Economic Benefits of Natural Areas within Parks in NYC

Methodology

January 2023

Project Background

In 2022, Trust for Public Land (TPL) published The Economic Benefits of Parks in New York City (TPL Parks Report), describing the environmental, recreational, health, and other economic benefits that parks provide city residents. The Natural Areas Conservancy (NAC) in NYC served as a member of the advisory committee for the project, and after publication approached TPL and the University of Maryland Environmental Finance Center (UMD EFC) about leveraging the report findings specifically in natural areas in the city.

In 2018, NAC developed a Forest Management Framework (NAC FMF), in collaboration with NYC Parks (https://naturalareasnyc.org/content/forests/fmf-2019-update-singles.pdf). The Framework is "a strategic and comprehensive plan to bolster and protect New York City's vital urban forests," with the intent to "guide restoration, management, and community engagement for 7,300 acres of New York City's forested parkland." The report estimates a need for $385 million in maintenance funding over the 25 years of the plan, identifying natural areas with high or low forest health and high or low threat due to climate change, invasive species, and other impacts.

Project Goal

NAC is interested in advancing new, alternative funding opportunities to meet the needs identified in the 2019 Framework, including a forest resilience bond or direct engagement of NYC corporate sustainability funds. To support their efforts, TPL and UMD EFC used the analyses from the TPL Parks Report and FMF to compare benefits and costs of maintaining natural areas in parks. Additionally, this methodology outlines a way to communicate the costs of not maintaining natural areas, due to both potential reduction in benefits and an estimated increase in maintenance costs over time.

This methodology document describes TPL and UMD EFC's rationale and integrates findings from the literature review.

The categories for benefit valuation are:

- Recreation;
- Health care cost savings due to exercise in parks;
- Water quality protection (either leveraging existing wastewater infrastructure, or implementing new green stormwater infrastructure); and
- Air pollution reduction (Ozone and PM2.5).

The case study template also has a tab for estimating a benefit cost ratio, that compares the costs of park maintenance to the benefits it provides.

Methodology

This methodology document is intended to be used with an Excel-based calculator, originally titled **FINAL Case Study Template v3.** In that Excel file, **orange** cells are inputs to be filled in by the user, **green** cells contain the results based on the equations built into the calculator, and **blue** cells contains data from the TPL Parks Report. **Gray** cells contain equations built into the calculator. Green, blue, and gray cells should be considered locked, while orange cells require user input.

Note: there may be some instances in which the user will want to override the equations in the template; the gray cells are therefore not locked in Excel.

Benefit Template Tab

Complete the following steps to estimate the benefits associated with individual parks.

1. Identify the study area(s), ideally a natural area already included in the Forest Management Framework.
2. Fill in demographic data on the provided Excel calculator in the appropriate boxes.

Using the Benefit Template tab, the user fills in the orange cells in the Excel calculator; the rest will fill in automatically in order to provide the following estimates:

Collect demographic information about the residents currently living within a ten-minute walk of the study area.

- Use the TPL Park Evaluator tool to view the report of the study area; if the park doesn't already exist or there isn't a report when you click the area, create a "new park" polygon around the study site: https://parkserve.tpl.org/mapping/index.html?CityID=3651000 (link is located in top right)
- Click "Run the Analysis," then "View Report" to identify the population that study area serves, including data on race, age, and income. Enter the data in the orange cells into the template.

The Park Evaluator tool is part of TPL's ParkServe effort. For more information about the tool, see the manual here:
https://parkserve.tpl.org/mapping/pdfs/ParkEvaluator%20Instructions%20May%202021.pdf

Service Area - Population within a 10-minute walk
Adults within a 10-minute walk
Children within a 10-minute walk

Seniors within a 10-minute walk

Estimate how many adults and children use the study area.

- Multiply the number of adults (over age 20) that live within a ten minute walk of the study area by 79.8%.
- Multiply the number of children (up to age 19) that live within a ten minute walk of the study area by 89.1%.

How many adults and seniors use the study area?
0
How many children use the study area?
0

These percentages are based on the results of the telephone survey conducted for the TPL Parks Report. As the survey respondents only included English-speaking residents, these park user estimates should be considered a lower-bound, conservative estimate, and should be replaced with locally-specific park user data whenever possible.

Estimate the recreational value of the study area.

- Multiply the total number of adult park users in the study area (from the previous step), by the percent of NYC residents who participate in each type of recreation. Then multiply the number of adults participating in each type of park use by the average number of annual visits per activity, to estimate annual usage.

Adult Park Use	Percent of Adults who Use Parks for Recreation	Number of Adults who use Parks for Recreation	Average Number of Annual Visits per Activity
Biking	9%		55.8
Picnic, visit with family, relax	14%		53.2
Photography	13%		59.3
Playground	4%		35.8

Running, Jogging	16%		81.2
Walking, hiking	35%		83.2

Other activities included in the survey but excluded here (due to the focus on natural, forested areas, not parks generally) are visiting a beach, participating in a fitness program, participating in team sports, and swimming).

- Multiply the number of annual visits for each type of park usage by the Consumer Surplus Values estimated in the TPL Parks Report, and sum across all activities. This will provide a total recreational value for adults for the study area.

Adult Park Use	**Annual Consumer Surplus Value (2021$)**
Biking	$ 14.61
Picnic, visit with family, relax	$ 27.48
Photography	$ 6.24
Playground	$ 40.28
Running, Jogging	$ 6.22
Walking, hiking	$ 23.72

Note: the survey these values are based on only included English-speaking, NYC residents. The rate of participation should be considered a conservative-lower-bound estimate. Additionally, the consumer surplus values are provided in 2021$; the Consumer Price Index (CPI) can be used to estimate 2022$ or later, as needed.

Estimate the public health values of the study area.

Note: if the natural area doesn't have trails or is otherwise inaccessible for physical activity, this value should be excluded from the analysis.

- Multiply the number of park users (already built into the calculator) by the percent of adults who use parks for vigorous exercise. Unlike recreation values, it's important to separate out adults under 65 and adults 65 and over, because of the differences in health care cost savings due to physical activity for different age ranges.

		Per person value:	$1,330
Adult Park Use	**Percent of Adults 18 - 64 Using Park for Exercise**	**Number of Adults Under 65 Using Park for Exercise**	**Public Health Value due to Exercise in Park**
Vigorous Exercise	15%	0	$0

	Per person value:	$2,660
Percent of Adults Over 65 Using Park for Exercise	**Number of Adults Over 65 Using Park for Exercise**	**Public Health Value due to Exercise in Park**
7%	0	$0

These percentages were based on the survey conducted for the TPL Parks Report. Survey respondents were stratified by age, then their frequency and type of activity per park visit was calculated from their responses. To meet CDC guidelines for physical activity (that would lead to annual health care cost savings), park users had to exercise at least 75 minutes a week of vigorous exercise or 150 minutes of moderate-intensity exercise. In the survey, "vigorous-intensity activity was limited to responses indicating running or jogging, while moderate-intensity activities included walking, hiking, and biking. The health care savings analysis does not include sedentary or low-heart-rate activities, such as picnicking, wildlife watching, or fishing." [1]

- Multiply the number of vigorous exercisers under 65 by $1,330. This is the estimated total value of avoided healthcare costs for adults under 65, because they leverage nearby parks to meet the CDC guidelines for physical activity.
- Multiply the number of vigorous exercisers over 65 by $2,660. This is the estimated total value of avoided healthcare costs for older adults, because they leverage nearby parks to meet the CDC guidelines for physical activity.

These avoided healthcare cost values were calculated by TPL's Center for Park Excellence, and are in 2021$.

3. Fill in the number of acres of natural area based on the Forest Management Framework.

In addition to the per person values calculated above, water quality and air quality benefits are calculated on a per acre basis in the calculator. Fill in the number of park acres to estimate both.

[1] Trust for Public Land. "The Economic Benefits of Parks in New York City." March 2022. https://www.tpl.org/economic-benefits-nyc

Park Acres from FMF

Estimate the value of avoided stormwater infrastructure due to the study area.

- If the study area is within a combined sewer, multiply the total acres of the study area by $291 for the total value of avoided gray stormwater infrastructure. Otherwise, multiple the total acres by $78,722, the average cost per acre for new green stormwater infrastructure identified in the TPL Parks Report for NYC (see below).

Water Quality Protection	Benefit Value	Per Capita Benefit in Service Area
Value as Green Stormwater Infrastructure	$0	TBD
Value as Wastewater Treatment Plant Cost Savings*	$0	TBD

There are 30,868 acres of parks analyzed in the TPL Parks Report, which found that the avoided cost of additional wastewater infrastructure due to the parks was $8.98 million. The average per acre value of avoided infrastructure would be $291/ acre; users can multiply this value by the total acreage of the study area for a general estimate. Similarly, you can calculate the avoided cost of new green stormwater infrastructure by leveraging $78,722/acre.

This assumes that the study area is permeable and unpaved, so that the natural areas absorb rainfall rather than creating additional runoff. If any acres within the study area can be identified as impermeable, they can be excluded from the calculation.

Estimate the value of reduced air pollution due to the study area.

1. Multiply the total acres of the study area by $201 for the total value of avoided impacts due to ozone air pollution.
2. Multiply the total acres of the study area by $658 for the total value of avoided impacts due to PM2.5 air pollution.

Air Pollution Reduction	Benefit Value	Per Capita Benefit in Service Area
PM 2.5	$0	TBD
Ozone	$0	TBD

There are 30,868 acres of parks analyzed in the TPL Parks Report, which found that the avoided cost of air pollution because of the parks was $6.2 million for ozone and $20.3 million for PM2.5. The average per acre value of avoided air pollution would be $201/ acre for ozone and $658/acre for PM2.5; users can multiply each value by the total acreage of the study area for a general estimate of the value of reduced air pollution.

BCR Estimates Template

The benefit cost ratio estimates tab has 7 sections (in Column A) and a Per Acre Values Table (starting in Column J). Like the benefit template tab, **orange** cells are inputs to be filled in by the user, **green** cells contain the results based on the equations built into the calculator, and **blue** cells contains data from the TPL Parks Report. **Gray** cells contain equations built into the calculator. Green, blue, and gray cells should be considered locked, while orange cells require user input.

1. **Ecosystem services**

This table estimates lower and upper bound ecosystem service benefits for the total park acreage. Fill in the orange cells with the number of acres in each threat level. (Note: it was constructed this way in case future users want to estimate benefits for subsets of the total; additional research would be needed on how ecosystem service delivery is impacted by ecosystem health, climate, and other impacts.) Alternatively, you can just fill in the total acres in cell F4 and override the sum function currently there.

Based on the per acres value table in this tab (which are derived from the TPL Parks Report), the value of stormwater mitigation and air quality protection are calculated for (a) the acreage in each threat level and (b) the total acres.

The Lower Bound estimate combines Stormwater: Existing Gray Infrastructure and Air Quality Protection: Ozone. The Upper Bound estimate combines Stormwater: New Green Infrastructure and Air Quality Protection: PM2.5.

In the Parks Report, TPL calculated avoided stormwater costs due to parks, leveraging existing gray infrastructure (for steady-state flows) and new green infrastructure (for peak flows). There is a significant cost difference per acre between them, so a range is provided to allow the user to choose a more or less conservative approach. Air quality protection is similarly divided between lower and higher per-acre values.

It's important to note, from the TPL Parks Report, that these values shouldn't be summed: "Because it is difficult to determine exactly which pollutant causes each incidence of the emergency visit, these values [i.e., avoided health care costs associated with air pollutant reduction] should not be considered additive, but instead illustrate the relative impact of each pollutant on health costs."

The annual ecosystem service value range for the individual park is calculated in cells F12 and F13.

Ecosystem Services					
Threat Level	Very Low Threat	Low Threat	Medium Threat	High Threat	**Cumulative Total**
Number of Acres					***0***
Stormwater					
Existing Gray Infra	$0	$0	$0	$0	***$0***
New Green Infra	$0	$0	$0	$0	***$0***
Air Quality Protection					
PM2.5	$0	$0	$0	$0	***$0***
Ozone	$0	$0	$0	$0	***$0***
Lower Bound Total (Annual)	$0	$0	$0	$0	**$0**
Upper Bound Total (Annual)	$0	$0	$0	$0	**$0**

2. Recreation

The recreation table is based directly on the benefit template; that is, the inputs for C17:C22 should match those of C23:C28 in the Benefit Template tab. The user should copy and paste strictly the values; alternatively, the cells can be directly connected so a change in one tab is automatically made to another.

The annual recreational value for the individual park is calculated in cell F24.

Recreation	*Table source: Case Study Template*					
Adult Park Use	**Percent of Adults who Use Parks for Recreation**	**Number of Adults who Use Parks for Recreation**	**Avg Number of Annual Visits Per Activity**	**Annual Consumer Surplus Value (2021$)**	**Total Consumer Surplus Value**	
Biking	9%		55.8	$ 14.61	$0	
Picnic, visit with family, relax	14%		53.2	$ 27.48	$0	
Photography	13%		59.3	$ 6.24	$0	
Playground	4%		35.8	$ 40.28	$0	
Running, Jogging	16%		81.2	$ 6.22	$0	
Walking, Hiking	35%		83.2	$ 23.72	$0	
			Annual Recreational Value Across All Types of Recreation for Park		**$0**	*Based on total acreage, regardless of threat level*

3. Fitness

The fitness table is also based directly on the benefit template; that is, the inputs for C28 and F28 should match those of C33 and F33 in the Benefit Template tab. The user should copy and paste strictly the values; alternatively, the cells can be directly connected so a change in one tab is automatically made to another.

The annual fitness value for the individual park is calculated in cell F31.

Fitness		*Per person value:*	$1,330		*Per person value:*	$2,660
Adult Park Use	**Percent of Adults Under 65 Using Park for Exercise**	**Number of Adults Under 65 Using Park for Exercise**	**Public Health Value due to Exercise in Park (Adults)**	**Percent of Adults Over 65 Using Park for Exercise**	**Number of Adults Over 65 Using Park for Exercise**	**Public Health Value due to Exercise in Park (Seniors)**
Vigorous Exercise	15%	0	$0	7%	0	$0
			Annual Avoided Healthcare Value for Adults for Park		**$0**	

4. Annual property taxes (optional)

Based on the methodology in the TPL Parks report, users can estimate the value of estimated property tax revenue attributable to parks. (This tab excludes the impact to property value itself, as it was not an annualized value; therefore any benefit cost ratio estimate should be considered conservatively estimated).

This is an optional benefit to calculate, and it would require some GIS analysis. A user will need to calculate (or estimate) the total annual property tax for residences within 500 ft of the park, and calculate the total property tax value using data from NYC OpenData (https://opendata.cityofnewyork.us/). TPL conservatively estimates 5% of the value of a residence (and therefore taxes) located proximate to a park can be attributed to the park itself.

The annual property tax value attributed to an individual park is calculated in cell D35.

Optional: Annual Property Taxes					
You must calculate (or estimate) the total annual property tax for residences within 500 ft of the park. TPL conservatively estimates 5% of the value of a residence (and therefore taxes) located proximate to a park can be attributed to the park itself. See TPL Report for additional methodology.					
Total Property Tax of Residences Near Park	$0				
Estimated Property Tax Revenue Attributed to Parks	**$0**	*Based on total acreage, regardless of threat level*			

5. Projecting benefits into the future

In order to compare the value of benefits to the value of costs estimated in the FMF, the user needs to project benefits out 25 years into the future. (The FMF estimated the total park maintenance costs to be approximately $385 million over 25 years).

The default discount rate is 7%. Both the number of years and the discount rate can be overridden in cell B39 and B40 if needed.

One important caveat is that projecting benefits into the future assumes there is no change in demographics, recreational user, cost of healthcare, or acreage in the parks.

The sum of benefit flows (again, both a lower and upper bound) are included in E43 and E44 as a check to ensure the discount rate is being integrated into the final equation; the sum of benefit flows should always be higher than their discounted counterparts.

The total lower bound and upper bound values for the benefits provided by parks are calculated in cells B43 and B44.

Projecting Benefits into the Future				
Discount Rate	0.07			
# Years	25			
Total, Present Value, 25 Yrs of Benefits			*Sum of Benefit Flow (No Discount Rate)*	
Lower Bound	***$0***		*Lower Bound*	*$0.00*
Upper Bound	***$0***		*Upper Bound*	*$0.00*

6. Total cost of maintenance

The total cost of maintenance comes from the individual cost calculators created by NAC, and can be copied in cell B47.

Note: the value of benefits in the TPL Parks Report are discounted in 2021$. Users should update the calculator cost estimates where possible so both benefits are costs are in the same year's dollar amounts, and cell D47 has no functionality beyond acting as a reminder that an adjustment may be necessary.

Total Cost of Maintenance				
Total Cost Over 25 Years		(discounted to:	2019	)

7. Benefit cost ratio range

The range of the ratio of benefits to costs over 25 years is presented in cells B50 and B51; the sentence beginning in D50 is a quick way to share the results of this analysis. Until a value is included in the total cost over 25 years (cell B47), these cells will show a divide by zero error.

Benefit Cost Ratio Range				
Lower Bound	#DIV/0!		"The benefit cost ratio is conservatively	
Upper Bound	#DIV/0!		#DIV/0!	
			with a 7% discount rate over 25 years."	

Leveraging Existing Park Maintenance Cost Calculators

If the park has an individual calculator used to estimate the cost of management for the FMF, the "annual degraded areas" row can be adjusted to account for the likelihood of increased forest degradation in the absence of active management.

- Note the total cost of the park's management under the assumption that the forest management framework has been implemented ("the *managed cost of the park").*
- Next, update Row 20, starting with Column X; for each area of the park, update the annual degradation rate based on the areas' threat level (Row 18, starting with Column X) ("the *cost of not managing the park").*

Threat Level	**Estimated Rate of Degradation**
High	5%
Medium	3%
Low	2%
Very Low	1%

- Subtract the managed cost of the park from the cost of not managing the park to determine the increased cost due to natural areas' degradation in the absence of management.

Natural areas degrade even with a long-term maintenance plan in place; NAC calculators estimated that 1% of each area would degrade each year the FMF was in place, returning the corresponding acreage to the restoration process (and its associated costs).

The table above is an estimate of how degradation rates may vary for areas of the park with different conditions, but these percentages should be evaluated when future research on natural areas' ecological condition is conducted.

Estimating Benefit Decline

This methodology assumes that all acres of natural areas provide similar benefits, though this is likely not the case. However, very detailed data collection (both scientific and economic) would be required to quantify ecological changes and associated economic value changes. Few studies empirically connect forest values, landscape attributes, and recreational values.

One study, however, quantified values for habitat preference for 12 structural attributes of forests that affect recreational values (i.e., attractiveness) for citizens. Giergiczny et al (2015) was the first study of its kind to connect forest attributes with quantitative recreational values, Examples of some attributes are shown in Figures 1 and 2 below.[2]

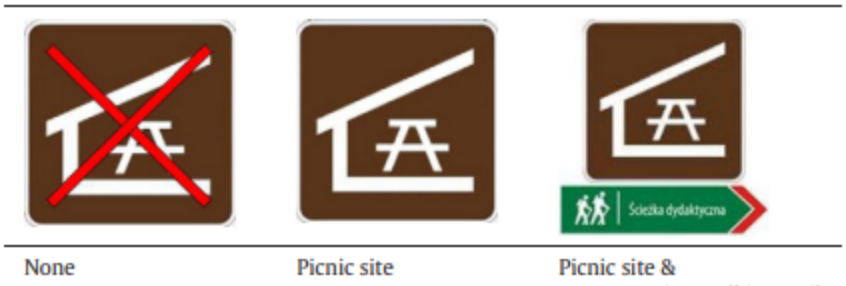

Figure 1. Ground vegetation height preferences. Source: Giergiczny et al (2015)

Figure 2. Tourist infrastructure. Source: Giergiczny et al (2015)

[2] Giergiczny, M., Czajkowski, M., Żylicz, T., & Angelstam, P. (2015). Choice experiment assessment of public preferences for forest structural attributes. *Ecological Economics*, *119*, 8-23.

The study found that "...forests that are managed (or left unmanaged) for biodiversity purposes are also likely to be attractive to humans" (p. 9). Forests that are mixed age and have a medium density of ground vegetation and the presence of a medium density of deadwood are all preferable. Therefore, the level of maintenance matters for recreational enjoyment, however, it does not lead to the ability herein to establish the way the preferences may impact willingness to pay for the maintenance levels.

For the purposes of communicating benefit decline, one simplified way is to assume that without maintenance, there will be some acres lost either entirely or that the area becomes unacceptable for human enjoyment.

Figure 3 below is an example from Forest Park, where total acreage of the forest declines at a rate of 0.5%, 1%, or 2% over the 16-year cost estimate timeframe calculated by NAC. The figure shows the difference in the value between the benefits of maintaining the full acres (full benefits) and the decline in acres due to maintenance. When the decline in acres causes a negative benefit value in 12 -14 years, this indicates that the acres lost are comparable to the acres maintained. In other words, it estimates the time (at a certain number of acres lost per year) becomes a loss of benefits in the future compared to the alternative where the acres are healthy and perpetuating the benefits into the future.

This figure was created by establishing a cumulative benefit value of the FMF over the 16 years of the cost estimate time frame. As the money is spent to implement the FMF, those expenditures are essentially maintaining benefits associated with those natural areas. In year 1 the cumulative benefits would be ~$2.2 M, and in year 16 they would be ~$110 M (based on the per-acre values calculated in the TPL Parks Report for NYC).

Without implementation of the FMF, we assumed that certain percentages of the natural areas are in "disutility" and the estimated benefit value is therefore lost. Losing those benefits over time means that at years 12-14, the lack of maintenance creates negative benefit values; or, after 12-14 years there is acreage loss that would not have occurred if the forest was appropriately maintained. After that timeframe, the number of benefit-producing acres falls below the current number of acres accruing benefits in Forest Park.

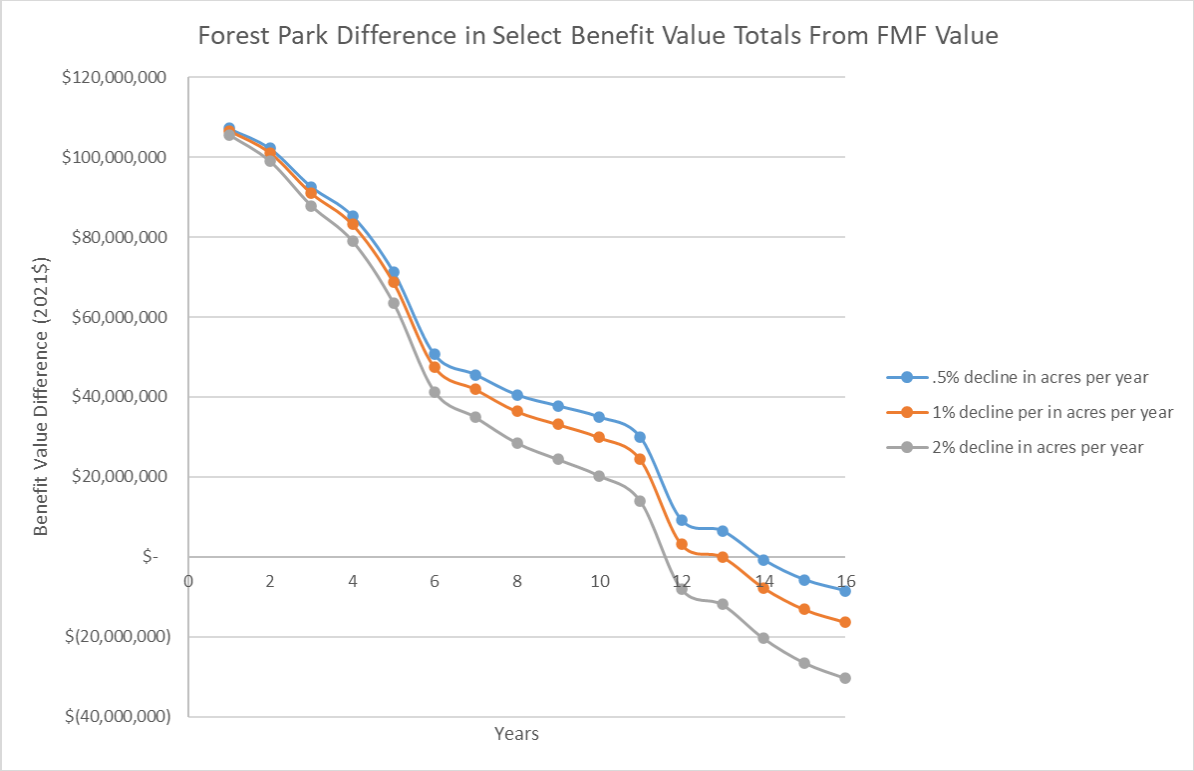

Figure 3. An example of potential benefit decline over time, without maintenance, called for in the FMF in Forest Park. At a 0.5%-to-2%-acre loss per year, by year 14 there is a cumulative value of $15 to $97 million lost due to forest acreage decline and its associated utility (and therefore benefits). The values lost are increasing with the percentage decline in acres each year. The cumulative values are estimated by totaling the losses in years when the benefit value difference becomes negative (year 12, 13, or 14 depending on the annual percentage decline), to year 16 (the last year that costs are calculated in the FMF for Forest Park).

Additional Information in the Case Study Template

In addition to the Cover, Benefit Template, and BCR Estimates Template, the Excel contains the following information:

- FP Benefit – This is an example of the Benefit template filled out for Forest Park.
- FP BCR Estimates – This is an example of the Benefit Cost Ratio template filled out for Forest Park.
- VC Benefit – This is an example of the Benefit template filled out for Van Cortlandt Park.

- VC BCR Estimates – This is an example of the Benefit Cost Ratio template filled out for Van Cortlandt Park.
- TPL Summary Tab – Provides dollar per acre estimates used in the FMF B_C and Benefit Template, as well as notes about the data used in the estimates. This tab also contains the recreation consumer surplus by activity per acre, if NAC wishes to estimate recreational values by activity type in the future.
- CS and & Values – This tab presents data and citations from the TPL Parks Report, identifying participation rates by activity, consumer surplus by activity, and the source citation.