy.

5. Helping to Promote Human Health

Several studies have documented the large economic burden related to physical inactivity. *(See Attachment 5.)* Lack of exercise is shown to contribute to obesity and its many effects, and experts call for a more active lifestyle. Recent research suggests that access to parks can help people increase their level of physical activity. The Parks Health Benefits Calculator measures the collective economic savings realized by city residents because of their use of parks for exercise.

The calculator was created by identifying the common types of medical problems that are inversely related to physical activity, such as heart disease and diabetes. Based on studies that have been carried out in seven different states, a value of $250 was assigned as the cost difference between those who exercise regularly and those who don’t. For persons over the age of 65 that value was doubled to $500 because seniors typically incur two or more times the medical care costs of younger adults.

The key data input for determining medical cost savings are the number of park users who are indulging in a sufficient amount of physical activity to make a difference. This is defined as “at least 30 minutes of moderate to vigorous activity at least three days per week.” To determine this, we conducted telephone park use surveys of activities and of their frequency, dividing respondents by age. This telephone survey was, in fact, the same as the one carried out for direct use data (above), consisting of 600 respondents chosen through random-digit dialing, and had an accuracy rate of plus or minus four percent. In order to modify the results to serve the health benefits study, low-heartrate uses such as picnicking, sitting, strolling and bird watching were eliminated. Also, all respondents who engaged in strenuous activities less than three times per week were dropped as not being active enough for health benefit. Based on the survey and the computations, we found that about 273,000 Bostonians engage actively enough in parks to improve their health – 255,000 of them being under the age of 65, 18,000 of them above 65. The calculator makes one final computation, applying a small multiplier to reflect the differences in medical care costs between State of Pennsylvania and the U.S. as a whole.

The health savings due to park use for the residents of Boston for the year 2007 is $78,042,000.

6. Income from Out-of-Town Park Visitor Spending (Tourists)

The amenities that encourage out-of-towners to visit a city include such features as cultural facilities, heritage places and parks as well as special events that take place there, like festivals and sports contests. And of course, a huge tourist attractant is Boston Independence National Historic Park. Though not always recognized, parks play a major role in Boston's tourism economy. *(See Attachment 6.)*

To know the contribution of parks to the tourism economy requires knowledge of tourists' activities, the number of park visitors and their spending. Unfortunately, there is a severe shortage of data on park visitation and on the place of origin of park visitors. (By definition, local users are not tourists – any spending they do at or near the park is money not spent locally somewhere else, such as in their immediate neighborhood.) Future studies of park impact would be greatly aided by the collection of more data on this topic.

The two principal park agencies in Boston – Boston Department of Parks and Recreation and the Massachusetts Department of Conservation and Recreation (Division of Urban Parks and Recreation) -- have virtually no information on out-of-town visitor activity and spending. Only the National Park Service, which operates Boston Independence National Historic Park, monitors visitation rates, but it is not possible to extrapolate those numbers to the rest of the city. We thus believe that our tourism economic estimate is severely low. Based on National Park Service figures, 1.8 million tourists – overnighters, day visitors and suburbanites – visited a park in 2007. We estimated that 10 percent of Boston park visitors came *because* of the parks. (This conservative methodology assures that we did not count the many tourists who came to Boston for other reasons – for instance, to see the Aquarium or Quincy Market or to attend an event at Fenway Park – and happened to visit a park without planning to.)

As for visitor spending, we used data generated by Greater Boston Convention and Visitors Bureau and the Boston National Historic Park, which reported average spending of $188 per day for an overnight visitor, $39 a day for a day visitor and $22 a day for a suburban visitor. Total spending for all these persons (keeping in mind that there is no data for users of non-National Parks in Boston) came to just over $19 million in 2006. With taxes on tourist spending averaging at 10 percent, the revenue for the city of Boston came to $1,917,000.

As for the profit revenue to the citizens of Boston, the accepted margin on tourist sales is

35 percent, yielding just over $6.7 million in "increased wealth" in 2006.

7. Stimulating Community Cohesion

Numerous studies have shown that the more webs of human relationships a neighborhood has, the stronger, safer and more successful it is. Any institution that promotes relationship-building – whether a religious institution, a club, a political campaign, a co-op, a school – adds value to a neighborhood and, by extension, to the whole city.

This human web, for which the term "social capital" was coined by Jane Jacobs, is strengthened in some communities by parks. From playgrounds to sports fields to park benches to chessboards to swimming pools to ice skating rinks to flower gardens, parks offer opportunities for people of all ages to communicate, compete, interact, learn and grow. Perhaps more significantly, the acts of improving, renewing or even saving a park can build extraordinary levels of social capital in a neighborhood that may well be suffering from fear and alienation partially due to the lack of safe public spaces.

While the economic value of social capital cannot be measured directly, it is possible to tally up a crude proxy – the amount of time and money that residents donate to their parks. Boston has thousands of park volunteers who do everything from picking up trash and pulling weeds to planting flowers, raising playgrounds, teaching about the environment, educating public officials and contributing dollars to the cause.

To arrive at the proxy number, all the financial contributions made to park foundations, conservancies and "friends of parks" organizations in a city were tallied. Also added up were all the hours of volunteer time donated to park organizations; the hours were then multiplied by the value assigned to volunteerism in Massachusetts -- $20.75 – by the organization Independent Sector.

The result of the Social Capital Calculator for the city of Boston for 2007 is $3,858,000.

Conclusion

While reams of urban research have been carried out on the economics of housing, manufacturing, retail, and even the arts, there has been until now no comprehensive study of the worth of a city's park system. The Trust for Public Land (TPL) believes that answering this question – "How much value does an excellent city park system bring to a city?" – can be profoundly helpful to all the nation's urban areas. For the first time parks can be assigned the kind of numerical underpinning long associated with transportation, trade, housing and other sectors. Urban analysts will be able to obtain a major piece of missing information about how cities work and how parks fit into the equation. Housing proponents and other urban constituencies will potentially be able to find a new ally in city park advocates. And mayors, city councils, and chambers of commerce may uncover the solid, numerical motivation to strategically acquire parkland in balance with community development projects.

Determining the economic value of a city park system is a science still in its infancy. Much research and analysis must be undertaken – and the city of Boston itself, perhaps in conjunction with one of its universities, could help greatly by collecting more specific data about park usership, park tourism, adjacent property transactions, water runoff and retention, and other measures. In fact, every aspect of city parks – from design to management to programming to funding to marketing – would benefit from much deeper investigation and analysis. In that spirit, this study, one of the first of its kind ever published, is offered as a mechanism to begin a great conversation about the present and future role of parks within the life – and economy – of Boston.

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[i] The data is from 1994.
[ii] See park quality value discussion in Attachment 3.

Appendix 1

The following individuals took part in the Colloquium, "How Much Value Does a Park System Bring to a City," in October, 2003.

Susan	**Baird**	Denver Dept of Parks & Recreation	Denver	Colo.
Kathy	**Blaha**	Trust for Public Land	Washington	D.C.
Blaine	**Bonham**	Pennsylvania Horticultural Society	Philadelphia	Pa.
Glenn	**Brill**	Ernst & Young	New York	N.Y.
Valerie	**Burns**	Boston Natural Areas Network	Boston	Mass.
Patrice	**Carroll**	Philadelphia Managing Director's Office	Philadelphia	Pa.
Donald	**Colvin**	Indianapolis Dept of Parks and Recreation	Indianapolis	Ind.
Ernest	**Cook**	Trust for Public Land	Boston	Mass.
John	**Crompton**	Texas A&M University	College Station	Tex.
Dick	**Dadey**	City Parks Alliance	New York	N.Y.
Nancy	**Goldenberg**	Philadelphia Center City Partners	Philadelphia	Pa.
Peter	**Harnik**	Trust for Public Land	Washington	D.C.
Nancy	**Kafka**	Trust for Public Land	Boston	Mass.
Alastair	**McFarlane**	U.S. Dept of Housing & Urban Development	Washington	D.C.
Ken	**Meter**	Crossroads Resource Center	Minneapolis	Minn.
Sarah	**Nicholls**	Michigan State Univerisity	E. Lansing	Mich.
Joan	**Reilly**	Pennsylvania Horticultural Society	Philadelphia	Pa.
Dan	**Stynes**	Michigan State Univerisity	E. Lansing	Mich.
Patrice	**Todisco**	Boston GreenSpace Alliance	Boston	Mass.
Susan	**Wachter**	University of Pennsylvania	Philadelphia	Pa.
Guijing	**Wang**	Centers for Disease Control	Atlanta	Ga.
Richard	**Weisskoff**	Everglades Economics Group	N. Miami	Fla.
Wayne	**Weston**	Mecklenburg Parks and Recreation Dept.	Charlotte	N.C.
Jennifer	**Wolch**	University of Southern California	Los Angeles	Calif.
Kathleen	**Wolf**	University of Washington	Seattle	Wash.
Matt	**Zieper**	Trust for Public Land	Boston	Mass.

Appendix 2

Resources Related to the Economic Value of Parks

Bedimo-Rung, A. L., Mowen, A. J., & Cohen, D. 2005. The significance of parks to physical activity and public health: A conceptual model. American Journal of Preventive Medicine, 28(2S2), 159-168.

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Attachment 1

Methods for Air Pollution Model

Methods and analyses conducted for this program are based on the Urban Forest Effects (UFORE) model developed by Nowak and Crane (2000). For each city, the pollutant flux (F; in g m^{-2} s^{-1}) is calculated as the product of the deposition velocity (V_d; in m s^{-1}) and the pollutant concentration (C; in g m^{-3}):

$$F = V_d \cdot C$$

Deposition velocity is calculated as the inverse of the sum of the aerodynamic (R_a), quasi-laminar boundary layer (R_b) and canopy (R_c) resistances (Baldocchi et al. 1987):

$$V_d = (R_a + R_b + R_c)^{-1}$$

Hourly meteorological data from local airports were used in estimating R_a and R_b. The aerodynamic resistance is calculated as (Killus et al. 1984):

$$R_a = u(z) \cdot u_*^{-2}$$

where u(z) is the mean windspeed at height z (m s^{-1}) and u_* is the friction velocity (m s^{-1}).

$$u_* = (k \cdot u(z-d))[\ln((z-d) \cdot z_o^{-1}) - \psi_M((z-d) \cdot L^{-1}) + \psi_M(z_o \cdot L^{-1})]^{-1}$$

where k = von Karman constant, d = displacement height (m), z_o = roughness length (m),

ψ_M = stability function for momentum, and L = Monin-Obuhkov stability length. L was estimated by classifying hourly local meteorological data into stability classes using Turner classes (Panofsky and Dutton 1984) and then estimating L^{-1} as a function of stability class and z_o (Zannetti 1990). When L < 0 (unstable) (van Ulden and Holtslag 1985):

$$\psi_M = 2\ln[0.5(1+X)] + \ln[0.5(1+X^2)] - 2\tan^{-1}(X) + 0.5\pi$$

where X = $(1 - 28 z L^{-1})^{0.25}$ (Dyer and Bradley 1982). When L > 0 (stable conditions):

$$u_* = C_{DN} \cdot u\{0.5 + 0.5[1 - (2u_o / C_{DN}^{\frac{1}{2}} \cdot u))^2]^{\frac{1}{2}}\}$$

where C_{DN} = k $(\ln (z/z_o))^{-1}$; u_o^2 = (4.7 z g θ_*) T^{-1}; g = 9.81 m s^{-2}; θ_* = 0.09 (1 - 0.5 N^2); T = air temperature (K°); and N = fraction of opaque cloud cover (Venkatram 1980; EPA

1995). Under stable conditions, u_* was calculated by scaling actual windspeed with a calculated minimum windspeed based on methods given in EPA (1995).

The quasi-laminar boundary-layer resistance was estimated as (Pederson et al. 1995):

$$R_b = 2(Sc)^{\frac{2}{3}}(\mathrm{Pr})^{-\frac{2}{3}}(k \cdot u_*)^{-1}$$

where k = von Karman constant, Sc = Schmidt number, and Pr is the Prandtl number.

In-leaf, hourly tree canopy resistances for O_3, SO_2, and NO_2 were calculated based on a modified hybrid of big-leaf and multilayer canopy deposition models (Baldocchi et al. 1987; Baldocchi 1988). Canopy resistance (R_c) has three components: stomatal resistance (r_s), mesophyll resistance (r_m), and cuticular resistance (r_t), such that:

$$1/R_c = 1/(r_s + r_m) + 1/r_t$$

Mesophyll resistance was set to zero s m^{-1} for SO_2 (Wesely 1989) and 10 s m^{-1} for O_3 (Hosker and Lindberg 1982). Mesophyll resistance was set to 100 s m^{-1} for NO_2 to account for the difference between transport of water and NO_2 in the leaf interior, and to bring the computed deposition velocities in the range typically exhibited for NO_2 (Lovett 1994). Base cuticular resistances were set at 8,000 m s^{-1} for SO_2, 10,000 m s^{-1} for O_3, and 20,000 m s^{-1} for NO_2 to account for the typical variation in r_t exhibited among the pollutants (Lovett 1994).

Hourly inputs to calculate canopy resistance are photosynthetic active radiation (PAR; μE m^{-2} s^{-1}), air temperature (K^o), windspeed (m s^{-1}), u_* (m s^{-1}), CO_2 concentration (set to 360 ppm), and absolute humidity (kg m^{-3}). Air temperature, windspeed, u_*, and absolute humidity are measured directly, or calculated, from measured hourly NCDC (National Climatic Data Center) meteorological data. Total solar radiation is calculated based on the METSTAT model with inputs from the NCDC data set (Maxwell 1994). PAR is calculated as 46 percent of total solar radiation input (Monteith and Unsworth 1990).

As CO and removal of particulate matter by vegetation are not directly related to transpiration, R_c for CO was set to a constant for in-leaf season (50,000 s m^{-1}) and leaf-off season (1,000,000 s m^{-1}) based on data from Bidwell and Fraser (1972). For particles, the median deposition velocity from the literature (Lovett 1994) was 0.0128 m s^{-1} for the in-leaf season. Base particle V_d was set to 0.064 based on a LAI of 6 and a 50-percent resuspension rate of particles back to the atmosphere (Zinke 1967). The base V_d was adjusted according to in-leaf vs. leaf-off season parameters.

Each city was assumed to have a tree/shrub leaf area index within the canopy covered area of 6 and to be 10% evergreen (Nowak, 1994). Regional leaf-on and leaf-off dates were used to account for seasonal leaf area variation. Particle collection and gaseous deposition on deciduous trees in winter assumed a surface-area index for bark of 1.7 (m^2 of bark per m^2 of ground surface covered by the tree crown) (Whittaker and Woodwell

1967). To limit deposition estimates to periods of dry deposition, deposition velocities were set to zero during periods of precipitation.

Hourly pollution concentration data (1994) from each city were obtained from the U.S. Environmental Protection Agency (EPA). Hourly ppm values were converted to µg m^{-3} based on measured atmospheric temperature and pressure (Seinfeld 1986). Missing hourly meteorological or pollution-concentration data are estimated using the monthly average for the specific hour. In some locations, an entire month of pollution-concentration data may be missing and are estimated based on interpolations from existing data. For example, O_3 concentrations may not be measured during winter months and existing O_3 concentration data are extrapolated to missing months based on the average national O_3 concentration monthly pattern. For some cities local pollution data were not available for some pollutants, so data from other regional monitors were used [Table 1].

Total pollutant flux (g m^{-2} of tree canopy coverage per year) is multiplied by tree-canopy coverage (m^2) (supplied by the model user) to estimate total pollutant removal by trees in the study area. The monetary value of pollution removal by trees is estimated using the median externality values for the United States for each pollutant. These values, in dollars per metric ton (t) are: NO_2 = \$6,752 t^{-1}, PM10 = \$4,508 t^{-1}, SO_2 = \$1,653 t^{-1}, and CO = \$959 t^{-1} (Murray et al. 1994). Externality values for O_3 were set to equal the value for NO_2.

Table 1. Location and Type of Surrogate Monitors Used for Cities with Missing Pollution Monitors

City Name	*Surrogate Monitor*	*Pollutants*
Albany, NY	Buffalo, NY	NO2
Albuquerque,NM	El Paso, NM	SO2
Chico, CA	Sacramento, CA	SO2
Columbus, OH	Cincinnati, OH	SO2
Fresno, CA	San Diego	SO2
Omaha, NE	Kansas City, MO	NO2
Pasadena, CA	Los Angeles, CA	O3, PM10, SO2
Santa Maria, CA	San Jose, CA	CO, NO2, SO2
Seattle, WA	Portland, OR	NO2
South Lake Tahoe, CA	Sacramento, CA	SO2
Visalia, CA	Fresno, CA	SO2

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Attachment 2

Technical description of the Storm Runoff Reduction Model

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INTRODUCTION

This model is based on research that led to development of two models: the Small Watersheds Model TR55 (United States Dept. of Agriculture, 1986) and the Single Tree Rainfall Interception Model (Xiao et al., 1998; Xiao et al., 2000a). Parks alter surface runoff because of their effects on land cover and interception. Large pervious surface areas in parks allows surface water to infiltrate and recharge the ground water. Also, vegetation in parks provides considerable surface area that temporally intercepts and stores rainwater, allowing some to evaporate before it becomes overland flow. Although the effects of different land cover types on runoff have been well documented in the literature (Moglen and Beighley, 2002), the effects of tree canopy and other park vegetation have not been considered to the same degree. For example, the runoff curve number used in TR-55 only considers grass cover for open space (e.g., park) (United States Dept. of Agriculture, 1986). Existing vegetation (e.g., trees and shrubs cover) in a park can intercept considerable rainwater (Xiao et al., 2000b). Most of the intercepted rainwater will never reach the ground surface and produce surface runoff. Research reported that rainfall interception may exceed 59% for old growth forests (Baldwin, 1938). Urban green spaces function like mini-reservoirs that create additional storage for rainwater. Trees/shrubs directly reduce the amount of precipitation that reaches the ground surface, while grasses and ground covers provide foliar and woody surfaces to which water adheres.

We assume that the problem domain is a park in small urban watershed and the goal is to quantify the runoff reduction for a typical hydrological year attributed to the park's existing park green space (i.e. trees, shrubs, grass, and other vegetation). The park's runoff reduction is calculated from baseline runoff for a hypothetical site with the same land area as the park, but with land cover that is typical of surrounding development. We adjust the baseline site's surface permeability index (the ratio of the total pervious surface area to the total study area) based on the mix of surrounding land use to create the baseline. The model requires basic site information (i.e., location, area, land cover, and vegetation cover) provided by the user. The total amount of storm runoff and the amount and value of runoff reduction due to the existing park or proposed green space are shown in the spreadsheet template. The model was designed for Washington, D.C. and Boston, MA but can be adopted for use in other geographic regions.

METHODS

Storm Runoff

Urbanization covers large natural pervious areas with impervious areas and causes large volumes of excess storm water runoff because of reduced surface detention storage and infiltration. The excess runoff causes flooding, water pollution, and groundwater recharge deficits. The important hydrologic role of parks in the urban landscape has been well described but not quantified in detail. Parks reduce runoff in three ways. The large pervious surfaces provide pathways for surface water infiltrate and recharge groundwater. Vegetation (trees, shrubs, and grasses) in the parks intercepts rainfall, thus reducing net precipitation. Vegetation in the park increases landscape surface roughness that reduces surface runoff flow rate.

TR-55, developed by the Soil Conservation Service's (SCS), has been widely used for calculating storm runoff of small watersheds. Precipitation, soil, and surface cover are considered to determine the amount of runoff from a given storm. This method is based on a dimensionless hydrograph and is widely used to estimate runoff for small watersheds. Assuming the impervious covers in the park are unconnected directly to the drainage system, the TR-55 assumes a relationship exists between accumulated total precipitation (P), direct runoff (Q), and infiltration occurring after runoff begins (F), as well as an initial abstraction I_a:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (1)$$

where S is potential abstraction which is related to runoff curve numbers CNs by CN=1000/(S+10). I_a can be estimated as 0.2S. Substituting 0.2S for I_a into equation (1) gives:

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad (2)$$

In urban watersheds, land use, soil, and land cover type have the most influence on the CN. Parameters used for calculating runoff are discussed in detail in following sections.

Precipitation (P)

The amount of precipitation for a given storm event can be obtained from local (county or city) hydrologic manuals or from the ***Precipitation-frequency atlas of the United States*** (Hershfield, 1963; Miller et al., 1973). Research indicates that once a tree crown is saturated it provides little additional storage (Xiao et al., 2000a). Typically, saturation occurs after the first 1-2 inches of rainfall have fallen. This model estimates annual runoff reduction with hourly annual precipitation from each study city (Xiao et al., 1998). The annual typical weather year was determined based on historical precipitation and air temperature for each city (Xiao and McPherson, 2002). The typical weather year for Washington D.C. was 2004, when annual precipitation totaled 45 inches (1,154.4 mm) compared to the historical average of 43 inches (1088.4 mm). The year 2003 was selected as the typical weather year for Boston, when annual precipitation totaled 44 inches (1,035.8 mm). Precipitation data were preprocessed to isolate individual storm events, defined as followed by at least 24 hours without precipitation (Xiao et al., 1998). The amount of precipitation was recorded for each event. Storm events were designated to occur either during the leaf-on period (from March 15 to November 15) or the leaf-off season. In conjunction with the Forest Service's development of i-Tree (see www.iTreetools.org), we are in the process of developing similar rainfall data for reference cities in 19 U.S. climate zones (Table 1, Figure 1).

Table 1. Climate Zones of the United States

Climate Zone	CITY	STATE
Northern Mtn & Prairie	Bismarck	North Dakota
Pacific Northwest	Portland	Oregon
Upper Midwest /New England	Minneapolis	Minnesota
New England	Portland	Maine
Temperate Interior West	Boise	Idaho
Midwest	Chicago	Illinois
Interior West	Salt Lake City	Utah
Northeast	New York	New York
Northern California	Sacramento	California
Lower Midwest	Wichita	Kansas
South Central	Memphis	Tennessee
Subtropical	Santa Monica	California
Lower South	Atlanta	Georgia
Southwest Desert	Phoenix	Arizona
Gulf Coast	Houston	Texas
Central Florida	Orlando	Florida
Tropical	Miami	Florida

Potential Retention Storage (S)

Potential retention storage S is related to the soil and cover condition of the watershed through the CN. The factors that mainly influence the CN are soil type, land cover type, hydrologic condition, and antecedent runoff condition.

The CN numbers are affected by both soil and land use type. Soils are classified into four different hydrologic soil groups to indicate the minimum rate of infiltration (Table 2). Soil names are from the USDA soil texture classification. Users input the percentage of the park area that is occupied by each soil group. Most park managers know what types of soils occur in their parks. However, the specific type of soil information is frequently available from soil maps and experts at the local Natural Resource Conservation Service.

Table 2. Hydrologic Soil Group	
Soil Group	Soil textures
A	Sand, loamy sand, sandy loam
B	Silt loam, loam
C	Sandy clay loam
D	Clay loam, silt clay loam, sandy clay, silty clay, clay

Land Cover Type and Coverage

Land cover types are often classified as pervious (e.g., lawn, bare soil, unpaved road, unpaved sports area), impervious (e.g., paved parking lots, roads, paved sports area, building roofs), and water. For modeling purposes, park managers must determine the percentage of each land cover type as listed in Table 3. Land cover (LC) type estimates can be taken from aerial photographs using methods described by Miller and others (Miller et al., 1973).

Table 3. Land cover	
Land cover type	Area (acre)
Pervious surface	LC_p
Impervious surface	LC_{ip}
Water	LC_w

Runoff CN Number

Table 4 lists runoff CN numbers used in the model for different land cover types and soil groups assuming average antecedent runoff conditions. The impervious surfaces were assumed to not be connected to the drainage system.

Table 4. Runoff curve numbers for urban areas

Land cover	Curve numbers for Hydrologic soil group			
	A	B	C	D
Pervious surface	39	61	74	80
Impervious surface	98	98	98	98
Water	100	100	100	100

The composite CN number of the study area is calculated based on a weighted average by area.

$$CN = \frac{LC_p \times CN_p + LC_{ip} \times CN_{ip} + LC_w \times CN_w}{LC_p + LC_{ip} + LC_w} \qquad (3)$$

where CN_p, CN_{ip}, and CN_w are the CN number of the specific land cover (LC) type with its specific hydrologic soil group. The subscript p, ip, and w stand for pervious surface, impervious surfaces, and water bodies, respectively.

Base runoff

We evaluate the amount of runoff reduction associated with the park by subtracting from the amount of base runoff for the same small watershed with a permeability index typical of surrounding development. Thus, the base runoff Q_0 is the surface runoff of the same-sized small watershed as the park, but with lower permeability due to more intense development. It can be calculated by

$$Q_0 = \frac{(P - 0.2S_0)^2}{P + 0.8S_0} \qquad (4)$$

The total impervious area for calculating base runoff was 51% for Washington D.C. based on an analysis of the city's land cover data (Personal communication, Peter Harnik, Trust for Public Land, 660 Pennsylvania Ave., S.E. Washington, D.C. 20003). Lacking specific data for Boston, we used the 51% value from Washington D.C. for Boston.

Canopy Rainfall interception

Interception of rainfall by green space cover keeps some rainfall from reaching the ground surface. Some raindrops pass through gaps in the tree/shrub canopy, reaching the ground as throughfall. Other raindrops are intercepted by the canopy surface and temporarily stored on leaves, branches, and stems surfaces. Part of this stored water flows down the trunk to the ground, some drips off the leaves and stems to the ground, and the rest evaporates to atmosphere. Water that evaporates is called interception loss or interception.

The canopy surface water storage (C) changes with time (t) and is described as

$$\frac{dC}{dt} = p - th - d - e \qquad (5)$$

where p is rainfall rate, th is free throughfall, d is the drip from canopy, and e is evaporation from the wetted canopy surface or interception.

For a given storm event, once tree/shrub surfaces are saturated, the surface storage reaches dynamic equilibrium. Thus dC/dt in equation (5) approaches zero. The tree/shrub surface storage C_{tree} can be calculated from:

$$C_{tree} = SA \times S_c \qquad (6)$$

where SA is the tree/shrub surface area, and S_c is surface water storage capacity. S_c varies with species and season. We assume a value of 0.0394 in. (1.0 mm) based on previous studies (Keim et al., 2005; Xiao et al., 2000a).

Converting the total vegetation interception to depth and subtract from gross precipitation yields net precipitation.

Vegetation Surface Area (SA)

We consider tree/shrub and grass surface areas differently. Tree/shrub surface area accounts for both leaf and stem surface areas. There are two ways to determine the total surface area (SA). Mathematically speaking, if we know the crown diameter D of each tree and its LAI (leaf area index) and SAI (stem surface index), the SA can be accurately calculated as

$$SA = \sum \pi (\frac{D}{2})^2 \times (LAI + SAI) \qquad (7)$$

This calculation will yield an accurate estimate of canopy surface area. However, specific information on species, crown diameter, LAI, and SAI for each tree is needed.

An alternative method uses tree vegetation coverage (CP). We assume that the park manager can provide information on the distribution of tree/shrub canopy cover by vegetation type as listed in Table 5. Open grown cover is distinguished from forest cover because of a different structure that influences rainfall interception. Forest cover has a richer understory than open grown tree/shrub cover, resulting in higher interception rates. Open grown cover is often actively managed turf areas with interspersed trees and shrubs, resembling a savanna landscape. Forest cover includes relict forests and other natural areas that are extensively managed. Vegetation cover data can be obtained from existing inventories, field sampling, or aerial photo interpretation.

Table 5. Vegetation Coverage

Vegetation type	Cover (acre)	
	Open grown	Forest
Broadleaf deciduous	(a)	(af)
Broadleaf evergreen	(b)	(bf)
Conifer	(c)	(cf)
Palm	(d)	(df)
Shrub	(e)	(ef)
Grass	(f)	(ff)
Total	(a+b+c+d+e+f+af+bf+cf+df+ef+ff)	

Table 6. Average leaf area indexes by tree type				
	Open grown		Forest	
Type	LAI (leaf on)	LAI (leaf_off)	LAI_(leaf on)	LAI_(leaf off)
Brdleaf Decid.	4.49	0.00	4.97	0.00
Brdleaf Evrgrn.	4.56	4.56	4.56	4.56
Conifer	5.10	5.10	6.82	6.82
Palm	2.58	2.58	2.58	2.58
Shrub	2.51	2.47	2.51	2.47

The average LAI by tree type are listed in Table 6. LAIs for open grown trees were calculated as mean values by tree type (e.g., deciduous, conifer) from 22 species of street trees measured in Charlotte, NC (E. G. McPherson et al., 2005). LAI values were estimated using a digital photo processing method developed for isolated trees (Peper et al., 2001a; Peper et al., 2001b). SAI is assumed to be 1.7 for all tree/shrub types (Whittaker and Woodwell, 1967). For forest trees, LAIs were based on the available literature (Duursma et al., 2003; Franklin et al., 1997; Parker et al., 2004; Pu et al., 2003).

Turf grass and other ground cover, such as native wild grasses, and herbaceous perennials intercept rainfall and reduce runoff. Interception by grass and other ground covers is calculated using the same methods used for tree/shrub cover, except we assume a LAI of 4.9 (Madison, 1974) that remains constant through the seasons. The total surface grass and other ground cover's surface area is

$$SA_g = LC_g \times LAI_g \qquad (8)$$

here LAI_g is the grass's LAI.

The total surface area of each vegetation type is the product of the sum LAI and SAI and their coverage area. It is calculated by

$$SA_{tree} = \sum (LC_x \times (LAI_x + SAI_x)) \qquad (9)$$

where the subscript x indicates each different vegetation type.

The total surface area of the open grown vegetation is the summation of all surface areas of all vegetation types (e.g., SA_g+SA_{tree}). A similar calculation yields the total surface area for forest vegetation.

Calculation of Total Runoff and Runoff Reduction

Using equation (2), we have the total amount of runoff off the small watershed without a park (Q_{base}) and with a park (Q_{park}).

$$Q_{base} = \frac{(P_{base} - 0.2S_{base})^2}{P_{base} + 0.8S_{base}}$$

$$Q_{park} = \frac{(P_{park} - 0.2S_{park})^2}{P_{park} + 0.8S_{park}} \qquad (10)$$

where the subscript base and park represents the base condition (e.g., no park) and current condition (e.g., with park).

S_{base} and S_{park} are linked to CN numbers that are dominated by soil and land cover conditions. We assumed that the soil was unchanged in both cases. The main factor affecting CN is land cover change associated more intensive development for the baseline.

For existing vegetation in the park, we treat rainfall interception as a reduction of net precipitation rather than a change in S. The P_{park} is calculated as

$$P_{park} = P_{base} - P_{\text{int}} \qquad (11)$$

where P_{int} is the total depth of water intercepted by vegetation in the small watershed.

The annual runoff is calculated with equation (10) by summing runoff from each individual storm event. The storm event is determined use hourly precipitation data, thus the foliation period of each type of vegetation is taken into account.

Results are presented in units of depth (inches) and volume (cubic feet).

Runoff reduction

The runoff reduction QR by the existing park is estimated as

$$QR = \sum Q_{base} - \sum Q_{park} \qquad (12)$$

The percentage reduction is calculated as

$$QR = (1 - \frac{\sum Q_{park}}{\sum Q_{base}}) \times 100 \qquad (13)$$

Monetized Value of Storm Runoff Reduction Benefits

The social and environmental benefits that result from reduced runoff include reduced property damage from flooding and reduced loss of soil and habitat due to erosion and sediment flow. Reduced runoff also results in improved water quality in streams, lakes, and rivers. This translates into improved aquatic habitats, less human disease and illness due to contact with contaminated water, and reduced water treatment costs. Calculating the value of these benefits is difficult because ambient water quality and flood risk conditions vary considerably place to place. As these conditions vary, so should the relative benefit associated with a given amount of runoff reduction.

This model monetizes runoff reduction benefits with data provided by Peter Harnik (Center for City Park Excellence, Trust for Public Land, 660 Pennsylvania Ave., S.E., Washington, D.C. 20003, 202-543-7552, www.tpl.org). The monetized benefit value of $0.04 per gallon for Washington D.C. was based on projected costs and water savings from the Water and Sewer Authority's 2002 Long-Term Control Plan (Table 7, *DC WASA Long-term Control Plan, 2002)*. The benefit value of $0.0036 per gallon for Boston was based on the annual cost of sewage treatment, where revenue covers the cost of annual debt service plus operating costs for the system (Table 8). This approach assumes that revenue per gallon equals cost per gallon.

Table 7. The Cost of Treating One Gallon of Stormwater in Washington, D.C. (in 2005 dollars)

Capital Construction Cost (assumed life expectancy, 20 years)	$1,265,000,000	
Capital Cost, annualized (i.e., divided by 20)	$63,250,000	
Annual O&M	$13,360,000	
O&M plus Annualized Capital Costs		$76,610,000
Total Annual Overflow (gallons)	2,490,000,000	
Predicted Reduction in Overflow (95% Reduction) due to Capital Construction (gallons)	2,365,500,000	
Cost per Gallon Reduced (2001 dollars)		$0.0324
Cost per Gallon (2005 dollars)		$0.0400

Table 8. Cost of Treating Sewage per Gallon in Boston

Annual Revenue from Sewer Fees, City of Boston	$128,200,000
Gallons of Sewage Processed per Year	35,817,752,505
Revenue per Gallon Treated	$0.00358

Avoided costs may not always be the best measure of social benefits, especially if current controls are overly costly or inadequate to control runoff. The costs used here are greater than (Washington D.C.) and less than (Boston) the average cost of about $0.01 per gallon reported in other research (Maco et al., 2003; McPherson et al., 2002; McPherson et al., 1999a; McPherson and Simpson, 2002; McPherson et al., 2003a; McPherson et al., 2000; McPherson et al., 1999b; McPherson et al., 2004; McPherson et al., 2001; McPherson et al., 2003b; McPherson et al., 2005).

The total dollar benefit (B), total savings due to park runoff reduction, is calculated as

$$B = B_{\cos t} \times QR \qquad (12)$$

where B_{cost} is the cost of treating one gallon of stormwater.

MODEL LIMITATIONS

The model does not include the spatial effects of topography and land cover types on overland flow, so it is not suitable for engineering purposes. Similarly, it does not account for depression storage that occurs in swales, lakes, wetlands, and other low-lying areas.

During large storm events, such as modeled here, rainfall exceeds the amount required to fill the storage capacity of tree crowns and other vegetation. The interception benefit for flood control is limited to interception loss and delaying the time of peak flow. Trees and other vegetation protect water quality by reducing runoff during less extreme rainfall events. Small storms, for which vegetation interception is greatest, are responsible for most pollutant washoff. Therefore, urban forests generally produce more benefits through water quality protection than through flood control (Xiao et al., 1998). Because relatively few cities treat runoff or make substantial investments in water quality protection, avoided costs are difficult to quantify. The implied values calculated in this model may not provide a full or completely accurate accounting of water quality protection benefits.

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Attachment 3

ESTIMATING THE IMPACT OF PARKS AND OPEN SPACE ON PROPERTY VALUES AND THE PROPERTY TAX BASE

The Proximate Principle

The premise that parks and open space have a positive impact on proximate property values derives from the observation that people frequently are willing to pay a larger amount of money for a home close to these types of areas, than they are for a comparable home which is not proximate to such an amenity. This observation has been empirically validated in over 30 studies whose results have been reported in the literature. A review of those studies is available elsewhere and can be downloaded from that web site.[1]

In effect, this represents a "capitalization" of park and open space land into increased property values for proximate landowners. It adopts the mechanism of market pricing to assess the value of parks. This process of capitalization is termed, "the proximate principle." Conceptually, it is argued that the competitive market will bid up the value of property just equal to the capitalized value of the benefits that property owners perceive they receive from the presence of the park or open space. Economists refer to this approach as "hedonic pricing." It is a means of inferring the value of a non-market resource (a park) from the prices of goods actually traded in the market place (surrounding residential properties).

An implication of this proximate principle is that impacted homeowners are likely to pay higher property taxes to government entities. The incremental amount of taxes paid by each property that is attributable to the presence of the park, when aggregated, are likely to substantially enhance the value of the tax base. If related to either the cost of acquisition and development of a park or open space, or to the annual maintenance and operating expenses, the annual increments of proximate value may be sufficient to meet or exceed either of those costs. The principle is illustrated by the hypothetical 50 acre park situated in a suburban community that is shown in Exhibit 1. 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% are approximately $90,000.

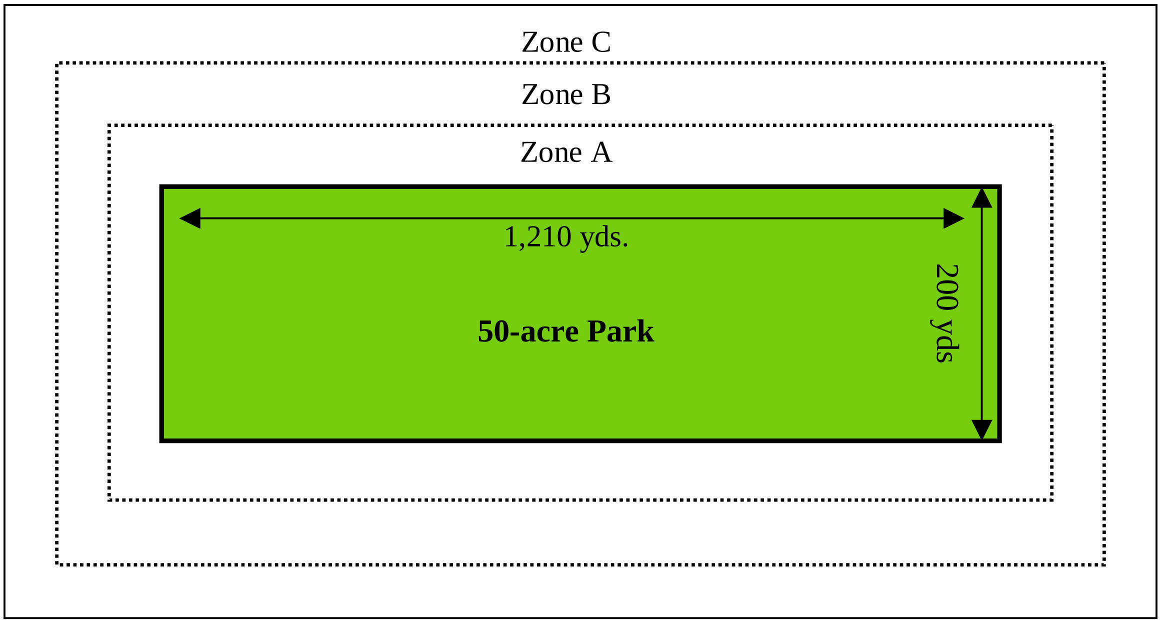


Exhibit 1 Layout of a 50 Acre Natural Park and Proximate Neighborhood Area

A projected annual income stream emanating from the park's impact on proximate properties was calculated using the following assumptions:

1. If properties around the park were 2,000 square feet homes on half-acre lots (40 yards x 60 yards) with 40 yard frontages on the park, then there would be 70 lots in Zone A (30 lots along each of the 1,210 yard perimeters and 5 lots along each of the 200 yard perimeters).
2. Total property taxes payable to city, county, and school district are 2½ of the market value of the property.
3. The market value of similar properties elsewhere in the jurisdiction beyond the proximate influence of this park is $200,000.
4. The desire to live close to a large natural park creates a willingness to pay a premium of 20% for properties in Zone A; 10% in Zone B; and 5% in Zone C, and that there are also 70 lots in Zones B and C. (The review of empirical studies suggests these values are a reasonable point of departure.[1])

Based on these assumptions, Exhibit 2 shows the annual incremental property tax payments in the three zones from the premiums attributable to the presence of the park amount to **$94,500.** This is sufficient to pay the $90,000 debt charges.

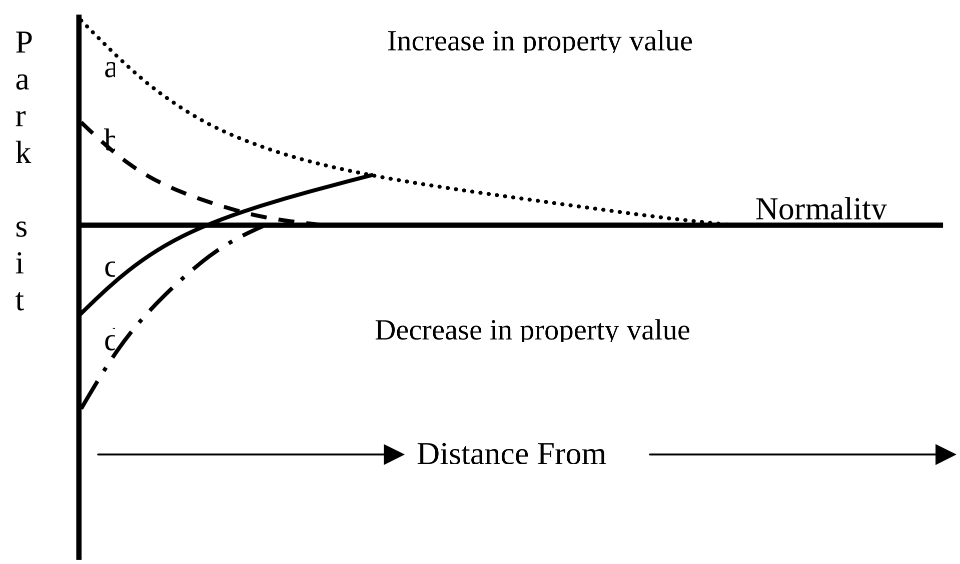
Zone	Market value of each home	Incremental value attributed to the park	Total property taxes at 2½ %	Incremental property taxes attributed to the park	Aggregate amount of property tax increments given 70 home sites
Outside the park's influence	$200,000	$0	$4,000	$0	$0
A (15% premium)	$230,000	$30,000	$6,000	$750	$52,500
B (8% premium)	$216,000	$16,000	$5,500	$400	$28,000
C (4% premium)	$205,000	$8,000	$5,250	$200	$14,000
					$94,500

Exhibit 2 Property Taxes Pay the Annual Debt for Acquisitions and the Development of the Park

Diversity of Proximate Impacts

It is important to recognize that some parks and open spaces are more desirable than others as places to live nearby. Some spaces are flat, sterile green fields; others belong to another era and have not changed in design or intended uses, even though the demographics of proximate populations have changed, so they have become irrelevant; others embrace nuisances such as traffic congestion, noise, litter, vandalism, or ballfield lights intruding into adjacent residences; others are poorly maintained; others are dispirited, blighted, derelict facilities; and others attract undesirable elements who engage in socially unacceptable behavior. It is unlikely that such parks and open spaces will add proximate value. Indeed, it is likely that in some of these cases they would detract from property values.

Exhibit 3 Alternate Scenarios Reflecting the Range of Impacts that Parks and Open Spaces may Exercise on Property Values



Thus, Exhibit 3 shows four alternate scenarios reflecting the range of impacts that parks and open spaces may exercise on proximate property values. In scenarios “a” and “b” value benefit increments are relatively high close to a natural-resource park and diminish gradually with distance from the facility. 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 elements as distance from the park increases- -that is, the positive curve is likely to be flatter than the negative curve. In scenario “c” the nuisance effect of traffic congestion, noise, ballfield lights et al. associated with the park dissipate after two blocks and properties in the three to five block range show a positive value.

Challenges in Deriving an Estimate of Proximate Impact

To undertake hedonic studies that calculate the impact of parks and open spaces on property taxes and the property tax base requires considerable skill in computer mapping and the use of statistical techniques, and it is time consuming. It is likely to be impractical for most park agencies to replicate studies of this nature. Nevertheless, many agencies seek a method of applying a valuation to parks that they can adapt for use in their own communities. An approach is offered here for doing this, but it is emphasized that this approach can only offer a rather crude “best guess” because of the difficulty of interpreting the results reported in the empirical studies that have calculated the proximate impact and adapting them to parks in different contexts. There are three challenges in making such adaptations.

The *first* challenge lies in the diversity of areas which are described by the rubric “parks.” A park may be a one-tenth acre brick plaza with minimal planting, subjected to the noise and pollution of a large city center, or it may consist of several million acres of mountainous wilderness in Alaska; even within the 50 largest cities in the US, parks that are beloved by their residents range in size from the jewel-like 1.7 acre Post Office Square in Boston to the 16,283 acre South Mountain Preserve in Phoenix.[2] A park may be be designed for recreational use with multiple floodlit athletic facilities, an array of cultural buildings and large paved parking lots, or a tranquil natural resource oasis with no improvements; or it may be a blighted eye-sore, or breathtakingly beautiful spectacle. In short, a park is a nebulous concept that defies standardization. For this reason, it is likely that the proximate impact of selected parks within the same community will be different, and it is unlikely that a selected park in one community will have the same proximate impact of another park in a different context.

A *second* challenge relates to the nature of the results reported in the empirical studies. It is difficult to directly compare these results because they have been ascertained in a variety of manners and have used a number of different measures of value.[3] Among the variations are (i) the measure of property value, (ii) the measure of distance, and (iii) the comparison criterion.

Many of the studies, especially those completed before 1980, used assessed valuation rather than sales price as their *measure of property value.* Assessed values are doubtful surrogates for sales price in these kinds of studies because most tax assessors are unlikely to consider park proximity in their valuations. Assessed valuations tend to be rather gross measures that ignore subtleties like the proximate principle. They also tend to be lower than sales price as tax assessors seek to avoid appeals from houseowners challenging their assessments.

To *measure distance* from a property to a park some of the studies used a straight-line from the property to the park, whereas others measured the distance people would have to travel along roads or paths to access the park. This latter street network approach is more accurate and has been more frequently used in recent years since the widespread adoption of GIS mapping has made it easier. The distances over which impact was measured also varied from two or three blocks to half a mile or more.

Premiums associated with the proximate principle were presented in a variety of forms. Some were presented in absolute terms without a *comparison criterion.* For example, the Lee County, Florida, study[4] reported an average premium across the county of $6015 for homes within 200 feet of a park compared to a similar home outside the influence of the park's proximity. However, the proportionate magnitude of this premium is unclear because the mean value of homes in the area is not reported. If these were $75,000 homes then the premium would be 8%, but if they were $300,000 homes it would be 2%. The absence of an indicator of the proportionate magnitude of the premium makes it impossible to meaningfully transfer these data to other contexts.

The most useful information for transferability purposes is offered by studies such as the Portland (OR) example[5] where proportionate property premiums are based on comparisons with similar properties outside the proximate impact area. In other cases, for example, the Austin (TX) study[6], the premiums are based on average home prices within the impacted area which means they are likely to be substantially lower than if the comparison criterion was with like houses outside the impacted area.

A *third* challenge in identifying a premium value that may be transferable to park sites in other communities from the results of the empirical studies may be termed "the aggregation problem." A number of studies, for example, the Leon County[4] and Portland[5] articles, reported proximate premiums that were derived by averaging the impact across a large number of parks in a jurisdiction. Thus, in the Portland case, the premiums of $1,214 and $10,648 were averages derived from 115 urban parks and 34 natural parks, respectively. It was emphasized in the previous section that there are many situations in which the proximate premium may be negative reflecting the undesirable nature of the open space. When premiums are derived from averages across multiple parks, it is likely that results will be self-canceling to some extent, since the impacts at individual parks may range from high positive to high negative. From a transferability perspective, premiums derived from case studies of individual parks whose attributes are carefully described are more useful than those derived from averages across multiple parks.

The Calculation Parameters

The goal is to develop a relatively simple "plug and chug" formulary approach that can be used to derive an estimate of the proximate premium in a community. *It is assumed that there will be electronic access to the assessed values of property assigned by the tax assessor's office and that the community has a GIS mapping system.* It was noted earlier that market values are preferred to assessed values, but only assessed values are likely to be available. Since assessed values are invariably lower than market values, the resulting estimates should be viewed as "conservative." Without these two tools, estimates of the aggregate value of the proximate premium to the community are unlikely to be financially feasible.

The following parameters are suggested as reasonable points of departure for deriving these premiums based on the empirical results reported in the literature.[1]

Consideration #1. The area of proximate impact of a park should be limited to 500 feet or three blocks. The empirical results suggest this is likely to capture almost all the premium from small neighborhood parks and 75% of the premium from relatively large parks. The remaining 25% is likely to be dissipated over properties between 500 and 2000 feet. Disregarding this will lead to an underestimate of the proximate impact of large parks which may be substantial because while the premiums at these distances are relatively low, the number of properties within these parameters is relatively high. However, adopting this 500 foot parameter substantially simplifies the estimation task.

Consideration #2. Use all the parks in the city of one acre or more. It is not practical to carry out the hedonic analysis for parks of less than an acre in size. It is sufficient to note that the final calculation is conservative because it omits the many tiny park fragments that exist in every city.

Consideration #3. Each park needs to be graded. While it would be ideal to utilize a subtle and sophisticated scale – using such emotional responses as, "An exceptionally attractive. well maintained natural resource-based signature park with genuine ambiance and distinctive landscaping and/or topography, often mentioned in sales advertisements for nearby properties, which engenders a high level of community pride and passionate attachment" or "An unkempt, dirty, noisy park with dilapidated facilities and broken equipment that is rejected and avoided by the community" – it is not feasible to do this under the limitations of time and budget. As a more quantitatively defensible fallback we use comparative crime rates as a measure of park desirability or repulsion. But in order to avoid comparing safer and less safe neighborhoods, the methodology compares park crime against crime in the neighborhood directly surrounding the park.

Specifically, using police department statistics and GIS computerized mapping software, the crime rate for every park (along with a 100-foot buffer around the park) should be ascertained on a crimes-per-acre basis. [The 100-foot buffer corrects for the fact that for administrative purposes most park crimes are assigned a location taken from the address of the nearest dwelling – which is technically outside the park.] Then, using the same statistics, the "base" neighborhood crime rate is determined by measuring crimes per acre in the buffer area from 100 feet to 200 feet around each park.

Next, subtract the "Park Crime" rate from the "Base Crime" rate. This will yield three categories of parks: Parks with a positive value ("good parks"), parks with a zero value ("average parks") and parks with a negative value ("bad parks").

Consideration #4. Based on the results reported in the literature,[1] the premiums applied to all dwelling units within the 500 foot proximate area are:

Good parks: +15%
Average Parks: + 5%

Bad parks: (-)5%

After reviewing the literature,[1] these may appear low to some readers. Several of the most recent, technically strong studies (for example, Portland,[5] the Barton neighborhood in Austin,[6] and the Dallas-Fort Worth metroplex[7]) reported premiums in the 16%-22% range. However, these were for the first block immediately adjacent to the park and the premiums declined for properties in the second and third blocks. The proportionate premiums suggested here are averages to be used for all properties within the 500 foot (three block) radius.

Consideration #4. Any incremental premium associated with utilitarian trails, i.e., trails that are not part of visually appealing park or open space land, would arise from access to the trail rather than from views of the amenity. Results from the limited number of empirical studies available at this point are indeterminate. There is agreement that trails are unlikely to exert a negative impact on proximate values, but at this time there is insufficient evidence to suggest there is a premium positive impact. This may emerge in the future as more studies are reported, but no proximate premium is recommended for them here.

Consideration #5. The technically strong empirical studies undertaken in Portland, Oregon,[5] and College Station, Texas,[3] suggest that the proximate premium associated with a golf course is likely to be around 25%. However, the premium decreases dramatically after one block. The premium is attributable almost exclusively to views and, unlike a park space, homeowners two or three blocks away are unable to use the space unless they play golf so their physical proximity to it has little utility. Thus, for golf courses, it is suggested that the 25% premium be limited to properties that are adjacent to it, i.e., a one block radius.

Steps in Calculating an Estimate of the Impact of Parks on the Property Tax Base

1. Identify all public parks of one acre or more, and grade the quality of each using the methodology described above.
2. Draw a 500 feetbuffer around each park.
3. Aggregate the assessed value of all homes within each of the 500-foot buffers, using data from the local tax assessor's office.
4. Apply the percentage premiums suggested above (15%, 5% or (-)5%) to the appropriate group of parks.
5. Aggregate the premiums calculated in step 4. This figure represents an estimate of the overall change in property value attributable to the parks examined.
6. Multiply the aggregated premiums calculated in step 5 by the effective local property tax rates imposed by all taxing entities to estimate the total positive impact of parks on the property tax base.

A template for these calculations is attached.

Note: Values that the Proximate Capitalization Measure Fails to Capture

The aggregated proximate premium that these calculations produce offers only a partial indication of their economic value to a community. There are at least three additional sources of economic value attributable to park and open space amenities which are not captured by this capitalization approach.

First, the capitalization of park and open space value into property prices captures the "private" benefits that accrue to proximate homeowners, but it does not capture the "public" benefits that accrue to those outside the proximate influence from such features as wildlife habitat, improved water quality, reduced soil erosion, reduced flooding, et al.

Second, there is evidence to suggest that investment in parks affects the comparative advantage of a community in attracting future businesses[8] and desirable residential relocators such as retirees.[9] However, the proximate capitalization approach does not capture the secondary economic impacts attributable to park provision that accrue from such sources.

Third, it was noted in point 1 of the Calculation Parameters, that relatively large parks rated positively by the scale in Exhibit 4 are likely to impact property values for distances beyond three blocks, and omission of these premiums may lead to underestimation of proximate impact that could be substantial.

In addition, large parks are likely to have value to populations beyond the radius that cannot be captured by proximate capitalization even if that radius is extended out to 2000 or 3000 feet. This occurs because some users of a large park are likely to come from beyond this radius, e.g. two or three miles distance. The benefits accruing to these users cannot be captured in capitalization calculations.

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Attachment 4

Calculating the Value of Direct Use

By Daniel J. Stynes

Valuing Recreation Use of City Parks

Direct park use values refer to the values to park visitors of the recreation opportunities provided in city parks and open spaces. To be considered a direct use, a person must come to the park to engage in one or more recreation activities. Direct use values do not cover the value of living near a park or simply knowing that a city park exists. Recreation uses range from active uses like hiking, golf or playing sports to more passive uses such as walking, socializing or sitting on a park bench.

Economists generally measure recreation use values in terms of the consumer's willingness to pay for the recreation experience (Loomis and Walsh 1997). The preferred economic measure of value is called "consumer surplus". Consumer surplus represents the net value to the user over and above their travel and other costs of participating. If we add any park admission or use fees paid by the visitor to their consumer surplus, we obtain their total willingness to pay to use the park.

It should be noted that park use values do not measure visitor spending or impacts on the local economy (jobs, income). While significant local economic impacts can result from park visitor spending, the costs of meals, lodging, equipment or souvenirs purchased during a park visit represent the value of these other goods or services rather than the value of the park use itself. Park use values capture just the value of the park experience to park users. In many cases no money is exchanged, so the value is based on what visitors would be willing to pay for the recreation opportunities provided.

Obtaining an economic measure of the value of city park use is difficult. Only some city parks charge admission fees and even when admission or special use fees exist they are often subsidized and do not therefore reflect the full value of the services provided. There is, however, a long history of research to determine recreation values in the absence of market prices.

Three methods were approved by the U.S. Water Resources Council (WRC) in 1979 to estimate recreation use values. Guidelines for applying the methods are published in the Federal Register (WRC 1979) and U.S. Army Corps of Engineers (2000) planning manuals.

(1) The **travel cost method** uses the fact that visitors living at different distances from a park incur different travel costs to estimate a demand curve for a site. Consumer surplus is calculated as the area under this curve.

(2) The **contingent valuation method** measures park users willingness to pay for recreation opportunities via direct questions, and

(3) The **unit day value method** establishes average values per unit of use and applies these to total use to derive a total value for an activity or recreation area. Unit day values are generally derived based on a combination of professional judgment and empirical studies that have used travel cost or contingent valuation methods.

The travel cost and contingent valuation approaches involve empirical studies of park visitors in specific situations. Unit day methods are commonly used to derive values for a wide range of situations without conducting additional research.

These three valuation methods have been widely applied to outdoor recreation activities outside of metropolitan areas (Rosenberger and Loomis 2001). Recreation valuation studies in urban areas are rare as research on city parks has been limited. There are also technical problems in applying travel cost and contingent valuation methods to city park uses, as the assumptions of these methods are less tenable in urban areas. The unit day value methods are therefore best suited as a general approach for estimating the values of city park use.

The East Bay Regional Park District has applied the unit day value approach to value use of their parks and trails. Per visit values established for the East Bay Regional park system were $4.50 per visit for most park visits, but ranged from $1.25 for trail uses to much higher per visit values for special uses such as boating ($20), golf ($42), and environmental education programs ($25). The average value across all park uses in the East Bay study was $6.52 per park visit and $1.84 for trail uses. These values include both consumer surplus and admission/use fees.

The Unit Day Value Method for City Park Uses

The unit day value (UDV) method is documented in the Water Resources Council procedures (1979), the U.S. Army Corps of Engineers planning manuals (2004), and Loomis and Walsh's (1997) textbook. The unit day value method establishes an average value per unit of use for different recreation activities and experiences. Total value provided by an individual park or a park system is obtained by multiplying the average value per visit by the number of visits.

Total use value of a park = average value per visit * number of visits

The principal obstacles to applying the method are coming up with good estimates of the two primary inputs: (1) city park use and (2) an average value per unit of use.

Values per unit of use for individual parks and activities will vary depending on duration and frequency of use, the quality of facilities, and available substitutes in the area,.

Average values for a park system will depend on the mix of programs, activities and facilities and the percentage of use in higher or lower valued activities.

Many popular uses of city parks, such as playground activities, sports participation and passive uses like walking or sitting have not been the subjects of valuation studies. Hundreds of valuation studies have been carried out for activities like fishing, hiking, boating, and picnicking, although almost all of these studies have been conducted in rural settings (Rosenberger and Loomis 2000). Until further research is conducted, we must therefore rely on some judgment to adapt existing unit day values to city park uses[1]. The range of values established by the WRC provides a useful starting point.

Applying the Unit day value approach to City Parks

There are two primary inputs to the valuation procedure: (1) estimates of the amount and types of uses of city parks, and (2) estimates of the average value per unit of use. Variations on the recommended approach entail different ways to estimate these two inputs.

The simplest approach is to multiply an overall average value per visit times a system-wide estimate of the total number of visits. However, it is almost impossible to estimate an overall average value of a park visit without itemizing the number and types of uses included. The value of a short walk in a park or sitting on a park bench will be very different from the value of the use of a city golf course or a visit to the zoo. An average value for a city will depend on the proportion of uses that have higher versus lower per visit values.

We therefore recommend both a simple aggregate method and a more detailed procedure that itemizes the amount of use and value for individual activities or park types. The aggregate approach provides a "ballpark" estimate of the recreation use value of a city park system without requiring extensive data gathering. The aggregate method is recommended in cases where there is limited reliable information about park use and when a quick ballpark estimate is desired.

Cities with established systems for counting particular uses and a high percentage of user fee programs can develop more reliable use and value estimates by taking advantage of their use and fee information. For example, estimates of the number of rounds of golf provided on city courses or entrances to parks with admission fees will

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[1] There are several factors that could cause values in urban park settings to be different than rural settings. Factors suggesting that city park values might be higher than corresponding activities in rural areas include the scarcity of open space and outdoor recreation opportunities in urban areas, the greater savings in travel costs when recreating near home, and, in some cases higher capital development and value added services in city parks. On the other hand, a greater variety of potential substitutes, congestion costs and in some cases lower environmental quality would tend to lower values. When use is dominated by a few regular participants, diminishing returns will also tend to lower the average values.

usually be more reliable than estimates of the use of neighborhood parks or playgrounds. Existing fees provide at least a minimum value for what users are willing to pay.

Estimating park use

Three common methods for estimating park use are :

A) Population-based approach
B) Site specific use counts
C) Based on physical capacity and occupancy rates

A. The **population-based method** is an aggregate approach that doesn't require use counts for individual parks or facilities. Park use is estimated based on the size of the resident population and estimates of the percentage of residents using the parks and their annual frequency of use. Non-resident use can be included by estimating the percentage of overall park use by non-residents.

Resident park use = Population * Participation Rate * Frequency of participation (1)

where,

Population = the size of the resident population (from Census figures)

Participation rate = the percentage of residents who have used city parks at least once during the past 12 months.

Frequency of participation = the annual average number of days of city park use by those who visit a city park at least once during the year.

Participation rates and frequencies of participation can be estimated in household surveys[2].

Non-resident or tourist use includes all use by people who live outside the city. Tourist use can be estimated as a percentage of overall city park use.

Tourist use = Resident use * (Percent of all use by tourists/(1- Percent by tourists)) (2)

B. The **site specific approach** requires counts of visitors to individual facilities. Use estimates are often available for city parks through reservations, registrations, vehicle and entrance counters or based on fees collected. Not all city park use will normally be covered by existing counting systems, but estimates are often available for higher valued and more prominent uses. Once all measured uses are accounted for, uses that are not covered by current use counts can be estimated as a percentage of overall use. Site specific use counts will include both resident and non-resident use.

To obtain an estimate of total park use:

[2] If the surveys cover participation in general, the rates must be multiplied by a "market share" to estimate the portion of activity provided by the city park system.

1. Add up all existing use counts being careful not to count the same use twice. All use measures must be converted to a per person basis[3].
2. Estimate the percentage of overall park use included in these counts.

3. Total use is given by:

Total use = Measured use / Percentage of total use that is measured

Example: If a city park system counts 400,000 visits and estimates that about half of all use is counted, total use is 400,000/.50 = 800,000 person visits.

C: **Based on physical capacity:** Use of some facilities can be estimated based on physical capacity and estimated use/occupancy rates. The specific formulas vary depending upon the activity/facility. The general approach can be illustrated for tennis court use.

Example: A city with 50 tennis courts available 100 days of the year has 5,000 potential court use days. If the turnover rate for each court is 5 groups of players per day with an average of 3 players per court and the courts are occupied 50% of the time, then total use can be estimated as:

Tennis use = courts * days per year * turnover rate per day * people at one time * occupancy rate

= 50 * 100* 5 * 3 * .50 = 37,500 person days of tennis

Rates for the number of people at one time, turnover, and occupancy can be determined by observational studies or small surveys. Where reservation systems are used, this information may be readily available.

Depending upon the available data and desired detail and accuracy desired, a combination of methods may be needed in a given situation.

Estimating per unit values

Given the wide range of city park uses and types of parks, deriving an overall average value covering all uses is difficult[4]. Based on the WRC unit day values, a range of $2 - $9 per visit is recommended for general park uses and $10-$40 for specialized activities[5]. Most recreational uses of city parks and open space fall into the general

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[3] For example, parks with vehicle counts must multiply vehicle counts by the average number of people per vehicle. If estimates of park use are based on admission fee collections, divide total revenue by an average per person fee.
[4] An overall average value can be derived using the disaggregate approach by assigning values to distinct types of parks/uses and estimating the amount of use of each type.
[5] The published ranges for FY2004 are $3-$9 for general uses and $12-$36 for special uses. The minimum value for city park uses is set at $2 to accommodate lower values associated with some high frequency,

recreation use category, while specialized facilities such as golf courses and zoos can be classified as specialized uses. In some cases fees charged at private facilities can be used to help set per unit values for comparable publicly provided opportunities[6].

Table 1. Recommended Unit Day Values for Uses of City Parks

Type of Use	Minimum	Typical	Maximum
General park use	$2.00	$4.00	$9.00
Special uses	$10.00	$20.00	$40.00

The WRC unit day value system includes a point system for rating facilities and programs in order to establish where along the recommended range of unit day values a particular recreation opportunity falls. Such systems could be developed for the most important city park uses.

The overall average per unit value for a particular community depends on the quality of its park system and the range of facilities and services provided. Six important determinants of quality, willingness to pay, and value are:

- Environmental quality
- Number & quality of facilities/structures
- Quality of visitor experiences (crowding, safety, etc.)
- Value added programming – education, interpretation, instruction, supervision
- Level of maintenance and customer service
- Uniqueness of the opportunities/ Availability of substitutes

The quality of the natural environment, capital improvements, and special programs that add value to visitor experiences determine how much visitors are willing to pay. The quality and costs of substitutes are also important. Values of individual facilities are lower in the presence of many substitutes of similar or higher quality since consumers are not willing to pay more than the cost of the next closest substitute.

Illustrative application of the unit day value approach – Aggregate version

Table 2 illustrates a simple application of the unit day value method for a city park system serving 750,000 residents. Use by local residents is determined using the population-based method. If 60% of residents use the parks at least once per year and park users average 10 days of use per year, total resident use is 4.5 million person days.

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short duration activities, such as daily walks in the park. The range for special uses has been rounded to $10 to $40.

[6] Differences in quality of facilities and the range of services provided should be taken into account in establishing a market price. Estimates of consumer surplus must be added to these prices to obtain a total willingness to pay measure. If ample local opportunities are provided by other recreation providers (the private sector or federal, state and other public providers), the market price may be a reasonable approximation of the per unit value.

At an average value of $4 per use occasion, the city parks provide $18 million in use value to residents. If non-resident (tourist) use accounts for 10% of overall park use, using equation (2) above, tourist use is estimated at 500,000 visits valued at an additional $2.0 million. Total direct use value of the park system is $20 million.

Table 1. City Park Use Value Calculator: Aggregate Version

	Park Use	Value per unit	Total value
General Park Use by Residents			
Target Population Served	750,000		
Percent participating	60%		
Average days of use per year	10		
Total resident use	4,500,000	$ 4.00	$18,000,000
Tourist General Use			
Percent of overall use by tourists	10%		
Tourist Use	500,000	$ 4.00	$2,000,000
Total park use and value	5,000,000	$ 4.00	$20,000,000

The aggregate version of the unit day method is simple in terms of the number of calculations required, but estimating overall park use and an average value per use may be difficult without itemizing individual types of use or types of parks. The calculations for the disaggregate version are basically the same, but are carried out for individual activities or parks, focusing especially on uses for which good counts are available and choosing distinct unit day values for each type of use.

The Disaggregate Version

The first step in the disaggregate version is to divide park uses into a set of categories based on activities or park types. The categories should reflect the kinds of use estimates that are available and differences in value across distinct uses. Lower valued uses and uses for which counts may be relatively unreliable can be grouped together, while uses with good counts can be itemized and valued separately.

For each category of use, the amount of annual use and a per visit value are established. The value to park users for each type of use is the product of these two figures. The overall system-wide value is the sum of the values across each type of use. The activity or park type categories for carrying out this analysis will vary across communities, depending on the types of parks/programs provided in the community and also existing systems of counting uses and/or collecting fees.

Table 3 illustrates the calculations for a typical set of activity categories. This park system provides a total of 1.6 million individual use occasions valued at $5 each for a total value of $8.3 million. With the disaggregate approach distinct values can be assigned to each category of use. The overall average value reflects the relative amounts of use of each type and their corresponding unit day values[7]. A spreadsheet is available to carry out these calculations.

Implementing the valuation procedures

Implementation of these procedures for a city park system requires a systematic examination of all park use data. Reliable use estimates should especially be made for the higher valued uses. Uses that are more difficult to measure should be estimated using some combination of the population-based, site-specific and capacity-based methods.

A panel of experts should be convened to develop a set of standard unit day values for the most common city park uses. Per unit values should be developed for a set of categories of activities and/or park types. A point system similar to that proposed by the WRC is recommended to capture differences in quality and value across parks and park systems. An example of a system for selecting unit day values for playground uses is included on the accompanying spreadsheet.

[7] The average values for the subtotals and grand total (shaded cells in Table 3) are computed by summing the use and value columns within each category and then dividing the total value by the corresponding total amount of use.

Table 3: Park Use Value Estimator –Disaggregate Version by Type of Use/Activity

Facility/Activity	Annual Use	Value per unit of use	Total Value ($)
General Park Uses	Use (person visits)	Value per person visit	Total Value ($)
Playgrounds	180,000	$3.50	$630,000
Picnic Areas	80,000	$3.00	$240,000
Trail uses	200,000	$4.00	$800,000
Gardens	3,000	$3.50	$10,500
Other Passive uses of parks	500,000	$2.50	$1,250,000
General Park Use Subtotal	963,000	$3.04	$2,930,500
Outdoor Sports facilities - individual use	Use (person visits)	Value per person visit	Total Value ($)
Tennis	52,000	$4.00	$208,000
Basketball	200,000	$3.00	$600,000
…			$0
Other fields/courts	25,000	$3.00	$75,000
Sports Subtotal	277,000	$3.19	$883,000
Facilities/Field rentals	Number of rentals	Rental value	Total Value
Picnic Shelters	700	$100.00	$70,000
Baseball/softball -league	1,000	$100.00	$100,000
Baseball/softball -community	3,000	$100.00	$300,000
Outdoor Performing areas	50	$500.00	$25,000
Others			$0
…			$0
Rental Subtotal (per facility)	4,750	$104.21	$495,000
Rental Subtotal (per visit) [a]	118,750	$ 4.17	
Special Uses/Fee Areas	Volume of use	Per unit value	Total value
Golf Courses	100,000	$20.00	$2,000,000
Nature centers	40,000	$10.00	$400,000
Zoo/arboreta	158,000	$10.00	$1,580,000
…			
Special Uses Subtotal	298,000		$3,980,000
Grand Total	1,656,750	$5.00	$8,288,500

a. Per visit value for facility/field rentals is based on 25 users per rental.

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Exhibit A. Example of a unit day value table with ranges for individual activities or park types

Table A. Sample Suggested City Park Unit Day Use Values

	Value Range			
General Park Uses	**Min**	**Typical**	**Max**	**Value indicators**
Playgrounds	$2.00	$4.00	$6.00	age, extent & variety of structures, maintenance
Picnic Areas	$2.00	$4.00	$6.00	shelters, grills, grounds, shade,
Trails	$2.00	$4.00	$6.00	surface, env quality, distance
Gardens	$2.00	$4.00	$6.00	size, variety & quality
Passive uses	$2.00	$4.00	$5.00	grounds, benches, shade, water features, average length of stay
Beaches/lake swim areas	$2.00	$4.00	$9.00	water quality, beach quality, grounds
Outdoor Swim pools/aquatic centers	$2.00	$4.00	$9.00	size, quality, special features
Nature center	$2.00	$4.00	$9.00	size, quality, programs
Ice Skating	$2.00	$4.00	$9.00	enclosed, artificial, rentals
Skateboard/inline	$2.00	$4.00	$9.00	size, quality, variety, amenities
Average/Other	$2.00	$4.00	$9.00	For use as an overall average or for oher activities
Outdoor sport/court uses - individual use (per person)				
Tennis	$2.00	$4.00	$7.00	surface, lights, …
Basketball, soccer, other team sports	$2.00	$3.00	$7.00	surface, lights, nets, …
General court/field use	$2.00	$4.00	$7.00	For an overall average or "other"
Special Facilities/uses				
Golf	$10.00	$20.00	$40.00	course quality, holes
Zoo/arboreta	$5.00	$15.00	$30.00	size, quality, programs
Camping (per site)	$5.00	$15.00	$40.00	quality, amenities
Nature center/Env. Ed. program	$5.00	$15.00	$40.00	size, quality, program extent
By Park Types				
Neighborhood park	$2.00	$4.00	$7.00	size, facilities, quality
Natural area	$3.00	$4.00	$9.00	size, access, quality
Sports fields	$2.00	$4.00	$7.00	facilities, quality
City-wide park	$4.00	$6.00	$9.00	size, facilities, quality
Rental facilities - group rental basis				
Picnic shelters	$25.00	$50.00	$150.00	size, quality, amenities
Sports fields	$25.00	$50.00	$150.00	quality, services

a. All values are dollars per person/individual use occasion except rental facilities, which are on a group rental basis.

Ranges and “typical values” are suggested. Further research is recommended to establish a set of recommended value ranges and guidelines for choosing a value from these ranges. Point systems based on ratings of the extent and quality of facilities and programs are one option that is illustrated in Exhibit B.

Exhibit B. Example of a point system for choosing unit day values for a particular park/use from a recommended range - Playgrounds..

Step 1. Establish a range of values for the activity. It is assumed that a range of values has been established for the activity. The point system is used to select a value from this range for a particular park or use.

Unit Day Value Range for Playgrounds

	Minimum	Typical	Maximum
Range	**$2.00**	**$3.50**	**$6.00**
Quality Points	20	50	100

Step 2. Identify determinants of value for this activity and a rating system for each attribute. The example below identifies four value criteria for playground use and allocates 100 points across these four attributes. Levels for each attribute are identified across the columns with suggested point values/ranges for each level.

	Levels of the attribute		
Size (20 points)	Small 5-10	Medium 10-15	Large 15-20
Facility Quality (30 points)	Below Avg 5-10	Average 11-19	Above Average 20-30
Variety of Structures (30 points)	Minimal 5-10	Average 11-19	Extensive 20-30
Environment (20 points)	Below Avg 5-10	Average 10-15	Above Average 15-20

Step 3. Establish the relationship between quality points assigned and the unit day value range. A simple linear interpolation formula can be used to assign unit day values based on the number of points accumulated over the four attributes.

Points to Value Conversion

Total Quality Points	Unit Day Value
20	$2.00
30	$2.50
40	$3.00
50	$3.50
60	$4.00
70	$4.50
80	$5.00
90	$5.50
100	$6.00

Step 4. Rate individual facilities or use occasions on each attribute. Sum the scores and determine the unit day value based on the point total. The examples below shows ratings and associated unit day values for four playgrounds that differ in size, quality, variety of structures and the surrounding environment.

Attribute	Examples Playgd A	Playgd B	Playgd C	Playgd D
Size (20 points)	6	11	6	15
Facility Quality (30 points)	7	14	25	25
Variety of Structures (30 points)	7	14	10	25
Environment (20 points)	5	11	12	15
Total Points	**25**	**50**	**53**	**80**
Unit Value	**$2.25**	**$3.50**	**$3.65**	**$5.00**

Playground A represents an older, small playground
Playground B represents an average playground
Playground C represents a newer, small playground.
Playground D represents a newer large, high-end playground.

Step 5. Estimate use of each facility and assign the corresponding value. Multiply the annual use of each facility by the unit day value and sum total values across all playgrounds to get an overall total value. The overall average unit day value ($4.06) reflects the mix of uses of the higher and lower valued facilities.

Playground	**Use**	**Per unit Value**	**Total Value**	**Characteristics**
PlayGd A	5,000	$2.25	$11,250	Small, older structure
PlayGd B	10,000	$3.50	$35,000	Large, older structures
PlayGd C	10,000	$3.65	$36,500	New, small
PlayGd D	20,000	$5.00	$100,000	New, large
…				
Playground Total	**45,000**	**$4.06**	**$182,750**	

Appendix 5

A Tool for Quantifying the Economic Value of Human Health Associated With City Parks

By Chenoweth & Associates, Inc./Health Management Associates, New Bern, North

Carolina

Introduction

During the past two decades, the rate of overweight and obesity among U.S. children and adults has been increasing rapidly. Based on the 1999 to 2000 National Health and Nutrition Examination survey, about 64% of U.S. adults are either overweight or obese.[1] Over the past decade, in adults, there has been a 12% increase in overweight and a 70% increase in obesity.[2] The age-adjusted prevalence of obesity (>= 95th percentile of body mass index) for children between the ages of 6 and 17 has almost doubled from 1976-1980 to 1988-1994.[3] This suggests that individuals have increased their caloric intake and decreased their caloric expenditure resulting in a state of "positive" energy balance. As technology has developed, most jobs have become less physically demanding, thus decreasing people's energy expenditure on the job. Consequently, in today's developed society, leisure time physical activity has become a critical component in meeting the recommended daily amount of physical activity level (30 minutes of moderate to vigorous activity on 5 or more days of the week).[4]

Many medical and epidemiological studies have documented the health benefits associated with physical activity.[4] For example, inactivity is an independent risk factor for many chronic diseases such as type-2 diabetes, cardiovascular disease, osteoporosis, and depression. However, most Americans do not engage in a sufficient amount of physical activity to obtain health benefits. The prevalence of engaging in an insufficient amount of physical activity has remained around 30% for adults, with only 25% achieving the level of physical activity recommended by the American College of Sports Medicine and Centers for Disease Control and Prevention in the past decade.[5] Current recommendations advise that people of all ages accumulate a minimum of 30 minutes of moderate intensity physical activity (brisk walking) on most, if not all, days of the week in order to obtain significant health benefits.[4] Increasing physical activity is essential because it promotes good health, and as a result, health care costs are reduced. In fact, several studies have documented a large economic burden related to obesity and physical inactivity.[6-11] Clearly, reducing obesity and promoting physical activity has great potential for containing growing health care costs. In this paper, we will investigate how city parks increase physical activity, how those increases in physical activity can lead to improved health, and how improved health may contain specific types of health care costs.

City Parks and Physical Activity

Recent research suggests that a supportive environment is an important factor for increasing physical activity. City parks are a component of the built environment that influences people's daily lives in myriad ways. For instance, access to parks and other open spaces has been linked to increased physical activity[12-18] For example, one study suggests that persons reporting a place to walk were significantly more likely to meet current recommendations for regular physical activity (41.5%) than were persons reporting no place to walk (27.4%).[17] There are a number of aspects of parks which can encourage or discourage their use as well as dictate what activities are engaged in at parks. An individual's decision to use a park can be influenced by aspects such as access to the park area, attractiveness of the park, and awareness of the parks existence. The accessibility of a park is influenced by factors such as travel time, quality of the route, and preference accommodation for mode (walking, biking, driving, etc). Several studies have shown a positive association between access to parks and physical activity levels, however most of these studies have relied upon self-reported data.[14-15,17] Using self-report instead of an objective measure of access is a limitation since many individuals are not always aware of the parks around their homes nor may be aware of their physical activity level. However, these findings are supported by a couple of studies that have used an objective measure of park availability and found a positive association between park access and physical activity.[16,18]

In addition to having access to the park, individuals must also view it as attractive. Some aspects of parks will have a more universal appeal such as being well maintained, while other aspects such as the availability of a playground for young children or a dog park may be viewed as attractive by some individuals but unattractive by others. Individuals may also be willing to travel farther to a park that offers unique facilities.[16] Some studies have linked physical activity with access to trails and safety but these factors have not been specifically examined within parks. [14-16, 19-23] While many variables have been suggested as important for influencing both park use and physical activity within parks (park size, lighting, safety, availability of drinking fountains, restrooms, availability of trails) there is little or no empirical data currently available to support these hypotheses.

Providing increased access to places where one can be physically active as well as increasing awareness of the facilities that are available is a strongly recommended strategy for promoting physical activity according to the *Community Guide for Preventive Services*.[24] Parks are also a popular place to engage in physical activity; 29.6% of physically active individuals from a national sample reported that they exercised in parks.[14] Thus increasing access to and awareness of parks has potential for increasing physical activity.

Physical Activity and Health

The overall health and quality of life of Americans can be substantially improved by incorporating moderate amounts of physical activity into their daily lives.[4] Amount of physical activity is a combination of frequency, duration and intensity. The *amount of physical activity a person must achieve in order to obtain health benefits* <u>*may not have a lower threshold*</u>*, which indicates that any activity is probably better then none*. However, it has been shown that ***additional health benefits*** can be gained through increasing amounts of physical activity. For example, people who can maintain a more regular regimen of activity or one that is of longer duration are likely to derive greater health benefits. The emerging consensus is that vigorous activity is not necessary to improve health and that it is not the intensity, but the *amount of physical activity* that appears to be proportional to health benefits. [4] Physical activity leading to an increase in daily caloric expenditure of approximately 150 kilocalories/day (or 1,000 kcal/wk) is generally associated with substantial health benefits. This amount of caloric expenditure can be achieved (assuming a 70 kg adult) by raking leaves for 30 minutes, walking briskly (4 mph) for 30 minutes or jogging (5 mph) for 18 minutes.[4] Emphasizing the amount versus the intensity of physical activity is more realistic and achievable for people and, thus, will hopefully encourage individuals to make physical activity a more regular part of their lives.

Physical activity has important positive effects on musculoskeletal, cardiovascular, respiratory and endocrine systems. Sufficient evidence exists that showing a causal relationship between physical activity and the prevention or reduced risk of developing the following diseases: coronary heart disease, type 2 diabetes, stroke, osteoporotic fractures, colon cancer and breast cancer. As well, the positive effects of physical activity are consistent with other health benefits like reduced risk of obesity, hypertension and premature mortality. Regular physical activity also appears to help reduce depression and anxiety, improve mood, and enhance ability to perform daily tasks throughout the lifespan.[4]

Physical Inactivity and Medical Conditions

The following section of this paper describes the relationship between physical inactivity and specific medical conditions.

Cardiovascular and Cerebrovascular Disease. Published research shows physical activity is strongly and inversely related to risk of cardiovascular heart disease (CHD).[25-41] Individuals who are physically active have a substantially lower overall risk for major coronary events. Studies have also demonstrated an inverse dose-response gradient between level of physical activity and risk of CHD. The greatest benefit seems to occur at *moderate* levels of physical activity.[42] The numerous estimated measures of association for cardiovascular outcomes generally falls within the range of a 1.5 to 2.0-fold increase in risk of adverse health outcomes associated with inactivity.[4]

Hypertension. The reduction of elevated blood pressure is important for preventing stroke and CHD. Cohort studies have shown that physical inactivity is associated with an increased risk of developing hypertension among both men and women.[4] A few studies have also demonstrated a dose-response gradient between amount of activity and degree of protection from hypertension.[43] Point estimates suggest that those least physically active have a 30% greater risk of developing hypertension than their most active counterparts.[44]

Type-2 Diabetes. There is considerable evidence to suggest a relationship between physical inactivity and type-2 diabetes. One study found that women aged 55-69 years who had high levels of physical activity were half as likely to develop type-2 diabetes as were same-aged women with low levels of physical activity. Moderately active women had an intermediate risk between the high active and low active groups.[45] Another study in men found that each additional 500 kilocalories of leisure-time physical activity per week was associated with a 6% decrease in risk of developing type-2 diabetes. This study showed a more pronounced benefit from vigorous sports than from lower intensity activities like stair climbing or walking.[46]

Colon Cancer. The research in this area strongly suggests that physical activity has a protective role against the risk of developing colon cancer. Studies have reported a statistically significant inverse relationship between physical activity and risk of colon cancer, with consistent results for both men and women. The majority of studies that used more than two categories of physical activity showed a statistically significant inverse dose-response gradient between level of physical activity or cardiorespiratory fitness and developing colon cancer.[4,47]

Breast Cancer. Epidemiologic studies of leisure-time or total physical activity and breast cancer have yielded inconsistent results. Some studies report a significant inverse association, while some are non-significant and others show no relationship at all. Nonetheless, there are studies to support the hypothesis that physical activity during adolescence and young adulthood may protect against later development of breast cancer.[48-51]

Osteoporosis. Physical activity plays a substantial role in the development of bone mass during childhood and adolescence and in the maintenance of skeletal mass during young adulthood. Thus, physical activity may avert the development of osteoporosis by preventing: (a) an insufficient level of peak bone mass at physical maturity; (b) failure to maintain peak bone mass during the third and fourth decades of life and; (c) the bone loss that begins during the fourth or fifth decade of life.[4, 52-53] In addition, physical inactivity may lower the risk of hip fracture, especially in post-menopausal women. [54]

Musculo-skeletal: Osteoarthritis is the most common form of arthritis which is a leading cause of chronic pain and is associated with obesity, physical inactivity, and poor quality of life.[55] Moreover, physical inactivity associated with arthritis can have several negative health consequences such as loss of function, increased risk for cardiovascular disease and unnecessary disability.[56-57] Research indicates that regular moderate exercise can relieve symptoms and improve function among people with both osteoarthritis and rheumatoid arthritis.[4] Moreover, other research shows that after regular physical activity, persons with arthritis have a significant reduction in joint swelling.[58] Furthermore, increased levels of physical activity in persons with osteoarthritis are associated with improved psychosocial status, functional status, and physical fitness.[59-60] Physical activity has been shown to reduce the prevalence and severity of various musulo-skeletal ailments including low back strain and various muscular strains and sprains.[61-64] There is also some evidence linking physical inactivity and obesity to increased risk for carpal tunnel syndrome.[65-67]

Obesity. Physical activity has been shown to be an important factor in maintaining a healthy weight. By expending energy and maintaining muscle mass, physical activity is useful and effective in avoiding weight gain as well as weight loss. Obesity plays a central role in the development of type-2 diabetes, increased risk for CHD, high blood pressure, various cancers and all-cause mortality. Cross-sectional studies show that higher levels of physical activity or fitness are related to lower weight, BMI and skinfold measures,[68-69] as well as an inverse relationship between leisure-time physical activity (either walking or engaging in high-intensity activity) and risk of becoming obese.[69-70]

Mental Health (Depression and Anxiety) The World Health Organization has conceptualized health as a positive state of physical, mental, and social well-being.[71] Therefore, the capacity to enjoy life and withstand challenges must also be acknowledged through psychological well-being, in addition to the reduced risk of developing diseases. Research suggests that people who are physically active or have higher levels of cardio-respiratory fitness have enhanced mood, higher self-esteem, greater confidence in their ability to perform tasks and better cognitive functioning than sedentary persons or those who are less physically fit.[4] In addition, the literature shows a beneficial effect of physical activity on relieving symptoms of depression and anxiety.[72-73]

Quality of life. Physical activity appears to improve health-related quality of life by enhancing psychological well-being and by improving physical functioning in persons compromised with poor health. The strength of this relationship is directly related to the length of time that an individual is involved in a physical activity program.[74] It is also important to note that the magnitude of improvement in both psychological well-being and physical function are highly dependent on the status of the patient's chronic disease. People with lower levels of mental or physical health may have the most to gain from physical activity since they have more room to improve their health status than those who are already in good health. This fact suggests that city parks may play an important role in promoting physical activity for both healthy and unhealthy populations.

Health and Health Care Cost

National health expenditure (NHE) and the NHE as a percentage of gross domestic product in the United States has been increasing over the years. In 2003, the national health expenditure was $1.7 trillion, accounting for approximately 15% of the gross domestic product.[75] Moreover, NHE is projected to reach $3.1 trillion in 2012.[75] Recently, several studies have shown that costs associated with obesity and inactivity account for a large amount of these medical expenditures.[6-8,10-11,76] For example, the direct medical costs of treating cardiovascular disease due to unhealthy weight was estimated at over $22 billion, which was 17% of the total medical cost of treating CVD. For people with arthritis, over 12% of the direct medical cost ($1,250 per person in 2000 dollars) may be associated with inactivity.[77] The total inactivity-associated medical expenditure was nearly $12 billion in 1987 ($38 billion in 2003 dollars) for people with mental disorders.[78]

In the general population, a large cross-sectional stratified analysis of national medical care claims data showed that physical inactivity may cost the nation over $76 billion in direct medical expenditures in 2000 dollars.[11] In particular, this analysis showed an annual difference of $330 in direct medical care expenses between physically active and inactive persons. Interestingly, the level of physical activity measured in the study was even more modest than current federal guidelines of 30 minutes or more of moderate physical activity five or more days per week, suggesting that following current recommendations could yield even greater cost-savings.

Several other studies also show decisive cost differences between active and inactive adults. For example, one of the earliest studies published studies in this area showed an annual medical care cost-difference of $391 (1992 dollars) between active and inactive workers in several large worksites.[79] Another study of auto assembly workers showed an annual cost difference of $96 (1995 dollars) between active and inactive workers.[80] A third study involving 5,689 adults in Minnesota showed physically active persons had 49% lower medical care charges than inactive peers.[81] And, most recently, a study of over 23,000 employees showed that physically active persons had annual medical care costs of approximately $250 lower than sedentary individuals across all body weight levels.[82]

Several studies have investigated the impact of the built environment on promoting health and preventing diseases.[14-18] Wang and colleagues (2004) investigated the cost-effectiveness of bike/pedestrian trails in health promotion and found that the average annual cost for persons becoming more physically active was $98 and $142 for those who were already active at the recommended levels.[83] These low per person costs indicate that the addition of biking/pedestrian trails is a cost effective means of increasing physical activity and promoting health. Thus, it is important to examine other aspects of the environment, such as availability of parks, which can influence physical activity. These quantitative estimates provide much needed information for policy makers and community developers when making decisions about policies and funding with respect to a city's recreational facilities.

Overall, the economic value of human health associated with city parks from physical activity include direct medical cost benefits and other indirect sociological and psychological benefits such as life enjoyment, family value, and enhanced productivity. Yet, due to limited data and methodological challenges, it is only feasible to focus on quantifying the direct medical costs, although this will certainly provide a very conservative estimate of economic value.

By and large, economic analysis of physical activity requires an understanding of the percentage of persons in a target population who are physically active. **Population-attributable risk percent (PAR%)** can be used to quantify the proportion of disease in a population that could have been prevented by improving physical activity. The PAR% measures the proportion of disease such as coronary heart disease and type-2 diabetes in the population that is attributable to a specific exposure such as physical inactivity. The PAR% is calculated as, **PAR%=P(RR-1)/[1+P(RR-1)],** where P is the prevalence of physical inactivity in the study population, and RR is the relative risk for contracting the disease comparing the inactive with the active persons.

The prevalence of inactivity (P) can be estimated using survey information from residents around a park, i.e., categorizing individuals into active and inactive persons. Many medical and epidemiological studies have estimated the RR of several chronic diseases such as coronary heart disease, type-2 diabetes, osteoporosis, and some cancers for various population groups. For example, the RR of coronary heart disease for inactive persons is estimated to be 1.5.[84] This means that the risk of contracting coronary heart disease for inactive persons could be 50% higher than for active persons. To derive the medical cost attributable to inactivity, the risk of disease from both a baseline level of physical activity (no parks) and from the expected increased level of physical activity when parks are present are calculated. Since most of the chronic diseases occur in adults, the impact of physical activity on medical costs among children is insignificant and thus is not usually included in this type of analysis. In addition, there is not sufficient data to make good estimates of the relationship between physical activity and chronic diseases in children. Therefore, only the economic value of human health for adults was determined in this model. The steps to derive medical cost savings of physical activity in city parks are described in **Part II – General Methodology**.

Conclusions

Evidence suggests a positive association between park existence and level of physical activity.[14-15,17] However, data on the actual degree of impact that parks have on physical activity as well as the aspects of parks that increase physical activity is lacking. This is one of the major challenges in assessing medical cost savings of physical activity associated with city parks.

Since medical cost saving estimates depend on accurate assessment of physical activity and park use, collecting data on physical activity performed in parks is critically important for an economic evaluation of human health. There is ample evidence showing the health benefits of physical activity. However, one potential problem in determining actual medical cost savings from physical activity and city parks is the overlapping of inactivity-related diseases (double counting). One way to address this issue would be to use the total medical cost of a specific disease by first diagnosis (first code listed on a medical claim).

Since conclusive research on the impact of city parks on physical activity is lacking, and the association between diseases and inactivity is complex, one economic method may not be sufficient to estimate the medical cost savings attributable to city parks through increasing physical activity. Therefore, caution should be taken when relying exclusively on any of the methods used in this analysis. Additionally, other types of economic analyses such as cost-effectiveness analysis of city parks in health promotion often require not only more but also different data regarding parks.

Part II: General Methodology

The process used to develop the calculation tool includes several steps subject to the following associations/assumptions:

• City parks provide opportunities for persons to engage in various levels of physical activity

• Park users who engage in moderate physical activity gain various health benefits from such activity

• Park users who engage in moderate physical activity incur fewer and less severe medical care conditions than non-users

• Cost-differences used in calculating the financial value of specific health benefits from physical activity are probably underestimated because we don't know or have data on all medical conditions which may be associated with physical inactivity

• Costs related to injuries incurred during physical activity were not considered in this analysis due to a lack of data published in this area

• While there is some evidence that physical activity can enhance the quality of life, there was
no attempt to financially quantify this association because the primary purpose of this analysis is solely to quantify **health benefits**.

Since ***physical activity*** is the **behavioral variable** that is measured in this tool, the initial step was to identify specific types of medical care cost conditions that are inversely related to physical activity. Upon conducting an extensive literature search, various medical care conditions inversely tied to physical activity were identified and are shown in Table 1. The vast majority of conditions listed in Table 1 are identified in the *1996 Surgeon General's Report on Physical Activity and Health* (SGR) as being directly associated with physical inactivity.[4] A few conditions including **breast cancer, carpal tunnel syndrome, stroke**, and **hip fracture** were added to the original SGR listing, based on additional sources which show their link to physical inactivity.[39-41,48-49,52-54,65-67]

Table 1: Medical Conditions Associated with Physical Inactivity [25-68]

DRG #	Condition	ICD Code
	MDC: Cancer (neoplasm)	
152,159,179	Colon cancer	230.3
274, 275	Breast cancer	174, 175
	MDC: Endocrine & Metabolic	
294	Diabetes >35 years of age	250.0 250.9
296-297 300-301	Obesity	278
	MDC: Circulatory	
134	Essential hypertension	401
134	Hypertensive heart disease	402.9
316 & 317	Hypertensive renal disease	403
	Hypertensive heart & renal disease	404
122	Acute myocardial infarction	410
	Acute & subacute ischemic heart disease	411
412	Old Myocardial infarction	412
140 & 143	Angina Pectoris	413
132 & 133	Coronary Atherosclerosis	414
127	Congestive Heart Failure	428.9
	Unspecified Heart Disease	429.9
014-017	Subarachnoid Hemorrhage	430
014-017	Intra-cerebral Hemorrhage	431
014-017	Unspecified Intracerebral Hemorrhage	432
014-017	Occlusion Precerebral arteries	433
014-017	Occlusion Cerebral Arteries	434
014-017	TransCerebral Ischemia	435
014-017	Acute Ill-defined cerebro vascular disease	436
014-017	Other cerebrovascular disease	437
014-017	Late Effects of Cerebrovascular Disease	438
132 & 133	Atherosclerosis	440

103	Heart transplant	
106 & 107	Coronary bypass	
	MDC: Injury & Poisoning	
236	Hip Fracture	808
		808.1
	MDC: Musculo-skeletal	
241	Rheumatoid Arthritis	714
245	Osteoarthritis	715-715.9
	Pain in joint	719.4
	Stiffness joint	719.5
	Lumbago	724.2
243	Backache	724.5
	Polymyalgia Rheumatica	725
248	Synovitis &Tenosynovitis	727
	Rheumatism	729
	Osteoporosis	733
243	Strain/Sprain of back	847.9
	MDC: Mental	
426	Neurotic Depression	300.4
426	Depressive Disorder	311
427	Anxiety states	300
	MDC: Nervous system	
6	Carpal Tunnel Syndrome	354.0

The second procedure was to calculate ***physical inactivity costs*** among the targeted medical care conditions. In the past few years, physical inactivity cost analyses have been conducted on seven (7) states including California, Massachusetts, Michigan, New York, North Carolina, Texas, and Washington.[85—91] State-specific costs for physical inactivity averaged were based on a Proportionate Risk Factor Cost Appraisal™ technique which took into account the following factors:

- # and payments for inpatient and outpatient claims
- ratio of inpatient to outpatient claims and payments
- risk factors associated with each of the targeted conditions
- risk factor (epidemiological) weights for each risk factor
- percentage of adults with a specific risk factor (PAR)

Once physical inactivity costs were quantified for each of the seven states, calculations were done to compute an average annual cost-difference between physically active vs. physically inactive persons. Cost differences among the states averaged $160 per adult (2004 $) which consisted of (1) direct medical care services and (2) prescription medication costs associated with each of the targeted medical conditions. The 7-state cost-difference average is near the low-end of the range comprised of the previously-cited cost-differences:

Source	Average Cost-difference
Edington[79]	$ 391
Pratt[11]	$ 330
Pronk[81]	$ 294
Wang[82]	$ 250
Seven states[84-90]	$ 160
Milliman & Robertson[80]	$ 96
Unadjusted Average	**$ 253.50**

The unadjusted average cost-difference of $253.50 does **not** take sample size into account. Consequently, each of the preceding cost-differences were treated equally when, in fact, they represent populations of vastly different sizes.. For example, two of the six samples [7 states –and- Pratt] represent large *multi-state* adult populations whereas the remaining four samples represent large worksites or randomized samples of adults within a single state. Thus, in order for each of the five analyses to be properly represented, it is necessary to assign proportionate weights to each of the samples, based on their sample sizes. Therefore, the two multi-state samples are **each** assigned a percentage multiple of .40 (40%) with **each** of the remaining smaller samples assigned a multiple of .05 (5%). Consequently, a comparison of unadjusted vs. adjusted cost-differences for each group is as follows:

Source	Unadjusted Average Cost-difference	Multiple*	Adjusted Cost-Difference
Edington[79]	$ 391	.05	$ 19.55
Pratt[11]	$ 330	.400	$132.00
Pronk[81]	$ 294	.05	$ 14.70
Wang[82]	$ 250	.05	$ 12.50
Seven states[85-91]	$ 160	.400	$ 64.0
Milliman & Robertson[80]	$ 96	.05	$ 4.80
Average	$ 253.50	1.00	$247.55

* Assigned percentage of total population

The adjusted cost-difference is slightly below the unadjusted cost difference. Thus, given the small difference between the two averages, a **median of $250** will be used as the official cost-difference.

Physical Activity Benefits Calculation Tool

The physical activity cost-saving tool uses summarized cost-difference data from the previously-cited analyses. It is important to note the cost difference [$250] listed in the attached spreadsheet should be viewed as an **approximate value** and not an exact or absolute value. Essentially, this cost-difference reflects the annual medical care cost-difference between a physically active vs. inactive adult.

A prerequisite for using the worksheet calculation is to factor in the number of park-using adults who can be classified as being physically active. For this particular equation, a *physically active* person is one who engages in *moderate* physical activity of some duration. Moreover, the *amount of physical activity a person must achieve in order to obtain health benefits may not have a lower threshold, which indicates that any activity is probably better than none*.[4] However, it has been shown that ***additional health benefits*** can be gained through increasing amounts of physical activity. For example, people who can maintain a more regular regimen of activity or one that is of longer duration are likely to derive greater health benefits. The emerging consensus is that *vigorous* activity is not necessary to improve health and that it is not the intensity, but the *amount of physical activity* that appears to be proportional to health benefits.[4] Physical activity leading to an increase in daily caloric expenditure of approximately 150 kilocalories/day (or 1,000 kcal/wk) is generally associated with **substantial** health benefits. This level of caloric expenditure can be achieved (for a person weighing 154 lbs.) by raking leaves for 30 minutes, walking briskly (4 mph) for 30 minutes or jogging (5 mph) for 18 minutes.[4]

Overall, there is no universal agreement among researchers on the exact minimum number of minutes per day or per week that a person must engage in moderate physical activity to obtain various health benefits. However, virtually all researchers agree that moderate exercise must be *regular* and of *sufficient duration* to render some level of measurable health benefits (e.g., risk factor level reduction).[91] Thus, persons who are responsible for computing the health benefits of physical activity in a park setting should consider the preceding examples in order to determine the quantity of park users who meet a minimum level of physical activity (e.g., walking briskly).

Since adults older than 65 tend to incur higher medical costs than younger adults, a multiplier of 2.0 has been inserted in the formula to account for this discrepancy. A baseline multiplier of **2.0** was chosen and is based on research showing adults $\geq$65 years of age typically incur two or more times more medical care services and costs than younger adults.[93]

Finally, a regional multiplier is included in the equation to reflect regional differences in medical care inflation.[94]

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Attachment 6

A Toll for Estimating the Spending of Visitors who use a Community's Park and Recreation Amenities

By John L. Crompton, Ph.D.

If leaders in most communities are asked to list the amenities that encourage people to visit and spend money in their community, the list is likely to be comprised of features such as cultural facilities, heritage places, parks, special events and festivals, sports facilities and tournaments, and arenas. Typically, these are operated by public agencies and nonprofit organizations. However, the general public frequently are unaware of the central role that parks, open space and recreation amenities play in the community's tourism effort.

To demonstrate their economic contribution to the community, an increasing number of agencies have undertaken studies of visitor spending. These studies measure the amount of new money coming into a community from outside that creates income and jobs for residents.

THE MEASUREMENT TEMPLATE

It is an unfortunate fact that urban park tourism is woefully under-measured. This is the case both from the perspective of tourists (what percentage of tourists come to a place because of its parks?) and from the perspective of the parks (what percentage of park users are out-of-town tourists?) A great deal of data is collected on tourism, but it is overwhelmingly oriented to the hotel, restaurant, airline, theme park, museum and retail sectors, not to public parks. The only methodical survey protocol for parks is conducted by the National Park Service, but the number of urban national parks is small and their usership are always numerically dominated by the much more highly visited municipally-operated parks in a city.

This data dearth makes it impossible to arrive at an accurate estimate of park-related tourism spending. Nevertheless, the number is an extremely important one, making it worthwhile to attempt a rough calculation. We have therefore designed a template to enable an estimate.

STAGE 1: Determine total tourist visits (i.e., visitation-days) to the city.

Most visitor and convention bureaus know the total annual visitation to a city. When getting that figure, however, it is important to seek a figure for the city itself rather than the more common one for the metropolitan area.

STAGE 2: Determine the breakdown between nearby visitors (less than 50 miles) and long-distance visitors (i.e., day-trippers and overnighters).

This information should (hopefully) be available from the visitor and convention bureau.

STAGE 3: Determine the average expenditure per tourist per day.

Again, this information should be available from the visitor and convention bureau. In some cases the information may be in the form of "spending per party" or "spending per trip"; in those cases, the results will need to be factored down to "per person per day." In some cases, the data will distinguish between business travelers and non-business travelers, so the ratio may have to be determined and the numbers averaged. It will be seen that overnight trips generate much more spending than day trips because of lodging and extra meals.

STAGE 4: Estimate the percentage of tourists who visit a park while on their city trip.

This is difficult. It would vary tremendously by city (i.e., Washington, D.C. with its public park National Mall vs. Las Vegas with its private indoor casinos), so there is no "official" number across all cities. Ideally, in the future, visitor bureaus will add questions about park visitation to their surveys, but at present this will have to be estimated.

STAGE 5: Estimate the number of tourists who come to the city "significantly" because of a park or because of the park system.

It is not enough that a tourist happens to casually intersect with a park – he or she may have to walk through a small park simply to get to the hotel. We are seeking those persons who choose to visit a city *at least in part* because of a park – someone who says, "When we go to New York I want to go to the top of the Empire State Building, eat in Chinatown, see the Brooklyn Museum, take the Circle Line boat trip and, of course, go to Central Park." Or someone who says, "I usually skip the annual convention, but this year it is in San Antonio and I've always wanted to see the River Walk." Or, "Normally we bypass Chicago on the way to Lake Superior, but we heard so much about Millennium Park that we decided to stay over for a couple of days and see all the sights."

Again, this is a difficult number to get and it will have to be estimated. In the future, it is hoped that visitor bureaus will routinely survey for this information.

Obviously, the combination of Stage 4 and Stage 5 will greatly diminish the total tourism spending number for the city, which is appropriate since most tourists don't come to most cities because of the parks. (But presumably if a city park system continually improves so as to gain regional, national and international notice, the number of park-oriented tourists will increase, and their spending will be recognized.)

STAGE 6: Calculate the tax receipts on tourist spending. The tax charged on tourist spending constitutes income to the city. If it is not possible to determine the statistically accurate tax rate on tourists, an estimate can be obtained by averaging the city's sales tax rate, hotel tax rate and auto rental tax rate.

The formula for determining spending is:

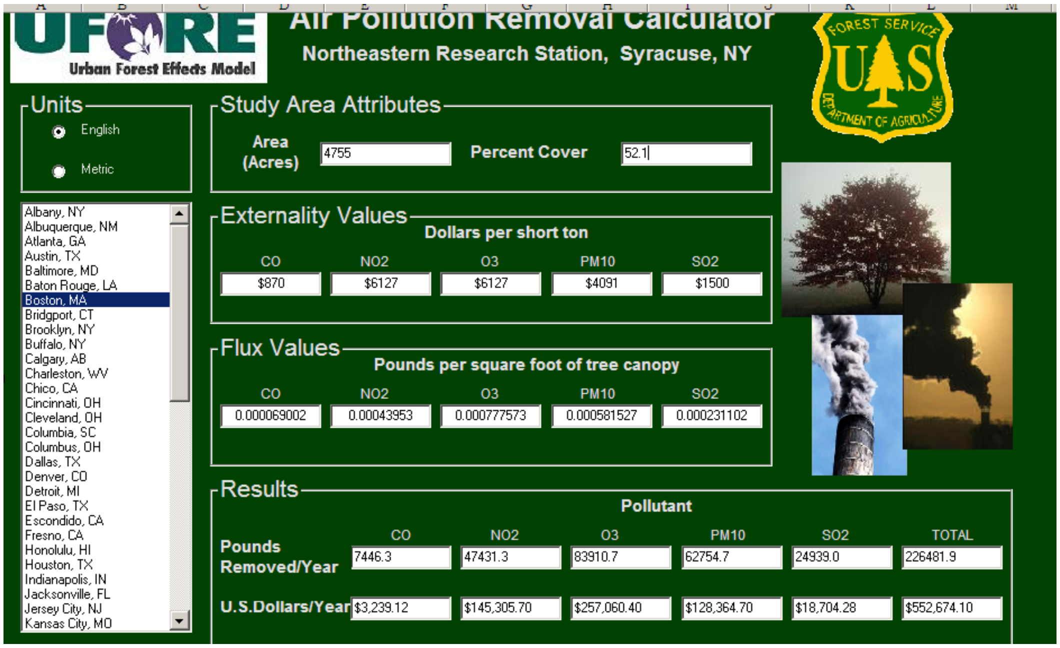
(Number of overnight person-visits) X (average spending per overnight person-visit) X (percentage of visitors who visit a park) X (percentage of those visitors who came to the city "significantly" because of a park or park system) X (the tax rate on tourist goods and services)
PLUS
(Number of day-trip person-visits) X (average spending per day-trip visit) X (percentage of day visitors who visit a park) X (percentage of those visitors who come to the city "significantly" because of a park, a park system or a park event) X (the tax rate on tourist goods and services)

OPTIONAL STAGE 7: Calculate the collective profit to the city economy from park-generated tourism. According to studies, about 65 percent of consumer spending covers expenses (such as the cost for restaurants of purchasing raw food) and 35 percent represents profit. Multiplying park-generated tourism dollars by 0.35 yields an estimate of the increase in the collective "wealth" of the community.

CAVEATS/COMMENTS

No attempt has been made to incorporate multiplier effects into this template. There is widespread recognition that these supposed effects are frequently abused when presenting economic impact data. If it is desired that they be used, then park and open space agencies should probably use those that are advocated by the community's tourism agency. These are likely to be exaggerated and inaccurate. However, if they are the accepted norms in the community, little is to be gained by developing accurate multipliers for park advocates because they will invariably be lower than those accepted norms.

Calculator #1 – Air Pollution



Calculator #2 – Stormwater Runoff

Location	Boston, MA
Climate Region	Northeast
Percent of City Pervious (omitting parkland and water)	38.3%

Acres of Parkland	Acre	% of Total
With Pervious Soil	3,647.5	76.7%
With Impervious Surface	669.4	14.1%
Under Water	437.6	9.2%
Total	4,754.5	100.0%

Vegetation Coverage						
	Open grown		Forest		Total	
Vegetation type	Acres	% of Total Parkland	Acres	% of Total Parkland	Acres	% of Total Parkland
Broadleaf deciduous	2,475.7	52.1	-	-	2,475.7	52.1
Broadleaf evergreen		-	-	-	-	-
Conifer		-	-	-	-	-
Palm		-	-	-	-	-
Shrub		-	-	-	-	-
Grass	1,171.8	24.6	-	-	1,171.8	24.6
Total	3,647.5	76.7	-	-	3,647.5	76.7

What Is a Park Worth? - Runoff Reduction

Results for a typical weather year	Inches	Cubic feet
Rainfall	40.78	703,815,291
Runoff with parks	3.68	63,508,663
Runoff without parks	11.57	199,701,548
Runoff reduction due to parks	7.89	136,192,885
Runoff reduction rate	68%	

Dollars	Cost of treating stormwater ($ per cubic foot)	0.0637
	Total savings due to park runoff reduction	$8,675,487

Calculator #3 – Property Value and Property Taxes

The Hedonic (Property) Value of Parks -- Boston

Total Value of Residential Properties Within 500 Feet of parks	$ 14,498,577,213	
The Contributing Value of an Average Park	5%	
Portion of the Value of These Properties Attributed to Parks		**$ 724,928,861**
Total Property Value Attributable to Park Proximity		**$ 724,928,861**
Effective Annual Residential Tax Rate (1.14%)	0.0114	
Additional Tax Revenue to the City Because of Park Proximity Value		**$ 8,264,189**

Calculator #4. Direct Use

Direct Use Value Estimater -- Boston

Facility/Activity	Person-Visits	Value per Person-Visit	Total Value ($)
General Park Use			
Playgrounds or Tot Lots	11,112,672	$2.74	$30,423,230
Walking on Park Trails	22,113,546	$1.41	$31,194,409
Walking Dog in Park	--	--	--
Picnicking or Bench-Sitting	20,145,910	$2.28	$45,848,155
Birdwatching/Enjoying Nature	21,945,849	$1.77	$38,764,442
Visiting a Flower Garden	1,092,262	$5.95	$6,497,335
General Use Subtotal	**76,410,237**	**$1.91**	**$146,230,236**
Sports Facilities Use			
Tennis	3,555,161	$3.14	$11,171,253
Team Sports	7,356,276	$2.32	$17,093,838
Bicycling on Park Trails	10,989,694	$2.92	$32,064,641
Swimming	7,421,863	$2.95	$21,868,724
Running on Park Trails	10,743,740	$2.93	$31,478,598
Rollerblading in Parks	2,951,454	$3.18	$9,381,375
Skateboarding	--	--	--
Ice Skating on Park Rinks	4,050,051	$5.81	$23,537,577
Sledding or Tobagganing	1,339,334	$0.91	$1,216,446
Surfing or Windsurfing	--	--	--
Sports Subtotal	**48,407,572**	**$3.05**	**$147,812,453**
Special Uses			
Golfing	1,598,704	$16.42	$26,250,053
Community Gardening	3,957,632	$2.71	$10,711,318
Festival or Cultural Performance	910,777	$25.64	$23,348,341
Visiting Monuments	--	--	--
Zoo	--	--	--
Boating	--	--	--
Horseback Riding	--	--	--
Special Use Subtotal	**6,467,113**	**$9.33**	**$60,309,713**
Grand Total	**131,284,922**		**$354,352,402**

(note a) The value of visiting the zoo is fully captured by the cost of visiting the zoo.

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Calculator #5. Health

Health Benefits Calculator -- Boston

Calculation based on persons engaging in moderate, vigorous, or strenuous physical activity at least 3 days per week in a park		
Instructions: Fill in amounts for rows 2, 5 and 9.		
Line	**Factor**	**Amount**
1	Average annual medical care cost difference between active and inactive persons, under 65 yrs. of age	$250
2	*Insert the number of adults under 65 years of age who are physically active in the park*	***254,738***
3	Subtotal of health care benefits for adults under 65 years of age [line 1*line 2]	**$63,684,431**
4	Average annual medical care cost difference between active and inactive persons over 65 years of age	$500
5	*Insert the number of adults 65 and older who physically active in the park*	***17,825***
6	Subtotal of health care benefits for adults 65 years of age and older [line 4*line 5]	**$8,912,743**
7	Subtotals combined [line 3+line 6]	**$72,597,174**
8	*Insert a regional multiplier (from Sheet 3)*	*1.075*
9	***Total annual value of health benefits from physical activity in the park [line 7*line 8]***	**$78,041,962**

Calculator 6. Tourism

Spending by Tourists Who Come to the Parks of Boston

I. Overnight Visitors			
Number of Overnight Visitors who visit parks			**833,201**
Spending per visitor		**$188**	
Spending by overnight visitors who visit parks (D6 * C10)			$156,641,788
Reducing the park spending number to the 10% who came ***because*** of parks	**10%**		$15,664,179
II. Day Visitors (from more than 50 miles)			
Number of Park Day Visitors (from more than 50 miles away)			**771,961**
Spending per day visitor		**$39**	
Spending by day visitors who visit parks			$29,913,489
Reducing the park spending number to the 10% who came ***because of*** parks	**10%**		$2,991,349
III. Suburban Visitors (closer than 50 miles)			
Number of Park Day Suburban Visitors (from less than 50 miles away)			**239,540**
Spending per suburban day visitor		**$22**	
Spending by suburban visitors who visit parks			$5,174,064
Reducing the park spending number to the 10% who came because of parks	**10%**		$517,406
Total spending by overnight and day visitors who came because of parks			**$19,172,934**
Taxes paid on goods and services by overnight and day visitors who came because of parks (10% of spending)	**10%**		***$1,917,293***
Profits earned on sales of goods and services to overnight and day visitors who came because of parks (35% of spending)	**35%**		***$6,710,527***

Blue numbers are taken directly from http://web4.msue.msu.edu/mgm2/, then click on "database site" and on Boston NHP and Boston African American NHP

Black numbers are calculations

Purple numbers are from Greater Boston Convention and Visitors Bureau

Green numbers are constants provided by Dan Stynes, Ph.D.

Red numbers are professional estimates

Calculator 7. Community Cohesion.

The Value of Community Cohesion from Parks -- Boston

Volunteers and Voluntary Organizations

Organization	Volunteer-Hours	Value of a Volunteer Hour in Massachusetts: $20.75	Financial Contribution	Total
Allston Brighton CDC	5,300	$109,975	$35,000	$144,975
Codman Common	120	$2,490		$2,490
Earthworks			$110,000	$110,000
Emerald Necklace Conservancy	2,000	$41,500	$649,700	$649,700
Fenway Alliance			$367,800	$367,800
Franklin Park Coalition	3,030	$62,873	$112,097	$174,970
Friends of Christopher Columbus Park			$84,045	$84,045
Friends of Codman Common	10	$208		$208
Friends of Copley Square			$89,600	$89,600
Friends of Elliot Norton Park	23	$467	$677	$1,144
Friends of Hayes Park	1,700	$35,275	$22,500	$57,775
Friends of Hiscock Park	342	$7,097	$41,995	$49,092
Friends of the Kelley Rink			$11,994	$11,994
Friends of Oak Square	100	$2,075	$1,800	$3,875
Friends of the Prado	310	$6,433		$6,433
Friends of Puddingstone Park			$70,337	$70,337
Friends of the Public Garden			$1,936,466	$1,936,466
Friends of Ramler Park	500	$10,375	$17,000	$27,375
Friends of Ronan Park	436	$9,047		$9,047
Friends of Savin Hill Park	226	$4,690		$4,690
Friends of Titus Sparrow Park	990	$20,543	$11,000	$31,543
Friends of Woodlands at McLaughlin	50	$1,038		$1,038
National Association for Olmsted Parks			$3,000	$3,000
Union Park Neighborhood Association	100	$2,075	$8,500	$9,575
Poplar Street/Delano Court	500	$10,375		$10,375
Total		**$326,532**	**$3,573,511**	**$3,857,543**