Dauphin County
Return on Environment Study

The Economic Value of Protecting, Restoring and Expanding Nature's Financial Benefits

2016

Acknowledgement

Keystone Conservation Trust

4WARDPlanning

Sponsored by Audubon Pennsylvania and the Appalachian Trail Conservancy

Funding assistance provided by the Pennsylvania Department of Natural Resources, Environmental Stewardship Fund

Consultants

John Rogers—Keystone Conservation Trust

Todd Poole—4WARD Planning

Thank you to Dauphin County Parks and Recreation Department and the Pennsylvania Fish and Boat Commission for graciously providing facilities for the Dauphin County Return on Environment meetings.

Table of Contents

Photo Credits

Meetings

Speakers

Dr. Jason Henning
U.S Forest Service

Dr. Elliott Campbell
Maryland Department of Natural Resources

Tanya Dierolf, Sustainability Manager
Capital Region Water

Contributor

John Dawes, President
The Foundation for Pennsylvania Watersheds

Attendees

The following organizations, agencies, and commissions participated in the 2016 Dauphin County Return on Environment:

Appalachian Trail Conservancy
Audubon Pennsylvania
Capital Region Water
Chesapeake Bay Commission
Chesapeake Bay Foundation
Clarks Creek Watershed Preservation Association
Dauphin County Parks and Recreation Department
Doc Fritchey Chapter of Trout Unlimited East Hanover Township
Parks and Recreation Department
Game Commission
GeoBees,
LLC Harrisburg Parks and Recreation Department
Harrisburg Young Professionals
Keystone Conservation Trust
Manada Conservancy
Maryland Department of Natural Resources
Penn State Extension
Pennsylvania Department of Conservation and Natural Resources,
Bureau of Recreation and Conservation
Pennsylvania Farmers Union
Pennsylvania Fish and Boat Commission
Susquehanna Greenway Partnership
Susquehanna Outfitters
The Nature Conservancy
The Office of State Senator Rob Teplitz
Tri-County Regional Planning Commission

Executive Summary

"We can't solve problems by using the same kind of thinking we used when we created them."

Albert Einstein

Scenic mountains, farmland views, river corridors and large forest habitats reflect the rich diversity of natural resources that exist in Dauphin County. Natural system services are the benefits people derive, directly or indirectly, from ecosystem functions. The large forests and stream corridors are like veins of biological diversity, which drive natural system services and recreational opportunities. The value of these resources impact residents' quality of life, health, sense of place, cost of living and the local economy. Because Mother Nature does not write receipts, nature's financial value is often overlooked or undervalued in policy debates, investment decisions and personal choices.

The results of this study show that nature is serious business. The goods and services that flow from Dauphin County's existing open space and natural systems save residents, communities and businesses $939.2 million in avoided costs for natural system services, air pollution removal and revenues from outdoor recreation each year. These benefits accrue to businesses, manufacturing, agriculture, governments and households. *Figure 1* shows why it is difficult to have a strong economy without a healthy environment and plenty of open space.

***Figure 1*. Dauphin County's Annual ROE**

$939.2 million in each year

Avoided Costs

- Natural System Services: $573.7 million
- Air Pollution Removal Impact on Health Care: $9.1 million

Outdoor Recreation Revenue

- Outdoor Recreation: 359.4 million expected revenue
- Jobs: 3,440 expected
  State and Local Taxes: $ 16.5million expected

Open Space Impact on Property Value

- $39.7-$50.5 million

For more than fifty years, suburban sprawl has been destroying and fragmenting forests, polluting the air and increasing flooding and stormwater. Sprawl costs Dauphin County incredible amounts of money, not just in cost of services, but reduction and loss of natural system services such as stormwater management, water supply, flood mitigation, erosion management, water and air quality, aquatic resources, pollination, natural regeneration and revenue from recreation each year. For policy makers, businesses and residents, losing millions of dollars year after year from sprawl and not knowing it, is poor asset management.

Once lost, regaining nature's full capacity can take fifty to one hundred years. In the meantime, these services must be replaced at the taxpayers' expense. Natural systems also provide a form of insurance or risk management. Natural systems work 24 hours a day, 365 days a year, and have been doing so since the last Ice Age. That's why conservation can be a good long-term business strategy.

Albert Einstein said, "We can't solve problems by using the same kind of thinking we used when we created them." Determining "what nature is worth" and what people are willing to pay to replace nature's cost-free services is a new way to promote conservation and more responsible investment, policy and personal decisions.

Just as financial analysts express return on investment, Return on Environment studies (ROE) explain nature's invisible financial value in terms everyone can understand. As a result, policy makers, businesses and residents can begin to see natural systems as a portfolio of financial assets, rather than a commodity or added expense.

It is important to note that the economic benefits presented in this study were meant to serve as estimates, not exact values. While approximates, they were based on peer-reviewed, defensible scientific principles and economic estimation methods and represent a vast improvement over making economic judgments regarding open space preservation or protection without good scientific and financial data.

All cover types and eco-prices were differentiated based on ecosystem functions and services. The natural cover types with the highest ROE are headwaters and forested wetlands and riparian and floodplain forests. The largest natural system services' avoided costs are for habitat, stormwater and flood control, groundwater and pollination.

The economic benefits presented in this study provide government officials, policy makers, businesses and the public with a perspective on the value of open space and should contribute to informed decisions concerning land use, economic development, safety, tourism and recreation.

With the knowledge of nature's financial value, communities are better equipped to strike an effective balance between maintaining connected, open spaces and supporting smart growth. This approach helps improve environmental quality and ensure a sustainable economy, moving toward a net gain in both.

It makes sense that every nature-related decision process should begin with an ROE analysis. People participating in the Dauphin County ROE meetings suggested that ROE would help with a

majority of environmental issues and suggest the following actions be taken:

- Create incentives for stormwater, riparian buffer and native plant incentives, such as tax abatement and free trees and native plants.
- Inform land use, economic development, recreation and tourism policy and decisions.
- Provide information on open space easement and land purchase investment decisions.
- Reinforce landscape approaches for habitat connectivity, expansion and protection.
- Create strategies to reduce flooding and protect water quality.
- Create strategies to enhance tourism and economic development.
- Create more opportunities for outdoor recreation.
- Educate residents about nature's value and inspire good stewardship.
- Assist businesses in their missions.

A good business person never overlooks an avoided cost, misses a major revenue stream or allows their brand to be tarnished. Neither should a county or municipal official, local business or resident.

Dauphin County is expected to have 28,000 new residents by 2040. [1] As one of the top nineteen fastest-growing counties in Pennsylvania in 2015, one of Dauphin County's largest challenges will be to promote sustainable growth, while maintaining open space and the substantial social and economic benefits it provides.

The choices made about the environment today will have a dramatic impact on the future of Dauphin County. New development increases the demand for recreation, water supply, stormwater management, clean air and water and many other nature-based services. Consequently, businesses, governments and households have to work together to manage the remaining open space in ways that result in the highest *Return on the Environment*. The best ways to sustain nature's cost free services are:

- Enhance and connect wildlife habitat and maintain and restore tree canopy cover.
- Retain as much pre-existing, natural landscape as possible during any new construction.
- Connect new landscape components with the surrounding native vegetation to create large contiguous areas of habitat.
- Create natural stormwater management and green infrastructure.
- Protect and restore riparian buffers and wetlands from disturbance and fill and remove invasive species.
- Minimize impermeable surfaces and reduce turf grass to areas only essential for recreation and landscape access.
- Expand natural system services by using native plants in areas surrounding parks, preserves, riparian areas and trails.

Introduction

Part of Dauphin County's attraction for growth is the region's scenic mountains and farmland views, river corridors, pristine groundwater, large forest habitat and a variety of high-quality recreation opportunities. All of this is provided by open spaces.

If you enjoy kayaking or fishing on the Susquehanna River, hiking on the Appalachian Trail, hawk watching in one of Pennsylvania's largest Important Bird Areas or getting naturally-filtered, clean water to run your business, you appreciate the rich diversity of natural resources available in Dauphin County.

The northern half of Dauphin County is traversed by the Kittatinny Ridge. The Ridge is visible from Harrisburg, the state capitol. The forests of the Kittatinny Ridge, the diversity of topography, natural stream corridors leading to the Susquehanna River and clean water are natural resources that define Dauphin County's sense of place and sustainable wealth. *Figure 3*

The impetus for this project came from the recognition of the real, significant yet hidden, financial and social values of the Kittatinny Ridge. In 2009, the Kittatinny Ridge Coalition (a partnership of land trusts, environmental non-profits, government agencies and academic institutions) began county-level studies to assess the financial, economic and social values of the Kittatinny Ridge.

***Figure 3*. Dauphin County**

The Objectives

The objectives of this study were to document:

1. The monetary value of natural system services.
2. The value of improved air quality relating to healthcare costs.
3. The monetary value of outdoor recreation and the number of participants.
4. The increased property value due to proximity of open space.
5. The spatial distribution of resource value (Map)
6. The integration of new land use and habitat expansion tools into everyday practice.

"America needs her forests and her wild spaces quite as much as her cities and her settled places."

Benton MacKaye, Founder of the Appalachian National Scenic Trail

Section ***§ 27*** (The Pennsylvania Constitution)

Natural resources and the public estate.
The people have a right to clean air, pure water and to the preservation of the natural, scenic, historic and esthetic values of the environment.

Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

Open spaces provide substantial economic, environmental and public-health benefits to communities—a triple bottom line. The loss of open space has broad impact on recreation, health, water supply, water and air quality and economic development.

As communities grow, it is important to consider the value and pattern of a region's open space. It is essential that we recognize the importance of trees, fields, forests and streams in filtering our water, cleaning our air, flood and stormwater mitigation, pollinating plants and providing habitat and other environmental services. In fact, the economy of any community would grind to a halt without the services that nature provides. [(2)]

The Constitution of Pennsylvania imposes a duty to conserve and to maintain public natural resources for this generation and generations yet to come.[(3)] If the goal is to maximize health, safety and social welfare and conserve and maintain public natural resources, our policy process must distinguish clear and concrete economic values from which to choose. The question is "Are nature's contributions to our welfare being adequately and accurately reflected in political, business and personal decisions?"

Open spaces positively affect scenic views, tourism, property values, health, and economic development to reduced costs for healthcare, stormwater management and flood mitigation. Open space also increases revenues from recreation and naturally improves air and water quality. Open space has a broad influence on life from supplying basic needs to enhancing health and well-being, jobs and the economy, while supporting plant and animal diversity. (*Figure 4*)

We may not understand the long-term impact of incrementally losing natural system services, one acre at a time. The losses seem invisible. A dollar value on natural system services provides information to help local officials understand and monitor their Return on Environment.

Return on Environment Valuation Benefits

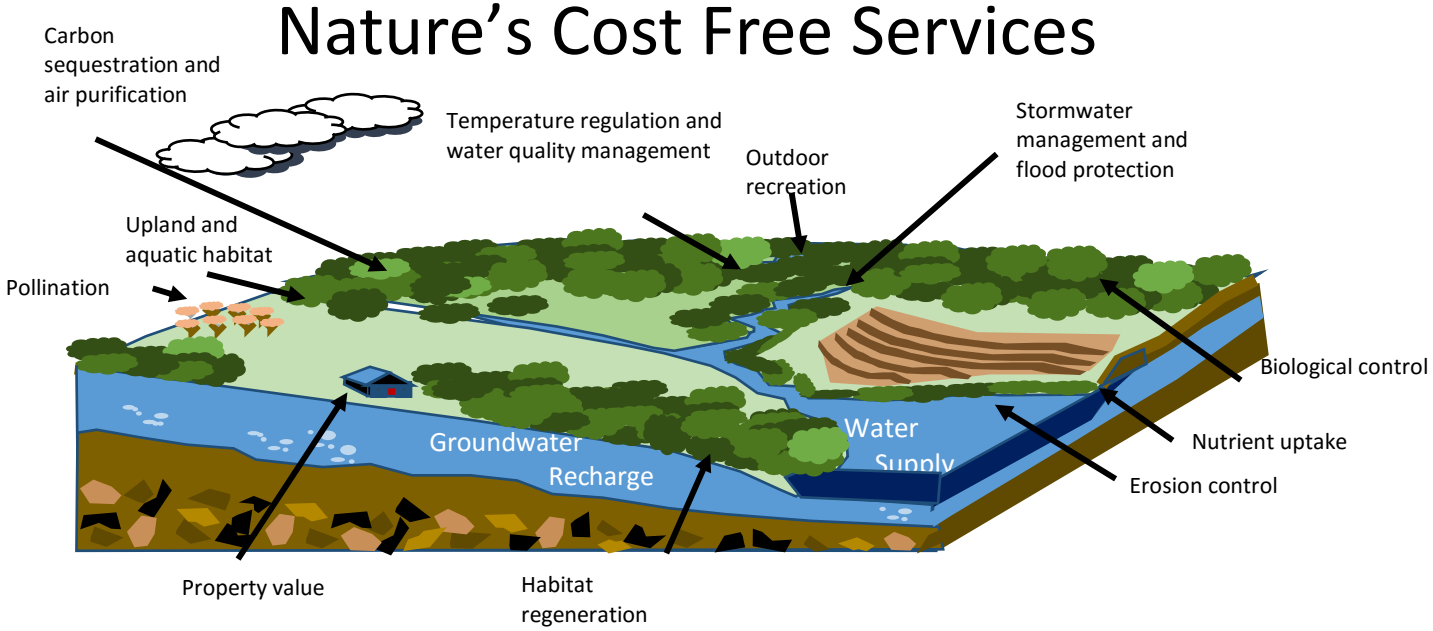
1. Money talks. Nature's complex system is conveyed in a simple, bottom line that is understandable to a broad audience.
2. Dollars, as a financial measure, underscore nature's connection to quality of life, health, cost of living, economy and sense of place. They also convey a level of significance or priority to allow for a better trade-off analysis.
3. Monetary estimates of the value of natural system services can be applied within decision frameworks related to land use, tourism, and economic development.
4. Discussion of natural system cover types, services and their value engages stakeholders in an educational process that can help organizations in their missions and raise awareness with policymakers and citizens.
5. Economic valuation of natural system services and biodiversity can make the value of protecting natural system services explicit to policymakers, investors and homeowners. As an example, Lehigh Valley's *2014* Return on Environment *Study* resulted in the addition of $2.2 million to Northampton County's 2015 open-space budget. [(4)]

The Process

This study was assisted by more than 40 people who attended five, 2.5 hour meetings over the course of six months. They provided, ideas, critical thinking, innovation and, in some cases, they provided data, all with across-the-board support. They came from a diverse group of people including interested citizens and those with experience in non-profits, government and business. The process followed a basic framework:

1. Identify and consider the free services that nature provides.
2. Develop economic processes to calculate the economic benefits of these services.
3. Establish the monetary value of natural system services to families, local communities and businesses.
4. Determine the monetary value of reduced health care costs due to forest canopy cover.

Nature's Cost Free Services



The Place

Dauphin County lies at the intersection of the Susquehanna River and the Kittatinny Ridge. It is the 19th fastest-growing county in Pennsylvania.

Dauphin County's current population is 272, 983. [5] As the 19th fastest-growing county in Pennsylvania, Dauphin County is expected to grow by 28,000 people by the year 2040. [6] Fortunately, Dauphin County still retains much of its natural character. The scenic views of the Susquehanna River form the western boundary of Dauphin County.

Natural Resources

The Kittatinny Ridge and Susquehanna River are natural resource treasures. The Kittatinny Ridges traverses the northern half of Dauphin County. Eighteen rivers and creeks flow through the county. Surface water supplies 90% of the area's water with 10% coming from groundwater. Even the most casual review of Dauphin County's growth and consequent loss of open space reveals the potential for additional environmental risk. Damage to natural systems is caused by forest fragmentation, loss of habitat, clearing of land near streams, introducing invasive species and over-grazing by deer.

According to Audubon Pennsylvania, over 40% of migrating birds are in conservation need. [7] This means more of the right habitats are needed. The goal is to maintain critical open space and natural systems while allowing for sustainable development.

As open space continues to be lost to development each year, what is left will need to provide more services in less available space. A hopscotch landscape pattern of small patches of open space will not provide for sustainable populations of wildlife and native plants. Dauphin County is in a position to sustain its economy,

quality of life and the health of its residents while maintaining a low cost of living. With less open space remaining, the size, quality, location and connectivity of open space will impact both quality of life and cost of living in Dauphin County.

Dauphin County's resources are many. [8]

- 161,000 acres of forest (45%)[9]
- 880 acres of forested wetlands
- 142 herbaceous wetlands
- Over 850 miles of streams
- Excellent groundwater quality
- Geographic diversity

Tourism

Hershey Park is ranked #2 in the top ten tourist attractions in the state, behind Independence Park and the Liberty Bell.

Dauphin County enjoys a thriving tourism and recreational economy based on its history of stewardship and protection. Its successes have been largely based on the lure of the natural environment. The county is host to a diversity of natural, historic and cultural resources.

Hershey Park is the second most popular tourist attraction in Pennsylvania and relies on high-quality water. [10]

http://www.planetware.com/tourist-attractions/pennsylvania-uspa.htm

Parks, Trails & Greenways [11]

Appalachian Trail

Clark Creek to Swatara Gap

Boyd Big Tree Preserve Conservation Area

Nature preserve

Joseph E. Ibberson Conservation Area

State Park

Wildwood Park

Dog-friendly nature preserve with trails

Shikellimy Trail

Primarily used for hiking

Stony Valley Rail Trail

17-mile moderately-trafficked loop trail

Victoria Trail

5.7 mile moderately-trafficked out and back trail

The county Parks and Recreation Department provides opportunities to learn about and enjoy the beauty of the area. The Dauphin County Park system includes: The Community Gardens, Fort Hunter Park, Fort Hunter Conservancy, Henninger Farm, Covered Bridge, Lykens Glen Park, Wiconisco Creek Park, and Woodland Park. [12]

The state's travel industry directly accounted for $14 billion (2.4%) of Pennsylvania's 2014 GDP.[48] The Dutch Country Road's region ranks second behind Philadelphia. In 2014, Dauphin County tourism spending totaled $2.315 billion. Tourism increased by 2% between 2013 and 2014. [13]

A tourist is anyone who travels more than 50 miles or stays overnight to enjoy their recreation activity. Everyone else is a day user, having fun as part of their local quality of life experience. The recreational element of tourism in Dauphin County is $544.1 million annually. This represents concerts, events and destinations like Hershey Park. Outdoor recreation activities are those in which residents generally travel less than 15 miles to enjoy interests that are part of their daily quality of life in Dauphin County. (*Table 2*)

***Table 2*. Tourism and Recreation Annual Spending in Dauphin County**

Tourism Spending	2014 Travel and Tourism Report	2016 Dauphin County ROE Report Page
Total Tourism Dollars Spent	$2.315 billion	
Recreation Tourism Spending	$544.1 million	
Non Tourism Expected Recreation Expenditures ROE		$359.4 million
Transportation	28%	
Recreation	19.6%	
Food and Beverage	21.1%	
Shopping/Retail	18%	
Lodging	13.1%	

A study, conducted by The Pennsylvania State University Department of Recreation, Park and Tourism Management analyzed the amount of revenue each state park within Pennsylvania receives annually from day users and overnight users. Three types of day users were identified in the study:

- *Local day users* (Pennsylvania residents who live within 50 miles of the park and make up 56% of visitation and 38% of total day spending); [14]

- *Non-local day users* are Pennsylvania residents who live more than 50 miles from the park and make up 28 % of visitation and 38% of total day spending;
- *Non-Pennsylvania resident day users* (who live more than 50 miles from the park and make up only 16% of visitation and 24% of total day spending).

Agricultural Lands

Agriculture remains a major part of the economy of Dauphin County. Dauphin County, while geographically diverse, contains many acres of productive farmland. This farmland has fertile soils, adequate water and favorable climate. These favorable agricultural features have shaped the agrarian history that has dominated the culture of Dauphin County.

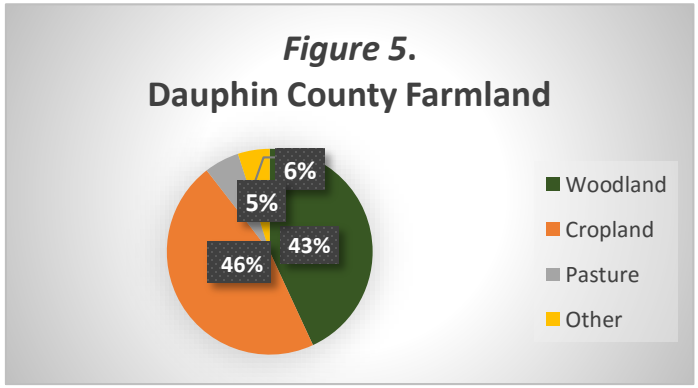
While the historical aspect of farming is valued by the county's residents, Dauphin County farming also remains a productive resource which contributes to the local economy, maintains groundwater recharge areas and provides open space valued by residents and tourists. Agriculture is also a major source of water pollution and a concern to the Chesapeake Bay Watershed Program.

As the county's prime agricultural soils become increasingly scarce, the importance of protecting the future value of farmland, as a food-producing resource for generations of Dauphin County citizens, is an issue. Most farmland in the county is located on relatively flat land, which presents few impediments to construction. This situation has led to even faster development in farmland areas because the diverse geography in the county limits development in areas of steep slopes.

Agricultural Lands[15]

The acreage numbers are based on aerial imagery assessment of land cover, not property lines. This is the most recent data (2014).

Number of farms	811
Acres in farms	129,378
Acres of Cropland	74,747.2
Acres of Pasture	4,550.48
Other	50
Crop sales	$28,705,000
Livestock sales	$93,884,000
Average annual farm revenue	$151,158
Certified organic farms [16]	36



Open Space Consumers

The 2015 estimated population for Dauphin County was 272, 983. [17] The population is expected to grow by 28,000 over the next 20 years. [18] In Dauphin County, 6.2% of residents are younger than five years old. 22.5% are younger than 18 years old and 15.6% are older than 65. While the ranks of the young and middle-aged may rise and fall over the next 25 years, the population of senior citizens, as a percentage of the total population, will steadily increase over the next 30 years.

Households

Dauphin County has 122,194 housing units, 109,027 households with approximately 2.41 persons in each. These are homeowners and renters who use Dauphin County's natural resources. [19]

Government

By having a more complete understanding of the financial value of open space, the 16 boroughs and 23 townships will be better equipped to set priorities and strike a balance between open space and other objectives. Government policies that favor greenery and outdoor opportunities will also benefit from better opportunities for economic development. [20]

Businesses

Together, Dauphin County's location and natural resources make the region very business-friendly. The quality and quantity of resources available to businesses are critical to business function.

The recreational opportunities available on open spaces benefit the region's workforce, translating into avoided medical and workers' compensation costs, as well as increased productivity.

The Kittatinny Ridge offers surface and ground water resources for businesses, ensuring clean, filtered water for both their products and their ability to meet water quality permit standards. Other businesses provide a wide range of outdoor recreation equipment and services. Several Dauphin County large employers lead the country in their "sustainability programs" and want their vendors and community partners to align with their social, environmental and economic goals.

Resource-Dependent Business

Any business that requires an National Pollution Discharge Elimination System (NPDES) permit to operate and relies on the quality of water upstream. For example, water is common to many business production processes.

Resource-Based Business

Any business that requires natural resources as part of their product delivery process. For example, water utilities, soft drink companies, breweries, pharmaceutical and technology production companies.

Recreation-Based Business

Any business that supplies equipment or services to participants in outdoor recreation. Bass Pro Shop, Dicks Sporting Goods, Pedal Pushers and Susquehanna Outfitters.

Green Business

Any business that uses a "sustainability" philosophy of People, Planet and Profit. Hershey Foods, IBM, Tyco Products, Pepsi Bottling are all large employers who believe that being environmental stewards is good for business. Hershey Foods was ranked 3rd in the United States for performance.

ENVIRONMENTAL SUSTAINABILITY

We value the limited natural resources on our planet, and work hard to use them responsibly and minimize our impact. Our widely-recognized environmental practices benefit not only today's generation, but also generations to come.
Hershey Foods Corporation

Top Performing Green Corporations Newsweek Magazine 2016 (21)			
Rank	**Newsweek Green Score**	**Company**	**GICS Sector**
1	88.1%	Hasbro, Inc.	Consumer Discretionary
2	81.9%	Nike, Inc.	Consumer Discretionary
3	80.7%	The Hershey Company	Consumer Staples
4	78.8%	NVIDIA Corporation	Information Technology
5	78.7%	Biogen, Inc.	Health Care
6	78.4%	Ecolab, Inc.	Materials
7	76.4%	Rockwell Automation Inc.	Industrials
8	76.4%	MetLife, Inc.	Financials
9	76.3%	Coca-Cola Enterprises, Inc	Consumer Staples
10	75.8%	Oracle Corporation	Information Technology

Naturally-Smart Business

Any business that harnesses several natural system services to help increase revenues or avoid costs. Capital Region Water utilizes natural system services to as a way to avoid additional water treatment costs and ensure user rates are invested back into the community's water system

Results and Findings

Nature is serious business. Nature's benefits are real, significant and impact a wide range of people.

Results of this study indicate that open space adds significant value to the regional economy, with benefits accruing to business, manufacturing, agriculture, governments and households.

Building on previous valuation studies and using standard economic analysis techniques, this study estimates the financial value of Dauphin County's open space by measuring the financial impacts across three areas: (1) avoided costs from natural system services and air pollution removal; (2) outdoor recreation revenues; (3) increased property value due to proximity to open space. Several additional findings were identified:

- Attitudes toward the environment are changing.
- The use of land is by far the greatest opportunity to make major financial changes.
- Expanding natural system services helps expand the local economy.
- Demand for outdoor recreation is increasing.
- Green companies and resource-dependent corporations are major employers and good neighbors.

Natural System Services

When considering the importance of Dauphin County's open space, it is essential to recognize the role that trees, fields, meadows and wetlands play in filtering water, cleaning air, controlling flooding and providing environmental services.

Open spaces are where the majority of natural systems function. The United States Environmental Protection Agency's (USEPA's) *Healthy Watersheds Program* noted that in some cases, decision makers realized that the environment created infrastructure solutions that were less expensive and more reliable than engineered solutions. [22] By relying on nature's ability to provide these valuable services, Dauphin County can avoid significant expense.

A good example of stewardship is protection of the DeHart Reservoir property. The water that supplies the Harrisburg and surrounding communities comes from a forested watershed that delivers pure, filtered water at a lower cost of treatment. It is also

a wonderful place to visit. The DeHart Reservoir is a good example of a win/win/win for resident quality of life, the environment and the economy. [23]

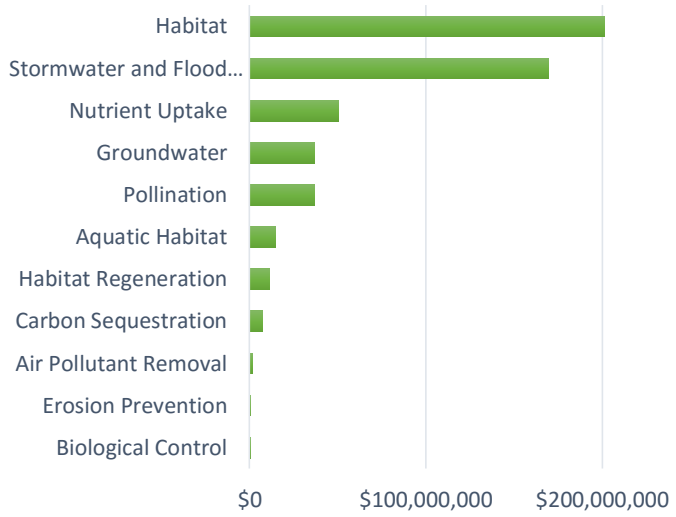
Key Findings

- Dauphin County's open spaces provide natural system services that support quality of life, cost of living, health and well-being at an estimated cost savings and economic benefit of $573.7 million annually. This represents the unnecessary cost of replacing vital ecosystem services currently provided by open space. *Figure 2* shows the breakdown of avoided natural system services costs.

- Preventing impairments to natural systems protects the services that they provide, which in turn, provides economic benefits to society and prevents expensive replacement and restoration costs.

- Maintaining connected habitats and corridors allows the full value of open space to be realized. These precious resources provide a more resilient environment during changing climatic conditions.
- A study of restoration in Pennsylvania state parks showed a $7-$20 return for every dollar invested in restoration. Similar results should occur in other open space projects.[24]

***Figure 2*. Dauphin COunty Annual Natural System Service Values**



Air Pollution Removal

Dauphin County faces substantial air quality issues due to its location, topography and growth. Dauphin County recently received its first ever passing grade—a "D"—for its reduced level of ozone smog pollution. Worsening pollution levels in the Harrisburg-York-

Lebanon metropolitan area are counter to the trend in eastern states, for less frequent days of unhealthy air, according to the American Lung Association. *2016 State of the Air Report*. The average annual number of unhealthy days due to high ozone (smog) in the region is 64. Much of the area's problems are attributed to its high concentration of trucking businesses, the presence of Interstate 81, the Pennsylvania Turnpike and the consistent traffic they bring. [25] This emphasizes the importance of maintaining natural system services.

Dauphin County's forests help reduce health problems by removing signification amounts of air pollution and consequently, improving environmental quality and human health. In particular, trees remove substantial amounts of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter (PM_{10}). Trees also remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. Trees also remove pollution by intercepting airborne particles. [26]

Trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide [CO_2]) in new biomass each year. As trees grow, they store more carbon by holding it in their accumulated tissue. As trees die and decay, they release much of the stored carbon into the atmosphere. Carbon storage is an estimate of the total amount of carbon that is currently stored in the above and below-ground biomass of the forest, while carbon sequestration is a measure of how much new carbon dioxide is taken up by the forest each year through new growth. Carbon storage is another way that trees can influence carbon change.

Using the i-Tree Landscape Model developed by the U.S. Forest Service, the following estimates were determined for Dauphin County. [27]

Tree covered urban areas have 24-29% lower incidence of childhood asthma. [28]

Over a year, one acre of forest can consume the amount of C02 created by one car driving 26,000 miles. [29]

Key Results for Dauphin County

- The total annual health benefit from trees is $9,070,141.
- The total annual avoided healthcare costs caused by air pollutants is $1,833,807.
- The total annual avoided costs caused by carbon sequestration is $7,236,334.
- If the carbon currently stored in trees on open space in Dauphin County were released into the air, carbon emission mitigation costs would be $1.1 billion.
- Currently, tree-covered open space in the county stores 7,189,897 tons of carbon over the life of the trees. Tree photosynthesis adds 190,430 tons of carbon sequestration annually.

Outdoor Recreation

Open space generates value by providing opportunities for people to engage in recreation and exercise for free or at below-market rates. According to data in *Table 1,* $128.4–$359.4 million is spent on outdoor recreation each year in Dauphin County. As a result, 1,223–3,440 jobs have been created, both within and outside Dauphin County and $5.8–$16.4 million has been generated in state and local taxes.

Key Findings

Every year, 75% of Pennsylvania residents enjoy some form of outdoor recreation. [30]

- Participation is greatest for walking, wildlife watching, hiking and bicycling.
- Overall outdoor recreation spending is greatest in hiking, hunting, bicycling and jogging/running and wildlife watching.
- Wildlife photography and bird and wildlife watching are growing in popularity. [31]

***Table 1*. Dauphin County Expected Outdoor Recreation Economic Contribution**

Outdoor Activity	Lowest Possible Spending	Expected Spending
Walking	$18,814,687	$20,155,101
Fishing	$15,195,200	$26,141,553
Hunting	$16,629,101	$52,171,256
Birding/Bird Watching	$5,634,709	$34,935,196
Wildlife Watching	$14,348,128	$37,980,337
Camping	$11,855,146	$21,734,435
Kayaking/Canoeing	$3,551,506	$21,985,510
Bicycling	$24,131,401	$42,671,379
Hiking	$9,241,350	$60,299,808
Jogging/Running	$8,409,628	$38,615,641
Nature Study	$604,233	$2,719,047
Total	$128,415,088	$359,409,263

- Hunting and fishing are still popular, with more women and younger adults participating. [32]
- Physically-active people are typically healthier and have a lower incidence of cardiovascular diseases, diabetes, depression, certain cancers and obesity.
- DCNR's *2014 Outdoor Recreation Participation Survey* of Pennsylvania residents found that 30 percent of residents

participate in moderate to strenuous activity that takes place on protected open space. [33]

- The outdoor recreation economy grew approximately 5% annually in the U.S. between 2005 and 2011, even during an economic recession. [34]
- 31% of Pennsylvanians surveyed by DCNR in 2014 plan to spend more time outdoors. [35] About half of the baby boomers expect to increase their outdoor activity, compared to 25% of their older counterparts. Given the aging population of Dauphin County, outdoor activities are expected to increase. [36]
- Young professionals and baby boomers want to spend more time outdoors. [37]
- Employees who live healthy lifestyles are more productive and innovative and miss less work. [38]
- Open space provides contact with nature, which provides health benefits and enhances well-being. [39]
- Open space encourages exercise and opportunities for physical activity which has been shown to increase fitness and reduce obesity and other health care costs. [40]
- Consistent exercise (30 minutes, 3 days a week) saves $1,800 a year in healthcare costs for adults. [41]

Property Value

Whether it's a trail, park, scenic area or waterfront, people will pay a premium to be near open space.

As a result, Dauphin County's existing open space adds to the overall value of its housing stock. This increased wealth is captured by citizens through higher sale values of homes near open space and increased government revenues via larger property tax collections and transfer taxes at time of sale.

Key Findings for Dauphin County

- 152,124 acres of protected open space. 72% of the protected open space is in North County, 37% in South County and 3% is in Harrisburg.
- The total real estate premium attributed to living within ¼ mile of protected open space for single family homes is between $39.7 to $50.5 million.
- According to property value data provided by the Tri-County Planning Commission, there are 5,840 single family homes located within a ¼ mile of protected open space.
- The average assessed property value for a single-family home is $146,200—ranging from $130,500 in North County to $160,300 in South County.

Attitudes toward the environment are changing.

Attitudes toward the environment are changing and the trends are not always friendly to Dauphin County. Over the past thirty years, national polls conducted by Gallup, Inc. have shown a changing attitude toward the environment over economic development. For 23 years, there was a clear preference for the environment; however, since 2008, opinions have wavered, with economic development now favored, particularly by people over age 65. [42] Attitudes can change once policy makers and residents understand that they are part of the problem and need to practice good stewardship to ensure their quality of life and local economy. A research study of 26 communities and 43,000 people in the United States undertaken during the 2008 recession, points out that our sense of place and quality of life are tied to scenic beauty and opportunities to enjoy outdoor activities.

The Knight Foundation's *Soul of the Community Study* showed that aesthetics and greenery are fundamental to why we form an emotional attachment with our community. Remarkably, the study also showed that the communities with high levels of attachment had the highest domestic product growth. Many communities in the study that did not rank these attributes "high," are now rethinking their economic development strategy. Studies such as this, link the value of the environment to economic growth, underscoring how important decisions are related to the use of land. [43]

The use of land is by far the greatest opportunity to make major financial changes.

Stormwater, flooding, air pollution, and forest fragmentation are some of the drivers of natural system service loss and disruption. Many problems have existed for years like sprawl, floodplain development and large lawns. Many still continue. The greatest financial leverage on open space and sustainable environmental and economic health is how land is used. Land use decisions are by far the greatest opportunity to make major financial changes. [44]

Traditional development requires intensive and costly additions of gray infrastructure to connect new neighborhood road and utility networks. In a review of 98 communities across 21 states, researchers found that, for every dollar received from residential development revenues, an average of $1.16 was spent to provide services to the new community. Conservation design provides economic benefits to communities because it consumes less land and requires fewer roads, resources and utility infrastructure. Additionally, studies have shown that people are willing to pay a premium to live in conservation developments, which provide greater revenues to local communities. [45]

Expanding natural system services helps expand the economy.

Creating connected patterns of open space is needed to maximize nature's ecological and financial value. An ecosystem is made up of plants and animals and the environment in which they live, including soil, air, water, sunlight, temperature, minerals and

nutrients. These conditions determine what native plants and animals will survive and flourish. Native plants are the foundation for all life and control the local biological diversity.

Native plants help drive natural system services like photosynthesis, pest control, pollination, erosion control, soil formation, water purification and the generation of oxygen and clean air. Biological diversity creates top soil out of rock and helps buffer extreme weather events such as drought and floods. Biological diversity recycles nutrients, carbon, chemicals and the mountains of garbage that we create every day. Biological diversity even maintains the base flow, width, water quality and temperature in streams. And now, with human-induced climate change threatening the planet, it is native plants and biological diversity that will help suck the carbon out of the air and sequester it in living plants. Native plants have 29 times the biological diversity as non-native plants. (46)

The two major causes of loss of biological diversity are forest fragmentation and non-native, invasive plants. Habitat size, shape and topography all play a role in sustaining biological diversity. (47) The large forests of the state, local parks and the Kittatinny Ridge, as well as the stream corridors that connect them, allow nature to regenerate and sustain itself, free of charge.

The best ways to sustain and expand natural system services and the cost-free financial benefits they provide is to create connected patterns of open space and plant native plants in areas surrounding parks, stream buffers, preserves and trails.

Practicing good stewardship and incorporating native vegetation into the landscapes of adjacent properties will help expand the financial and environmental benefits of nature and a township's bottom line.

Demand for outdoor recreation is increasing.

The trend for current residents is to spend more time outdoors and this will continue with future growth. 31% of Pennsylvanians surveyed during the DCNR's *2014 Outdoor Recreation Participation Survey of Pennsylvania* said they planned to spend more time outdoors. (48) That equates to 200,000 Dauphin County residents. It is estimated that the population of Dauphin County will increase by 28,000 people by the year 2040. (49) About half of the region's baby boomers plan to increase their outdoor activity, compared to 25% of their older counterparts. Given the aging population of Dauphin County, outdoor activities are expected to grow. (50) Millennials and young professionals also seek healthy and adventuresome lifestyles. (51)

Green companies and resource-dependent corporations are major employers and good neighbors.

Green companies are major employers and good neighbors. (52) What do Hershey Foods, IBM, Pepsi Bottling Company and TYCO all have in common? They all want to be the "greenest" provider in their respective market sector for two reasons:

- Being "green" increasingly follows the trends of their customers' values.
- It saves money. Even during the recession, "going green" programs increased rather than decreased. (53)

These sustainable companies use the 3Ps—"People, Planet and Profit. Sustainability programs use an accounting framework that incorporates three dimensions of performance: social, environmental and financial. This differs from traditional reporting frameworks, as it includes ecological (or environmental) and social measures that can be difficult to assign an appropriate means of measurement. (54)

- Every company with a discharge permit is dependent on clean water.
- At least 5 of the top 50 major employers in Dauphin County have sustainability programs. (55)
- Pure, naturally-filtered water is critical to bottling, pharmaceutical and technology companies in their business processes.
- Green companies care about communities that share their environmental goals.

Economic Value Analysis

Natural System Services are human life-support systems. Determining what people have been willing to pay to replace nature's cost-free services is one way to promote more informed decision-making and conservation.

The economic value of Dauphin County's open spaces was estimated by measuring impact in four areas:

1. The avoided costs associated with natural system services provided by Dauphin County's open spaces.
2. The avoided costs associated with air pollution removal.
3. The value of open space related to recreational activity (e.g., sale of goods and services).
4. The impact of open space on property value. (e.g., higher property values and earnings from open space-related activities).

While the most obvious natural system services include food, drinking water and plants, there are also many less-visible natural system services, such as climate regulation and the natural flood defense provided by forests. Over time, billions of tons of carbon are stored in Dauphin County forests. Forests and meadows also support natural pollination and biological control of insects and rodents.

In Dauphin County's Return on the Environment Study (ROE), conservative approaches were used to estimate monetary values. For example, only major recreational activities were included and not all natural system services. Even with this conservative approach, the analysis is subject to caveats common to any economic valuation or impact analysis. These caveats include substitution effects, double counting and value transfer.

Substitution effects are important when considering the benefits that residents enjoy by recreating and exercising in local public parks as opposed to a private facility. If all open space were developed, it is unlikely that residents would discontinue the recreational activities they now enjoy, but would rather go elsewhere. Because of this, estimates of recreational value in this study should only be understood to represent the benefit that existing open space in the county provides.

Double counting occurs when a value is overstated because it has been derived from two separate analyses. While this study aimed to minimize any double counting, it is likely that some double counting exists in property valuation.

Natural System Service Benefits

Natural system services represent the benefits that human populations derive, directly or indirectly, from ecosystem functions. Because natural system services are not fully captured in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often overlooked or undervalued in policy debates and investment decisions.

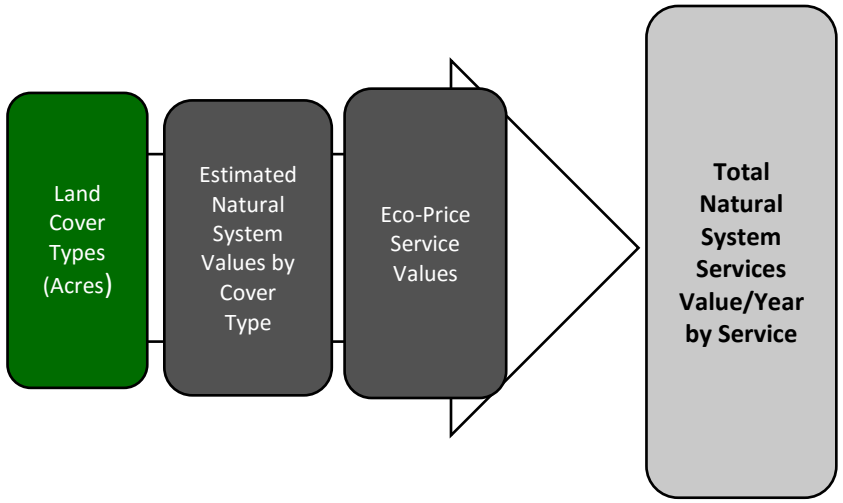
This component of the study estimated the avoided costs associated with nine natural system services in Dauphin County's open space—groundwater, stormwater and flood mitigation, wildlife habitat, aquatic habitat, erosion prevention, habitat regeneration, pollination, biological control and nutrient uptake. These represent natural system services that, if lost, would require costly intervention to replicate, at tax payer expense. The method used in this analysis is called Value Transfer (VT).

Value Transfer (VT) involves the adaptation of existing valuation or data from one location to a similar location. It is used as an alternative strategy when primary research is not possible or justified because of limited time or budget constraints. While VT is an alternative strategy, it is better than discounting natural system services and implying that their value is zero.

Value transfer is an important tool for policymakers, since it uses existing research to reliably estimate landscape natural system service value for considerably less time and expense than a new primary study.

(*Figure 6*). VT information for this report was obtained from the 2011 satellite-derived land cover data from the Multi-Resolution Land Characteristics (MRLC) Consortium. [56]

***Figure 6*. Value Transfer Model for Natural System Services**



Since most services are natural functions, markets for these services do not exist. When there are no explicit markets for the services, more indirect means of assessing values must be utilized. The techniques are defined as follows:

Avoided Cost (AC): Helps society avoid costs that would have been incurred in the absence of those services. An example is flood control provided by intact riparian buffers helping to avoid property damage downstream.

Replacement Cost (RC): Costs to replace services with man-made systems. For example, the waste assimilation service provided by wetlands could be replaced with chemical or mechanical alternatives (such as wastewater treatment plants). The replacement cost would be the estimated costs of replacing the natural waste assimilation service with chemical or mechanical alternatives.

Contingent Valuation (CV): Survey-based economic technique for the valuation of non-market resources, such as environmental preservation or the impact of contamination.

Direct Market Valuation (DM): Obtaining values for the provision of services.

Direct Investment in a resource(DI): Investment in water supply facilities or the protection of land.

Market Valuation (MV): The amount of money paid to purchase credits in a trading market. Examples would include the price of a carbon credit for air quality or the purchase of a nutrient credit for water quality. Another example would include the purchase of potable water.

Cost of Regulation (CR): Fines and procedures.

Cost of Damage (CD): Estimate of monetized damages associated with the release of carbon or other pollutants.

Travel Cost (TC): Cost of travel and its reflection on the implied value of a service.

Tax Benefits (TB): Adjustment benefiting a taxpayer's tax liability.

Eco-Pricing

The value of nature's services and biodiversity is a reflection of what price we, as a society, are willing to pay to conserve these natural resources. There is a difference between price and intrinsic value. Eco-pricing relies on data that reflect a price people are willing to pay to maintain or restore services and does not estimate intrinsic value. [57]

The eco-price method used in ROE studies, collates instances where society has paid for an increase in ecosystem services, avoided their loss or restored damages to those services. For example, many restoration practices are focused on reducing the amount of nitrogen entering waterways. The cost of paying for this can be expressed in terms of $/pound of nitrogen removed. Different natural systems, such as wetlands, forests, riparian covers, etc. remove nitrogen at different rates on an annual basis. Using eco-prices, an annual benefit can be calculated for each natural system.

Campbell (2016) compiled and summarized over 55 academic studies comprising 210 individual value estimates for the types of ecosystems present in the state of Maryland. [58] Costanza reviewed over 100 peer-reviewed articles in a similar study in New Jersey. [59] Due to the similarity of the climate, land cover and ecosystems of Maryland and New Jersey to our study area, we relied on these data.

Table 3 contains 77 exchanges of money for some form of ecological work, the replacement of ecological work or cost of damages to an ecosystem service (i.e., eco-prices), divided into nine categories (water, nutrient uptake, soil erosion, pollination, stormwater and flooding, habitat and habitat regeneration, aquatic resources, groundwater and biological control) and eight economic classifications (investment, replacement cost, avoidance cost, market price, cost of regulation, cost of damages, taxes incurred, and tax benefit). *Table 4* contains the criteria (eco-prices) used and their primary source.

Table 3.

Studies Reviewed by Campbell, Rogers and Costanza (2006)

Natural System Service	Number of Studies	Valuation Methods
Water Supply	5	AC (2), CV (12), HP (1), RC (1), TC (5), VT (2)
Nutrient Uptake	14	VT (3)
Stormwater and Flood Mitigation	27	AC (3), VT (2)
Aquatic Resources	3	VT
Habitat	12	CV (11), VT (1)
Habitat Regeneration	4	RC (4)
Erosion Prevention	4	DM (1), VT (2)
Pollination	5	AC (1), DM (1), RC (1), VT (1)
Biological Control	3	VT (3)

Abbreviations in *Table 3* refer to economic methods described above. Numbers in parenthesis show number of references for

Table 4.

Summary of Natural System Service Values Per Acre By Cover Type

Natural System Services	Eco-Price	Primary Source
Carbon	$38	*U.S. Forest Service i-Tree Landscape Model*
Air Pollutants	$7-$122	*U.S. Forest Service i-Tree Landscape Model*
Ground Water	$110-$409	*NYC, 2016, PA Water Plan, 2009 Campbell 2016*
Nutrient Uptake	$76-$1,128	*World Resources Institute, 2011 PA. Nutrient Trading Program Campbell, 2016*
Stormwater Mitigation	$697-$1,803	*King and Hagan, 2012 PADEP, Stormwater Management, 2009*
Erosion Prevention	$4-$15	*USDA, NCRS, 2014 USEPA*
Wildlife Habitat (Biological diversity)	$400-$1,111	*Campbell, 2016 Ducks Unlimited, 2012 Conservation Fund, 2014 The Baybank, 2012*
Habitat Regeneration	$66-$350	*Natural Conservation Resource Service, PA DEP RELEAF*
Pollination	$7-$184	*Georgia Forest Service, 2011 New Jersey Department of Natural Resources, 2007*
Biological Control	$2-$12	*New Jersey Department of Natural Resources, 2007*
Aquatic Resource	$275.4-$755.32	*PA Fish and Boat Commission, 2016*

that natural system service. As part of the effort to document eco-prices relevant to Dauphin County, several state agencies provided information.

- Pennsylvania Department of Conservation and Natural Resources-Forestry Division
- Pennsylvania Fish and Boat Commission
- Pennsylvania Game Commission
- Maryland Department of Natural Resources

The total natural system service value of a given type of preserved and undeveloped open space was determined by aggregating the individual natural system service values associated with each land-cover type.

Natural System Service Benefit Categories

Water Supply and Groundwater

Pennsylvania cover types (e.g., forests and wetlands) and their underlying soils help ensure that rainwater is stored and released gradually to streams and rivers, rather than immediately flowing downstream as runoff. As Dauphin County grows, the value of infiltration and quality water to residents will continue to be very high. The sources for this eco-price were investment in water supply and the market price of municipal water supply in Maryland and Pennsylvania. [60] [61] [62]

Nutrient Uptake

Forests and wetlands provide a natural protective buffer between human activities and water supplies, helping to filter out pathogens, excess nutrients, metals and sediments. Waste assimilation benefits were derived by the amount of forest, wetland and riparian buffer cover. [63]

The nutrient category included fourteen eco-prices. Eleven are prices per pound of nutrient removed. [64] These were averaged, with the cost of implementing Best Management Practices (BMP) cost share and cost of nutrient removal retrofits on water treatment facilities. [65] Also included in this category is the price of nitrogen in the PA nutrient trading market. [66]

Stormwater and Flood Mitigation

Many natural landscapes provide a buffering function that protects humans from destructive activities. Forests, wetlands, riparian buffers and floodplains mitigate the effects of floods by slowing, trapping and containing stormwater. The stormwater and flood mitigation category consists of 27 eco-prices, 24 of which are stormwater best management practices that were averaged together. [67] [68]

Biological Control

Native birds and insects dynamically regulate and control invasive and unwanted species, such as pests, weeds and disease vectors (e.g., mosquitoes). This eco-price is based on a valuation study. [69]

Wildlife Habitat

Contiguous patches of land cover with sufficient area allow naturally-functioning ecosystems and support a diversity of sustainable plant and animal life. Intact forests and wetlands

function as critical population sources for plant and animal species that humans value for both aesthetic value and functional reasons. Native vegetation supports 29 times more biological diversity than non-native plants. (70)

The eco-price associated with biodiversity and wildlife habitat was assumed to be investments made to preserve natural lands or habitats and the tax benefit gained by doing so. The habitat category includes five instances of investments in wildlife habitat and the calculated average yearly tax benefit of donating land for conservation. The yearly value per acre is estimated to be this tax benefit plus the average annualized value of the conserved land. (71) (72) (73) (74) (75) (76) (77)

Habitat Regeneration

Natural habitats regenerate. Forests and wetland habitat regeneration is the act of renewing habitat cover by naturally establishing young plants promptly after the previous habitat has been altered. This eco-price is based on two valuation studies. (78) (79)

Aquatic Habitat

The Pennsylvania Fish and Boat Commission (PFBC) has created a wild trout designation and biomass classification system. PFBC also secures fines from activities that kill fish. Fines vary by species and size of fish. Based on the average size and fine for different stream classifications, an eco-price was developed for each exceptional value and high quality stream classification. (80) (81) (82)

Pollination

Pollination is essential for native vegetation and many agricultural crops and substitutes for local pollinators are increasingly expensive. Pennsylvania has been experiencing a severe "bee colony collapse." Forests and meadows provide pollination service benefits, which are a form of insurance for farmers and nature in the event that bee collapse continues to be an issue. This eco-price is based upon a valuation study (83)

Soil Retention

Soils provide many of the services mentioned above, including water storage/filtration, waste assimilation and a medium for plant growth. Natural systems create and enrich soil through weathering and decomposition and retain soil by preventing it from being washed away. Four eco-prices are included in the soils category: two are costs of erosion and two are costs associated with preventing erosion. (84) (85 (86) (87)

Natural System Land Cover Types

Forests

Large regenerating forests are forests over 500 acres that support sustainable wildlife populations. The eco-prices that distinguish this category are the quality of habitat, regenerating forests and sustainable populations of wildlife. (88) (89)

Working regenerating forests are actively harvested forests that occur on state lands. They can be small or large, with the average working forest being 200 acres. These forests generally regenerate but have less habitat quality than larger, undisturbed forests. (90)

Forests under 100 acres. The size of these forests allows light to penetrate from all sides and this promotes invasive species of plants. This retards natural regeneration. The services provided by these forests are only useful as long as the forest exists. (91)

Riparian forests (100 feet on either side of a stream). Riparian forests help stabilize banks and due to the presence of water, attract a wider biological diversity than upland forests. Some studies estimate the biological diversity to be double. (92) (93)

Urban forests. Urban forests can be any size. Except in rare instances where the urban forest is large and connected, such as Fairmont Park in Philadelphia, urban forests do not regenerate. The carbon and greenhouse gas value of these forests is significantly greater than other forests. These forests also help in stormwater management, but provide very little groundwater recharge. (94)

Floodplain forests. Floodplain forests are within the 100-year floodplain boundary. (95)

Wetlands

Headwater forests and wetlands (100 feet on either side of the stream). These, classified as first order streams, are designated as having exceptional value and high quality. Headwaters often make up 50-70% of a watershed. (96) The streams have some of the cleanest water in Pennsylvania. The water provides an excellent habitat for native trout and other aquatic organisms. (97)

Forested wetlands. Riparian forests and forested wetlands have high biological diversity, as most wildlife needs water for survival. (98)

Rural Wetlands. Rural wetlands provide many benefits. What distinguishes them is their location. They provide good biological diversity. Their benefits impact a smaller number of people, yet downstream human populations all benefit from their existence. (99)

Urban wetlands. These wetlands impact urban populations. They have a limited role in groundwater recharge, as they are usually located at the base of streams. (100)

Land Uses

Cultivated fields. Cultivated fields can change vegetation from year to year; however, they do serve a value for many species of birds and other wildlife. They also help to support pollinator species and biological control. (101) Cultivated fields can also be a source of sediment, pesticides and fertilizers that pollute water bodies and streams.

Pastures. Pastureland can be a source of pollution. Because the soils are compacted, they provide only a small value in runoff control. They do support pollinator species and biological control.(102) Most state endangered bird species are associated with pastures and wetlands.(103)

Open water. Open water is great for recreation and provides groundwater recharge. Birds and other wildlife use water as part of their regular habitat, as well as during migration. (104)

Developed open space (parks and preserves with less than 30% impervious cover). Urban open space and street trees provide many benefits including air quality, energy conservation, cooling and pavement protection. They also can provide habitat for many species, as long as a larger habitat is within a half mile. (105)

Developed landscapes (urban areas with greater than 30% impervious cover). These areas often create more problems than benefits for natural systems. (106)

***Figure 7*. Natural System Service Financial Value by Cover Type**

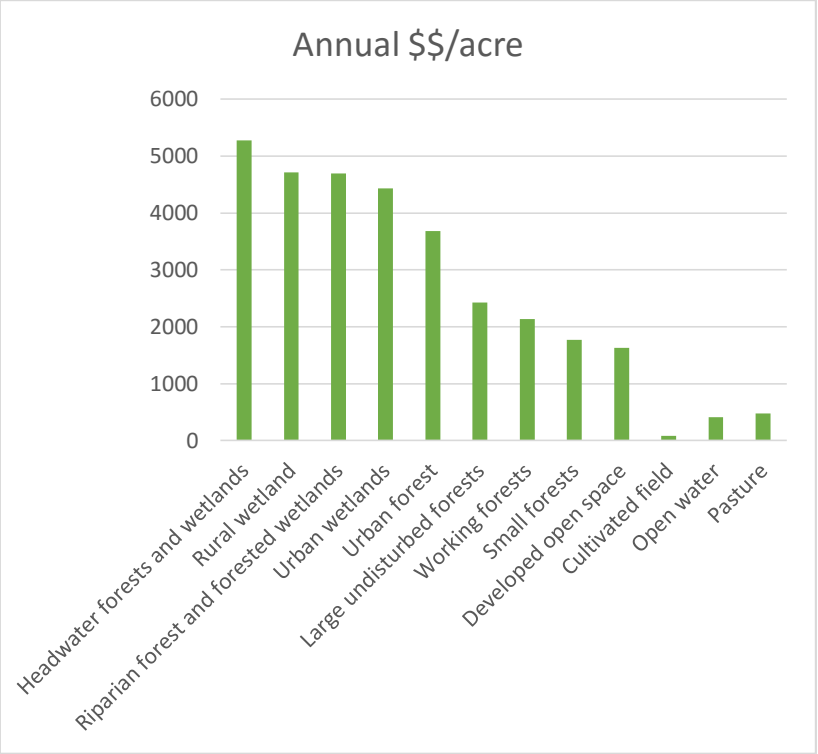


***Table 5*. Natural System Services Provided by Different Land-Cover Types**

Land Cover Types Associated with Natural System Services	Natural System Services
Large Undisturbed Forests	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Habitat Regeneration, Biological Control
Working Forests	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Small Forests	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Biological Control
Riparian Forests and Forested Wetlands	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Urban Forests	Stormwater and Flood Mitigation, Nutrient Uptake, Soil Erosion Prevention, Pollination, Biological Control
Floodplain Forests	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Headwater Forests and Wetlands	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Rural Wetlands	Stormwater and Flood Mitigation, Nutrient Uptake, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Urban Wetlands	Stormwater and Flood Mitigation, Nutrient Uptake, Soil Erosion Prevention, Pollination, Aquatic Habitat, Habitat Regeneration, Biological Control
Cultivated Fields	Soil Erosion Prevention, Pollination, Biological Control
Pastures	Biological Control
Open water	Groundwater
Developed Open Space	Stormwater and Flood Mitigation, Nutrient Uptake, Groundwater, Soil Erosion Prevention, Pollination, Biological Control

According to the data shown in *Table 6*, the natural system services of Dauphin County currently generate a benefit of $573,669,718 million per year.

Table 6. **Dauphin County Ecosystem Service Benefits Calculated Using the Minimum, Mean and Maximum Values**

Natural System Services	$ Millions/year
Habitat and Wildlife Conservation	$209,594,112
Stormwater and Flood Protection	$195,374,817
Nutrient Uptake	$53,230,080
Groundwater	$39,045,239
Pollination	$36,509,696
Aquatic Habitat	$19,598,356
Habitat Regeneration	$17,476,330
Biological Control	$1,510.144
Erosion Prevention	$1,330,944
Total	**$573,669,718**

Capital Region Water: Case Study

Capital Region Water is the steward for drinking water, wastewater and stormwater services for the City of Harrisburg and portions of surrounding municipalities. As a special-purpose unit of local government, Capital Region Water improves, maintains and operates the greater Harrisburg area's water system and infrastructure — from raindrop to river. This journey begins with the DeHart Reservoir, the primary drinking water source for Capital Region Water. The 22 square mile watershed, located northeast of the City of Harrisburg, is lightly populated with the primary surrounding land use being forest and wetlands.

Source water protection and sustainable watershed management enable Capital Region Water to realize a Return on Environment. Although Capital Region Water does not own this entire area, much of it is publicly owned and managed. Capital Region Water wants to ensure the 8,200 acres they own and manage in Clarks Valley are also well-protected. Through a partnership with nearby Fort Indiantown Gap (FTIG), Ward Burton Wildlife Foundation and The Nature Conservancy, Capital Region Water is committed to protecting the property with a permanent conservation easement. This conservation easement will protect the property's natural, scenic, forested and open space condition, thereby, protecting water quality, regional conservation significance and the military mission of FTIG.

Capital Region Water has further committed to sustainably manage the forest under a Forest Stewardship Council forest management plan. Responsible forest management will allow Capital Region Water to realize revenues from timber and pulpwood harvests in a manner that does not compromise water quality or ecosystem health. An early evaluation is also underway to assess qualification in generating and selling voluntary carbon offsets or credits through

an improved forest management plan. Such sources of non-rate revenue allow for further investment back into the water systems while ensuring natural system services like stormwater control, nutrient uptake and habitat availability.

Capital Region Water customers should be proud of their water. Harrisburg is fortunate to have such a pristine drinking water source that, in combination with a skilled drinking water treatment staff, won Pennsylvania's Best Tasting Water in the 2016 taste test organized by the PA Section of the American Water Works Association (PA-AWWA). [107]

An EPA study of drinking water source protection efforts concluded that for every $1 spent on source water protection, an average of $27 was saved in water treatment costs.
U.S. EPA Healthy Watersheds Program, 2012

Air Quality Benefits

The forests of Dauphin County reduce air pollution and related health problems. The American Lung Association (ALA) *State of the Air Report 2016* measured air quality for cities across the nation from 2012 to 2014. [108] The six-county area around Harrisburg, is ranked as the 6th worst for year-round fine particle pollution in the country – an improvement of three spots from 2015 and 21 spots from 2014. The metropolitan area includes Dauphin, Cumberland, York, Perry, Lebanon and Adams Counties.

The American Lung Association report focused on pollution from particles and ozone. Particle pollution, also known as soot, involves microscopic particles from cars and trucks, coal-fired power plants, construction sites and tilled fields. Ozone pollution, known as smog, comes from sources such as vehicle and industrial emissions and evaporating gasoline that react with sunlight and heat. It can cause shortness of breath, wheezing, coughing, asthma attacks and respiratory infections. Particle pollutants are the solid and liquid particles suspended in the air. They can increase the risk of heart disease, lung cancer and asthma attacks and can also interfere with the growth and work of the lungs, according to the report.

Dauphin County recently received its first-ever passing grade — a "D" — for its reduced level of smog pollution. Dauphin County received an "F" for 24-hour fine particulate matter and is ranked as the 9th worst area for fine particulate matter pollution of 171 metro areas in the country.

The American Lung Association reported that the air in the metro area is particularly bad for two reasons. The first is the amount of activity of commuters and industries that release pollution into the air. The second reason is due to the area's location near other pollution sources. Winds bring pollution from Baltimore and Washington, D.C. Winds also bring pollution from fossil-fuel burning power plants in surrounding jurisdictions. [109]

The American Lung Association noted, in a prepared release, that "while the metropolitan area has improved over the past 16 years, there is still a lot of work to do to make the air cleaner. Reducing pollution will only become more challenging because warmer temperatures increase the risk for ozone and particle pollution and make cleaning up the air harder in the future." [110]

Air pollution can also damage buildings and plants, disrupt many natural system services and can cause reduced visibility. Trees remove significant amounts of air pollution, consequently improving environmental quality and human health. Specifically, they remove nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter (PM_{10}) from the atmosphere. [111]

***Table 7*. Dauphin County Polluant Removal from Trees (total tons/year)** [111]

Pollutant	Tons/Year
O_3	6,579,352
PM_{10}	1,412,792
NO_2	1,000,697
SO_2	463,483
CO	80,058
Total	9,536,382

***Table 8*. Carbon Storage and Sequestration Rates in Dauphin County (tons/acre of tree canopy)** [112]

	i-Tree Landscape
Pollutant	Expected
Carbon Sequestration	190,430
Carbon Storage	7,189,896

Methodology

Total pollutant removal values for each pollutant varies depending on the amount of tree canopy cover; increased tree cover leads to greater total removal and greater pollutant removal values. The i-Tree Landscape Model (*Figure 8*) [113] developed by the USDA Forest Service, was used to estimate the air pollution removal and carbon sequestration and storage rates of Dauphin County's tree cover. The model uses National Land Cover Datasets (NLCD) to estimate the amount of tree canopy and then uses pollution removal rates to estimate the total amount of pollutant removal.

i-Tree Landscape analyzes tree canopy, land cover and basic demographic information by specific locations. With the information provided by i-Tree Landscape, levels and financial value are calculated.

By removing carbon dioxide, trees help mitigate climate change. The shade provided by urban tree canopies can also help minimize

the warmer urban conditions due to human activities (urban heat-island effect).

As trees die and decay, they release much of the stored carbon into the atmosphere. Carbon storage is an estimate of the total amount of carbon that is currently stored in the above and below-ground biomass of the forest. [114]

***Figure 8*. i-Tree Landscape Model Process**[115]

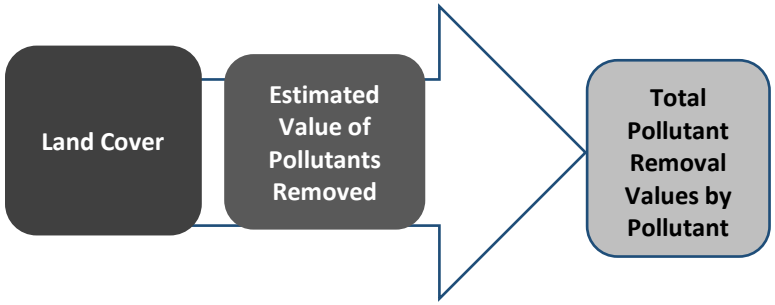


***Table 9.* Dauphin County Air Pollution Removal Benefit Values ($/year)**[116]

Pollutant	$/year
O_3	$558,279
$PM_{2.5}$	$1,180,151
PM_{10}	$80,631
NO_2	$12,242
SO_2	$1,532
CO	$972.00
Total	$1,833,807

Table 9 includes the annual pollution benefit value for Dauphin County.

Table 10 includes the total tons of carbon storage and sequestration.

***Table 10*. Dauphin County Carbon Storage and Sequestration (total tons)** [117]

	i-Tree Landscape
Pollutant	Expected
Carbon Sequestration (tons/year)	190,430
Carbon Storage (total tons)	7,189,896

Table 11 includes the expected values of pollutant removal benefits.

***Table 11*. Dauphin County Carbon Storage and Sequestration Benefits ($millions/year)** [118]

	i-Tree Landscape
Pollutant	Expected
Carbon Sequestration	$7,236,344

Dauphin County Key Findings

- The total annual health benefit from trees including carbon sequestration and air pollution removal benefits is $9,081,421.
- The total annual avoided healthcare costs resulting from air pollutants is $1,833,807. (*Table 9*)
- The total annual avoided costs provided by carbon sequestration is $7,236,334. *(Table 11)*
- If the carbon currently stored in trees on open space in Dauphin County were released into the air, carbon emission mitigation costs would be $1.1 billion.
- Currently, tree-covered open space in Dauphin County is estimated to store 7,189,897 tons of carbon over the life of the trees. (*Table 10*)
- Tree photosynthesis provides an additional 190,430 tons of carbon sequestration annually. (*Table 10*)

Caveats

Note that NLCD provides tree-cover estimates with a 30-meter pixel resolution for the contiguous United States. The national database provides important information on our national tree resources, but has limitations, particularly at the local scale. Tree-cover estimates obtained from NLCD cover maps are believed to underestimate tree cover by an average of about 10 percent. [119] Thus, local tree-cover and ecosystem service estimates are likely conservative, but the exact degree of underestimation in specific areas is unknown.

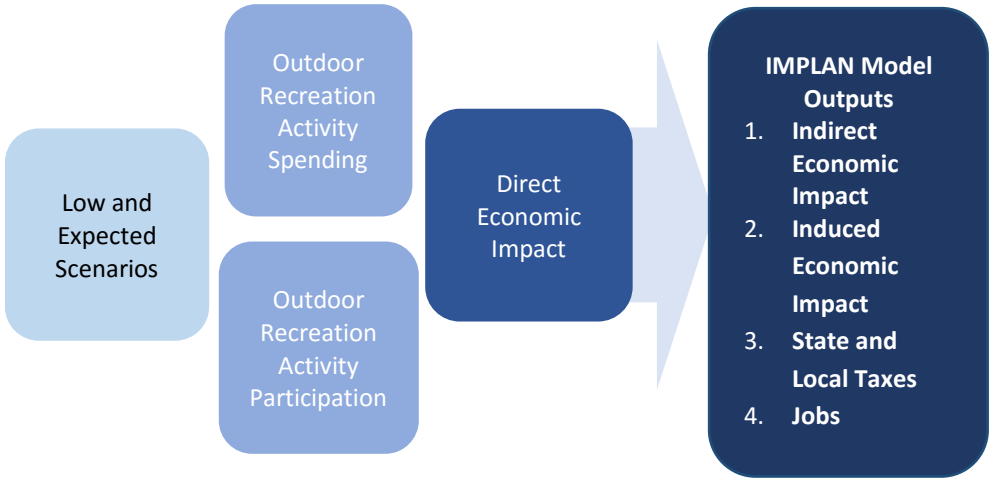
Outdoor Recreation Benefits

Dauphin County's open space provides a desirable place for many free and low-cost recreational activities that enhance the quality of life and health for residents and visitors. Resident levels of participation and direct annual spending were tracked across 11 recreational activity categories. This list was compiled by reviewing the major activities in the DCNR *2014 Outdoor Recreation Participation Survey*. Only those activities with the highest participation rates were included. Some residents may enjoy horseback riding, but the numbers are small relative to other activities. Further, motorized activities like motorcycling, snowmobiling and driving for pleasure were not included, as these are long-distance activities associated with tourism. The working definition for tourism activities is that they involve a 50-mile, one-way trip and or an overnight stay.

The major recreational activities identified for Dauphin County include:

- Fishing (freshwater)
- Hunting (all types)
- Walking (on trails, in parks and on streets)
- Running (on and off-road)
- Bicycle-based recreation (on paved roads or off-road)
- Camp-based recreation (in a tent)
- Water-based recreation, (kayaking, rafting and canoeing)
- Trail-based recreation (hiking on an unpaved trail, backpacking and climbing natural rock)
- Wildlife viewing (wildlife watching and photography, except birds)
- Birding (near home and away-from-home, bird feeding, watching and photography)
- Outdoor education (nature study)

***Figure 9*. IMPLAN Economic Impact Assessment Tool**



Methodology

Economic impact analysis is an assessment of the change in overall economic activity as a result of change in one or several specific economic activities. IMPLAN is an economic impact assessment software system. Economic activity can be either outside the region or be reflected in transactions between people and businesses within Dauphin County. This form of economic activity is often referred to as "economic contributions."

Economic contributions are usually expressed as jobs, income, retail

sales (expenditures) and tax revenues. For the purpose of economic modeling, economic contributions and impacts can be divided into three standard components: direct, indirect and induced effects. Indirect and induced effects are the two components of the "multiplier" or "ripple" effect. Each of these is considered when estimating the overall economic effect of any activity. (*Figure 9*)

Direct effects are initial purchases made by the consumer and calculated by multiplying the number of participants by their average annual spending for a particular activity. Participants are defined as those who engage in a given activity at least once a year, and their recreational activity spending includes such things as travel, clothing, equipment and fees.

Indirect effects measure how sales in one industry affect the other industries that provide supplies and support. For example, an angler buys fishing rods, hats, hip boots, gasoline and food, which may be produced in other parts of the state, country or world.

Induced effects result from the wages and salaries paid by impacted industries to employees who then spend their money. These expenditures are induced effects that create a continual cycle of indirect and induced effects. The sum of the direct, indirect and induced effects is the total economic impact or contribution. The IMPLAN economic model examined Dauphin County's economic and demographic data. Indirect and induced economic effects, along with employment and state and local taxes, were analyzed for the eleven, previously-identified outdoor recreation activities. [120]

Data Collection

The first phase of this analysis focused on data gathering that included:

1. Researching existing published surveys that gathered information on regional, state and national participation and spending estimates.
2. Estimating the total annual expenditures made by recreationists at the local, regional and national levels for each category examined.
3. Interviewing local experts in each activity to validate the survey data for participation and spending for Dauphin County.
4. Creating a set of expected estimates for participation and spending.

While not all surveys collect information in the same data categories, there are some consistencies. Most surveys provide information on a majority of activities, participation rates and spending.

The rate of participation and levels of spending depend on the recreational activity. Statistics on the different activities are difficult to collect. Transaction receipts are impractical, if not impossible, to collect. Therefore, the primary sources of information are surveys. Recreation surveys generally accept respondent estimates without validation and since outdoor recreation is considered a desirable activity, respondents may overestimate their participation.

Most surveys ask people about their activities over the previous seven days, two weeks or even a year. A natural inability to recall

behavior over periods of time, combined with a tendency to remember recent events more accurately, can lead to overestimates. Nevertheless, surveys do indicate trends, several surveys have similar outcomes and local experts and users can help validate survey results. Creating scenarios allows results to be bracketed and presented with an accurate range of economic impacts. *Figure 10* compares the participation rates obtained from five surveys.

Financial data is less available than participation rates and is usually derived from surveys and national studies. For example, the U.S. Fish and Wildlife Service (USFWS) conducts a *National Survey of Fishing, Hunting and Wildlife-Associated Recreation* every five years. The survey breaks down spending, demographic and participation information. In addition, it also provides information on a state-by-state basis. This survey is a well-established reference for fishing, hunting and wildlife watching. (121)

Very few studies give spending ranges. However, one study on running asked the question, "How much do you spend on running in a lifetime?" Three categories were identified and results were to totaled in four expense categories (*Table 12*). The costs on a per-day basis ranged from $.069 – $10.22, which corresponds to the annual expenditure ranging from $196 – $3,734. Spending can vary by region.(122) As an example, the 2009 DCNR statewide *Outdoor Recreation Resident Survey e*stimated annual spending for an individual to be $238 per year. (123)

***Figure 10*. Comparison of Survey Participation Rates From National, State and Regional Surveys**

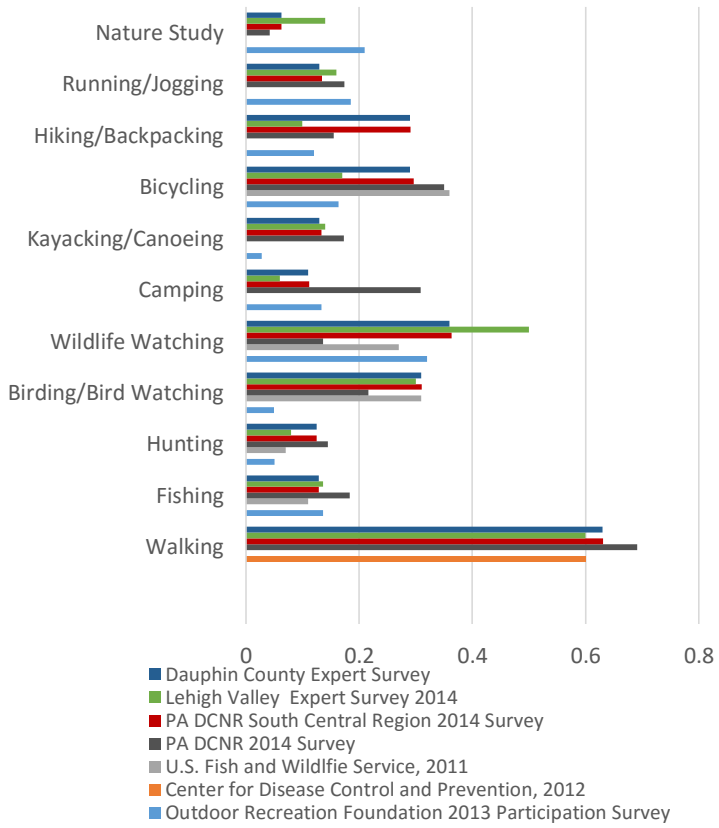


***Table 12*. How Much Do Runners Spend in a Lifetime?** [121]

	Least Expensive	Average	Most Expensive
Clothing	$11,196.43	$22,392.86	$50,485.71
Races	$0.00	$17,670.00	$51,642.00
Food	$3,145.12	$11,145.54	$88,838.75
Fluid	$15.70	$3,834.06	$16,205.63
Total Lifetime Expenditures	$14,357.25	$55,042.46	$207,172.09
Yearly Average	$196	$393	$3,734

***Table 13*. Dauphin County Participation Rate Analysis (percentages**

Outdoor Recreation Activity	Outdoor Recreation Foundation Participation Survey[124] 2013	Center for Disease Control and Prevention[125] 2012	U.S. Fish and Wildlife Service[126] 2011	PA DCNR Survey [127] 2014	PA DCNR South Central Region Survey[128] 2014	Lehigh Valley Expert Survey[129] 2014	Dauphin County Expert Survey
Walking		0.6		0.691	0.631	0.6	0.63
Fishing	0.136		0.11	0.183	0.129	0.136	0.129
Hunting	0.051		0.07	0.145	0.125	0.08	0.125
Birding/Bird Watching	0.05		0.31	0.216	0.311	0.3	0.31
Wildlife Watching	0.32		0.27	0.136	0.363	0.5	0.36
Camping	0.133			0.309	0.112	0.06	0.11
Kayaking/Canoeing	0.028			0.173	0.133	0.14	0.13
Bicycling	0.164		0.36	0.35	0.296	0.17	0.29
Hiking/Backpacking	0.12			0.155	0.291	0.1	0.29
Running/Jogging	0.185			0.174	0.134	0.16	0.13
Nature Study	0.21			0.042	0.063	0.14	0.063

Table 13 shows the participation data from different survey sources. Colored boxes identify the recommended participation rates used in the IMPLAN model. Light blue identifies the lowest participation rates. Green and dark blue identify the participation rates that best reflect local recreational use.

These data meet four criteria:

- Local survey data is consistent with other surveys.
- Local expert estimates are given priority over the activities that meet the criteria above.
- The most conservative choice is made when possible.
- National trends favor a given activity.

***Table 14*. Dauphin County Return on Environment Spending Rate Analysis**

Outdoor Recreation Activity	U.S. Fish and Wildlife Service Recommended by Game Commission (130) 2011	DCNR Outdoor Recreation Resident Participation Survey (131) 2009	Outdoor Industry Survey (132) 2011	Pennsylvania Fish and Boat Commission Study(133)	Lehigh Valley Survey (134) 2014	Dauphin County Experts 2016	Jim Warrenfeltz (135) 2013	
Walking		$96			$96	$96		
Fishing	$409	$831		$600	$409	$600		
Hunting	$1,207	$687			$1,207	$1,207		
Birding/Bird Watching	$329	$211			$329	$329		
Wildlife Watching	$308				$308	$308		
Camping		$2,529	$2,009		$600	$600		
Kayaking/ Canoeing			$482		$375	$500		
Bicycling		$453	$1,196		$600	$450		
Hiking/Backpacking		$280	$1,115		$458	$630		
Jogging/Running		$238			$900	$2,000	$196	$3,734
Nature Study		$150			$150	$126		

Table 15 shows several spending estimates, with light blue indicating the lowest annual spending estimates per person. Green indicates the expected annual spending rate per person and dark blue estimates spending rates used in both scenarios.

Expected direct economic impact was calculated for all eleven recreational activities.

***Table 15*. Dauphin County Direct Economic Impact**

Outdoor Recreation Activity	Minimum Participation Rate	Number of Participants	Minimum Spending	Minimum Direct Economic Impact	Participation Rate Expected	Number of Participants	Expected Spending	Expected Direct Economic Impact
	Low Economic Contribution Scenario				Expected Economic Contribution Scenario			
Walking	0.60	162,562	$96	$15,605,971	0.63	170,690	$96	$16,386,270
Fishing	0.11	29,803	$409	$12,189,456	0.129	34,951	$600	$20,970,524
Hunting	0.07	18,966	$687	$13,029,360	0.125	33,867	$1,207	$40,877,620
Birding/Bird Watching	0.05	13,547	$329	$4,456,914	0.31	83,990	$329	$27,632,865
Wildlife Watching	0.14	36,847	$308	$11,349,009	0.36	97,537	$308	$30,041,495
Camping	0.06	16,256	$600	$9,753,732	0.11	29,803	$600	$17,881,842
Kayaking	0.03	7,586	$375	$2,844,839	0.13	35,222	$500	$17,610,905
Bicycling	0.16	44,434	$450	$19,995,151	0.29	78,572	$450	$35,357,279
Hiking	0.10	27,094	$280	$7,586,236	0.29	78,572	$630	$49,500,190
Jogging/Running	0.13	35,222	$196	$6,903,475	0.13	35,222	$900	$31,699,629
Nature Study	0.04	11,379	$126	$1,433,799	0.063	17,069	$126	$2,150,698
Totals				**$105,147,940**				**$290,109,315**

Table 15 shows the direct costs for Dauphin County. These numbers are based on the 2014 estimated population of 272,983. [(130)]

***Figure 11*. Results of the IMPLAN Model for Both Low and Expected Economic Impacts**

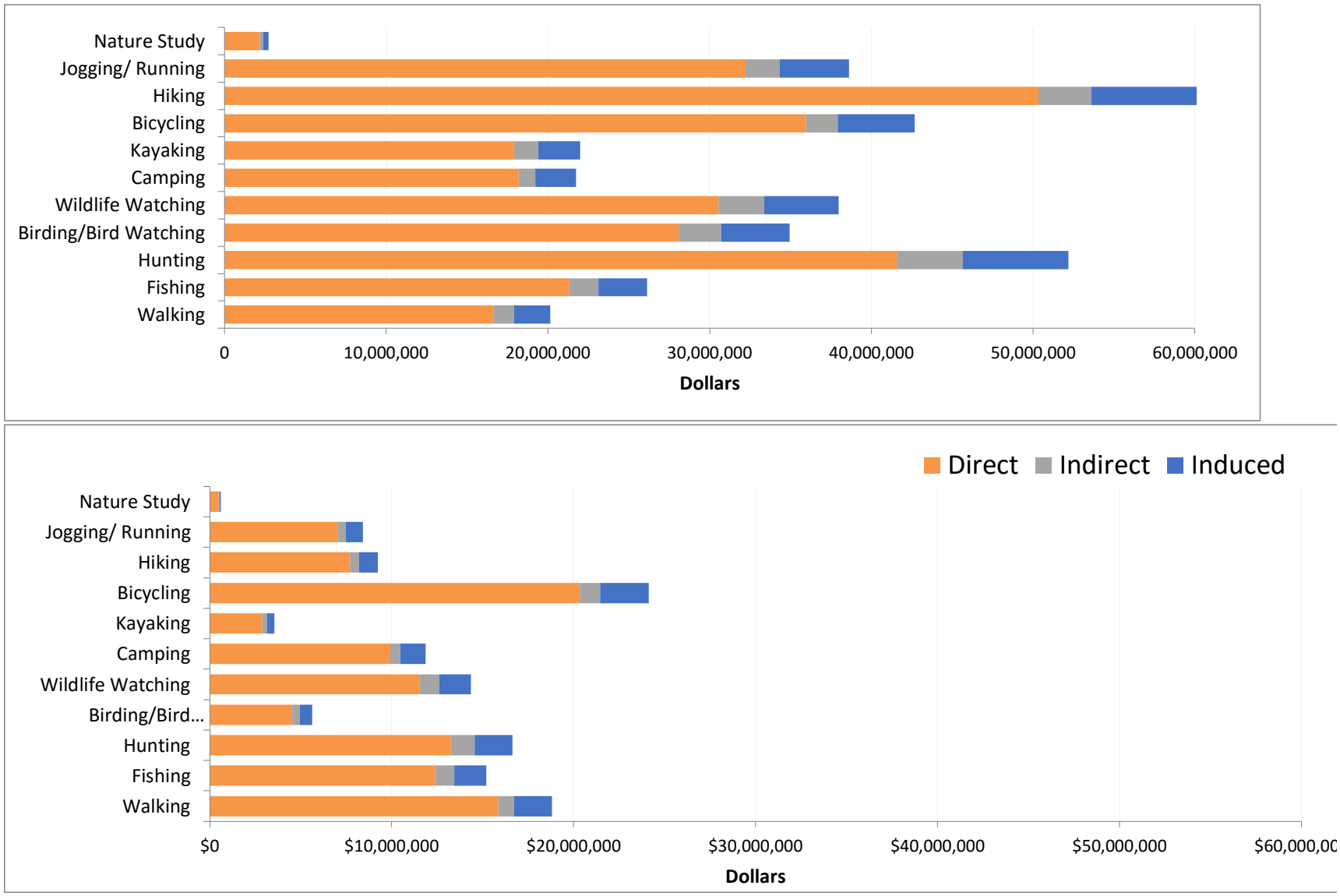


Figure 11 shows the final economic impact summary in terms of jobs and state and local taxes.

***Table 16*. Results of the IMPLAN Model for Employment and State and Local Taxes For Each Scenario**
Low Economic Contribution Scenario

Activity	Direct Impact (Spending)	Output (Indirect + Induced)	ROI (Direct - Output)	Employment	State and Local Taxes
Walking	$15,866,842	$2,947,845	$12,918,997	181	$785,110
Fishing	$12,393,215	$2,801,985	$9,591,230	147	$700,565
Hunting	$13,247,160	$3,381,941	$9,865,219	171	$858,759
Birding/Bird Watching	$4,531,416	$1,103,293	$3,428,123	57	$279,431
Wildlife Watching	$11,538,720	$2,809,408	$8,729,312	144	$711,537
Camping	$9,916,776	$1,938,370	$7,978,406	108	$531,799
Kayaking/	$2,892,393	$659,113	$2,233,280	34	$164,059
Bicycling	$20,329,391	$3,802,010	$16,527,381	212	$1,036,327
Hiking	$7,713,048	$1,528,302	$6,184,746	85	$389,819
Activity	**Direct Impact (Spending)**	**Output (Indirect + Induced)**	**ROI (Direct - Output)**	**Employment**	**State and Local Taxes**
Walking	$16,660,184	$3,494,917	$13,165,267	193	$844,409
Fishing	$21,321,068	$4,820,485	$16,500,583	252	$1,205,238
Hunting	$41,560,933	$10,610,323	$30,950,610	537	$2,694,225
Birding/Bird Watching	$28,094,777	$6,840,419	$21,254,358	352	$1,732,468
Wildlife Watching	$30,543,670	$7,436,667	$23,107,003	382	$1,883,480
Camping	$18,180,756	$3,553,679	$14,627,077	199	$974,965
Kayaking/	$17,905,290	$4,080,220	$13,825,070	212	$1,015,598
Bicycling	$35,948,313	$6,723,066	$29,225,247	374	$1,832,529
Hiking	$50,327,638	$9,972,170	$40,355,468	557	$2,543,567
Jogging/ Running	$32,229,522	$6,386,119	$25,843,403	356	$1,628,885
Nature Study	$2,186,649	$532,398	$1,654,251	27	$134,840
Totals	**$294,958,801**	**$64,450,463**	**$230,508,338**	**3,440**	**$16,490,204**

Key Results

Low Economic Contribution Scenario—$128.4 million in annual economic output, $105.9 million low economic direct contribution for Dauphin County resulting in over 1,223 jobs and approximately $5.8 million in annual state and local taxes.

Expected Economic Contribution Scenario—$359.4 million in annual economic output, $294.95 million expected direct economic contribution, resulting in over 3,440 jobs and $16.5 million in annual state and local taxes. The expected value is based on local expert input.

Case Study

Bass Pro Shops is an example of a recreation-based business located in Dauphin County to serve a very active recreation economy. Bass Pro Shops is one of America's premier outdoor retailers with destination outdoor retail stores across America and Canada, serving over 75 million sportsmen a year. The Pennsylvania store is located in Harrisburg because of the outdoor sportsman culture in the region. It has become a destination for thousands of sportsmen and their families in the Dauphin, Lebanon, Cumberland, Perry and York Counties.

Property Value Benefits

Methodology

A 2011 analysis, conducted by the Delaware Valley Regional Planning Commission (DVPC), found that Pennsylvania homeowners are willing to pay a premium to live within close proximity to protected open space - a premium that ranged by county and planning area. [136] In order to estimate the real estate premium attributed to proximity to protected open space in Dauphin County, 4WARD Planning identified the average assessed value of single-family homes located adjacent to protected open space across Dauphin County's three planning areas. [137] For purposes of this analysis, Dauphin County was divided into the following three regions: (*Figure 12)*

Greater Harrisburg (urban): A fairly dense area, including the following places: Harrisburg, Susquehanna Twp., Lower Paxton Twp., Paxtang, Penbrook, Swatara, Steelton, and Highspire.

South County (mixed): A mix of some denser boroughs, and suburban and rural areas, including: Lower Swatara Twp., Middletown, Royalton, Londonderry Twp., Conewago Twp., Derry Twp., Hummelstown, South Hanover Twp., East Hanover Twp., and West Hanover Twp.

North County (rural): A generally rural area, encompassing a number of small boroughs including: Middle Paxton Twp., Dauphin, Rush Twp., Jackson Twp., Jefferson Twp., Wayne Twp., Reed Twp., Halifax Twp., Halifax, Millersburg, Upper Paxton Twp., Washington

***Figure 12*. Dauphin County Planning Districts**

Twp.,

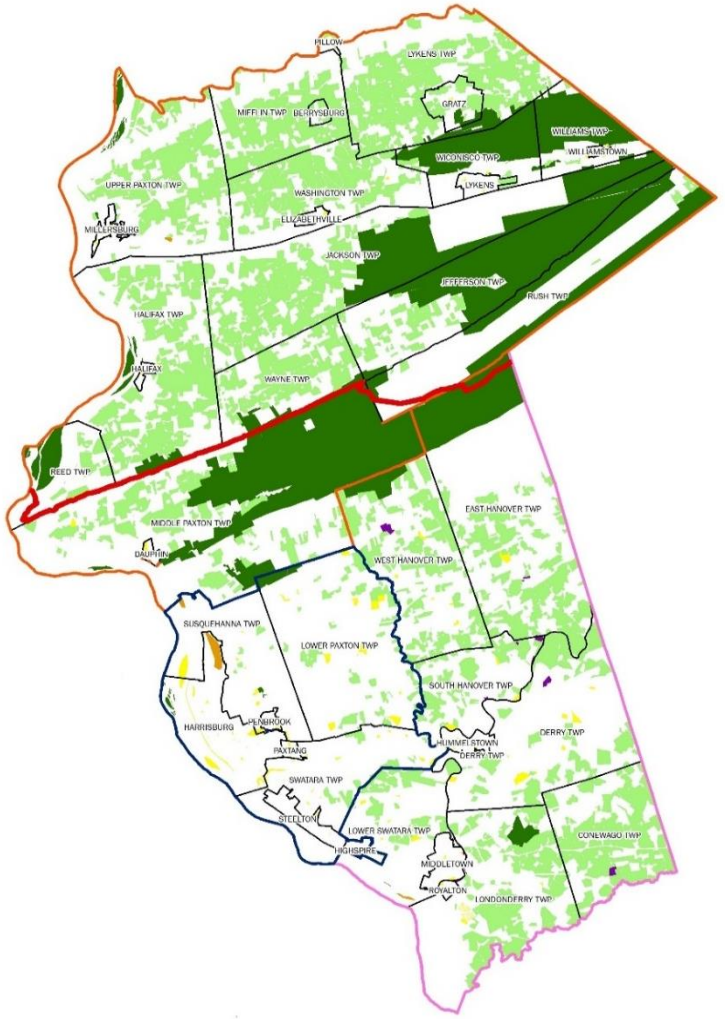
Elizabethville, Mifflin Twp., Berrysburg, Pillow, Lykens Twp., Gratz, Wiconisco Twp., Lykens, Williams Twp., and Williamstown.

North County

South County

Greater Harrisburg

County; $6,010 to $8,015 per single-family home in suburban/rural South County; and $20,020 to $26,670 per single-family home in the urban Greater



Harrisburg area. (*Table 17*).

Utilizing low and expected percent value capture assumptions adapted from the DVPC study findings, the average real estate premium ("willingness to pay") attributed to living adjacent to protected open space in Dauphin County ranged from approximately $980 to $1,300 per single-family home in rural North

The total real estate premium attributed to proximity to protected open space in Dauphin County, overall, is approximately $37.9 to $50.5 million.

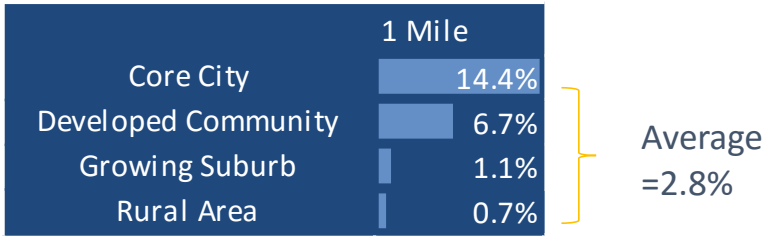
A 2011 DVRPC hedonic regression analysis conducted in southeastern Pennsylvania found that homes located within a mile of protected open space captured a measurable increase (from less than 1 to 14.4 percent) in their property values, largely based on their proximity to open space. The report also found that average value-added and percent value findings for these homes ranged by county and planning area.

4WARD Planning conducted a conservative value transfer analysis for Dauphin County, utilizing value transfer assumptions adapted from the 2011 DVRPC study and assessed property value, zoning and open space data provided by Dauphin County. Our analysis looked specifically at single-family homes located adjacent to protected open space, since these homes are most likely to benefit from their proximity to open space. Multi-family properties were omitted in our analysis to avoid property value differences associated with property type and unit count.
Table 18 presents the percent value change assumptions applied to single-family homes located immediately adjacent to protected open space within Dauphin County.

Since our analysis looked specifically at single-family homes immediately adjacent to protected space (vs. one mile away), the percent value capture assumptions increase as distance from protected open space decreases. Conservative 17% (approximately 72% of linear trend line projections), 5%, and 1% value changes were used for homes located adjacent to open space, within each respective area.

Community, Growing Suburb and Rural Area percent value assumptions from the 2011 DVRPC study were used for purposes of analysis. Row homes were not part of this analysis.

Table 17
(The shaded areas in the table reflect the relative real estate value impact.)



Average Assessed Value (2016)

Area	Average Assessed Value (Observed)		
	Adjacent Properties	All Area	Difference
Greater Harrisburg (urban)	$148,300	$50,900	$97,400
South County (suburban & rural)	$160,300	$71,400	$88,900
North County (rural)	$130,500	$41,600	$88,900
Total County	$146,200	$55,200	$91,000

Value Capture (Estimates): Adjacent Properties

Area	Low			Expected		
	Percent Capture	Per Property	Total	Percent Capture	Per Property	Total
Greater Harrisburg (urban)	13.5%	$20,021	$20,941,443	18.0%	$26,694	$27,921,924
South County (suburban & rural)	3.8%	$6,011	$14,691,495	5.0%	$8,015	$19,588,660
North County (rural)	0.8%	$979	$2,296,148	1.0%	$1,305	$3,061,530
Total County			$37,929,086			$50,572,114

***Table 18*. Percent Value Change Applied to Single Family Homes (Proximity Effect)**

	Adj. Prop.	1/4 Mile	1/2 Mile	1 Mile
Greater Harrisburg (urban)	17.0%	16.0%	15.0%	14.4%
South County (suburban & rural)	5.0%	4.5%	3.5%	2.8%
North County (rural)	1.0%	0.9%	0.8%	0.7%

Study Area

Single-Family Homes

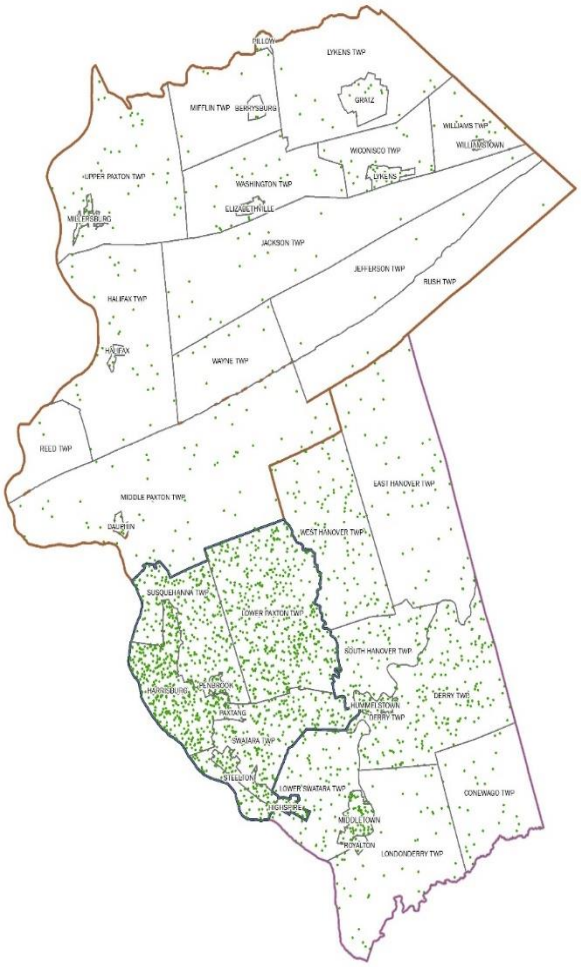


***Table 19*. Homes Adjacent to Protected Open Space**

Single Family Housing Units (2016)

Area	Adjacent	Total
Greater Harrisburg (urban)	1,046	91,330
South County (suburban & rural)	2,444	40,180
North County (rural)	2,346	19,092
Total	5,836	150,602

Total Assessed Value (2016)

Area	Adjacent	Total
Greater Harrisburg (urban)	$155,123,200	$4,649,207,750
South County (suburban & rural)	$391,675,700	$2,867,511,340
North County (rural)	$306,221,900	$794,840,850
Total	$853,020,800	$8,311,559,940

Average Assessed Value (2016)

Area	Adjacent	Total
Greater Harrisburg (urban)	$148,300	$50,900
South County (suburban & rural)	$160,300	$71,400
North County (rural)	$130,500	$41,600
Total	$146,200	$55,200

Key Findings

152,124 acres of protected open space.

As summarized in *Table 20*, there are currently 152,124 acres of protected open space within Dauphin County, a large portion of which encompasses preserved farmland (60%) and state parks, forests, and game lands (37%). Approximately 72%of all protected open space in Dauphin County is located within North County, another 25%is located within South County, and just under 3% is located within the Greater Harrisburg area.

5,840 single-family homes located adjacent to protected open space.

According to property value data provided by Dauphin County, approximately 5,840 single-family homes (4%of all single-family homes) are located adjacent to protected open space.

$146,200 in average assessed value.

The average assessed property value for a single-family home located adjacent to protected open space in Dauphin County is $146,200 - ranging from $130,500 in North County to $160,300 in South County.

Average open space premiums range from $980 to $26,690.

The average real estate premium attributed to property adjacent to protected open space ranged from approximately $980 to $1,300 per single-family home in North County; $6,010 to $8,015 per single-family home in South County; and $20,020 to $26,670 per single-family home in the Greater Harrisburg area.

As presented in *Table 20*, there are approximately 5,840 single-family homes located adjacent to protected open space (4% of all single-family homes in the county). These properties have a total assessed value (including building and land value) of $853 million (10% of all single-family homes in the county). Average assessed values for these homes is $146,200, with average values lowest in North County ($130,500) and highest in South County ($160,300).

$37.9 to $50.5 million impact on adjacent property values.

The total real estate premium attributed to adjacency to protected open space in Dauphin County overall, is approximately $37.9 to $50.5 million.

***Table 20*. Types of Protected Open Space (in acres)**

Area	Federal	State	County	Municipal	Preserved Farmland	Nonprofit	Total	Percent
Greater Harrisburg	-	429	255	1,132	2,448	0.2	4,264	2.8%
South County	321	5,856	28	603	30,762	255	37,825	24.9%
North County	2,343	49,725	19	211	57,736	0.4	110,034	72.3%
Total	2,664	56,010	302	1,946	90,946	256	152,124	100.0%
Percent	1.8%	36.8%	0.2%	1.3%	59.8%	0.2%	100%	

***Table 21*. Assessment Summary**

Percent Value Capture Assumption: Adjacent Properties

	Low *	Expected
Greater Harrisburg (urban)	13.5%	18.0%
South County (suburban & rural)	3.8%	5.0%
North County (rural)	0.8%	1.0%

Average Assessed Value (2016)

	Average Assessed Value (Observed)		
Area	Adjacent Properties	All Area	Difference
Greater Harrisburg (urban)	$148,300	$50,900	$97,400
South County (suburban & rural)	$160,300	$71,400	$88,900
North County (rural)	$130,500	$41,600	$88,900
Total County	$146,200	$55,200	$91,000

The total real estate premium attributed to properties adjacent to protected open space in Dauphin County overall, is approximately $37.9 to $50.5 million.

Value Capture (Estimates): Adjacent Properties

	Low *			Expected		
Area	Percent Capture	Per Property	Total	Percent Capture	Per Property	Total
Greater Harrisburg (urban)	13.5%	$20,021	$20,941,443	18.0%	$26,694	$27,921,924
South County (suburban & rural)	3.8%	$6,011	$14,691,495	5.0%	$8,015	$19,588,660
North County (rural)	0.8%	$979	$2,296,148	1.0%	$1,305	$3,061,530
Total County			$37,929,086			$50,572,114

Dauphin County Return on Environment Map

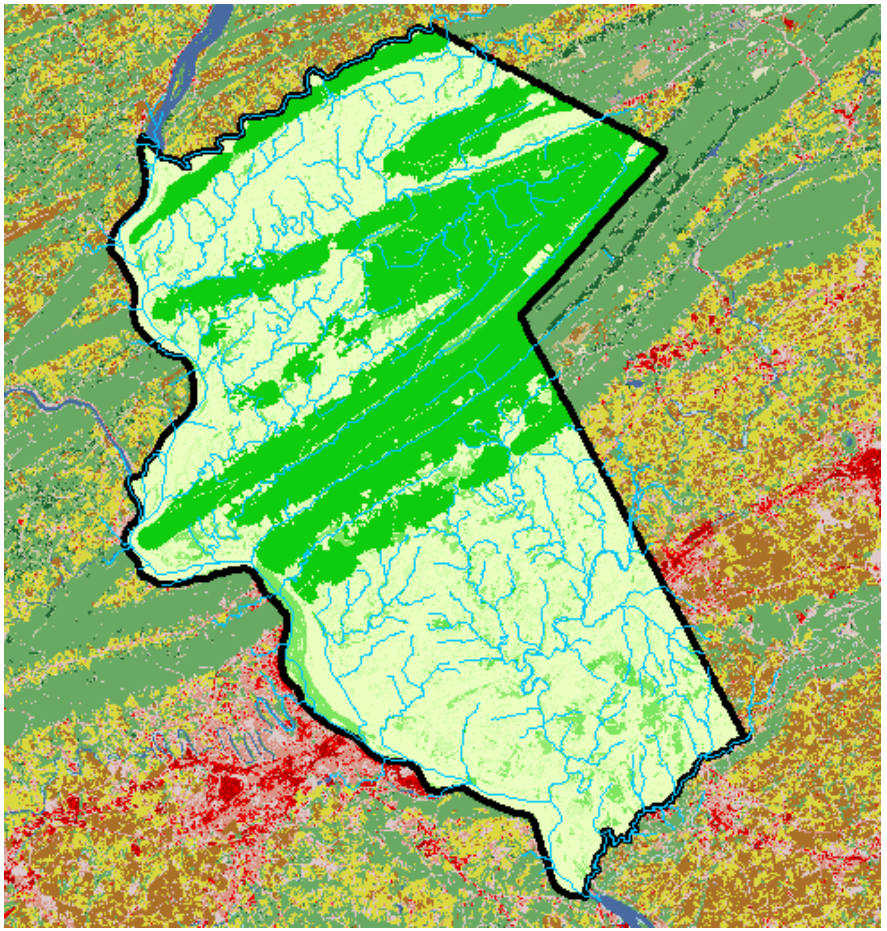
Dauphin County's residents and visitors want to experience nature at its best. Areas in need of protection within the county have the highest economic value from a natural system services standpoint. These areas help define resident quality of life and sense of place.

Using the values listed in this report for natural county resources, a map has been created showing higher values for more natural, undeveloped acres (darker green) that return a higher financial value to the local economy than the more developed (red and brown) acres. (*Figure 13*)

Satellite-derived land-cover data for 2011 was obtained from the Multi-Resolution Land Characteristics (MRLC) Consortium and ArcGIS was used to calculate the acres of seven different land-cover types.

While it is difficult to see from a map at this scale, the highest Return on Environment is in green corridors along streams and creeks, with the second highest being ridges and slopes. The darker the color green, the higher the ROE financial value.

***Figure 13*. Dauphin County Return on Environment Map**



Putting Return on Environment Studies to Work:

A Blueprint for Action. *We can't afford not to protect Dauphin County's open spaces and natural system services. New approaches to protect and expand open space are essential to the everyday life of Dauphin County residents and businesses.*

Growth can fragment habitat and impact natural systems by causing water pollution, flooding and stream bank erosion. With less open space remaining, the size, quality, location and connectivity of that remaining open space will be critical in determining the future quality of life, health and cost of living for residents.

In today's planning activities, we must do more to quantify the financial benefits provided by nature and link those values directly to the well-being of a community. For example, a natural resource inventory does not explain the financial consequences of losing a habitat or species. Industrial site selection might not estimate the cumulative impact on stormwater, flooding or loss of wetland functions.

Communities that understand the value of nature have a better chance to strike an effective balance between maintaining connected, resilient open spaces and smart growth. This includes arresting the decline in habitats and species and the degradation of landscapes. The strategy will help improve the quality of our natural environment and sustain the economy in Dauphin County and along the Kittatinny Ridge, moving to a net gain in the value of both.

During the five meetings of this study, attendees listed a number of long-term issues which, in their opinion, have not been adequately addressed. These issues were dubbed "Natural Conundrums." (*Table 22)* The attendees believed that eleven of the sixteen natural conundrums (70%) would be addressed by placing a value on natural system services.

The attendees also listed a number of ideas that they believed would help solve many of these problems. They sought to integrate Return on Environment data into existing and new practices. The goal is to help protect priority habitats and safeguard vulnerable non-renewable resources. We will achieve this through collaborative action at local and regional levels, creating an ecological and economic network to solve the natural conundrums.

The first stage of putting Return on Environment studies to work is articulating the ways open space provides natural system services. Placing a dollar value on different land covers helps decision makers understand what is critical to the environment and the economy and what lands can be developed. This leads to mapping the pattern of connected habitat that is required for sustainable environmental and economic benefits.

Table 22. Nature's Conundrums in Dauphin County	*Impact H,M,L*
Water quality is a major concern; however, riparian buffer protection of high quality streams - one of the best tools to maintain water quality - was rescinded in Pennsylvania in 2014 after 30 years of enforcement. Pennsylvania is one of only two states without this regulation. (138)	*H*
Many residents in Pennsylvania are interested in outdoor recreation, yet open space continues to decrease as the population is growing. In the future, meeting demand for open space will be difficult due to diminishing land open space. (139)	*H*
We are now influenced by a global economy with more economic uncertainty and less financial control, yet we barely manage significant avoided costs and major environmental risks which are under our control. (140)	*H*
Sprawl continues, even after 30 years of water quality regulation. Turf grass, one of the top sources of stormwater pollution, is now the major crop in the Chesapeake Bay Watershed. Main Street either hasn't understood the message or has expected others to solve the problem. (141)	*H*
Air quality is a major concern in many growth areas; meanwhile the Chesapeake Bay Watershed is losing 100 acres of forest each day—the equivalent of CO2 offsets for 50 - 100 homes per day. (142)	*H*
As sprawl continues, people move away from urban centers and create the same experience they left behind; meanwhile, disinvestment and underutilization of existing infrastructure create numerous financial and environmental consequences. (143)	*H*
New development often cuts down trees even though people care more about greenery and tree canopy in their community than low taxes or local services. (144) (145)	*H*
Some of the fastest growing counties in Pennsylvania are in areas with the highest quality of natural resources that support water quality, bird migration and resilience to climate change for an entire region. (146)	*H*
While counties create land use plans, the plans do not always have "teeth."	*H*
Habitat connectivity is the primary management technique to sustain natural system services, the local economy and resilience to climate change, yet hopscotch patterns of development are allowed to occur across the landscape, incrementally fragmenting natural habitat and reducing connectivity.(147)	*H*
People over 65 want more access to outdoor recreation but want to save money more than protect the environment.(148)(149)	*M*
The director of the USA's Centers for Disease Control and Prevention (CDC) has declared that obesity is the nation's number one health problem leading to heart disease, cancer, and stroke. Open space encourages people to exercise and have healthy lifestyles. (150)	*M*
Climate change is expected to increase the size and frequency of major storms, yet homes are still being developed or reconstructed in existing floodplains.	*M*
The foundation for all natural system services is native plants; however, most homes are landscaped with very few native plants.	*M*
Regulations are created and then are not always enforced by state agencies.	*L*
Complying with regulation creates difficult timing concerns, as agencies are understaffed in order to support their own policies.	*L*

All Stakeholders Play a Part

If the economy of Dauphin County is to remain strong, environmental stewardship cannot be the responsibility of a few dedicated people. Environmental stewardship must become part of Dauphin County's everyday culture. Residents, planners, non-profits, land trusts, businesses and policy makers require strong alignment to succeed. Only then can Dauphin County ensure a foundation for a vibrant, balanced economy, high quality of life, low cost of living, good health and well-being for current residents and future generations.

Enabling change through a process of engagement is available for stakeholders at all levels of a community. The ROE process can help elected officials, policy makers, economic development, land use and tourism planners, businesses and residents use ROE data and planning principles. (*Figure 14*)

A stakeholder is anyone who can affect or be affected by the proposed actions, objectives and policies. Each group of stakeholders has different interests and needs; however, they all share an interest in a healthy environment and lots of greenery.

Residents: Residents are interested in quality of life, health, cost of living, sense of place and economic issues.

Land Trusts and Environmental Organizations: These groups are interested in protecting open space, environmental quality and the pattern of the natural landscape.

Figure 14. ROE Stakeholders

Land Use and Economic Development Planners: Land planners want to help create "smart growth" activities while economic development groups want to help attract resource-based, as well as high-employment organizations.

Tourism and Recreation Planners: These planners want to ensure places that attract visitors and where people enjoy their community.

Businesses: Businesses want to locate in places that can provide the resources and workforce they need as well as amenities that encourage healthy lifestyles.

Elected Officials and Policy makers: Community leaders have a responsibility to protect the health, safety and welfare of all residents. Dauphin County can take strategic actions to enhance its environment, economy and sense of place.

Recommended Strategic Actions

Stakeholders can't afford to continue to subsidize growth. Actions that can help communities provide more environmental, social and financial sustainability are shown below.

Leveling the Playing Field

"Leveling the playing field" gives nature a place at the table. This helps ensure that residents will have a fair chance at clean air, clean water, low cost infrastructure and recreational opportunities.

1. **Include ROE in decision making.**
   Begin every land use, economic development, tourism and recreation planning process with a clear understanding of the financial value of nature's current financial portfolio of assets. Ask what is needed to sustain these avoided costs.

2. **Create incentives.**
   Incentives are needed to protect and restore critical natural system services like "green ribbon landscapes," stream buffers, cluster development and use native plants in backyard design.

3. **Level the playing field, by mapping ROE financial values and performing annual environmental audits.**
   Map the relative financial values of natural system services to reflect financial priorities and develop protection and risk management strategies that maintain these assets.

   Perform environmental audits by chronicling the change in cover types over time and estimate the financial losses and report them to all interested groups and agencies. Fund critical projects to protect high-quality areas (mature woodlands and rare resources), as well as critical resources like headwaters, riparian and wetland areas. See Dauphin County Return on Environment Map.

4. **Change the rules of the game by estimating the annual Return on Environment for all new proposed ordinances.**

- Riparian ordinance
- Official map ordinance
- Open space referenda

Changing the Rules of the Game

Harvard University business professor, Michael Portner notes in the article *"What Is Strategy?"* that businesses should strive to create a sustainable competitive advantage by "performing *different* activities from rivals or performing similar activities in *different* ways." In this way, businesses will have far more success by creating a new game with an entirely new set of rules and forcing others to compete on your terms, not theirs.[151]

5. **Develop a stewardship balance sheet for all new developments.**
   For every new development proposal, develop a balance sheet that reflects the full cost of benefits in the form of tax revenues and jobs and the true cost of services over time, as well the loss in natural system services that will be paid by taxpayers.

6. **Connect and expand open spaces.**
   Develop stewardship buffer zones (green ribbon landscapes) along riparian areas and around parks, trails and natural preserves that expand natural system services by incentivizing the use of native plants and good stewardship practices. Expanding natural system services helps expand the economy.

7. **Teach the principles of good stewardship to land owners and provide a clear idea of how protecting nature has financial value for them and the community.**
   Create a habitat benefits calculator to help residents understand the value of backyard stewardship. Train residents in backyard conservation design and stewardship, particularly in stewardship buffer zones. Chronicle the potential benefits of backyard conservation design and stewardship and provide this information to neighborhoods and all interested agencies. (152)

   Provide educational tools to landowners about good land stewardship. In Pennsylvania, many acres are already developed and over 85% of the land is privately held. (153) Many land owners don't understand what they can and should do to be good environmental stewards. Strategies are available that help teach homeowners, municipalities and businesses how to become good stewards in their own backyards while making their properties beautiful and helping to expand the local economy.

   Teach private property owners low impact and restorative approaches along the borders of forests and vegetated streamside buffer areas. These strategies have significant financial benefits. As backyards become connected to stream corridors, parks and natural areas, neighborhoods expand and create larger, self-sustaining habitats. These voluntary buffers and habitats are called "green ribbon landscapes."

   Increase local knowledge of recreational users so they understand the significance of natural capital value. This also becomes a tool for forecasting future needs at the local level.

8. **Assist sustainable businesses.**
   Businesses can benefit from the data collected on the financial impact of the environment on the local economy as well as data collected on recreation demand and demand for high quality water. One example is that Capital Region Water may use these data to explain the value of their watershed property to customers. Recreation-related businesses can use these data to help them understand their markets.

9. **Involve schools.**
   Trout in the Classroom (TIC) is an environmental education program that has interdisciplinary applications in science, social studies, mathematics, language arts, fine arts and physical education. This program is already available in Dauphin County.

Data on ROE can help students better appreciate the value of nature. Similar applications can be used in school curriculums from early childhood through high school.

Glossary

Air Pollution
The release of harmful matter, particulates and gases, such as sulfur dioxide, nitrogen oxides, carbon monoxide and volatile organic compounds, into the air.

Avoided Costs (AC)
Dollars that do not need to be spent on the provision of environmental services, such as improving water quality and removing air pollution.

Biological Connectivity
The ability of individual plants and animals to move across complex landscapes, allowing species to shift their geographic range in response to habitat needs and climate change.

Biological Control
The dynamic regulation of species populations, including the control of invasive species and unwanted species, such as pest, weeds and disease vectors (i.e. mosquitoes).

Carbon sequestration
The process involved in carbon capture and the long-term storage of atmospheric carbon dioxide (CO 2) through photosynthesis. Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change.

Conservation Design
A planning process that rearranges the development on each parcel as it is being planned so that half (or more) of the buildable land is set aside for open space.

Ecosystem Function
The habitat, biological or system properties or processes of ecosystems.

Eco-Pricing
The value of nature's services and biodiversity is a reflection of what price we, as a society, are willing to pay to conserve these natural resources.

Flood Mitigation
The management and control of flood water movement, such as redirecting flood run-off through the use of floodwalls and flood gates, rather than trying to prevent floods altogether.

Green Ribbon Landscapes.
Areas within 300 feet of parks, preserves, riparian buffers and trails that encourage 60% canopy cover and 60% use of native plants in landscaping to expand natural system services and the local economy.

Habitat
The area or environment where an organism or ecological community normally lives or occurs.

Habitat Loss
Loss and degradation of the natural conditions that animals and plants need to survive.

Hedonic Regression Analysis
A model identifying price factors according to the premise that price is determined both by the internal characteristics of the goods being sold and the external factors affecting it.

Natural Capital
A portfolio of natural assets, such as geology, soil, air, water and all living things.

Natural Habitat Regeneration
The process by which vegetation and habitat grow back by without human intervention.

Natural System Services (or Ecosystem Services)
The flow of goods and services that benefits people, directly or indirectly, from ecosystem functions**.**

NPDES Permit
The NPDES permit program addresses water pollution by regulating point sources that discharge pollutants to waters of the United States.

Open Space
Land that is valued for aesthetic beauty, recreation, natural process, agriculture and other public benefits.

Pollination
The process by which pollen is transferred from the anther (male part) to the stigma (female part) of the plant, thereby enabling fertilization and reproduction.

Resource Use
The way in which resources are used that can affect the ecosystem.

Return on Environment (ROE)
The economic value created from the flow of goods and services into the economy from natural resources and natural systems.

Riparian Buffer
A vegetated area ("**buffer** strip") near a stream, 100 feet wide and usually forested, which helps shade and partially protect a stream from the impact of adjacent land uses. It plays a key role in increasing water quality in associated streams, rivers and lakes, thus providing environmental benefits.

Soil Retention
The development of soil as a result of the interplay of parent material, climate, organisms, relief and time.

Soil Retention
A system that creates and enriches soil through weathering and decomposition, preventing it from being washed away.

Water Pollution
Sewage, fertilizers, pesticides, oil, silt and other pollutants that are discharged, spilled or washed into water, including contaminants from air pollution that settle onto land and are washed into water bodies.

Water Supply
A source, means or process of supplying water, including groundwater aquifers, reservoirs, streams, rivers and pipelines.

Waste Assimilation
The method by which forests and wetlands provide a natural protective buffer between natural system activities and water supplies.

References

1. Michael Behney, MURP; Sue Copella; Jennifer Shultz; Debbie Bowalick; Aaron Koontz; Larry Meyers and Michael Kotovsky, 2014. Pennsylvania *Population Projections 2010-2040* . The Center for Rural Pennsylvania.
2. World Economic Forum, 2016. *The Global Risks Report*. 11th edition.
3. Pennsylvania State Constitution.
4. Bryan Cope, 2015. Open Space Coordinator, North Hampton County, PA.
5. Michael Behney, MURP; Sue Copella; Jennifer Shultz; Debbie Bowalick; Aaron Koontz; Larry Meyers and Michael Kotovsk. 2014. *Pennsylvania Population Projections 2010-2040*. The Center for Rural Pennsylvania.
6. IBID.
7. PA Audubon Society-Annual Report. 2011. *Planning for Forest Birds*. Blue Ridge Mountains, Kittatinny Ridge Conservation Project.
8. Multi-Resolution Land Characteristic, (MRCL) Consortium. 2011.
9. United States Forest Service, *i-Tree Landscape Model*. 2016
10. http://www.planetware.com/tourist-attractions/pennsylvania-uspa.htm
11. Dauphin County Parks and Recreation Department website.
12. IBID.
13. Tourism Economics. 2014. *The Economic Impact of Tourism in Pennsylvania*.
14. IBID.
15. U.S. Department of Agriculture. *2012Census of Agriculture of Dauphin County*.
16. Certified Organic Farms, PA. Department of Agriculture.
17. Michael Behney, MURP; Sue Copella; Jennifer Shultz; Debbie Bowalick; Aaron Koontz; Larry Meyers and Michael Kotovsky. 2014. *Pennsylvania Population Projections 2010-2040*. The Center for Rural Pennsylvania.
18. IBID.
19. U.S. Census. *2015 Quick Facts*, Dauphin, County PA.
20. IBID.
21. http://www.newsweek.com/green-2016/top-green-companies-us-2016
22. US Environmental Protection Agency. 2012. *The Economic Benefits of Protecting Healthy Watersheds*, EPA 841-N-12-004, 1.
23. Capital Regional Water Project. 2016.
24. Department of Recreation, Park, and Tourism Management, The Pennsylvania State University Keystone Fund Report; www.tpl.org/Pennsylvania. 2012. *The Economic Significance and Impact of Pennsylvania State Parks: An Updated Assessment of 2010 Park Visitor Spending on the State and Local Economy, 2012.* Trust for Public Land. 2013. Pennsylvania's Return on Investment in the Keystone Recreation, Park, and Conservation Fund, DCNR.
25. American Lung Association. *2016 State of the Air Report*.
26. Nowak, D. J., Crane, D. E., & Stevens, J. C. 2006. Air Pollution Removal by Urban Trees and Shrubs in the United States. *Urban Forestry & Urban Greening 4*, 115-116.
27. United States Forest Service. 2010. *i-Tree Vue User's Manual*, Version 3.0.
28. Gina Lovasi, Ph.D., (2013) of Columbia University, and colleagues online in the *Journal of Epidemiology and Community Health Estimate* of Columbia University, and colleagues online in the *Journal of Epidemiology and Community Health*.
29. Maryland Department of Natural Resources, Forest Service, 2013.
30. Pennsylvania Department of Conservation and Natural Resources (DCNR). 2014. *Outdoor Recreation Participation Survey*.
31. IBID.
32. Bass Pro Shop Interview. June 2016.

33. Pennsylvania Department of Conservation and Natural Resources (DCNR), (2014). *Outdoor Recreation Participation Survey*.
34. Outdoor Industry Association. 2012. *Economic Outlook*.
35. Pennsylvania Department of Conservation and Natural Resources (DCNR), 2014. *Outdoor Recreation Participation Survey*.
36. IBID.
37. National Park Association, 2015. *7 Ways to Make Parks Millennial Friendly*.
38. *Headwater Economics*. 2009. The Economic Benefits of the Land and Water Conservation Fund.
39. Graham, P., and U.K. Stigsdotter. 2010. The Relation between Perceived Sensory Dimensions of Urban Green Space and Stress Restoration. *Landscape and Urban Planning* 94, 3-4: 264-275.
40. Louv, R. 2011. *The Nature Principle*. Chapel Hill, North Carolina: Algonquin Press.
41. Holohan, E. (2012). Fitness in middle age lowers medical costs later: study. *HealthDay News.* http://consumer.healthday.com/fitness-information-14/gum-health-news-253/fitness-in-middle-age-lowers-medical-costs-later-study-664646.
42. Gallup, Inc. and the John S. and James L. Knight Foundation. *Soul of the Community Study* 2010, 10-12. Retrieved from http://knightfoundation.org/sotc/overall-findings/
43. Knight Foundation *Soul of the Community Study*. 2010.
44. Peter Clagett, 201, United State Geological Survey
45. Crompton, J. L. 2007. The impact of parks and open spaces on property taxes. *The Economic Benefits of Land Conservation.* Ed. Constance T.F.de Brun. The Trust for Public Land, 1-12.
46. Doug Tallamy, 2007. *Bringing Nature Home*. Algonquin Books.
47. PA Audubon Society. 2011. *Planning for Forest Birds*. Blue Ridge Mountains, Kittatinny Ridge Conservation Project.
48. Department of Conservation and Natural Resources (DCNR), 2014. Outdoor Recreation Participation Survey.
49. Michael Behney, MURP; Sue Copella; Jennifer Shultz; Debbie Bowalick; Aaron Koontz; Larry Meyers and Michael Kotovsky, 2014. *Pennsylvania Population Projections 2010-2040*. The Institute of State and Regional Affairs, Penn State, Harrisburg. The Center for Rural Pennsylvania.
50. Department of Conservation and Natural Resources (DCNR), 2014. *Outdoor Recreation Participation Survey*.
51. National Park Association, 2015. *7 Ways to Make Parks Millennial Friendly*.
52. Center for Workforce Information Analysis. 2015. *Dauphin County Top 50 Employers*.
53. Franchise Help Holdings, LLC. (2015). *Green Industry Analysis 2015 – Costs and Trends*. Retrieved from https://www.franchisehelp.com/industry-reports/green-industry-report/
54. Haanaes, K., Arthur, D., Balagopal, B., Kong, M. T., Reeves, M., Velken, I., Hopkins, M., & Kruschwitz, N. 2011. Sustainability: The Embracers' Seize Advantage. *MIT Sloan Management Review*. Retrieved from http://sloanreview.mit.edu/reports/sustainability-advantage
55. Center for Workforce Information Analysis. 2015. *Dauphin County Top 50 Employers*.
56. Multi-Resolution Land Characteristic, (MRCL) Consortium. 2011.
57. Elliott Campbell, 2016. Maryland.
58. IBID.
59. New Jersey Department of Environmental Protection, 2007. *Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources.*
60. Maryland Department of the Environment. 2015. Bay Restoration Fund Advisory Committee Annual Status Report.
61. http://www.mde.state.md.us/programs/Water/BayRestorationFund/Documents/2015%20BRF%20Report%20-%20Final.pdf

62. New York State Department of Environmental Conservation. 2015. New York City Water Supply. http://www.dec.ny.gov/lands/25599.html
63. https://www.wsscwater.com/files/live/sites/wssc/files/Resolutions/Resolution%202014-2054%20Adopting%20the%20Washington%20Suburban%20Sanitary%20Commission's%20FY%202015%20Operating%20and%20Capital%20Budgets_1045151.pdf Washington Suburban Sanitation Commission. 2014. Resolution No. 2014-2054
64. Talberth, John, Selman, Mindy, Walker, Sara, Gray, Erin. 2015. *Pay for Performance: Optimizing public investments in agricultural best management practices in the Chesapeake Bay Watershed*. Ecological Economics 118 (2015) 252–261
65. Maryland Department of the Environment. 2015. Bay Restoration Fund Advisory Committee Annual Status Report. http://www.mde.state.md.us/programs/Water/BayRestorationFund/Documents/2015%20BRF%20Report%20-%20Final.pdf
66. Pennsylvania Department of Environmental Protection (PA DEP). 2015. Nutrient Trading. http://www.dep.pa.gov/Business/Water/PointNonPointMgmt/NutrientTrading/Pages/default.aspx#.Vpau_PkrIgs
67. King, Dennis and Patrick Hagan. 2012. *Costs of Stormwater Management Practices In Maryland Counties*. Ref. No. [UMCES] CBL 11-043. Prepared for Maryland Department of the Environment Science Services Administration (MDESSA) Maryland Department of the Environment. 2015. Bay Restoration Fund Advisory Committee Annual Status Report. http://www.mde.state.md.us/programs/Water/BayRestorationFund/Documents/2015%20BRF%20Report%20-%20Final.pdf
68. Pennsylvania Department of Environmental Protection. *Stormwater Best Practices Manual.*
69. New Jersey Department of Environmental Protection, 2007. *Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources.*
70. Doug Tallamy, 2007. *Bringing Nature Home*. Algonquin Books.
71. Conservation Fund, 2006. *Forests of the Chesapeake Bay Watershed*.
72. Kauffman, Gerald; Homsey, Andrew; McVey, Erin; Mack, Stacey; Chatterson, Sarah. 2011. *Socioeconomic Value of the Chesapeake Bay Watershed in Delaware*. Prepared for Watershed Assessment Section Division of Watershed Stewardship Delaware Department of Natural Resources and Environmental Control.
73. Ducks Unlimited. 2014. *Annual Report Fiscal Year 2013*. http://www.ducks.org/resources/media/About%20DU/Annual%20Report/2013/2013AnnualReport_Full_FINAL.pdf
74. *Delaware Habitat Restoration*. 2001. Partners of the Fish and Wildlife Program. U.S. Fish and Wildlife Service.
75. Krieger, D. J., 2001. *Economic Value of Forest Ecosystem Services: A Review*. The Wilderness Society. 31 pp.
76. Dan Brauning. 2016. Pennsylvania Game Commission, personal communication.
77. Ingraham, M. and S. G. Foster. 2008. The Value of Ecosystem Services. Provided by the U. S. National Wildlife Refuge System in the Contiguous U.S. *Ecological Economics*. 67:608-618.
78. Pennsylvania Department of Environmental Protection. *Stream Releaf: A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams*. https://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StreamReleaf/Forestbufftool/ReLeaf_Plan.pdf
79. NCRS Tree Planting Program.
80. Pennsylvania Fish and Boat Commission, Fish Kill Fines.
81. Weber, Bob and Tome Greene. 2016. *Pennsylvania's Wild Trout Streams*. Pennsylvania Fish and Boat Commission
82. *Program: Cost Report*. Pennsylvania Fish and Boat Commission Bureau of Fisheries, Division of Fish Production

83. Moore, Rebecca, Williams, T, Rodriguez, E. Cymmerthan, J.H. 2011. *Quantifying the Value of Non-Timber Ecosystem Services from Georgia's Private Forests*. Georgia Forestry Foundation.
84. United States Department of Agriculture- Natural Resource Conservation Service. 2014. *Regulatory Impact Analysis (RIA) for the Environmental Quality Incentives Program*. (EQIP). http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nc/home/?cid=stelprdb1242633
85. United States Environmental Protection Agency. 2015. *FACT SHEET: Clean Power Plan Framework*. https://www.epa.gov/cleanpowerplan/fact-sheet-clean-power-plan-framework
86. King, Dennis and Patrick Hagan. 2012. *Costs of Stormwater Management Practices In Maryland Counties*. Ref. No. [UMCES] CBL 11-043. Prepared for Maryland Department of the Environment Science Services Administration (MDESSA) Maryland Department of the Environment. 2015. Bay Restoration Fund Advisory Committee Annual Status Report. http://www.mde.state.md.us/programs/Water/BayRestorationFund/Documents/2015%20BRF%20Report%20-%20Final.pdf
87. Pennsylvania Department of Environmental Protection. *Stormwater Best Practices Manual.*
88. Rosenberg, K.V., R.S. Hames, R.W. Rohrbaugh, Jr., S. Barker Swarthout, J.D. Lowe, and A.A. Dhondt. 2003. *A Land Manager's Guide to Improving Habitat for Forest Thrush*.
89. Jones, C., J. McCann, and S. McConville. 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*. Chesapeake Bay Critical Area Commission, Annapolis, MD. 63 pp.
90. Nature Conservancy Working Forest Program. http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/ pennsylvania/workingwoodlands/
91. Jones, C., J. McCann, and S. McConville. 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*. Chesapeake Bay Critical Area Commission, Annapolis, MD. 63 pp.
92. Newbold, J. D., Herbert, S., Sweeney, B. W., Kiry, P., & Alberts, S. J. 2010. Water Quality Functions of a 15-Year-Old Riparian Forest Buffer System. *Journal of the American Water Resources Association*. 1-12. DOI: 10.1111/j.1752-1688.2010.00421.
93. Sweeney, Bernard W. and J. Dennis Newbold. 2014. Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review. *Journal of the American Water Resources Association* 50:560-584.
94. Nowak, David J.; Crane, Daniel E.; and Stevens, Jack C. 2006. Air Pollution Removal by Urban Trees and Shrubs in the United States. *Urban Forestry and Greening*. Vol. 4: 115-123.
95. Federal Emergency Management Association, (FEMA) Flood Map Service Center
96. Fritz, K., Johnson, B., & Walters, D. 2008. Physical Indicators of Hydrologic Permanence in Forested Headwater Streams. *J. N. Am. Benthol. Soc.* 27(3). 690–704. DOI: 10.1899/07–117.1.
97. Gregory, S.V., Swanson, F.J. McKee W.A., Cummins, K.W. 1991. An Ecosystem Perspective of Riparian Zones. *Bioscience* Vol. 1. 41. No.8.
98. Forest and Range. 2016. *Wetlands Management. 2016*. Wetlands Economics and Recreation. Forest and range.org
99. http://docplayer.net/3998422-Forested-wetlands-functions-benefits-and-the-use-of-best-management-practices-united-states-department-of-agriculture.html
100. Tracy Boyer and Stephen Polasky. 2004. Valuing Urban Wetlands: A Review of Non-Market Valuation Studies. *Wetlands*. Vol. 24, No. 4. December 2004, pp. 744–755.
101. http://www.audubon.org/conservation/project/grassland-birds
102. http://www.hampshirebiodiversity.org.uk/pdf/PublishedPlans/StandingOpenWater-final.pdf

103. Laurie Greenrich.2016. Hawk Mountain Director of Long-Term Monitoring.
104. New Jersey Department of Environmental Protection, 2007. *Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources.*
105. Jones, C., J. McCann, and S. McConville. 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*. Chesapeake Bay Critical Area Commission, Annapolis, MD. 63 pp.
106. US Environmental Protection Agency. 2012. *The Economic Benefits of Protecting Healthy Watersheds*, EPA 841-N-12-004, 1.
107. Capital Regional Water Project. 2016.
108. American Lung Association. *2016 State of the Air Report*.
109. IBID.
110. IBID.
111. Nowak, David J; Crane, Daniel E.; and Stevens, Jack C. 2006. Air Pollution Removal by Urban Trees and Shrubs in the United States. *Urban Forestry and Greening.* Vol. 4: 115-123.
112. IBID.
113. IBID.
114. IBID.
115. IBID.
116. IBID.
117. IBID.
118. IBID.
119. IBID.
120. IMPLAN.com
121. US Fish and Wildlife Service. 2011. *National Survey of Fishing, Hunting and Wildlife Watching.*
122. Jim Warrenfeltz. *Runners World*. July 22, 2013.
123. Department of Conservation and Natural Resources (DCNR). *2009 Outdoor Recreation Participation Survey.*
124. Outdoor Recreation Foundation. *2013 Participation Survey*.
125. Center for Disease Control and Prevention. 2012. *The Benefits of Walking*.
126. .US Fish and Wildlife Service. 2011. *National Survey of Fishing, Hunting and Wildlife Watching.*
127. Department of Conservation and Natural Resources (DCNR). *2014 Outdoor Recreation Participation Survey*.
128. Department of Conservation and Natural Resources (DCNR). *2014 Outdoor Recreation Participation Survey, South Central Region Survey*.
129. Lehigh Valley Planning Commission. 2015. *Lehigh Valley* Return on Environment*: The Economic Value of Open Space in the Lehigh Valley*.
130. U.S Fish and Wildlife Service. 2011. *National Survey of Fishing, Hunting and Wildlife Watching.*
131. Department of Conservation and Natural Resources (DCNR). 2009. *Outdoor Recreation Participation Survey*.
132. Outdoor Industry Association. 2011. *Outdoor Recreation Survey*.
133. Shields, Martin. 2010. *Economic Contribution and Impact of Angling on the Middle and Lower Susquehanna, and Lower Juniata Rivers*. Pennsylvania Fish and Boat Commission.
134. Lehigh Valley Planning Commission. 2015. *Lehigh Valley* Return on Environment*: The Economic Value of Open Space in the Lehigh Valley*.
135. Jim Warrenfeltz. *Runners World*. July 22, 2013.
136. Delaware Valley Regional Planning Commission and Green Space Alliance (2011) Return on Environment: *The Economic Value of Protected Open Space in Southeastern Pennsylvania*.
137. Dauphin County GIS, 2016. mbirch@dauphinco.org
138. PA Department of Environmental Protection. 2009. *Pennsylvania Water Plan*.
139. DCNR. 2014. *Outdoor Recreation Participation Survey*.
140. World Economic Forum, 2016. *The Global Risks Report*. 11th edition.

141. http://www.bayjournal.com/article/lawns_turf_the_largest_of_all_plantings_in_Chesapeake_Bay region
142. Conservation Fund. 2006. *Forests of the Chesapeake BayWatershed*.
143. Crompton, J. L. 2007. *The Impact of Parks and Open Spaces on Property Taxes*. *The Economic Benefits of Land Conservation.* Ed. Constance T.F. de Brun. The Trust for Public Land. 1-12.
144. Knight Foundation *Soul of the Community Study*. 2010.
145. Morgan Graves, et.al., 2004. Demographic and socioeconomic research team: Research Highlights. *Baltimore Ecosystem Study*.
146. Michael Behney, MURP; Sue Copella; Jennifer Shultz; Debbie Bowalik; Aaron Koontz; Larry Meyers and Michael Kotovsky. 2014. *Pennsylvania Population Projections 2010-2040*. The Center for Rural Pennsylvania.
147. US Environmental Protection Agency. 2012. *The Economic Benefits of Protecting Healthy Watersheds*., EPA 841-N-12-004, 1. Retrieved from: http://water.epa.gov/polwaste/nps/watershed/upload/economic_benefits_factsheet3.pdf
148. DCNR. 2014. *Outdoor Recreation Participation Survey*.
149. http://www.gallup.com/poll/168017/americans-again-pick-environment-economic-growth.aspx
150. U.S Department of Commerce, Census Bureau. 2013. American Fact-Finder. *Profile of General Population and Housing Statistics*.
151. Michael Porter, 1996. What Is Strategy? *Harvard Business Review*. November/December.
152. Rogers, John. 2011. *Designing With Natives*.
153. U.S Department of Commerce, Census Bureau, 2013. American Fact-Finder. *Profile of General Population and Housing Statistics*.