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Blue Mountain Sports

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Peterson's Ski and Cycle

Pocono Biking

White Water Challengers

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Audubon Pennsylvania

Blue Mountain Resort

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The Kittatinny Coalition is a group of land trusts, conservation organizations, state and federal government agencies, and academic institutions working with municipal officials and private landowners to conserve the natural, scenic, cultural, and aesthetic resources of the Kittatinny Ridge and Corridor.

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Photo: Mark Zakutansky

White Haven resident Regina Nicolardi enjoys dam-release whitewater in Lehigh Gorge State Park.

01 // EXECUTIVE SUMMARY

Nature is one of Carbon County's major competitive advantages for future economic growth

More than just pretty places, Carbon County's forested ridges and stream valleys are productive assets that generate over \$800 million annually in avoided costs for natural system services and air pollution removal, revenues from outdoor recreation and local and state taxes, and increased tax revenues from real estate premiums (Figure 1). Its resources have historically provided essential goods and services to ensure the survival and economic prosperity of residents and the millions of people who live close by and downstream.

Carbon County supplies communities with sparkling clean drinking water, critical wildlife habitats, food protection, and impressive recreational and tourism opportunities. Seasonal outdoor recreation activities attract millions of visitors annually, playing an important role during tough economic times.

The biggest challenge facing Carbon County is promoting sustainable economic growth while maintaining its high quality of life, low cost of living, good health, and the unique sense of place that has been the region's hallmark for hundreds of years. The careful protection, management, and use of its natural resources are essential to the long-term sustainability of nature and the local and regional economies.

FIGURE 01 // CARBON COUNTY ANNUAL RETURN ON ENVIRONMENT

AVOIDED COSTS

- // Natural system services: \$652.4 million
- // Air pollution removal impact on health: \$7.9 million

OUTDOOR RECREATION REVENUES

- // Outdoor recreation: \$108.8 million
- // Jobs: 823
- // Economic output: \$26.5 million
- // State and local taxes: \$5.1 million

OPEN SPACE IMPACT ON PROPERTY VALUE

- // \$14.4 million in added annual property tax revenue from properties in proximity to water

NATURE IS SERIOUS BUSINESS

The economic benefits presented in this report are a new way to provide government officials, businesses, and residents with a perspective on the value of natural system services, and should contribute to informed decisions concerning land use, economic development, safety, tourism, and recreation.

Natural system services are the benefits we receive from nature—free of charge. Since Mother Nature does not write receipts, nature's financial value is often overlooked or undervalued in policy debates, investment decisions, and personal choices.

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

Given these financial values, it becomes apparent that it's very difficult to have a strong economy without a healthy environment and plenty of open space. Once lost, regaining nature's full capacity can take 50 to 100 years. In the meantime, these services must be replaced at the taxpayers' expense. That's why conservation in Carbon County can be a good long-term business strategy.

FIGURE 02 // ROE VALUATION BENEFITS

- // Nature's complex system is conveyed in a simple bottom line that is understandable to a broad audience.
- // Dollars, as a financial measure, underscore nature's connection to quality of life, health, cost of living, economy, and sense of place—and convey a level of significance or priority to allow for a better trade-off analysis.
- // Monetary estimates of the value of natural system services can be applied within decision frameworks related to land use, tourism, and economic development.
- // 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.
- // Economic valuation of natural system services and biodiversity can make the value of protecting natural system services explicit to policymakers, investors, and homeowners.

CARBON COUNTY IS IN TRANSITION

Over the next 20 years, the interests of aging adults and millennials will drive economic growth. The trends of changing demographics, growth in nearby areas, increased

demand for outdoor recreation, interest in healthy lifestyles and adventure experiences, investments in water quality, agriculture needs, internet access, changing forms of business, and changing climate conditions will all impact Carbon County's future.

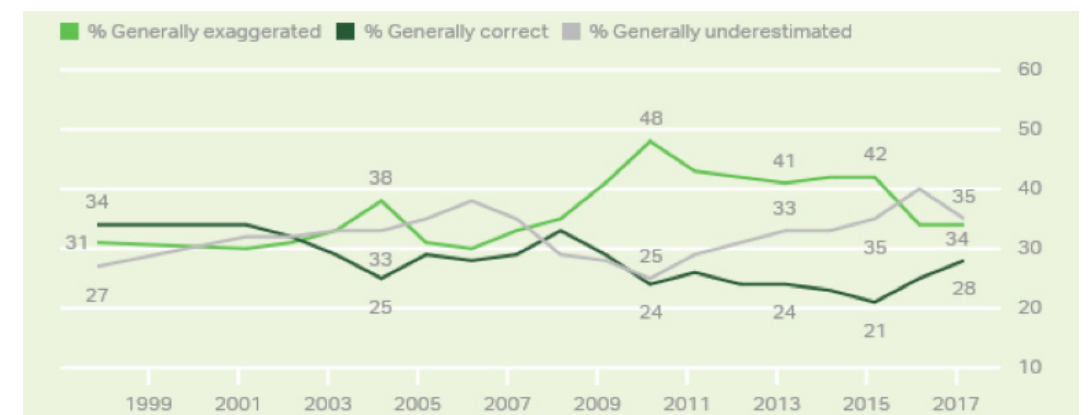
The county's clean air and water, scenic views, easy access to beautiful state and local parks, one of the best white-water rafting rivers in the Northeast, migrating birds, the Appalachian and Delaware and Lehigh (D&L) Trails, and many other outdoor recreation opportunities are the major quality-of-life assets that residents (many of whom are willing to commute an hour or more), second-home dwellers, businesses, and visitors seek and enjoy. This makes Carbon County uniquely positioned to take advantage of many of these trends.

ATTITUDES TOWARD THE ENVIRONMENT ARE CHANGING

Over the past 30 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 65.¹ American attitudes toward the environment paint a complicated picture that sometimes raises more questions than answers.

Gallup's 2017 survey found that Americans care about the quality of the environment, but focus more on immediate environmental insults than on issues like climate, which they consider a long-term threat. Recently, more Americans think that reports of the danger posed by the climate crisis are understated. Nevertheless, most do not see a climate crisis and consider most other policy issues more urgent than climate change.²

FIGURE 03 // IS THE SERIOUSNESS OF GLOBAL WARMING GENERALLY EXAGGERATED, GENERALLY CORRECT, OR GENERALLY UNDERESTIMATED?



Source: Gallup

A generational shift is under way, with younger people more supportive of environmental protection than older people. Millennials (born between 1980 and 2000) are not only different from previous generations, but also more numerous than any generation since the soon-to-retire baby boomers. Their use of technology sets them apart, and one of their defining characteristics is their affinity with the digital world. They also want a flexible approach to work and opportunities to live a healthy lifestyle.³ Millennials already comprise 25 percent of the workforce in the United States and are beginning to make money, buy homes, and expand the economy.⁴

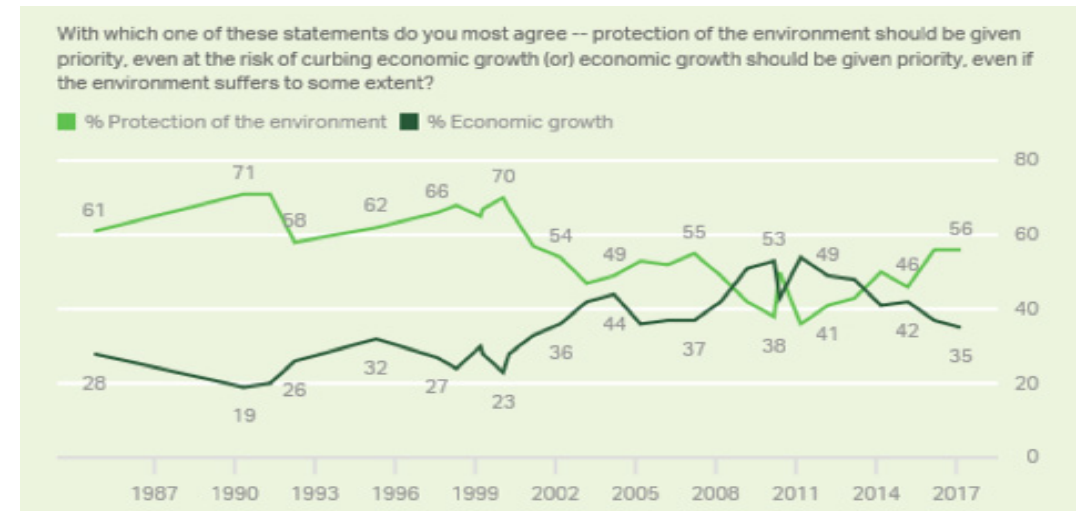
Finally, the decline in environmentalism that occurred during the Great Recession has been reversed, as Americans again oppose economic development that threatens environmental quality.⁵ According to a new poll, 76 percent of millennials say they are more focused on the environment than their parents' generation. In a 2017 Gallup survey, 66 percent of millennials say there is "solid evidence" that the earth is getting warmer, and 75 percent of those respondents believe human activity is the cause.⁶

THE USE OF LAND IS BY FAR THE GREATEST OPPORTUNITY TO MAKE MAJOR FINANCIAL CHANGES⁷

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—and many still continue. The greatest financial leverage on open space and sustainable environmental and economic health is how land is used.

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 saves communities money because it consumes less land and requires fewer roads and resources, as well as less utility infrastructure. And, studies have shown that people are willing to pay a premium to live in conservation developments, which provide greater revenues to local communities.⁸

FIGURE 04 // ENVIRONMENTAL PROTECTION VS. ECONOMIC GROWTH



Source: Gallup

BIODIVERSITY IS CENTRAL TO MAXIMIZING NATURE’S ECOLOGICAL AND FINANCIAL VALUE

Native plants are the foundation for all life and control local biological diversity. They help drive natural system services like photosynthesis, pest control, pollination, erosion control, soil formation, water purification and the generation of oxygen, and clean air. Additionally, they support 29 times more biological diversity than non-native plants.

Biological diversity creates topsoil out of rock, and helps buffer extreme weather events such as droughts and floods. It 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 of streams. And now, with human-induced climate change threatening the planet, native plants and biological diversity will help remove carbon from the air and sequester it in living plants.⁹

The two major causes of biological diversity loss are forest fragmentation and non-native, invasive plants. Habitat size, shape, and topography all play a role in sustaining biological diversity.¹⁰ The large forests of the state and 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.

FIGURE 05 // THE BEST WAYS TO SUSTAIN AND EXPAND NATURAL SYSTEM SERVICES

- // Protect water quality at its source in headwaters and wetlands, and along riparian areas.
- // Protect large forests, particularly on steep slopes, connect wildlife habitats, and maintain and restore tree canopy cover.
- // Remove invasive plants by minimizing disturbance (edges, clearings) in natural areas.
- // Remove obsolete dams to improve water quality and aquatic habitats.
- // Minimize impermeable surfaces and limit turf grass to areas essential for recreation and landscape access.
- // Practice good stewardship and incentivize the use of native plants in the landscape of commercial, government, and residential areas surrounding parks, preserves, riparian areas, and trails.

DEMAND FOR OUTDOOR RECREATION IS INCREASING AND MAY HELP ATTRACT FUTURE GROWTH

The outdoor recreation industry is strong and growing, generating \$646 billion annually in the United States. By comparison, gasoline and other fuels yield \$354 billion annually.¹¹ Thirty-one percent of Pennsylvanians surveyed during the Pennsylvania Department of Conservation and Natural Resources (DCNR) 2014 Outdoor Recreation Participation Survey of Pennsylvania said they planned to spend more time outdoors.¹² That equates to 20,189 Carbon County residents.

Carbon County is host to diverse natural, historic, and cultural resources. It 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. However, the demand for outdoor recreation in Carbon County is larger than the business capacity to meet it, and much of the retail business related to outdoor recreation leaks into surrounding areas.

About half of the region's baby boomers plan to increase their outdoor activity, compared to 25 percent of their older counterparts. Given the overall aging population of Carbon County, outdoor activities are expected to grow.¹³ By 2025, millennials will make up 75 percent of the workforce, and these young professionals enjoy the outdoors and seek healthy and adventurous lifestyles.¹⁴

The trend for current residents is to spend more time outdoors, and this will continue with future growth. A 2015 report by the National Outdoor Foundation found that the following outdoor activities have been increasing: paddle sports, mountain biking, cross-country skiing, day hiking, bird watching, and bicycling. Local Carbon County outdoor recreation experts concur, and add fishing, running, and nature study to the list.

WE CAN'T AFFORD NOT TO PROTECT CARBON COUNTY'S OPEN SPACE

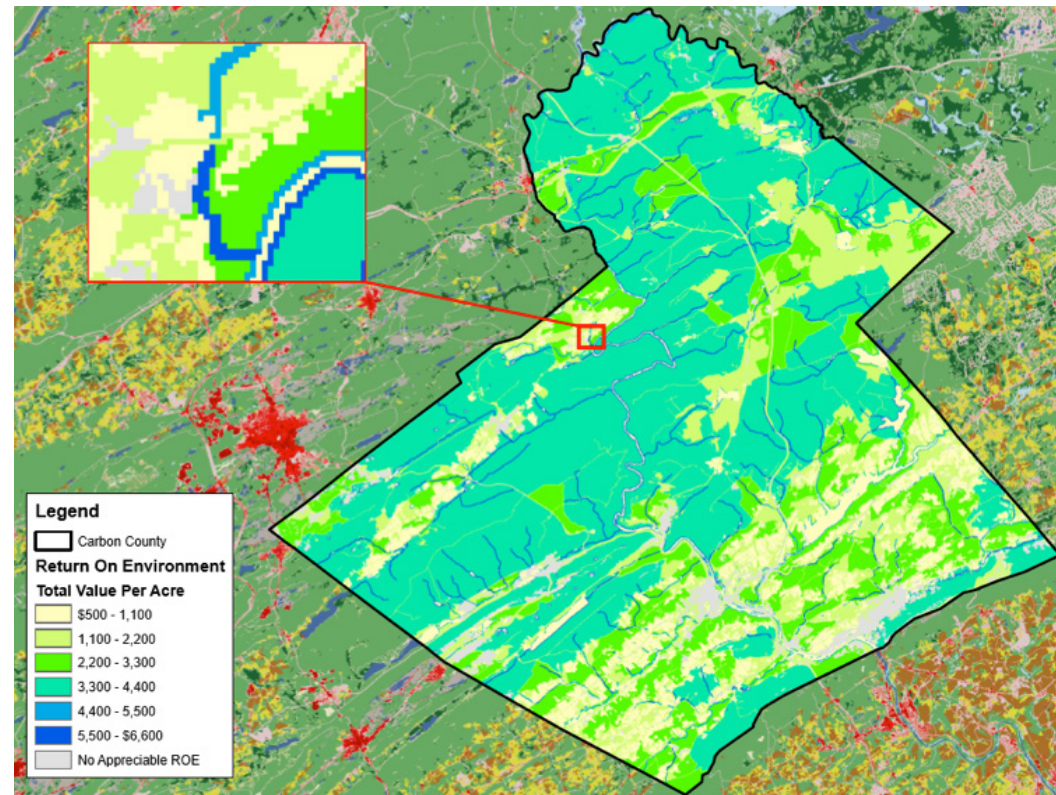
The first rule of ecology is that everything is connected to everything else. Whatever we do to natural habitats—good or bad, big or small—ripples through the economy. Simply stated, the loss of open space costs more than we know. Losing natural resources, like trees and good water quality, is a significant strategic choice. Natural systems provide a form of insurance or risk management. They work 24 hours a day, 365 days a year, and have been doing so for the last 10,000 years, free of charge.

Following the Lehigh Valley ROE report, Northampton County understood the value of nature and, based on its ROE results, returned \$2.2 million to its open space budget.¹⁵ The Lehigh Valley and Tri-County Regional planning commissions are including their ROE results in their comprehensive planning. Warrington Township, Bucks County, used ROE data to support an open space referendum that raised \$3 million.

Carbon County 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 residents' quality of life and sense of place.

Using the values listed in this report for natural county resources, Figure 6 shows higher values for more natural, undeveloped acres (darker blue) that return a higher financial value to the local economy than the more developed (yellow and gray) acres. 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 (Figure 7).

FIGURE 06 // CARBON COUNTY ROE MAP



While difficult to see from a map at this scale, the highest ROE is in green corridors along streams and creeks, with the second highest being ridges and slopes. See the map cutout.

FIGURE 07 // ARCGIS CALCULATION OF CARBON COUNTY'S LAND-COVER TYPES (IN ACRES)

FORESTS	189,484
DEVELOPED OPEN SPACE	20,187
WETLANDS	537
CROPLANDS	5,631
PASTURES	15,773
WATER	5,432
DEVELOPED/URBAN	10,561
TOTAL	247,605

PUT ROE STUDIES TO WORK

Businesses, governments, and households need to work together to manage open space in ways that result in the highest ROE. Choices made about the environment today will have a dramatic impact on the future. So it makes sense that economic development, land use, tourism, water resources, recreation, and infrastructure decisions begin with a review of the ROE analysis.

Participants in the Carbon County ROE meetings suggested the following ways to support local efforts:

- // Create incentives for stormwater management, riparian buffer restoration/expansion, and installing native plants (e.g., free trees).
- // Provide information on the financial value of open space for easement and land purchase investment decisions.
- // Reinforce landscape approaches for habitat connectivity, expansion, and protection.
- // Create strategies to reduce flooding and protect water quality.
- // Promote Carbon County as an outdoor adventure destination.

During the committee meetings, attendees listed long-term environmental issues they felt could be addressed by placing a value on natural system services, such as building awareness of the value of the environment, addressing sprawl, promoting economic growth without adversely impacting the environment, retaining and expanding employment opportunities, preserving beautiful scenery and forested mountain views, and maintaining high-quality water and clean air.

The attendees also listed ideas they believed would help solve many of these problems. The highest-rated suggestion was to integrate ROE data into existing and new practices to help protect priority habitats and safeguard vulnerable non-renewable resources (Figure 8).

FIGURE 08 // CARBON COUNTY PUTTING ROE TO WORK STRATEGY

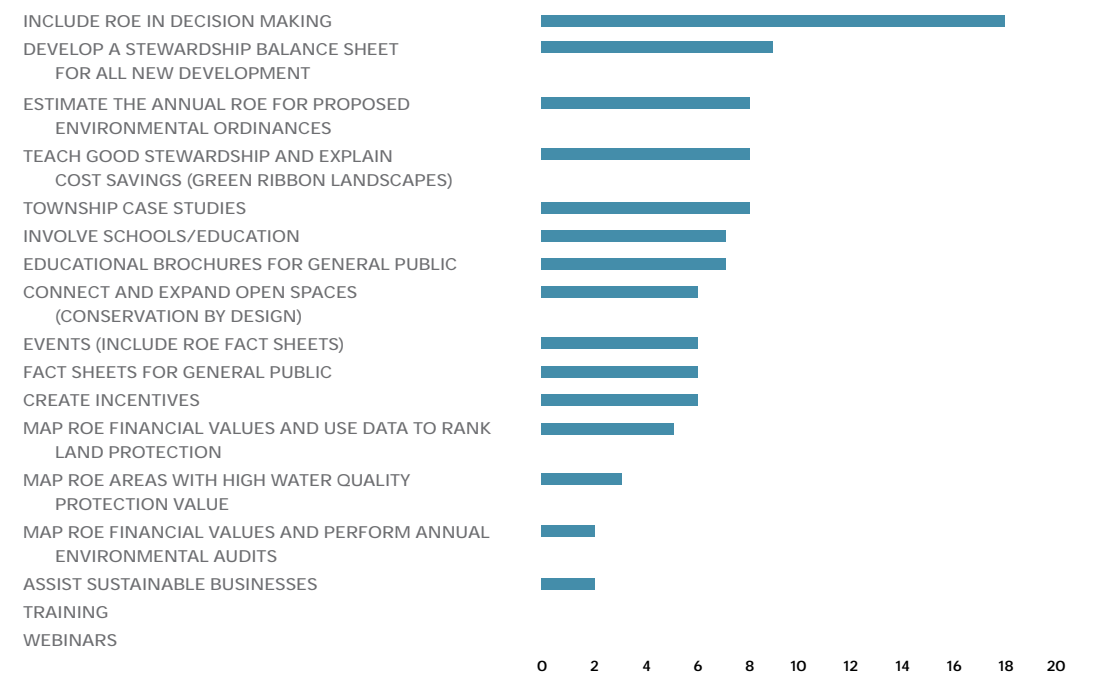




Photo: Mark Zakutansky

A Bald Eagle scans the creek for trout from its perch on Mud Run in Albrightsville, Pennsylvania.

02 // INTRODUCTION

Why an ROE?

Pennsylvania's constitution imposes a duty to conserve and maintain public natural resources for this generation and generations yet to come.¹⁶ If the goal is to maximize health, safety, and social welfare—and to conserve and maintain public natural resources—our policy process must distinguish clear and concrete economic values from which to choose.

Not understanding the financial value of nature to the local economy may bias decisions in favor of other investments. It is essential that we recognize the importance of trees, fields, forests, and streams in filtering our water, cleaning our air, mitigating floods and stormwater runoff, pollinating plants, and providing habitats and other environmental services.

By understanding nature's financial value and how it is connected to our quality of life and well-being, 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 ensures a sustainable economy.

The Carbon County ROE—supported by the William Penn Foundation's Delaware River Watershed Initiative, the Pennsylvania Department of Conservation and Natural Resources, and the Kittatinny Coalition—demonstrates how open space is integral to Carbon County's economy, health, sense of place, and cost of living.

DELAWARE RIVER WATERSHED INITIATIVE

The Delaware River Watershed Initiative (DRWI) is an unprecedented collaboration of more than 50 leading nonprofit organizations that have developed shared action plans to reduce threats to water quality in carefully targeted areas.¹⁷ Informed by science, the initiative is designed to protect and restore ecological systems that provide drinking water to 15 million people and support \$25 billion in water-related jobs and industry.

The initiative identified eight sub-watershed clusters that constitute 25 percent of the river basin and include portions of Delaware, New Jersey, New York, and Pennsylvania.

Organizations working in these clusters developed shared priorities to accelerate land protection and restoration in the areas with the greatest potential for safeguarding or improving water quality.

Launched in 2014, the initiative began with a three-year, \$35 million investment from the William Penn Foundation. Working with the foundation, the Academy of Natural Sciences of Drexel University, the Open Space Institute, and the National Fish and Wildlife Foundation helped develop the initiative and are deeply engaged in its implementation, which is actively supported by many other local, state, and national partners.

UPPER LEHIGH CLUSTER

The Lehigh River supplies drinking water to hundreds of thousands of people, and the abundant forests and wetlands of the Upper Lehigh are critical to protecting water quality and quantity in the Lehigh and Delaware Rivers.

Excellent fishing areas and popular whitewater rapids bring substantial recreational and economic benefits to the region. There are 176 Natural Heritage Inventory sites in the Upper Lehigh Cluster that contain plants, animals, and habitats at risk of local or global extinction. The cluster also contains four Important Bird Areas and five Important Mammal Areas. Together these areas support species of concern and broad expanses of natural ecosystems that protect Pennsylvania's biodiversity.

Forests and wetlands remain relatively abundant, but development has become a significant stressor. Poorly planned development has started to fragment the landscape, with negative implications for wildlife habitat, forest health, and water quality. Deforestation is a major concern. A related stressor is the widespread impact of energy projects, such as new transmission lines and pipelines, on forests, streams, and wetlands, as energy companies select routes to avoid population centers. Dams have also degraded some in-stream habitat. These dams result in increased water temperature and sediment, decreased dissolved oxygen, and degraded habitat where fish live and spawn.

FOCUS AREAS

The Upper Lehigh Cluster plan addresses the stressors of development and legacy

stream alterations (dams) through a variety of projects that include land preservation, outreach to municipal and county officials, and stream-corridor restoration. The initiative organizations anticipate that this critical mass of conservation, combined with stream-corridor restoration projects, will measurably improve quality in impaired streams.

WILDLANDS: LEAD ORGANIZATION

Carbon County is in the Upper Lehigh River Watershed, one of the eight DRWI clusters. The Wildlands Conservancy was selected by the William Penn Foundation to be the lead organization in the Upper Lehigh cluster. Partnering organizations include: The Nature Conservancy, Natural Lands, Pocono Heritage Land Trust, North Branch Land Trust, North Pocono CARE, and Audubon Pennsylvania. Together, these nonprofits have identified lands in the Upper Lehigh that should be high priorities for permanent protection because of their significant natural resources and their ability to protect water quality. In addition, these organizations are working to engage local municipalities in conservation and offer assistance to improve land use and conservation planning practices and to establish local funding for land protection.

OBJECTIVES

The objectives of the Carbon County Return on Environment study were to document:

- // The monetary value of natural system services
- // The value of improved air quality relating to healthcare costs
- // The monetary value of outdoor recreation and the number of participants
- // Increased property values due to proximity to open space
- // The spatial distribution of resource value
- // The integration of new land use and habitat expansion tools into everyday practice

PROCESS

This study was assisted by a steering committee who attended four, two-hour meetings over the course of four months. They came from diverse backgrounds—interested citizens and those with experience in nonprofits, government, and business—and provided ideas, critical thinking, innovation, and data with across-the-board support.

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 healthcare costs due to forest canopy cover.
5. Assess Carbon County's natural conundrums (long-term, major environmental issues).
6. Assess how ROE can help meet Carbon County's future goals.
7. Identify ways to put ROE to work in Carbon County.

CHALLENGES

The trends of changing demographics, growth in nearby areas, increased demand for outdoor recreation, interest in healthy lifestyles and adventure experiences, investments in water quality, agriculture needs, internet access, changing forms of business, and changing climate conditions will all impact Carbon County's future. For example:

Outdoor recreation: Demand for outdoor recreation is increasing due to a growing and aging population and the quality-of-life goals of millennials.

Agriculture: While agriculture has been part of the local culture and economy for over 200 years, the remaining agricultural areas in the county are relatively small and occupy the former land that will be a target for future development. With limited space to farm, growing food locally is a concern.

Demographics: An aging population and lack of local jobs is affecting the local population and culture. After high school, many young people look for jobs outside the region or go on to college and have difficulty finding jobs back home once they graduate.

Climate: Carbon County's climate is changing. In 2012, the United States Department of Agriculture (USDA) released a new plant hardiness zone map, which contours the nation according to average annual lowest winter temperatures. The new zones analyze temperatures for the period from 1976 to 2005. While plant hardiness zones are not a tool to measure climate change, Carbon County moved one entire zone—from six to seven—during this period. This represents a distance change in annual lowest winter temperature of over 60 miles in 30 years, or two miles per year.¹⁸

These trends all point to a region in transition over the next 20 years. While the long-term impact of these changes may not be fully understood, it's clear that decisions on the use of land can create both positive and negative results on the local economy and quality of life. Being able to put a dollar value on natural system services provides information to help local officials understand and monitor their ROE.



Photo: Mark Zakutansky

The sun rises over Tank Hollow Overlook and the Lehigh River on State Game Lands 141 in Penn Forest Township.

03 // THE PLACE

Carbon County is a region in transition, and nature is a competitive advantage

Just north of the Kittatinny Ridge, beyond the Lehigh Valley, lie the green hills of Carbon County. Nestled among the Appalachian Mountains, the landscape is dominated by the Mauch Chunk Ridge, Bear Mountain, Pisgah Ridge, Mount Pisgah, Nesquehoning Ridge, and Broad Mountain, and their various forested prominences and summits.

Most of Carbon County's landscape drains to the Lehigh River as it winds through the heart of the county. The Lehigh River cuts a gorge between Jim Thorpe and White Haven that hosts the Lehigh Gorge State Park. The clean, white water of the Lehigh River is one of the best paddling places in the Northeast.

Kayaking and fishing on the Lehigh River, camping and hunting in state parks, hiking on the Appalachian or D&L Trails, hawk watching in one of Pennsylvania's largest Important Bird Areas, and ensuring the availability of naturally filtered, clean water to run businesses all depend on the rich diversity of natural resources available in Carbon County.

FIGURE 09 // CARBON COUNTY'S MAJOR ASSETS (PARTIAL LIST)

- // Driving distance to major population centers—scenery and second homes
- // Close proximity to major growth area
- // Beautiful scenery and forested mountain views
- // High-quality water
- // Water quality for resource-dependent businesses
- // Clean air
- // Great habitats for hunting and fishing
- // Adventure destination
- // Whitewater rafting
- // High-quality outdoor recreation for residents' quality of life
- // Hiking and cycling trails
- // Trail towns

- // Paddle sports
- // Skiing
- // Mountain biking
- // Running
- // Agri-tourism (farms and wineries)
- // Rail system

POPULATION

The 2015 estimated population for Carbon County's 12 boroughs and 11 townships was 65,126.¹⁹ The population is expected to remain stable or slightly decline over the next 20 years.²⁰ In Carbon County, 6.2 percent of residents are younger than five years old, 19.7 percent are younger than 18 years old, and 20 percent 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.²¹

Mark Zakutansky's Move to Carbon County for the Lifestyle

Mark is an example of someone who loves to live in Carbon County. Here is Mark's story.

"I've always been an outdoor enthusiast. After college, I got involved in the conservation field. I would always find myself traveling to Pennsylvania's Pocono Mountains on weekends and vacations to enjoy my favorite pastimes of paddling whitewater on the Lehigh River, hiking in the local state parks and the Delaware Water Gap, and downhill skiing at the resorts in the winter. My network of friends developed around this geography and these activities.

I was thrilled to finally move closer to my outdoor playground in 2009 when an opportunity came my way with the Appalachian Mountain Club in Bethlehem. Despite a near 20 percent reduction in my salary from my previous employment in New Jersey, I was willing to make the move permanently knowing that my quality of life and cost of living change would easily make up for my lower take-home pay. My wife enjoys the same outdoor pursuits as me—hiking, whitewater paddling, and downhill skiing—all of which we can do within 20 minutes of home, four seasons of the year. Many of my friends in the Poconos have similar stories. These are small business people, educators or administrators, and outdoor industry professionals."

HOUSEHOLDS

Carbon County has 34,387 housing units, with 25,751 households averaging 2.46 persons each. These are homeowners and renters who use Carbon County's natural resources.²²

INCOME

The median household income is \$49,973 and the median per capita income is \$25,398.²³

EDUCATION

A total of 88.7 percent of Carbon County residents have a high school education or higher, and 15.5 percent have a college degree or higher.²⁴

BUSINESS

Together, Carbon 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.²⁵

The forested mountains offer 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.

BUSINESS TYPES

Resource-dependent: Any business that requires a National Pollutant Discharge Elimination System (NPDES) permit to operate and relies on the quality of water upstream, such as Lehigh Cement, Carbon County Airport, and Tarheel Quarry.

Resource-based: Any business that requires natural resources as part of its product delivery process, such as water utilities, ski resorts, soft drink companies, breweries, and pharmaceutical production companies.

Recreation-based: Any business that supplies equipment or services to participants in outdoor recreation. These activities also support local restaurants, food stores, gasoline stations, and hotels.

Naturally smart: Any business that harnesses several natural system services to increase revenues or avoid costs. The Lehigh and Jim Thorpe Water Authorities use natural system services as a way to avoid additional water treatment costs and ensure user rates are invested back into the community's water system.²⁶ In 2015, The Nature Conservancy and the Bethlehem Water Authority received an award from the Northeast Pennsylvania Environmental Partners for the Working Woodlands project, which leverages large-scale land conservation for minimal cost by taking advantage of opportunities in the carbon market. The partners protected 22,000 acres of forested watershed land in Carbon and Monroe Counties, making it the largest private conservation project in Pennsylvania history.

TOURISM

Tourism in Carbon County generates \$352.1 million annually.²⁷ This represents concerts, events, and destination activities such as whitewater rafting and skiing. (Carbon County hosts three of Pennsylvania's 13 major ski resorts: Big Boulder, Blue Mountain, and Jack Frost.)

Salerno Family Farm

The Salerno family started the Foothill Farm in October 2015. The 108-acre farm currently is growing over 20,000 Christmas trees. In 2016, the Foothill Farm was designated as Community Supported Agriculture (CSA). CSAs strive to connect farms, food, and people in a mutually supportive community. CSA members pledge in advance to support a local grower for the full season and, in return, members receive shares of the produce each week of the season. The Salernos are beginning to develop a certified organic farm.

AGRICULTURE

Agriculture remains a major part of the economy of Carbon County. Carbon County, while geographically diverse, contains 21,000 acres of productive farmland, with 207 farms (one of which is organic) at an average size of 97 acres.²⁸ This farmland has fertile soils, adequate water, and favorable climate. These favorable agricultural features have shaped the agrarian history of Carbon County.

While the historical aspect of farming is valued by the county's residents, Carbon County farming also remains a productive resource that contributes to the local economy, maintains groundwater recharge areas, and provides open space that is valued by residents and tourists. Agriculture is also a major source of water pollution and a concern to the Delaware River Watershed Initiative and the Lehigh River Stocking Association.

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 Carbon 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.

NATURAL RESOURCES

FORESTS

Carbon County lies beneath the Atlantic Flyway, and its forested ridges are a major hub for bird migration. Audubon Pennsylvania notes that over 40 percent of migrating birds in the Atlantic Flyway are in conservation need.²⁹

Forests that are larger than 750–1,000 acres provide the habitat required to sustain breeding populations of wildlife. A broad-winged hawk, for example, uses a breeding area of mostly forest (80 percent) and of that forest, half or more of it is core forest (or forests greater than 1,000 feet from an edge)—around 750 to 1,000 acres total.³⁰ Areas over 500 acres are needed by migrating songbirds.

Tolerance to forest fragmentation varies. Forest shape can affect quality or amount of edge. Forests less than 150 acres in long strips are lower quality than forests 150 acres square.³¹ The goal is to maintain large, connected forests, as well as forested stream and river corridors.

TOPOGRAPHY

The geographic diversity of Carbon County creates an environment more resilient to climate change than less mountainous areas. The mountains in Carbon County are natural barriers to the movement of wind. For example, they cause eddy currents that allow migrating birds to soar. They are also colder than surrounding flatlands because temperature decreases with elevation.

Mountains are cooler on the north side than on the south side, due to less sun, and wetter on the windward side because of a temperature differential. Winds carrying moist air rise when they reach the mountain, and cool as they rise higher. Cold air cannot hold as much water as warm air and precipitation is the usual result. Therefore, Carbon County receives more rain than Philadelphia. However, the leeward side of the mountain tends to be drier because the wind loses all its moisture on the windward side and the air compresses and warms as it works its way down the mountain.³²

WATER

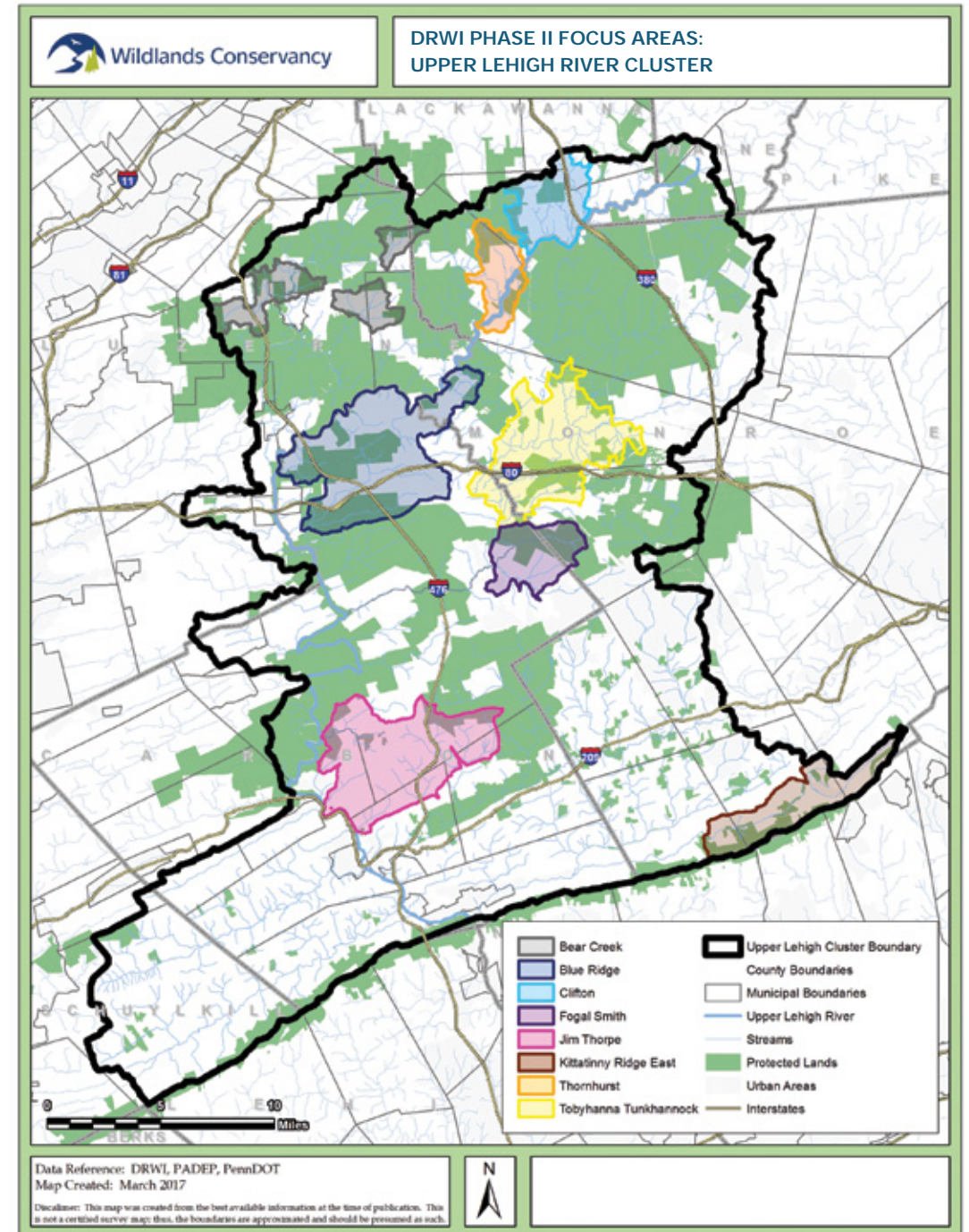
Water is one of the chief ways we will experience more frequent and dangerous extremes of climate change, through heavier downpours and resulting floods, and longer-lasting droughts and heat waves.

Carbon County's open space provides a major advantage for resilience to climate change. Its waters are filtered by the forests and support many exceptional-value and high-quality streams. As an example, the Bethlehem Water Authority manages its water treatment operations from a watershed in Carbon County. A study by the American Water Works Source Protection Committee showed that for every 10 percent increase in forest cover, water treatment costs are reduced by 20 percent. This is the equivalent of \$65,000 per year, based on a typical treatment plant in this study.³³

To ensure a sustainable future, all those with a stake in water—land managers, water utilities, hydropower operators, cities, conservation groups, and corporations—must work together to increase investment in nature as a core part of the solution to today's greatest water challenges.

PARKS, TRAILS, AND GREENWAYS

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.³⁴ Three types of day users were identified in the study:



- // Local day users are Pennsylvania residents who live within 50 miles of the park and make up 56 percent of visitation and 38 percent of total day spending.
- // Non-local day users are Pennsylvania residents who live more than 50 miles from the park and make up 28 percent of visitation and 38 percent of total day spending.
- // Non-Pennsylvania resident day users are those who live more than 50 miles from the park and make up 16 percent of visitation and 24 percent of total day spending.

The Pennsylvania DCNR conducted a study and determined that all Carbon County residents live within five miles of a trail.³⁵

Appalachian Trail: In Carbon County, the trail passes through two townships—Lower Towamensing and East Penn—for a distance of approximately 10 miles. There are at least 15 vistas in Carbon County, offering visitors and residents spectacular views, especially along the Lehigh Gap area, which is remembered by hikers long after they have left the trail.

Beltzville State Park: This 3,002-acre park is in the southern foothills of the Poconos. Pohopoco Creek, an excellent trout stream, feeds the 949-acre Beltzville Lake, which is a rest stop for migrating waterfowl and a destination for boaters and anglers. The sand beach and picnic pavilions are very popular. Recreational facilities are the result of a cooperative effort of the US Army Corps of Engineers, the DCNR Bureau of State Parks, and the Pennsylvania Game Commission.³⁶

Joe Forte's Lifestyle Fits Carbon County

"I've lived in Carbon County since second grade and have a deep passion for outdoor recreation. As a child, I went on many adventures with my family, usually "roughing it" in the back of an old Toyota pickup truck somewhere between Maine and Mexico. In my teens and 20s, I would work hard to save up my money, and then travel to a new destination every year. I've climbed, biked, fished, and paddled all over this beautiful country, visiting most of the major national parks and hundreds of state parks. These adventures have helped me appreciate the incredible beauty and natural resources of Carbon County. Nowadays, I spend my time and money adventuring locally. Instead of taking one big expensive trip per year, I stay local, and adventure on the weekends or after work. With mountains, rivers, and forests like these in our backyards, we should all be spending more of our time and money locally, here in Carbon County!"

Carbon County Environmental Education Center: The CCEEC offers a variety of educational opportunities for students from preschool through high school and college. Visitors can spend a day of fun and adventurous learning, or the CCEEC can bring the learning to different locations in the form of classroom lectures, school assemblies with live animals, or schoolyard explorations of trees, insects, fungi, and animal signs.³⁷

Hickory Run State Park: This 15,990-acre park in Carbon County lies in the western foothills of the Pocono Mountains, and boasts over 40 miles of hiking trails, three state park natural areas, and miles of trout streams. Boulder Field, a striking boulder-strewn area, is a National Natural Landmark.³⁸

Lehigh Gorge State Park: A deep, steep-walled gorge carved by a river, thick vegetation, rock outcroppings, and waterfalls characterize this park. In Luzerne and Carbon Counties in eastern Pennsylvania, the park follows the Lehigh River from the outlet of the US Army Corps of Engineers Francis E. Walter Dam at the northern end, to the town of Jim Thorpe at the southern end of the park. Whitewater boating and biking are popular activities.³⁹

Lehigh Gap Nature Center: This member-supported 501(c)(3) nonprofit conservation organization is located in Lehigh Gap, at the foot of the Kittatinny Ridge. The nature center includes the Osprey House, a "green" building used for indoor instruction and gatherings as well as a 756-acre wildlife refuge.⁴⁰ It is the only Superfund site in the country to be restored to an environmental education center.

Delaware and Lehigh (D&L) Trail: This multiuse trail in eastern Pennsylvania runs north to south from Wilkes-Barre to Bristol, east of Philadelphia. During 2012, the Rails-to-Trails Conservancy (RTC) conducted a study that analyzed data on the users of the D&L Trail between the boroughs of White Haven and Morrisville. The work was supported by a grant from the Pennsylvania DCNR. As part of the study, a survey was designed specifically to monitor trail user characteristics and the economic impact of trail visits.⁴¹

An analysis of data gathered from infrared counters located along the D&L Trail and completed user surveys indicated an estimated 282,796 annual user visits to the trail, resulting in a total economic impact in 2012 of \$19,075,921. Of this, \$16,358,201 is estimated to have been directly injected into the local economy. The northern region of the trail experienced over 70,000 trips. Along the Carbon County portion of the trail, \$7,515,440 is spent each year on recreation. The primary users are hikers and bikers, and the average user is 40–65 years old. The expenditures along this section of the trail are \$406.59 (per person) each year for hard goods (equipment, clothing) and \$43.23 for soft goods (food and drink).⁴²

Use of the trail is expected to grow as a 250-foot bridge is being built across the Lehigh River, nearly completing the D&L National Heritage Corridor in Carbon County.⁴³

Mauch Chunk Lake Park: While visiting this park located on the outskirts of historic Jim Thorpe, visitors enjoy Mother Nature on the 2.8-mile Mauch Chunk Lake, and walk or bike on Switchback Gravity Railroad and many other trails.⁴⁴

Switchback Trail: One of the most popular trails in Carbon County since it opened more than 80 years ago, this was one of the first rail-to-trail projects in the nation. The trail follows the route of the former Switchback Gravity Railroad and can be accessed near the main entrance to the park. The 8.3-mile trail is designated for hiking and biking. Hikers of all ages enjoy the uneven, aged forest tract below the dam where towering hemlocks, white pines, and American beech dominate the overstory. The shaded trail runs parallel to the Mauch Chunk Creek and provides easy access to fishing. Mountain bikers enjoy the trail as it leads to Mount Pisgah, where there is a magnificent overlook of the Lehigh Gorge State Park.

FIGURE 10 // ECONOMIC IMPACTS OF STATE PARKS AND TRAILS

PARKS	VISITATION	ANNUAL SPENDING (2017 \$ IN MILLIONS)	JOBS
BELTZVILLE STATE PARK ⁴⁵	223,047	\$13.45	166
LEHIGH GORGE STATE PARK ⁴⁶	147,977	\$12.99	206
HICKORY RUN STATE PARK ⁴⁷	115,278	\$11.82	177
D&L TRAIL ⁴⁸	70,000	\$7.51	Data unavailable



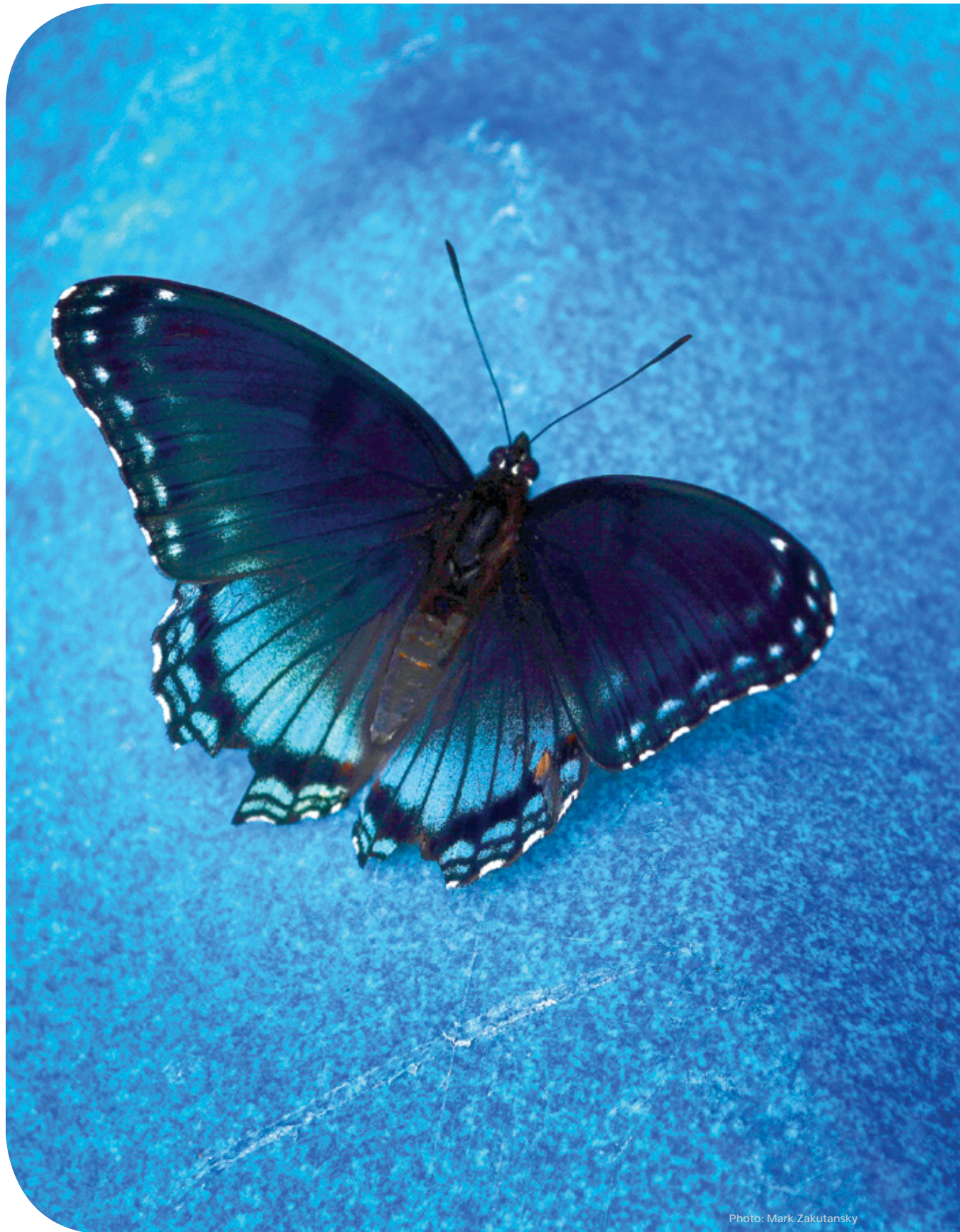


Photo: Mark Zakutansky

A Red-Spotted Purple butterfly (*Limenitis arthemis*) alights on a whitewater kayak along the Lehigh River.

04 // METHODOLOGY

How ROE values are calculated

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

- // Avoided costs associated with natural system services provided by Carbon County's open spaces
- // Avoided costs associated with air pollution removal
- // Value of open space related to outdoor recreation (e.g., sale of goods and services)
- // Impact of open space and water 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 food defense provided by forests. Over time, billions of tons of carbon are stored in Carbon County forests. Forests and meadows also support natural pollination and biological control of insects and rodents.

Building on previous valuation studies and using standard economic analysis techniques, this study estimated the financial value of Carbon County's open space by measuring the financial impacts of avoided costs from natural system services and air pollution removal, outdoor recreation revenues, and increased property values due to proximity to open space.

In Carbon County's ROE study, 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 instead go elsewhere. Because of this, estimates of recreational value in this study should be understood to represent only 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.

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's natural system service value for considerably less time and expense than a new primary study (Figure 11). VT information for this report was obtained from the 2011 satellite-derived land cover data from the MRLC Consortium.⁴⁹

FIGURE 11 // VALUE TRANSFER MODEL FOR NATURAL SYSTEM SERVICES



NATURAL SYSTEM SERVICES

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 Carbon 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 taxpayers' expense.

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, including:

- // Avoided cost (AC)
- // Contingent valuation (CV)
- // Cost of damage (CD)
- // Cost of regulation (CR)
- // Direct investment in a resource (DI)
- // Direct market valuation (DM)
- // Market valuation (MV)
- // Replacement cost (RC)
- // Tax benefits (TB)
- // Travel cost (TC)

See Glossary for full definitions.

NATURAL SYSTEM SERVICES METHODOLOGY

The value of natural system services is a reflection of what price people and governments are willing to pay to conserve, restore, and expand these natural resources.⁵⁰ This method is known as eco-pricing and is used in ROE studies to develop a list of natural system services provided by forests, wetlands, and riparian and grassland areas in Pennsylvania. Most of these services do not have established markets, making estimates difficult. These estimates are based primarily on transfer of data from peer-reviewed studies, as well as data from regulatory fines, nutrient trading, forest production, habitat replacement costs, tax benefits, and easement values.

As part of an effort to document eco-prices relevant to Pennsylvania, several state agencies provided information:

- // Pennsylvania DCNR—Forestry Division
- // Pennsylvania Fish and Boat Commission
- // Pennsylvania Game Commission
- // Maryland Department of Natural Resources

Campbell (2016) reviewed and summarized over 55 academic studies comprising 210 individual value estimates for the types of ecosystems present in the state of Maryland.⁵¹ Weber reviewed over 80 peer-reviewed articles in Cecil County, Maryland.⁵² Costanza reviewed over 100 peer-reviewed articles in a similar study in New Jersey.⁵³

Due to the similarity of climate, land cover, and ecosystems of Maryland and New Jersey, we relied on these data as well. Data from Maryland and New Jersey was used where Pennsylvania data was not available. Data from elsewhere in the United States was a third choice.

Figure 12 contains 72 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). Eight economic classifications (investment, replacement cost, avoidance cost, market price, cost of regulation, cost of damages, taxes incurred, and tax benefit) were reviewed.

FIGURE 12 // STUDIES REVIEWED BY CAMPBELL, ROGERS, AND COSTANZA

NATURAL SYSTEM SERVICE	NUMBER OF FINANCIAL EXCHANGES USED IN DEVELOPING ECO-PRICES
GROUNDWATER	5
NUTRIENT UPTAKE	14
STORMWATER AND FLOOD MITIGATION	27
AQUATIC RESOURCES	3
HABITAT	11
HABITAT REGENERATION	4
EROSION PREVENTION	4
POLLINATION	2
BIOLOGICAL CONTROL	2

In cases where there was a range of values for a given service, we chose the most conservative number. All dollar figures were transformed to 2017 equivalents, using an online inflation calculator (<http://www.westegg.com/inflation/>), which employs the Consumer Price Index from the annual Statistical Abstracts of the United States.

These numbers are estimates only and have several issues to consider. Many times, the data are not spatially explicit. Some services, like pollination, depend on proximity to crops, yet not all forests in the county are within pollinator range of cropland. The value of food protection, groundwater recharge, and other services also depends on human demand relative to supply. This ratio tends to be higher in urban areas than rural.

Similarly, not all forest and wetland types provide services equally. 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, and so on remove nitrogen at different rates on an annual basis.⁵⁴

Other examples include soils and carbon sequestration. More productive soils facilitate faster plant growth and faster uptake of carbon. Some tree species are better at carbon uptake than others.

Using eco-prices, an annual benefit can be calculated for each natural system.

Further, large, contiguous blocks of forest and wetland are more likely to contain fully functioning ecosystems and provide corresponding benefits to humans. Smaller, fragmented ecosystems are more likely to be impaired.^{55 56 57 58} Retaining connectivity using configured corridors can help to offset some of the functional losses caused by fragmentation.^{59 60 61 62 63 64}

Finally, using some services may impair other services. For example, constructing trails for recreation can create more opportunities for invasive species. Proper management is therefore necessary to prevent long-term ecological degradation.

We attempted to overcome these concerns in the following ways:

- // Each cover type was distinguished by one or more eco-price.
- // Eco-prices varied by cover types.
- // Position in the landscape distinguished cover types (headwaters versus riparian forests).
- // Locational differences were used as separate cover types (urban versus rural)
- // Forest size was used to differentiate cover types (750 acres, 500–750 acres, 150–500 acres and less than 150 acres).
- // Current uses or practices, like working forests and developed open space, were also used to differentiate cover types.

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

NATURAL SYSTEM SERVICES 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 Carbon 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 Pennsylvania and Maryland.^{65 66 67}

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.⁶⁸

The nutrient category included fourteen eco-prices. Eleven are prices per pound of nutrient removed.⁶⁹ These were averaged, with the cost of implementing best

management practices (BMP) cost share and cost of nutrient removal retrofits on water treatment facilities.⁷⁰ Also included in this category is the price of nitrogen in the Pennsylvania nutrient trading market⁷¹ and studies on the value of trees in reducing water treatment costs.⁷²

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.^{73 74}

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.⁷⁵

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.⁷⁶

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.^{77 78 79 80 81 82 83 84 85}

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.^{86 87}

Aquatic habitat: The Pennsylvania Fish and Boat Commission (PFBC) 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.^{88 89 90}

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 colony collapse continues to be an issue. This eco-price is based on a valuation study and the cost of replacing bee hives.^{91 92}

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.^{93 94 95 96}

NATURAL SYSTEM LAND-COVER TYPES

Forests over 750 acres are sustainable forests that support breeding populations of migrating birds and larger mammals. In the case of forests over 750 acres in size, consideration was given to the costs of relocating species that require areas of this size to sustain.⁹⁷

Large regenerating forests are forests over 500 acres that support sustainable wildlife populations. The eco-prices that distinguish this category are based on the quality of habitat, regenerating forests and sustainable populations of birds and wildlife.^{98 99}

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.¹⁰⁰

Forests under 150 acres (small forests) allow light to penetrate from all sides, thus promoting invasive species of plants. This retards natural regeneration. The services provided by these forests are useful only as long as the forest exists.¹⁰¹

Riparian forests (100 feet on either side of a stream) help stabilize banks and, due to the presence of water, attract wider biological diversity than upland forests. Some studies estimate the biological diversity to be double.^{102 103}

Urban forests can be any size. Except in rare instances where the urban forest is

large and connected, such as Fairmount 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 with stormwater management, but they provide very little groundwater recharge.¹⁰⁴

Floodplain forests are within the 100-year floodplain boundary.¹⁰⁵

Headwater forests and wetlands (100 feet on either side of a stream), classified as first-order streams, are designated as having exceptional value and high quality. Headwaters often make up 50–70 percent of a watershed.¹⁰⁶ These streams have some of the cleanest water in Pennsylvania. The water provides an excellent habitat for native trout and other aquatic organisms.¹⁰⁷

Forested wetlands have high biological diversity, as most wildlife needs water for survival.¹⁰⁸

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.¹⁰⁹

Urban wetlands impact urban populations. They have a limited role in groundwater recharge, as they are usually located at the base of streams.¹¹⁰

Cultivated fields can change vegetation from year to year; however, they do serve a value for many species of birds and other wildlife. They help to support pollinator species and biological control.¹¹¹ Cultivated fields can also be a source of sediment, pesticides, and fertilizers that pollute water bodies and streams.

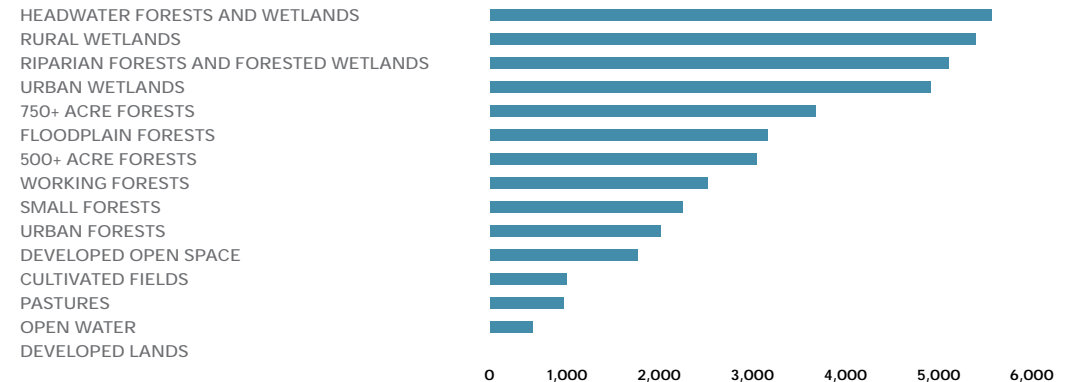
Pastures support pollinator species and biological control.¹¹² Most state endangered bird species are associated with pastures and wetlands.¹¹³ However, pastures can be a source of pollution, because the soils are compacted and provide only a small value in runoff control.

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.¹¹⁴

Developed open space includes parks and preserves with less than 30 percent 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.¹¹⁵

Developed lands are urban areas with greater than 30 percent impervious cover. These areas often create more problems than benefits for natural systems.¹¹⁶

FIGURE 13 // FINANCIAL VALUE PER ACRE OF CARBON COUNTY LAND-COVER TYPES



AIR POLLUTION REMOVAL

The Clean Air Act (CAA) requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. A nonattainment area is any area that does not meet the primary or secondary NAAQS. Once a nonattainment area meets the standards and additional redesignation requirements in the CAA [Section 107(d)(3)(E)], EPA will designate the area as a maintenance area.

Carbon County has been designated as part of the Allentown-Bethlehem-Easton nonattainment area under the 2008 eight-hour ozone NAAQS. Transportation conformity requires nonattainment and maintenance areas to demonstrate that all future transportation projects will not prevent an area from reaching its air quality attainment goals.

Ozone is formed by chemical reactions occurring under specific atmospheric conditions. Precursor pollutants that contribute to the formation of ozone include volatile organic compounds (VOC) and oxides of nitrogen (NOx), both of which are components of vehicle exhaust. VOCs may also be produced through the evaporation of vehicle fuel, as well as by displacement of vapors in the gas tank during refueling. By controlling VOC and NOx emissions, ozone formation can be mitigated. Both precursor pollutants are analyzed in the transportation conformity process. Air pollution can also damage

buildings and plants, disrupt many natural system services, and cause reduced visibility.

AIR POLLUTION REMOVAL METHODOLOGY

Total pollutant removal values for each pollutant vary, depending on the amount of tree canopy cover; increased tree cover leads to greater total removal and greater pollutant removal values. As trees die and decay, they release much of their 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.¹¹⁷

The i-Tree Landscape Model (Figure 14) developed by the US Forest Service was used to estimate the air pollution removal and carbon sequestration and storage rates of Carbon County's tree cover. The model uses National Land Cover Datasets 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.

FIGURE 14 // I-TREE LANDSCAPE MODEL PROCESS¹¹⁸



OUTDOOR RECREATION

Outdoor recreation includes those activities that can be performed in natural settings, without causing harm. Resident levels of participation and direct annual spending were tracked across 14 recreational activity categories. This list was compiled by reviewing the major activities in the DCNR 2014 Outdoor Recreation Participation Survey and having discussions with the Carbon County ROE steering committee members. 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 major recreational activities identified for Carbon 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, bird watching and photography)
- // Outdoor education (nature study)
- // Downhill skiing
- // Mountain biking
- // Cross-country skiing

OUTDOOR RECREATION METHODOLOGY

IMPLAN is an economic impact assessment software system that was used to assess the change in overall economic activity as a result of change in one or several specific economic activities. Economic activity can be either outside the region or reflected in transactions between people and businesses within Carbon 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 15).

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.

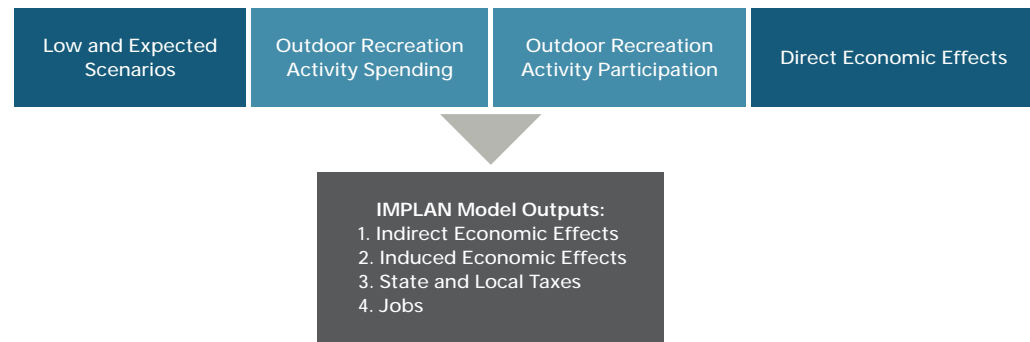
Indirect effects measure how sales in one industry affect the other industries that provide supplies and support. For example, an angler buys fishing rods, hats, hip boots, gasoline and food, which may be produced in other parts of the state, country or world.

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 Carbon County's economic and demographic data. Indirect and induced economic effects, along with employment and state and local taxes, were analyzed for the 14 previously identified outdoor recreation activities.¹¹⁹

FIGURE 15 // IMPLAN ECONOMIC IMPACT ASSESSMENT TOOL



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

1. Researching existing published surveys that collected 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 Carbon County.
4. Creating a set of expected estimates for participation and spending.

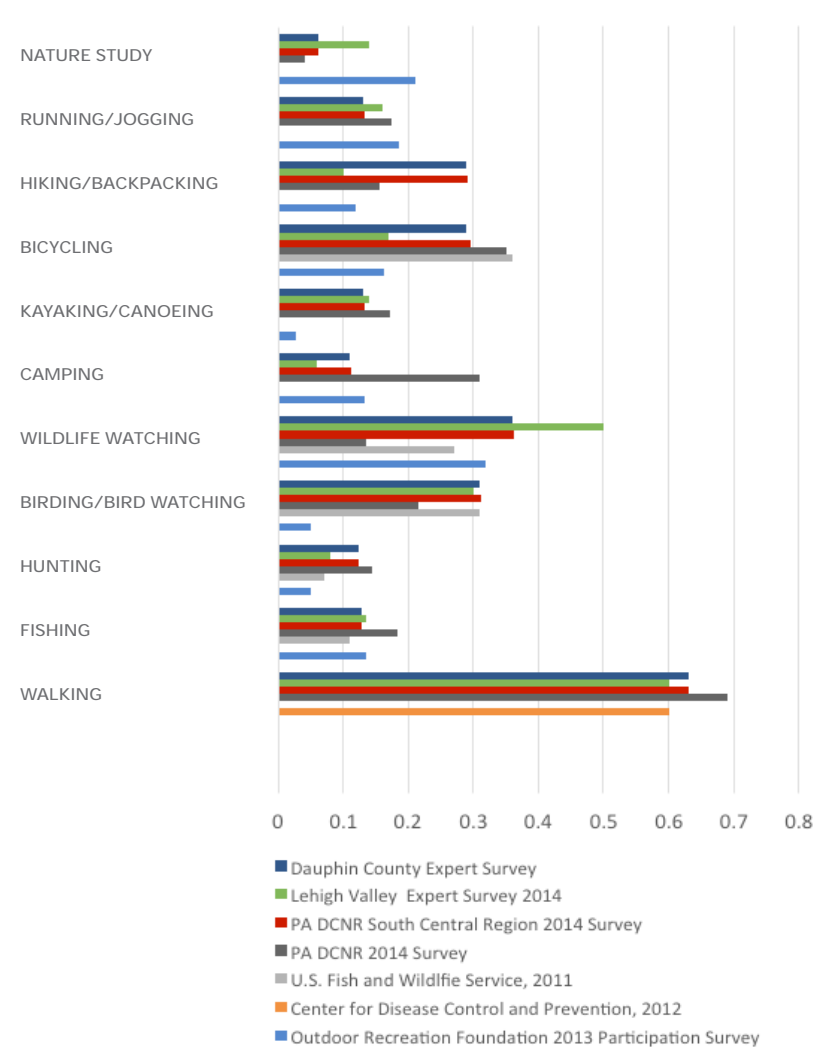
While not all surveys collect information in the same data categories, there are some consistencies. Most surveys provide information on a majority of activities, participation rates, and spending. The rate of participation and levels of spending depend on the recreational activity. Statistics on some 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 16 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 US Fish and Wildlife Service 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 provides information on a state-by-state basis. This survey is a well-established reference for fishing, hunting, and wildlife watching.¹²⁰

FIGURE 16 // COMPARISON OF NATIONAL, STATE, AND REGIONAL SURVEY PARTICIPATION RATES



PROPERTY VALUES

PROPERTY VALUES METHODOLOGY

This analysis began by reviewing property values for single-family homes within proximity of protected open space and water frontage throughout Carbon County. The study found that there was no significant increase in value for single-family homes adjacent to open space. The relatively large amount of available open land (supply), whether publicly or privately owned in Carbon County, may be a reason why the price premium associated with living close to protected open space (demand) might not be as apparent. There were significant property value impacts for waterfront property.

To identify the value of lakes within Carbon County, parcel data provided by Carbon County was used to calculate total assessed property values (land and building values for single-family homes located within the county).

Next, ArcGIS was used to identify single-family homes within 500-foot buffers of Carbon County's 28 lakes. The average total assessed property values for all single-family homes located within 2,000 feet of a lake were calculated. The average total assessed property value for all single-family homes in the county is referred to as the waterfront premium.

Utilizing millage rates by jurisdiction provided by the Carbon County Assessment Office, annual property tax revenues for identified single-family homes in Carbon County were calculated.

FIGURE 17 // CARBON COUNTY OVERALL PROPERTY VALUE METHODOLOGY

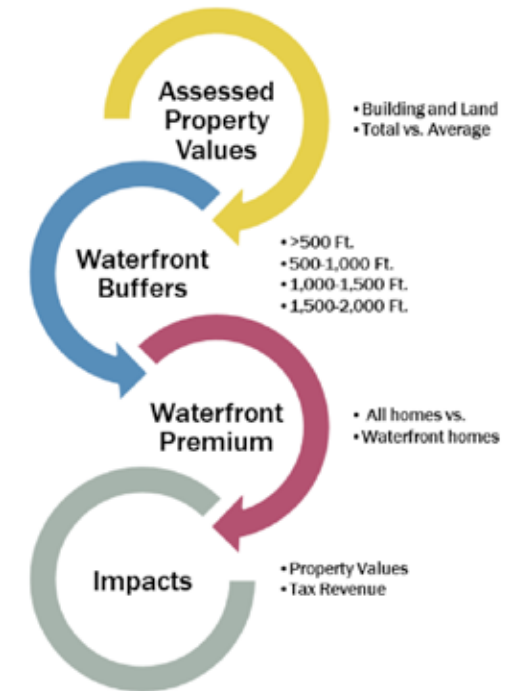




Photo: Courtesy Blue Mountain Resort

A snowboarder gets big air during peak season at Blue Mountain Resort in Palmerton, Pennsylvania.

05 // RESULTS AND FINDINGS

Nature's benefits are real and significant, and they 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. In addition, ROE steering committee members determined that:

- // ROE studies can help solve major environmental problems.
- // ROE studies can help with future growth efforts.
- // 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.
- // Quality habitat supports resident interest in locally grown food for health and economic reasons.

NATURAL SYSTEM SERVICES

Open spaces are where the majority of natural systems function. When considering the importance of Carbon County's open space, it is essential to recognize the role of trees, fields, meadows, and wetlands in filtering water, cleaning air, controlling flooding, and providing environmental services.

The EPA 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.¹²¹ By relying on nature's ability to provide these valuable services, Carbon County can avoid significant expense.

Our research compiled a list of 11 natural system services (Figure 18) that occur on 16 different land-cover types. This list is not comprehensive, but expresses major services that nature provides throughout Pennsylvania. Therefore, estimates are conservative.

FIGURE 18 // SUMMARY OF NATURAL SYSTEM SERVICE VALUES PER ACRE BY COVER TYPE

NATURAL SYSTEM SERVICE	ECO-PRICE	PRIMARY SOURCE
CARBON	\$38	US FOREST SERVICE I-TREE LANDSCAPE MODEL
AIR POLLUTANTS	\$7-\$122	US FOREST SERVICE I-TREE LANDSCAPE MODEL
GROUNDWATER	\$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	\$871-\$1,803	KING AND HAGAN, 2012; PA DEP, STORMWATER MANAGEMENT, 2009
EROSION PREVENTION	\$4-\$15	USDA, NCRS, 2014; US EPA
WILDLIFE HABITAT (BIOLOGICAL DIVERSITY)	\$400-\$1,941	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	GA FOREST SERVICE, 2011 NJ DEPARTMENT OF NATURAL RESOURCES, 2007
BIOLOGICAL CONTROL	\$2-\$12	NJ DEPARTMENT OF NATURAL RESOURCES, 2007
AQUATIC RESOURCE	\$275-\$755	PA FISH AND BOAT COMMISSION, 2016

KEY FINDINGS

- // Carbon County's open spaces provide natural system services that support quality of life, decrease cost of living, and improve health and well-being at an estimated cost savings and economic benefit of \$652.4 million annually (Figure 20). This represents the unnecessary cost of replacing and restoring vital ecosystem services currently provided by open space.
- // 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.
- // Pollination by native birds, bats, and insects helps protect agriculture during problematic environmental events like Pennsylvania's recent bee colony collapse.
- // A study of restoration in Pennsylvania state parks showed a \$7 return for every dollar invested in restoration. Similar results should occur in other open space projects.¹²²
- // We need to protect our water at its source. The value of green infrastructure in Carbon County is \$264.2 million annually. This includes stormwater and food protection, nutrient uptake, water supply, aquatic habitat, and erosion prevention.
- // Habitat-related avoided costs amount to \$388.2 million annually. This includes habitat, pollination, biological control, and habitat regeneration.
- // The land areas with the highest ROE are headwaters and forested wetlands, riparian and floodplain forests, and upland forests over 750 acres.
- // The largest avoided costs are for habitat, stormwater and food control, groundwater, nutrient uptake, pollination, and groundwater.
- // Removing obsolete dams will improve water quality and aquatic habitats. This will expand opportunities for recreational fishing, and provide the added benefit of eliminating public safety hazards from our streams.

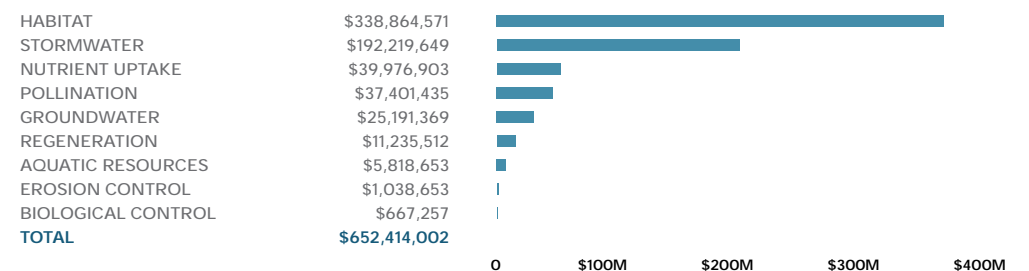
Hickory Run State Park

The 15,990-acre, forested Hickory Run State Park in Carbon County lies in Kidder Township. In 2010, the county had approximately 297,368 visitors, and generated \$14.8 million in community business revenue and 117 jobs, according to an economic study of state parks (2010). While park attendance varies from year to year, in 2016 visitation increased to 367,360 according to park staff. Park attendance grew by over 10 percent between 2014 and 2016.

FIGURE 19 // HICKORY RUN STATE PARK NATURAL SYSTEM SERVICES ANNUAL AVOIDED COSTS

HABITAT	\$24,285,444
STORMWATER	\$12,720,968
WATER QUALITY	\$2,673,245
GROUNDWATER	\$1,654,519
POLLINATION	\$2,474,780
REGENERATION	\$862,643
AQUATIC RESOURCES	\$411,419
EROSION CONTROL	\$63,106
BIOLOGICAL CONTROL	\$28,130
CARBON SEQUESTRATION	\$529,598
AIR POLLUTION REDUCTION	\$180,154
TOTAL	\$45,884,006

FIGURE 20 // CARBON COUNTY NATURAL SYSTEM SERVICES ANNUAL AVOIDED COSTS



AIR POLLUTION REMOVAL

Trees are critical to our survival, and Carbon County's forests help reduce health problems by removing significant amounts of air pollution and, consequently, improving environmental quality and human health. Trees remove substantial amounts of nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), and particulate matter (PM). 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.¹²³

KEY FINDINGS

- // Total tons of air pollutants removed each year is 8.7 million (Figure 21).
- // The total annual health benefit from trees including carbon sequestration and air pollution removal benefits is \$7.9 million (Figures 22 and 24).
- // The total annual avoided healthcare costs resulting from air filtration is \$1.5 million (Figure 22).
- // Tree photosynthesis provides an additional 44,569 tons of carbon sequestration annually (Figure 23).
- // The total annual avoided costs provided by carbon sequestration is \$6.4 million (Figure 24).
- // Currently, tree-covered open space in Carbon County is estimated to store more than 7 million tons of carbon over the life of the trees (Figure 23).
- // Tree covered urban areas have 24–29 percent lower incidence of childhood asthma.¹²⁴
- // Over a year, one acre of forest can consume the amount of CO₂ created by one car driving 26,000 miles.¹²⁵

FIGURE 21 // CARBON COUNTY ANNUAL POLLUTANT REMOVAL FROM TREES (IN TONS)¹²⁶

OZONE	5,954,266
PARTICULATE MATTER 20	1,445,048
NITROGEN DIOXIDE	928,001
SULFUR DIOXIDE	299,316
CARBON MONOXIDE	73,875
TOTAL	8,700,506

FIGURE 22 // CARBON COUNTY ANNUAL AIR POLLUTION REMOVAL BENEFIT¹²⁷

OZONE	\$382,953
PARTICULATE MATTER 2.5	\$1,067,760
PARTICULATE MATTER 10	\$82,472
NITROGEN DIOXIDE	\$5,322
SULFUR DIOXIDE	\$1,376
CARBON MONOXIDE	\$879
TOTAL	\$1,540,762

FIGURE 23 // CARBON COUNTY CARBON STORAGE AND SEQUESTRATION (IN TONS)¹²⁸

NATURAL PROCESS	EXPECTED (1-TREE LANDSCAPE)
ANNUAL CARBON SEQUESTRATION	44,569
TOTAL CARBON STORAGE	7,047,768

FIGURE 24 // CARBON COUNTY ANNUAL CARBON STORAGE AND SEQUESTRATION BENEFIT¹²⁹

NATURAL PROCESS	EXPECTED (1-TREE LANDSCAPE)
CARBON SEQUESTRATION	\$6,373,895

OUTDOOR RECREATION

Carbon 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. It generates value by providing opportunities for people to engage in recreation and exercise. Outdoor recreation participants in Carbon County spend between \$36.3 and \$108.8 million per year on gear, accessories, vehicles, and other trip-related sales (Figure 25).

FIGURE 25 // CARBON COUNTY OUTDOOR RECREATION ECONOMIC CONTRIBUTION

OUTDOOR RECREATION ACTIVITY	MINIMUM DIRECT ECONOMIC IMPACT	EXPECTED DIRECT ECONOMIC IMPACT
WALKING	\$3,376,132	\$3,376,132
FISHING	\$1,465,009	\$3,581,930
HUNTING	\$1,700,179	\$6,747,054
BIRDING/BIRD WATCHING	\$687,079	\$6,149,392
WILDLIFE WATCHING	\$2,727,998	\$5,997,584
CAMPING	\$1,953,780	\$1,953,780
KAYAKING/CANOEING	\$683,823	\$5,587,811
BICYCLING	\$4,806,299	\$13,936,964
HIKING/BACKPACKING	\$1,823,528	\$5,265,437
RUNNING/JOGGING	\$1,659,410	\$22,794,100
NATURE STUDY	\$344,647	\$1,201,575
MOUNTAIN BIKING	\$9,701,169	\$9,701,169
DOWNHILL SKIING	\$1,614,474	\$18,705,294
CROSS-COUNTRY SKIING	\$3,792,938	\$3,842,043
TOTAL	\$36,336,465	\$108,840,265

KEY FINDINGS

- // Nearly 49,000 people participate in outdoor recreation in Carbon County each year. Participation is greatest for walking, wildlife watching, hiking, bicycling, running, and paddle sports.
- // Most notably, joggers and runners are estimated to spend between \$1.7 and \$22.8 million per year, mountain bikers are estimated to spend \$9.7 million per year, and bicyclists are estimated to spend between \$4.8 and \$13.9 million per year (Figure 25).
- // Based on the IMPLAN model for Carbon County, outdoor recreation spending results in \$7.7 to \$26.4 million in total economic output and contributes \$1.5 and \$5.1 million in annual state and local taxes (Figure 31).
- // If 100 percent of outdoor recreation spending were captured in Carbon County, this spending would result in \$12.2 to \$33.9 million in total economic output and would contribute \$2.6 to \$5.9 million in annual state and local taxes.
- // Carbon County supports between 259 and 857 jobs, contributing \$8.9 to \$29.5 million in total labor income (Figure 31). If 100 percent of outdoor recreation spending were captured in Carbon County, this spending would support 401 and 1,120 jobs, contributing \$12.9 to \$35.8 million in total labor income.
- // Outdoor recreation trends show increased interest in paddle sports, running, mountain biking, hiking, nature study, fishing, birding, wildlife watching, and cross-country skiing.
- // Hunting remains the same, as more women and young adults are participating.¹³⁰
- // Physically active people are typically healthier and have a lower incidence of cardiovascular disease, diabetes, depression, certain cancers, and obesity.¹³¹
- // DCNR's 2014 Outdoor Recreation Participation Survey of Pennsylvania residents found that 30 percent of residents participate in moderate to strenuous activity on protected open space.¹³²
- // The outdoor recreation economy grew approximately 5 percent annually in the United States between 2005 and 2011, even during an economic recession.¹³³
- // Thirty-one percent of Pennsylvanians surveyed by DCNR in 2014 plan to spend more time outdoors.¹³⁴ About half of baby boomers expect to increase their outdoor activity, compared to 25 percent of their older counterparts. Given the aging population of Carbon County, outdoor activities are expected to increase.¹³⁵
- // Employees who live healthy lifestyles are more productive and innovative and miss less work.¹³⁶
- // Open space provides contact with nature, which provides health benefits and enhances well-being.¹³⁷
- // Open space encourages exercise and opportunities for physical activity, which have been shown to increase fitness and reduce obesity and other health care costs.¹³⁸
- // Consistent exercise (30 minutes, three days a week) saves \$1,800 a year in healthcare costs for adults.¹³⁹

Carbon County Downhill Skiing

Pennsylvania is ranked fifth in the country for downhill skiing, and Carbon County's rough topography provides strong opportunity for three of the Commonwealth's top five ski resorts: Blue Mountain, Big Boulder, and Jack Frost. Blue Mountain is one of the most popular resorts and has the state's highest vertical at 1,082 feet, and 100 percent of the trails are serviced by snow guns. The skiing experience at Blue Mountain equals that of resorts more than 1.5 hours further north. Jack Frost and Big Boulder combine to be the big two-for-one resorts, with Big Boulder focusing on snowboarders. As high points in the county and region, temperatures for these two slopes are colder and can produce a longer ski season.

Ski resorts are big business and have a strong positive impact in Carbon County. Following are some economic impacts of Blue Mountain and Big Boulder Resorts.

FIGURE 26 // CARBON COUNTY DOWNHILL SKIING ANNUAL ECONOMIC IMPACT

	BLUE MOUNTAIN	BIG BOULDER/JACK FROST	TOTAL
TOTAL EMPLOYEES	1,376	800	2,176
CARBON COUNTY EMPLOYEES	511	200	711
TOTAL PASS HOLDERS	6,757	2000	8,757
CARBON COUNTY PASSHOLDERS	158	686	844
TOTAL DAY-TRIPPERS	236,720	151,500	388,220
CARBON COUNTY DAY-TRIPPERS	15,754	Data unavailable	N/A

FIGURE 27 // CARBON COUNTY PARTICIPATION RATE ANALYSIS (%)

OUTDOOR RECREATION ACTIVITY	OUTDOOR RECREATION FOUNDATION PARTICIPATION SURVEY 2013 ¹⁴⁰	CENTER FOR DISEASE CONTROL AND PREVENTION 2012 ¹⁴¹	US FISH AND WILDLIFE SERVICE 2011 ¹⁴²	PA DCNR SURVEY 2014 ¹⁴³	PA DCNR NORTHEAST REGION SURVEY 2014 ¹⁴⁴	LEHIGH VALLEY EXPERT SURVEY 2014 ¹⁴⁵	DAUPHIN COUNTY EXPERT SURVEY 2016 ¹⁴⁶	CARBON COUNTY EXPERT SURVEY 2017
WALKING		0.6		0.691	0.54	0.6	0.63	0.54
FISHING	0.136		0.11	0.183	0.055	0.136	0.129	0.11
HUNTING	0.051		0.07	0.145	0.038	0.08	0.125	0.08
BIRDING/BIRD WATCHING	0.05		0.31	0.216	0.257	0.3	0.31	0.287
WILDLIFE WATCHING	0.32		0.27	0.136	0.299	0.5	0.36	0.299
CAMPING	0.133			0.309	0.207	0.05	0.11	0.05
KAYAKING/CANOEING	0.028			0.173	0.131	0.14	0.13	0.15
BICYCLING	0.164		0.36	0.35	0.033	0.17	0.29	0.2
HIKING/BACKPACKING	0.12			0.155	0.114	0.1	0.29	0.15
RUNNING/JOGGING	0.185			0.174	0.146	0.16	0.13	0.2
NATURE STUDY				0.042	0.091	0.14	0.063	0.12
MOUNTAIN BIKING				0.112	0.112			0.112
DOWNHILL SKIING	0.21							0.105
CROSS-COUNTRY SKIING	.037			0.114	0.114			0.114

Figure 27 shows the participation data from different survey sources. Colored text identifies the recommended participation rates used in the IMPLAN model. Light blue identifies the lowest participation rates. Dark blue shows participation rates used in both scenarios. Black identifies the participation rates that best reflect local recreational use by local experts. These data meet four criteria: (1) local survey data is consistent with other surveys, (2) local expert estimates are given priority over the activities that meet the criteria above, (3) the most conservative choice is made when possible, and (4) national trends favor a given activity.

FIGURE 28 // CARBON COUNTY ROE SPENDING RATE ANALYSIS

OUTDOOR RECREATION ACTIVITY	US FISH AND WILDLIFE SERVICE 2011 ¹⁴⁷	DCNR OUTDOOR RECREATION PARTICIPATION SURVEY 2009 ¹⁴⁸	OUTDOOR INDUSTRY SURVEY 2013 ¹⁴⁹	PENNSYLVANIA FISH AND BOAT COMMISSION STUDY ¹⁵⁰	DAUPHIN COUNTY EXPERT SURVEY 2016 ¹⁵¹	LEHIGH VALLEY EXPERT SURVEY 2014 ¹⁵²	JIM WARRENFELTZ 2013 ¹⁵³	CARBON COUNTY EXPERT SURVEY 2017
WALKING		\$96			\$96	\$96		\$96
FISHING	\$409	\$831		\$600	\$600	\$409		\$500
HUNTING	\$1,207	\$687			\$1,207	\$1,207		\$1,295
BIRDING/BIRD WATCHING	\$329	\$211			\$329	\$329		\$329
WILDLIFE WATCHING	\$308				\$308	\$308		\$308
CAMPING		\$2,529	\$2,009		\$600	\$600		\$600
KAYAKING/CANOEING			\$482		\$500	\$375		\$572
BICYCLING		\$453	\$1,196		\$450	\$600		\$1,070
HIKING/BACKPACKING		\$280	\$1,115		\$630	\$458		\$539
RUNNING/JOGGING		\$238			\$2,000	\$900	\$196	\$1,783
NATURE STUDY		\$150			\$126	\$150		\$150
MOUNTAIN BIKING								\$1,330
DOWNHILL SKIING								\$1,410
CROSS-COUNTRY SKIING								\$514

Figure 28 shows several spending estimates, with light blue indicating the lowest annual spending estimates per person. Dark blue shows the spending used in both low and expected scenarios. Black is the expected annual spending rate per person. Expected direct economic impact was calculated for all 14 recreational activities.

FIGURE 29 // CARBON COUNTY DIRECT ECONOMIC IMPACT

LOW ECONOMIC CONTRIBUTION SCENARIO					EXPECTED ECONOMIC CONTRIBUTION SCENARIO				
OUTDOOR RECREATION ACTIVITY	PARTICIPATION RATE	NUMBER OF PARTICIPANTS	ANNUAL SPENDING	TOTAL ANNUAL SPENDING	OUTDOOR RECREATION ACTIVITY	PARTICIPATION RATE	NUMBER OF PARTICIPANTS	ANNUAL SPENDING	TOTAL ANNUAL SPENDING
WALKING	54.0%	35,168	\$96	\$3,376,132	WALKING	54.0%	35,168	\$96	\$3,376,132
FISHING	5.5%	3,582	\$409	\$1,465,009	FISHING	11.0%	7,164	\$500	\$3,581,930
HUNTING	3.8%	2,475	\$687	\$1,700,179	HUNTING	8.0%	5,210	\$1,295	\$6,747,054
BIRDING/BIRD WATCHING	5.0%	3,256	\$211	\$687,079	BIRDING/BIRD WATCHING	28.7%	18,691	\$329	\$6,149,392
WILDLIFE WATCHING	13.6%	8,857	\$308	\$2,727,998	WILDLIFE WATCHING	29.9%	19,473	\$308	\$5,997,584
CAMPING	5.0%	3,256	\$600	\$1,953,780	CAMPING	5.0%	3,256	\$600	\$1,953,780
KAYAKING/CANOEING	2.8%	1,824	\$375	\$683,823	KAYAKING/CANOEING	15.0%	9,769	\$572	\$5,587,811
BICYCLING	16.4%	10,681	\$450	\$4,806,299	BICYCLING	20.0%	13,025	\$1,070	\$13,936,964
HIKING/BACKPACKING	10.0%	6,513	\$280	\$1,823,528	HIKING/BACKPACKING	15.0%	9,769	\$539	\$5,265,437
RUNNING/JOGGING	13.0%	8,466	\$196	\$1,659,410	RUNNING/JOGGING	20.0%	13,025	\$1,750	\$22,794,100
NATURE STUDY	4.2%	2,735	\$126	\$344,647	NATURE STUDY	12.3%	8,010	\$150	\$1,201,575
MOUNTAIN BIKING	11.2%	7,294	\$1,330	\$9,701,169	MOUNTAIN BIKING	11.2%	7,294	\$1,330	\$9,701,169
DOWNHILL SKIING	3.7%	2,410	\$670	\$1,614,474	DOWNHILL SKIING	20.4%	13,266	\$1,410	\$18,705,294
CROSS-COUNTRY SKIING	11.2%	7,294	\$520	\$3,792,938	CROSS-COUNTRY SKIING	11.3%	7,389	\$520	\$3,842,043
TOTAL		103,811		\$36,336,465	TOTAL		170,509		\$108,840,265

Numbers for this figure are based on the 2016 estimated population of 65,126.¹⁵⁴

FIGURE 30 // CARBON COUNTY ECONOMIC IMPACT BREAKDOWN (IMPLAN MODEL RESULTS)

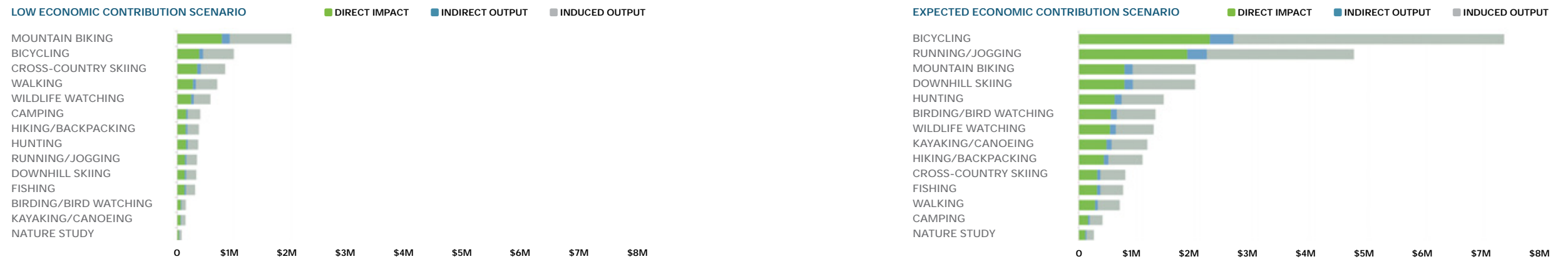


FIGURE 31 // CARBON COUNTY ECONOMIC IMPACT SUMMARY (IMPLAN MODEL RESULTS)

LOW ECONOMIC CONTRIBUTION SCENARIO						EXPECTED ECONOMIC CONTRIBUTION SCENARIO					
OUTDOOR RECREATION ACTIVITY	DIRECT IMPACT SPENDING	ECONOMIC OUTPUT	EMPLOYMENT	LABOR INCOME	STATE AND LOCAL TAXES	OUTDOOR RECREATION ACTIVITY	DIRECT IMPACT SPENDING	ECONOMIC OUTPUT	EMPLOYMENT	LABOR INCOME	STATE AND LOCAL TAXES
WALKING	\$3,376,132	\$705,513	24.0	\$834,130	\$135,150	WALKING	\$3,376,132	\$705,513	24.0	\$834,130	\$135,150
FISHING	\$1,465,009	\$313,201	10.5	\$354,501	\$61,448	FISHING	\$3,581,930	\$765,772	25.6	\$866,752	\$150,239
HUNTING	\$1,700,179	\$369,710	12.2	\$404,824	\$73,787	HUNTING	\$6,747,054	\$1,467,170	48.5	\$1,606,518	\$292,818
BIRDING/BIRD WATCHING	\$687,079	\$148,171	4.9	\$164,905	\$29,327	BIRDING/BIRD WATCHING	\$6,149,392	\$1,326,135	44.1	\$1,475,905	\$262,484
WILDLIFE WATCHING	\$2,727,998	\$588,301	19.6	\$654,742	\$116,443	WILDLIFE WATCHING	\$5,997,584	\$1,293,397	43.0	\$1,439,470	\$256,004
CAMPING	\$1,953,780	\$406,586	13.9	\$484,507	\$77,538	CAMPING	\$1,953,780	\$406,586	13.9	\$484,507	\$77,538
KAYAKING/CANOEING	\$683,823	\$144,868	4.9	\$166,870	\$28,156	KAYAKING/CANOEING	\$5,587,811	\$1,183,777	39.9	\$1,363,569	\$230,074
BICYCLING	\$4,806,299	\$1,000,160	34.2	\$1,191,931	\$190,727	BICYCLING	\$13,936,964	\$7,362,877	210.9	\$7,336,231	\$1,217,287
HIKING/BACKPACKING	\$1,823,528	\$381,064	13.0	\$450,533	\$72,998	HIKING/BACKPACKING	\$5,265,437	\$1,100,323	37.5	\$1,300,914	\$210,780
RUNNING/JOGGING	\$1,659,410	\$346,768	11.8	\$409,985	\$66,427	RUNNING/JOGGING	\$22,794,100	\$4,763,303	162.2	\$5,631,664	\$912,472
NATURE STUDY	\$344,647	\$74,324	2.5	\$82,718	\$14,710	NATURE STUDY	\$1,201,575	\$259,123	8.6	\$288,388	\$51,288
MOUNTAIN BIKING	\$9,701,169	\$2,018,751	69.0	\$2,405,826	\$384,968	MOUNTAIN BIKING	\$9,701,169	\$2,018,751	69.0	\$2,405,826	\$384,968
DOWNHILL SKIING	\$1,614,474	\$336,969	11.5	\$399,314	\$64,467	DOWNHILL SKIING	\$18,705,294	\$2,987,553	102.0	\$3,540,264	\$748,202
CROSS-COUNTRY SKIING	\$3,792,938	\$846,134	27.1	\$942,221	\$152,322	CROSS-COUNTRY SKIING	\$3,842,043	\$805,790	27.5	\$954,875	\$154,159
TOTAL	\$36,336,466	\$7,680,520	259.0	\$8,947,007	\$1,468,468	TOTAL	\$108,840,264	\$26,446,070	857.0	\$29,529,013	\$5,083,463

PROPERTY VALUE

No significant increase in property value of single-family homes adjacent to open space was found. The large amount of existing beautiful open space may be the reason for no apparent impact. There were significant property value impacts to waterfront property. This increased wealth is captured by citizens through higher sale values of homes near water and increased government revenues via larger property tax collections and transfer taxes at time of sale.

Existing research demonstrates that lakes can bring recreational and aesthetic value to surrounding properties, which has economic and fiscal implications, due to increased property and tax assessment values.

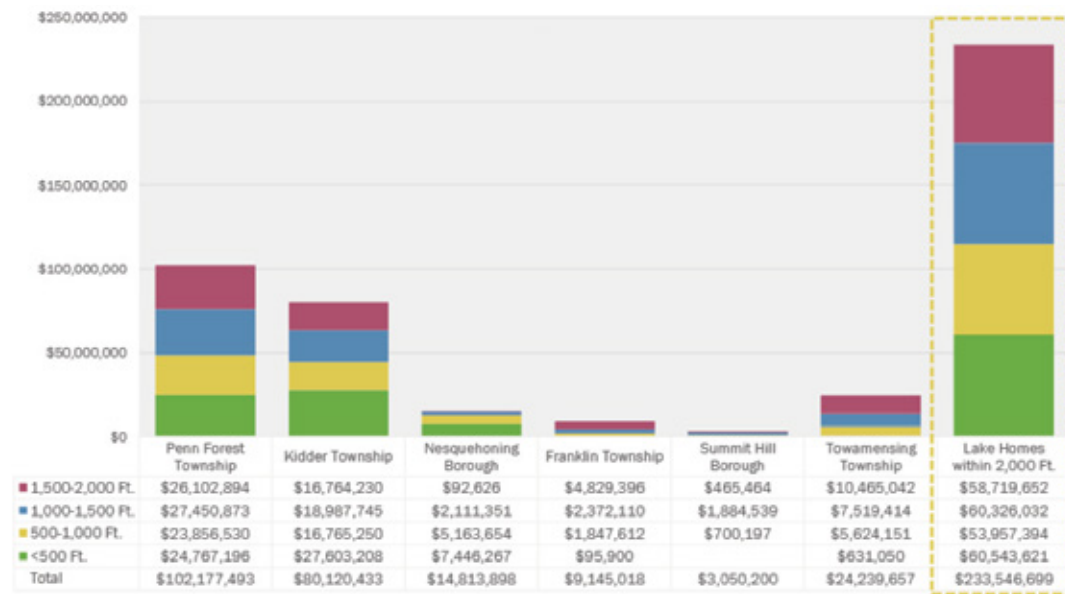
- // Nationally, waterfront homes are worth more than double the value of homes overall. According to 2014 median home value data provided by Zillow for 247 cities across the United States, the value of a single-family home was \$282,577, while the average value of a waterfront single-family home was \$697,920, a difference of more than 235 percent. This waterfront premium—the difference between waterfront and non-waterfront home values—is \$415,343.¹⁵⁵
- // Lakes can influence the property values of surrounding homes, particularly for those in closest proximity. A 2012 analysis of property values and tax revenues in Kosciusko County, Indiana, found that properties within 500 feet of the county's 41 largest lakes accounted for 37 percent of total property tax revenues. A 1995 hedonic study conducted in central Texas found several statistically significant recreational and aesthetic (RA) characteristics of housing, with proximity to the lake being the most important. Specifically, the study found that waterfront properties captured 75 percent of the RA value for all homes within 2,000 feet of a lake. Beyond the waterfront, the marginal RA price falls rapidly with increasing distance.¹⁵⁶

- // Property values and tax revenues are subject to change based on improved or degraded water quality. A 2003 analysis conducted in Maine found that a one-meter decrease in water clarity causes property values to decrease 3 to 9 percent. Similar effects were seen in New Hampshire and Vermont, and there is indication that effects such as these hold true in Pennsylvania.¹⁵⁷

KEY FINDINGS

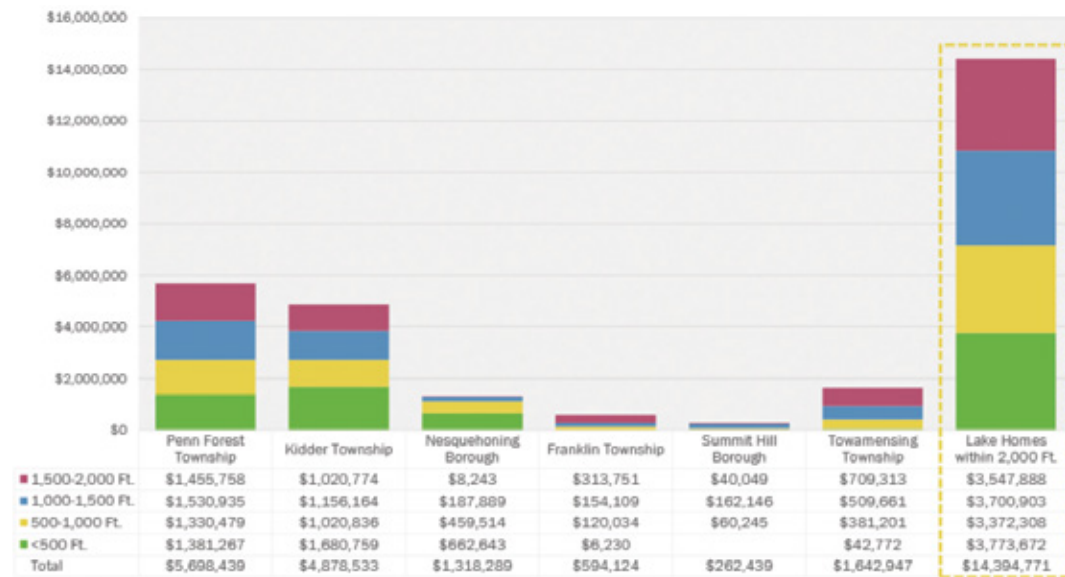
- // Approximately 13.8 percent of all single-family homes (3,801 homes) in Carbon County are located within 2,000 feet (just over a third of a mile) of a lake (Figure 35). These waterfront homes represent \$233.5 million in total assessed property value, representing 17.9 percent of the county's total assessed property value (Figure 32).
- // On average, the difference between all average total assessed property values in Carbon County and those within 2,000 feet of a lake ranges from approximately \$8,560 to \$25,910 per home, and is highest for those homes within 500 feet of a lake. This waterfront premium represents an increase of 15 to 35 percent of average total assessed property values within each jurisdiction. Although this analysis does not account for differences in home size, quality, and other characteristics, which may partially explain value disparities between waterfront and non-waterfront homes, research suggests that a significant portion of this waterfront premium is likely attributed to lake proximity. Based on millage rates by jurisdiction provided by the Carbon County Assessment Office, these waterfront homes bring in approximately \$14.4 million in annual property tax revenue (Figure 33).
- // A hypothetical 3 to 9 percent decrease in total assessed property values for these waterfront homes, due to decreased water clarity, could decrease annual tax revenues between \$431,840 and \$1.3 million per year. As a result, protecting Carbon County's lakes has both personal wealth and fiscal revenue considerations.
- // Poor water clarity can reduce property value by 15 percent.¹⁵⁸
- // The high scenic quality of Carbon County is so common that proximity to parks or open space has no measurable impact on property value.

FIGURE 32 // TOTAL ASSESSED VALUES: WATERFRONT HOMES (2,000-FOOT BUFFER)



Source: Carbon County, 4ward Planning Inc., June 2017

FIGURE 33 // ANNUAL TAX REVENUES: WATERFRONT HOMES (2,000-FOOT BUFFER)



Source: Carbon County, 4ward Planning Inc., June 2017

FIGURE 34 // PROPERTY VALUES AND TAX REVENUES: ALL SINGLE-FAMILY HOMES

JURISDICTION	SINGLE-FAMILY HOMES	TOTAL ASSESSED VALUE	AVERAGE TOTAL ASSESSED VALUE	TOTAL MILLAGE RATE*	ANNUAL TAX REVENUE
PENN FOREST TOWNSHIP	6,630	\$364,189,191	\$54,930	55.7700	\$20,310,831
JIM THORPE BOROUGH	1,971	\$83,098,352	\$42,161	65.6700	\$5,457,069
KIDDER TOWNSHIP	1,960	\$126,846,641	\$64,718	60.8900	\$7,723,692
PALMERTON BOROUGH	1,826	\$73,812,527	\$40,423	77.5493	\$5,724,110
LANSFORD BOROUGH	1,740	\$24,674,563	\$14,181	104.9700	\$2,590,089
TOWAMENSING TOWNSHIP	1,655	\$110,539,021	\$66,791	67.7793	\$7,492,257
LEHIGHTON BOROUGH	1,652	\$61,255,632	\$37,080	65.6300	\$4,020,207
FRANKLIN TOWNSHIP	1,483	\$90,487,236	\$61,016	64.9670	\$5,878,684
MAHONING TOWNSHIP	1,385	\$77,076,255	\$55,651	63.6300	\$4,904,362
NESQUEHONING BOROUGH	1,372	\$44,047,802	\$32,105	88.9900	\$3,919,814
SUMMIT HILL BOROUGH	1,161	\$35,128,462	\$30,257	86.0400	\$3,022,453
LOWER TOWAMENSING TOWNSHIP	1,010	\$54,405,748	\$53,867	67.3793	\$3,665,821
WEATHERLY BOROUGH	828	\$31,108,253	\$37,570	61.0100	\$1,897,915
EAST PENN TOWNSHIP	770	\$46,650,254	\$60,585	66.2650	\$3,091,279
BANKS TOWNSHIP	513	\$13,941,675	\$27,177	37.8590	\$527,818
PACKER TOWNSHIP	341	\$20,072,929	\$58,865	55.3100	\$1,110,234
BOWMANSTOWN BOROUGH	285	\$12,439,797	\$43,648	76.7843	\$955,181
BEAVER MEADOWS BOROUGH	258	\$7,207,617	\$27,937	44.2590	\$319,002
LEHIGH TOWNSHIP	184	\$8,517,405	\$46,290	55.1800	\$469,990
PARRYVILLE BOROUGH	166	\$7,297,058	\$43,958	70.6300	\$515,391
WEISSPORT BOROUGH	107	\$3,364,154	\$31,441	69.0300	\$232,228
LAUSANNE TOWNSHIP	94	\$4,825,134	\$51,331	55.2800	\$266,733
EAST SIDE BOROUGH	82	\$3,239,325	\$39,504	56.7100	\$183,702
TOTAL	27,473	\$1,304,225,031	\$47,473		\$84,278,862

* Includes county debt and real estate, jurisdiction and school millage (1/1000th of a dollar). Assumes average millage rates for Kidder Township (North) and Kidder Township (South).

Source: Carbon County, 4ward Planning Inc., June 2017

FIGURE 35 // SINGLE-FAMILY HOMES: WATERFRONT HOMES (2,000-FOOT BUFFER)

JURISDICTION	<500 FT	500-1,000 FT	1,000-1,500 FT	1,500-2,000 FT	TOTAL
PENN FOREST TOWNSHIP	358	460	528	497	1,843
KIDDER TOWNSHIP	354	296	293	259	1,202
NESQUEHONING BOROUGH	102	91	40	4	237
FRANKLIN TOWNSHIP	1	23	37	67	128
SUMMIT HILL BOROUGH	-	13	27	9	49
TOWAMENSING TOWNSHIP	10	80	103	149	342
LAKE HOMES WITHIN 2,000 FT	825	963	1,028	985	3,801
LAKE HOMES AS SHARE OF COUNTY	3.0%	3.5%	3.7%	3.6%	13.8%

Source: Carbon County, 4ward Planning Inc., June 2017

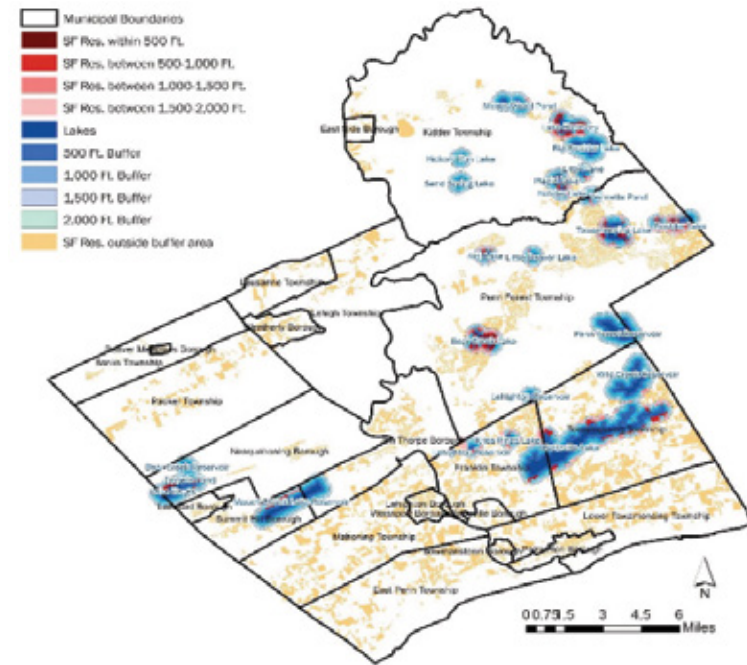




Photo: Courtesy Carbon Chamber & Economic Development Corporation

Completed in 1869, St. Mark's Episcopal Church in Jim Thorpe has been designated a National Historic Landmark.

06 // PUTTING ROE STUDIES TO WORK

A blueprint for action

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 residents' future quality of life, health, and cost of living.

Today, we must do more to quantify the financial benefits provided by nature and link those values directly to the community's well-being. For example, a natural resource inventory does not explain the financial consequences of losing a habitat or species. Development proposals 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 of striking 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 Carbon County and along the Kittatinny Ridge, moving to a net gain in the value of both.

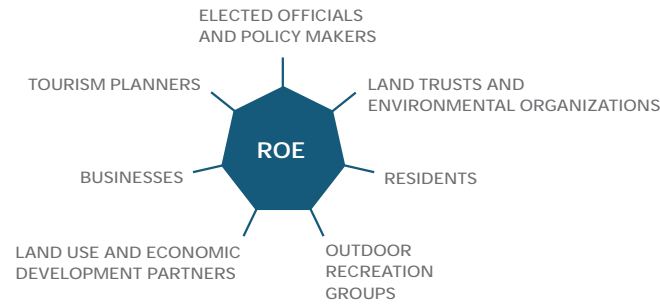
The first step to putting ROE studies to work is articulating the ways in which open space provides natural system services. Placing a dollar value on different land covers helps decision makers understand what is critical to the environment and the economy and what lands can be developed. This leads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

ALL STAKEHOLDERS PLAY A PART

If the economy of Carbon County is to remain strong, environmental stewardship cannot be the responsibility of a few dedicated people. Environmental stewardship must become part of Carbon County's everyday culture. Residents, planners, nonprofits, land trusts, businesses, and policy makers require strong alignment to succeed. Only then can Carbon 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 36).

FIGURE 36 // ROE STAKEHOLDERS



RECOMMENDED STRATEGIC ACTIONS

Stakeholders can't afford to continue to subsidize growth. Harvard University business professor Michael Porter notes 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.¹⁵⁹

HELP COMMUNITIES PROVIDE MORE ENVIRONMENTAL, SOCIAL, AND FINANCIAL SUSTAINABILITY

Level the playing field. Map the relative financial values of natural system services to reflect financial priorities and develop protection and risk management strategies that maintain these assets.

Incorporate ROE into 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.

Develop a stewardship balance sheet for all new development. 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 as the loss of natural system services that will be paid by taxpayers.

Perform environmental audits. Chronicle the change in cover types over time, 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 and riparian and wetland areas.

Change the rules of the game. Estimate the annual ROE for all new proposed ordinances, including riparian and official map ordinances, open space referenda, open space acquisitions, and restorations.

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.

Teach the principles of good stewardship to landowners, 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; chronicle the potential benefits of backyard conservation design and stewardship; provide educational tools to landowners about good land stewardship; teach private property owners low-impact and restorative approaches along the borders of forests and vegetated streamside buffer areas; and increase local knowledge of recreational users so they understand the significance of natural capital value.

Create incentives. Create incentives to protect and restore critical natural system services like "green ribbon landscapes," stream buffers, cluster development, and the use of native plants in backyard design.

Assist sustainable businesses. Provide businesses with data on the financial impact of the environment to the local economy, as well as data on recreation demand and demand for high-quality water, to help them understand their markets.

Involve schools. Create environmental education programs with interdisciplinary applications in science, social studies, mathematics, language arts, fine arts, and physical education.

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 cost (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, maintaining regional populations in the short term and 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 pests, weeds, and disease vectors (e.g., mosquitoes)—by beneficial insects.

Carbon sequestration

The process of carbon capture and long-term storage of atmospheric carbon dioxide (CO₂) 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.

Carbon storage

The estimate of the total amount of carbon currently stored in the above- and below-ground biomass of a forest.

Climate change

Regional or local climate patterns, particularly a change apparent from the mid-20th century onward, attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

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.

Contingent valuation (CV)

A survey-based economic technique for the valuation of non-market resources, such as environmental preservation or the impact of contamination.

Cost of damage (CD)

An estimate of monetized damages associated with the release of carbon or other pollutants.

Cost of regulation (CR)

Fines and procedures.

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.

Ecosystem function

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

Flood mitigation

The management and control of flood water movement, such as redirecting flood runoff through the use of floodwalls and floodgates, rather than trying to prevent floods altogether.

Groundwater

Water found underground in the cracks and spaces in soil, sand, and rock. It is stored in and moves slowly through geologic formations of soil, sand, and rock called aquifers. Groundwater is the source of water for streams and supplies water through wells.

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 by both the internal characteristics of the goods being sold and the external factors affecting it.

Market valuation (MV)

The amount of money paid to purchase credits in a trading market, for example, the price of a carbon credit for air quality, the purchase of a nutrient credit for water quality, or the purchase of potable water.

National Pollutant Discharge Elimination System (NPDES) permit

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

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 without human intervention.

Natural system services

The flow of goods and services that benefit people, directly or indirectly, from ecosystem functions; also called ecosystem services.

Open space

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

Outdoor recreation

Activities that can be performed in natural settings, without causing harm. **Pollination** The process by which pollen is transferred from the anther (male part) to the stigma (female part) of a plant, thereby enabling fertilization and reproduction.

Replacement cost (RC)

Cost 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 cost of replacing the natural waste assimilation service with chemical or mechanical alternatives.

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

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

Tax benefits (TB)

Adjustment benefiting a taxpayer's tax liability.

Travel cost (TC)

Cost of travel and its reflection on the implied value of a service.

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 quality

A measure of the suitability of water for a particular use (drinking, fishing, or swimming), based on selected physical, chemical, and biological characteristics.

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.

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