Lehigh Valley
Return on Environment

Lehigh Valley Planning Commission
2014

The work that provided the basis for this publication was supported by funding through Lehigh Valley Economic Development Corporation under an award with the U.S. Department of Housing and Urban Development. The substance and findings of the work are dedicated to the public. The author and publisher are solely responsible for the accuracy of the statements and interpretations contained in this publication. Such interpretations do not necessarily reflect the views of the Government.

Cover photos courtesy of Michael Kaiser, Teresa Mackey and Wildlands Conservancy.

Lehigh Valley Planning Commission

Kent H. Herman, Esq., *Chair*

Liesel Dreisbach, *Vice Chair*

Stephen Repasch, *Treasurer*

Norman E. Blatt, Jr., Esq.

Christen T. Borso

John Brown

Gordon Campbell

John N. Diacogiannis, CPCU

Robert Donchez

Percy H. Dougherty, PhD

Karen Duerholz

Charles W. Elliott, Esq.

Charles L. Fraust

George F. Gemmel

Matthew Glennon

Steven L. Glickman, RA, NCARB

Armand V. Greco

Virginia Haas (alt.)

Michael C. Hefele, AICP (alt.)

Darlene Heller (alt.)

Benjamin F. Howells, Jr.

Edward D. Hozza, Jr.

George Kinney (alt.)

Robert A. Lammi

Kevin Lott

Kenneth M. McClain

Christina V. Morgan

Thomas Muller

Thomas J. Nolan

Sara Pandl, AICP, RLA

Salvatore J. Panto, Jr.

Edward Pawlowski

Pamela Pearson, MBA

Kathy Rader

Michael Reph

Lisa Scheller

Lori Sywensky (alt.)

Seth Vaughn

Donna Wright

Lehigh Valley Planning Commission Staff

Becky A. Bradley, AICP, Executive Director

Anne L. Esser, MBA, Director of Administration

Eric C. McAfee, AICP, LEED AP, Director of Community Planning

Geoffrey A. Reese, P.E., Director of Environmental Planning

Tracy L. Oscavich, Associate Director of Development

William H. Deegan, Architectural/Urban Designer

David E. Manhardt, AICP, Chief Geographic Information Systems Planner

Ngozi Obi, Senior Community Planner

Lynette E. Romig, Senior Geographic Information Systems Analyst

Travis I. Bartholomew, P.E., Senior Environmental Engineer

Teresa Mackey, Senior Environmental Planner

Susan L. Rockwell, Senior Environmental Planner

Michael S. Donchez, Senior Transportation Planner

Gabriel F. Hurtado, Community Planner

Alice J. Lipe, Graphics & Publications Coordinator

Kathleen M. Sauerzopf, Executive Secretary

ADVISORY COMMITTEE

John Mikowychok, City of Allentown
Ralph Carp, City of Bethlehem
Stephen Repasch, Bethlehem Authority
Lynn Prior, Buy Fresh Buy Local Greater Lehigh Valley
Elissa Garofalo, Delaware & Lehigh National Heritage Corridor
Sherry Acevedo, Delaware & Lehigh National Heritage Corridor
Claire Sadler, Delaware & Lehigh National Heritage Corridor
Mike Stershic, Discover Lehigh Valley
Steve Johnson, L.L. Bean Inc.
Dan Kunkle, Lehigh Gap Nature Center
Mike Keller, Lehigh Valley Economic Development Corporation
Andrew Kleiner, Lehigh Valley Economic Development Corporation
Michele Deegan, Lehigh Valley Research Consortium
Maria Bentzoni, Northampton County
Bryan Cope, Northampton County
Diane Kripas, Pennsylvania Department of Conservation and Natural Resources
Bob Pitcavage, Pennsylvania Department of Environmental Protection
Joseph Napolitano, Rider-Pool Foundation
Budd Coates, Rodale Inc., Lehigh Valley Road Runners
Janet Roth, Harry C. Trexler Trust

PARTNERSHIP COMMITTEE

Robert Egolf, Bushkill Stream Conservancy
John Berry, Delaware River Shad Fishermen's Association
Bill Derhammer, Lehigh Coldwater Fishery Alliance
John Mosovsky, Lehigh Coldwater Fishery Alliance
Liesel Adam, Lehigh County Authority
Brian Nagle, Lehigh County Authority; Wildlands Conservancy, Board of Directors
Laura Hopek, Lehigh County Conservation District
Jim Mishko, Lehigh River Stocking Association
Jim Wilson, Northampton County Conservation District
Mike Topping, Northampton County Federation of Sportsmen's Clubs
John Tunney, Trout Unlimited, Little Lehigh Chapter
Norb Szymanski, Trout Unlimited, Monocacy Chapter

ACKNOWLEDGEMENTS

We want to thank the following people who helped with interviews, providing information, case studies and ideas:

John Brunner, Appalachian Mountain Club
Ralph Carp, City of Bethlehem
Stephen Repasch, Bethlehem Authority
Vicky Bastidas, Bethlehem Bird Town
Michael Yozell, Bicycling Magazine
Lynn Prior, Buy Fresh Buy Local Greater Lehigh Valley
John Berry, Delaware River Shad Fishermen's Association
Chris Schmidt, Emmaus Run Inn
Rob McVeigh, Genesis Bike Shop
Steve Johnson, L.L. Bean Inc.
Aurel Arndt, Lehigh County Authority
Liesel Adam, Lehigh County Authority
Dan Kunkle, Lehigh Gap Nature Center
Peter Saenger, Lehigh Valley Audubon Society
Bill Mondjock, Lehigh Valley Bee Keepers
Neal Novak, Lehigh Valley Road Runners
Laurie Reinhart, Lehigh Valley Road Runners
Jill Forsythe, Lehigh Valley Running Scene
Eric Andreus, Nestlé Waters North America
Bryan Cope, Northampton County
Maria Bentzoni, Northampton County
Mike Topping, Northampton County Federation of Sportsmen's Clubs
Tinku Khanwalkar, PPL Corporation
Cheryl Trewella, Pennsylvania Game Commission
Budd Coates, Rodale Inc., Lehigh Valley Road Runners
John Tunney, Trout Unlimited, Little Lehigh Chapter
Norb Szymanski, Trout Unlimited, Monocacy Chapter

PARTNERS

We want to thank our partners for their assistance:

Wildlands Conservancy
Keystone Conservation Trust
4ward Planning Inc.
Econsult Solutions, Inc.

Table of Contents

Tables

Figures

Maps

Lehigh Valley Return on Environment

EXECUTIVE SUMMARY

The Lehigh Valley is a special place with its scenic mountains and farmland views, river corridors, pristine groundwater and large forest habitat. These features, along with the opportunities provided by growth in the region, are the foundation for a strong economy and high quality of life. A strong economy compared to environmental protection is not an "either/or" choice. This report explains why a strong economy requires plenty of connected, accessible open space and a healthy environment.

A top priority of local residents is more open space, according to a Lehigh Valley Planning Commission 2010 land use poll. However, every year the region loses more than three square miles of open land to development. Open spaces provide substantial economic, environmental and public health benefits to surrounding communities. These benefits, however, are generally not well-understood and are often undervalued in policy debates and investment decisions. Beyond their intrinsic value, open space and nature (i.e., forests, wetlands, meadows and farmland) provide these vital services free of charge. Once lost, natural system services are costly, and difficult or impossible to replace.

To provide a better understanding of these benefits, this study estimates the economic value generated by open space in the Lehigh Valley. The study found that open space adds significant value to the regional economy with benefits accruing to businesses, governments and households. The economic benefits generated by open space accrue in different ways—some are direct revenue streams to individuals or governments, some represent asset appreciation value, and some accrue in the form of avoided loss.

The biggest challenge facing the Lehigh Valley related to open space is promoting sustainable growth while maintaining a high quality of life, a low cost of living and good health for all residents.

Building off of previous valuation studies and using standard economic analysis techniques, this study estimates the value of open space in the Lehigh Valley by measuring impacts across four areas: 1) Natural System Services, 2) Air Quality, 3) Outdoor Recreation and 4) Property Value. Each of these areas generates the "natural capital" or economic value from the flow of goods and services supported by natural resources. These benefits represent the Return on Environment for the Lehigh Valley.

It is important to note that the economic data presented in this study approximates the value of open space in the Lehigh Valley, taking into account the broad variety of land cover, economic activities, recreational

Photo courtesy of Teresa Mackey

activities, natural system services and other factors that exist or occur on this open space.

The economic benefits presented in this study provide elected leaders, policy makers and the public with a perspective on the value of open space and should contribute to informed decision-making concerning development and open space preservation in the Lehigh Valley.

Natural System Services

Considering the importance of the Lehigh Valley's open space, it is essential to recognize the role that trees, fields, meadows and wetlands play in keeping the cost of living low by filtering water, cleaning the air, controlling flooding and providing other environmental services.

Key Findings:

- The highest natural system services on a per acre basis is found in wetlands, riparian corridors and forests. Maintaining and restoring connected habitats and corridors will provide the full potential value of natural system services.
- The current green infrastructure along streams in the Lehigh Valley reduces tax dollars by avoiding more than $110.3 million annually in expenditures for water supply ($45.0 million), disturbance (flood) mitigation ($50.6 million) and water quality ($14.7 million).
- Natural areas provide over $22.4 million annually in pollination and $2.5 million in biological control services to agriculture, backyards and the natural landscape.
- Natural areas provide $219.5 million annually in habitat for insects, birds, animals and plants.
- Natural areas provide $0.8 million annually in soil formation/retention.

In summary, open space provides value in the form of natural system services for water supply, water quality, flood control, pollination, biological control, habitat and soil formation/retention estimated at $355.5 million or more each year in the Lehigh Valley.

Air Quality

The Lehigh Valley faces substantial air quality problems. Poor air quality is a common problem in many urban and suburban areas and can lead to a variety of human health problems, including asthma and other respiratory ailments. Additionally, air pollution can damage buildings and plants, disrupt many natural system services and can cause reduced visibility and smog. Trees remove significant amounts of air pollution and, consequently, improve environmental quality and human health. In particular, trees can remove significant amounts of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter. Trees remove gaseous air pollution primarily by uptake via leaf stomata, though some

Photo courtesy of Teresa Mackey

gases are removed by the plant surface. Trees also remove pollution by intercepting airborne particles.

Urban and suburban trees also help mitigate climate change by removing carbon dioxide (CO_2) from the air and sequestering the carbon in new biomass each year. As trees grow, they store more carbon by holding it in their accumulated tissue. As trees die and decay, they release much of the stored carbon back to the atmosphere. Carbon storage is an estimate of the total amount of carbon that is currently stored in the above and below ground biomass of the forest, while carbon sequestration is a measure of how much new carbon is taken up by the forest each year through new growth.

The incidence of childhood asthma worldwide has paralleled the sharp increase in CO_2 emissions, over at least the last two decades, in part due to climate-related factors. In a report released by the Harvard Medical School and the Center for Health and the Global Environment, an increase in asthma incidence of 160% among preschool children in the United States was documented from 1980-1994.

Key Findings:

- Air quality services provided by trees removing pollutants are estimated at $48.2 million annually.
- Tree-covered open space stores 5,496,069 tons of carbon over the life of the current forest in the Lehigh Valley.
- Without carbon storage by trees, damage due to increased carbon emissions would cost $111.2 million to mitigate in the Lehigh Valley, which, if divided by an assumed average tree life of 50 years, represents a value of about $2.2 million annually.
- Photosynthesis by trees removes CO_2 from the atmosphere, releases oxygen and adds or sequesters 181,189 tons of carbon each year, providing health and other benefits of about $3.6 million per year.

In summary, the total annual avoided healthcare costs and damage to agriculture and buildings provided by Lehigh Valley open space is estimated to be $54 million.

Outdoor Recreation

Open space generates value as residents enjoy engaging in recreation and exercise. Residents recognize that outdoor recreation and open spaces are key ingredients to healthy communities, contribute to a high quality of life, and very importantly, attract and sustain families and businesses.

Key Findings:

- Approximately 75% of people in Pennsylvania enjoy some form of outdoor recreation on an annual basis as reported by the Department of Conservation and Natural Resources *2014 Outdoor Recreation Participation Survey* of *Pennsylvania Residents.*

Photo courtesy of Wildlands Conservancy

- Physically active people typically enjoy a variety of health benefits, including lower incidence of cardiovascular diseases, diabetes, depression, certain cancers and obesity.
- A growing body of evidence shows that contact with nature reduces stress, depression and blood pressure; increases concentration, creativity and learning; and connects people to their community. This helps reduce medical care costs and enhances productivity.
- According to the *D & L Trail 2012 User Survey and Economic Impact Analysis*, an estimated 68,327 people spent about $2.5 million along the Lehigh Valley portion of the Delaware & Lehigh Trail.
- The fastest growing outdoor recreation activities are kayaking, birding, wildlife watching, outdoor photography, running, bicycling and other sports. The popularity of these activities is replacing more traditional activities like hunting and fishing.
- An estimated $795.7 million is spent on outdoor recreation each year in the Lehigh Valley. This represents the amount of money that residents in the Lehigh Valley spend on outdoor activities and their total impact on the economy.
- Recreational activity on open space in the Lehigh Valley creates an estimated 9,678 jobs both inside and outside the Lehigh Valley. These jobs generate about $58.9 million in state and local taxes.
- An estimated 25% of all tourism in the Lehigh Valley comes from recreation. This is the largest percentage in the state.

Property Value

Square footage, quality of schools, landscaping and structural condition can raise or lower the value of a home. So can proximity to open space. Whether it is a trail, park, scenic area or waterfront, people will pay a premium to be near open space. As a result, the Lehigh Valley's existing open space adds to the overall value of its housing stock.

This increased wealth is captured by citizens through higher sales values of homes near open space and generates increased government revenues via larger property tax collections and transfer taxes at time of sale.

Photo courtesy of Teresa Mackey

Key Findings:

- The average premium afforded each home within ¼ mile of protected open space is $14,600 in the Lehigh Valley. Protected open space includes: 1) parks, natural areas and outdoor recreation sites that are owned by federal, state, county, municipal governments or conservancies or privately-owned property with a conservation easement, and 2) agricultural easements.
- There are 127,850 single family homes located within a ¼ mile of protected open space in the Lehigh Valley.
- The total real estate premium attributed to living within ¼ mile of protected open space in the Lehigh Valley is more than $1.8 billion (number of homes times average premium).
- The average real estate premium for single family homes within ¼ mile of protected open space in the Lehigh Valley is lowest for homes located in rural townships ($2,600) and highest for homes located in cities and boroughs ($28,200).

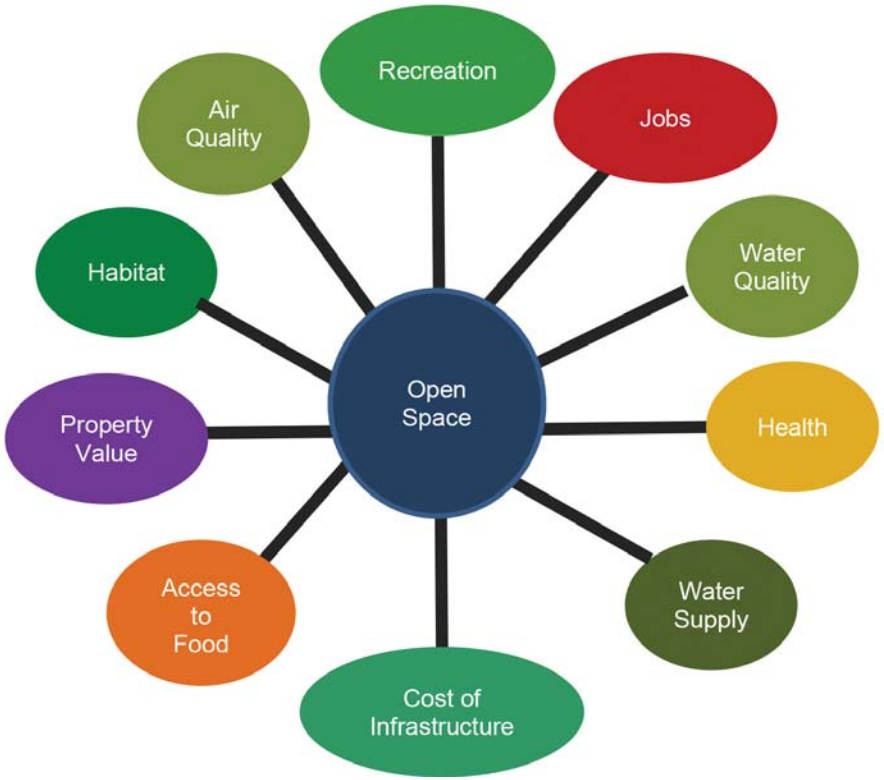
INTRODUCTION

The trees, stream valleys, farms and forests of the Lehigh Valley account for millions of dollars each year in savings, earnings, avoided costs and attraction for economic development. This report describes how open space is an integral part of the Lehigh Valley's quality of life, health and lower cost of living. Open space can be as big as the Kittatinny Ridge or as small as the setback on a tree-lined street. Open space can be public or private land.

People expect an unending supply of clean air, water and beauty. A top priority of local residents is more open space, according to a Lehigh Valley Planning Commission (LVPC) 2010 land use poll. (1) However, every year the region loses more than three square miles of open land to development.(2) More than just pretty places, open spaces are productive assets that generate significant economic value and supply basic needs for the Lehigh Valley like clean air and water. Open space positively affects everything from scenic views, tourism, property values and economic development, and reduces costs for healthcare, stormwater management and flood mitigation. Open space also increases revenues from recreation and naturally improves air quality and water quality. Open space has such a broad influence on life from supplying basic human needs to health and well-being, jobs and the economy and supporting plant and animal diversity that, in effect, open space affects everything (Figure 1).

The LVPC, Lehigh and Northampton counties and the region's municipalities have a long-standing appreciation of the environmental and social value of open space. The LVPC *Comprehensive Plan*, originally crafted in the 1960s and updated through 2010, defines the role that natural resources, farmland, and park and recreation facilities serve to provide critical environmental services, fresh local food, and recreational and scenic benefits to residents. Lehigh and Northampton counties, along with the region's municipalities and other organizations, have been active in acquiring and preserving farmland and open space and providing recreational opportunities. What has been lacking, however, is an economic valuation of the benefits provided by open space to fortify these efforts, and that is the purpose of the *Lehigh Valley Return on Environment* study.

Figure 1. Open Space Affects Everything



To that end, the objectives of the *Lehigh Valley Return on Environment* study are to document:

1. The current state of the environment in the Lehigh Valley.
2. The monetary value of natural system services to families, local communities and businesses.
3. The monetary value of outdoor recreation and the number of participants.
4. The monetary value of improved air quality through reduced healthcare costs due to forest resources.
5. The increased property values due to proximity to open space.

The results of the *Lehigh Valley Return on Environment* study are anticipated to be valuable for the following reasons:

- To inform land use policy and decisions using information on the economic benefits of open space and natural systems.
- To provide information for open space purchase or easement investment decisions.
- To reinforce landscape approaches for habitat connectivity and protection.
- To inform strategies to reduce flooding and protect water quality and water supply.
- To inform strategies for economic development.

Different valuation approaches were used to express the economic significance of natural system services, air quality, outdoor recreation and impact of open space on property value. Each methodology is explained, and detailed information and results are provided.

Ten trends that relate to the role of open space in the Lehigh Valley's future are discussed. These trends are:

1. Attitudes about environmental protection and economic growth are evolving.
2. Attachment to where people live and their quality of life is impacting economic development.
3. The "green business" trend is tied to open space.
4. A growing body of evidence shows nature's positive impact on stress management, healthy lifestyles and well-being.
5. People are increasingly interested in outdoor recreation.
6. Investing in green infrastructure can be very cost-effective.
7. The pattern, size and connectivity of open space and native habitat is increasingly important.
8. Creating stewardship zones along open space boundaries increases natural system services.
9. Property values are positively impacted by open space.
10. Americans are showing a growing interest in organic, locally-grown food.

To develop this report, meetings were periodically held with the Advisory and Partnership committees to discuss data sources, suggest knowledgeable people to be interviewed and to review and discuss concepts. Their comments, suggestions and critiques were invaluable. Advisory and Partnership committee members are listed at the beginning of the report.

It is important to note that the economic data presented in this study approximates the value of open space in the Lehigh Valley, taking into account the broad variety of land cover, economic activities, recreational activities, natural system services and other factors that exist or occur on this open space.

This study makes no policy recommendations in presenting these economic value estimates, but is intended to heighten awareness of the economic benefits of open space to residents, municipalities and businesses in the Lehigh Valley. Its purpose is to help educate the dialog about open space's role in the Lehigh Valley's economy, quality of life, cost of living and good health and well-being of its residents.

The estimates in this study represent different types of values, such as wealth generation via asset appreciation or earnings, additional tax revenues, avoided costs and personal expenditures that support the economy and help provide jobs. Because of this, the results should not be added together to produce a single number representing the total aggregate value of open space in the Lehigh Valley.

THE PLACE

The Lehigh Valley is one of the fastest growing regions in the Commonwealth. The highway system enables easy access from all directions. Clearly, the Lehigh Valley, with three major cities and an enviable collection of open space, plays an important role in the economy of eastern Pennsylvania.

The Kittatinny Ridge, the northern mountain that defines the Valley, is internationally-recognized for its role in bird migration in the Atlantic Flyway and is part of one of Pennsylvania's largest Important Bird Areas (Figure 2). The forested mountains, farmlands and stream corridors in the Lehigh Valley have many high ranking natural areas based on the model developed by Natural Lands Trust called Smart Conservation. The LVPC has documented these important resources within the Natural Resources element of the *Comprehensive Plan The Lehigh Valley…2030*. These resources are essential to migrating and resident birds and the ecology of both North and South America.

According to Audubon PA, over 40% of migrating birds in the Atlantic Flyway are in conservation need (3), which means more appropriate habitats are needed.

Figure 2. Bird Migration in the Atlantic Flyway

Source: Texas Parks & Wildlife Department

The Lehigh Valley's growth and consequent loss of open space reveals the potential for added environmental risk. Damage to natural systems is caused by forest fragmentation, loss of habitat, clearing of land near streams and introducing invasive species.

Part of the Lehigh Valley's attraction for growth is the region's scenic mountains and farmland views, river corridors, pristine groundwater, large forest habitat and a variety of outdoor recreation opportunities. All of this is provided by open space.

Photo courtesy of Maria Bentzoni

As open space continues to be lost to development each year, the remaining open space could become too fragmented to provide all the environmental services the Lehigh Valley has always enjoyed. A landscape pattern of patchwork open space will not provide for sustainable

Without connected habitats and corridors, the full value of open space may not be realized, and these precious benefits may be significantly diminished or lost forever.

Photo courtesy of Michael Kaiser

populations of wildlife and native plants. With less open space remaining, the size, quality, location and connectivity of open space will play a major role in determining the future quality of life and cost of living in the Lehigh Valley. Wetlands, riparian forests and river corridors, and large forests drive natural system services, outdoor recreational opportunities and the highest return on environment.

As highlighted in the State of the Environment chapter of this report, more work needs to be done to ensure the needed interconnectedness of open space resources throughout the Lehigh Valley. Only then can the residents and policy makers of the Lehigh Valley ensure a foundation for a vibrant and balanced economy, high quality of life, low cost of living and good health and well-being for existing and future residents.

OPEN SPACE CONSUMERS

In 2010, 647,232 people were living in the Lehigh Valley, drinking the water, breathing the air and enjoying the scenic landscape. About 75% of them were participating in some form of outdoor recreation, (4) which accounts for 485,424 residents.

The Lehigh Valley Planning Commission (LVPC) projects that the Valley will grow by another 145,696 residents by the year 2030, and by 2040, there will be 873,954 people living in the region, a 35% increase over three decades. The age of residents is also expected to shift in the Lehigh Valley over the next 30 years. The LVPC predicts that the number of people over 65 years of age will nearly double by the year 2040. (5)

The Lehigh Valley has 247,548 households, with approximately 2.54 persons in each. These are homeowners and renters who use the Lehigh Valley's natural resources. Approximately 83% are White, 15% Hispanic (ethnicity), 6% African American, 3% Asian and <0.5% American Indian. (6)

The Lehigh Valley's location and natural resources together make the region very business-friendly. Beverage companies like Nestlé Waters and Sam Adams Brewery require clean water to operate their businesses. Manufacturing companies like Air Products and Chemicals, Inc. use water in processing their products. Farmers require natural system services like pollination and biological control. Many small retailers, like Aardvark Sports Shop and Genesis Bike Shop, as well as large companies like L.L. Bean, sell outdoor-related products and services. Some create outdoor equipment like Olympus Camera. Many companies are going "green" because their customers demand it and because it provides cost savings.

The quality and quantity of resources available to businesses are critical to business function. The recreational opportunities available on open spaces contribute to the health of the region's workforce, translating into avoided medical, workers compensation and lost productivity costs.

New development increases the demand for outdoor recreation, water supply, stormwater management, clean air, clean water and many other nature-based services. Consequently, businesses, governments and households have to work together to manage the remaining open space in ways that create the highest possible overall value.

Business managers, policy makers and residents need better information about the value of natural systems to make informed choices. Land use decisions involve a choice between preserving the land in its existing state or converting it to developed uses. Green businesses take a broader look at their processes and practices to become more environmentally aware; green households learn and apply more about stewardship at home and in their own backyards. The choices made about the environment today will have a profound impact on the future of the Lehigh Valley.

STATE OF THE ENVIRONMENT

Air Quality

Air quality affects the health of Lehigh Valley residents and their quality of life. As the population of the Valley increases and open space is lost to development, air quality is expected to decrease. More people and more development means more vehicles and longer commutes. The Lehigh Valley already faces air quality challenges, continuing to fail to meet the standards mandated by the Federal Clean Air Act. According to the American Lung Association's (ALA) national 2013 *State of the Air* report, the Lehigh Valley experiences high levels of year-round and daily pollution, earning both Lehigh and Northampton counties an 'F' for air quality. The ALA ranked the Allentown-Bethlehem-Easton Metropolitan Statistical Area as 14th worst for year-round particle pollution and the 22nd worst for short-term particle pollution. Particle pollution includes: 1) coarse particles that come from natural sources like pollen, bacteria and mold, and from man-made sources like construction, resource extraction and agriculture, and 2) fine particles that come from burning of fossil fuels. The Allentown-Bethlehem-Easton area is ranked as the 42nd worst area for ozone pollution. Ozone, often called "smog," is formed when fossil fuels (gasoline, oil, coal) are burned.

The Lehigh Valley's number of high ozone days per year has, on average, been decreasing over the past decade, as well as the number of days with unhealthy particle pollution levels, but levels have never been low enough to meet federal standards.

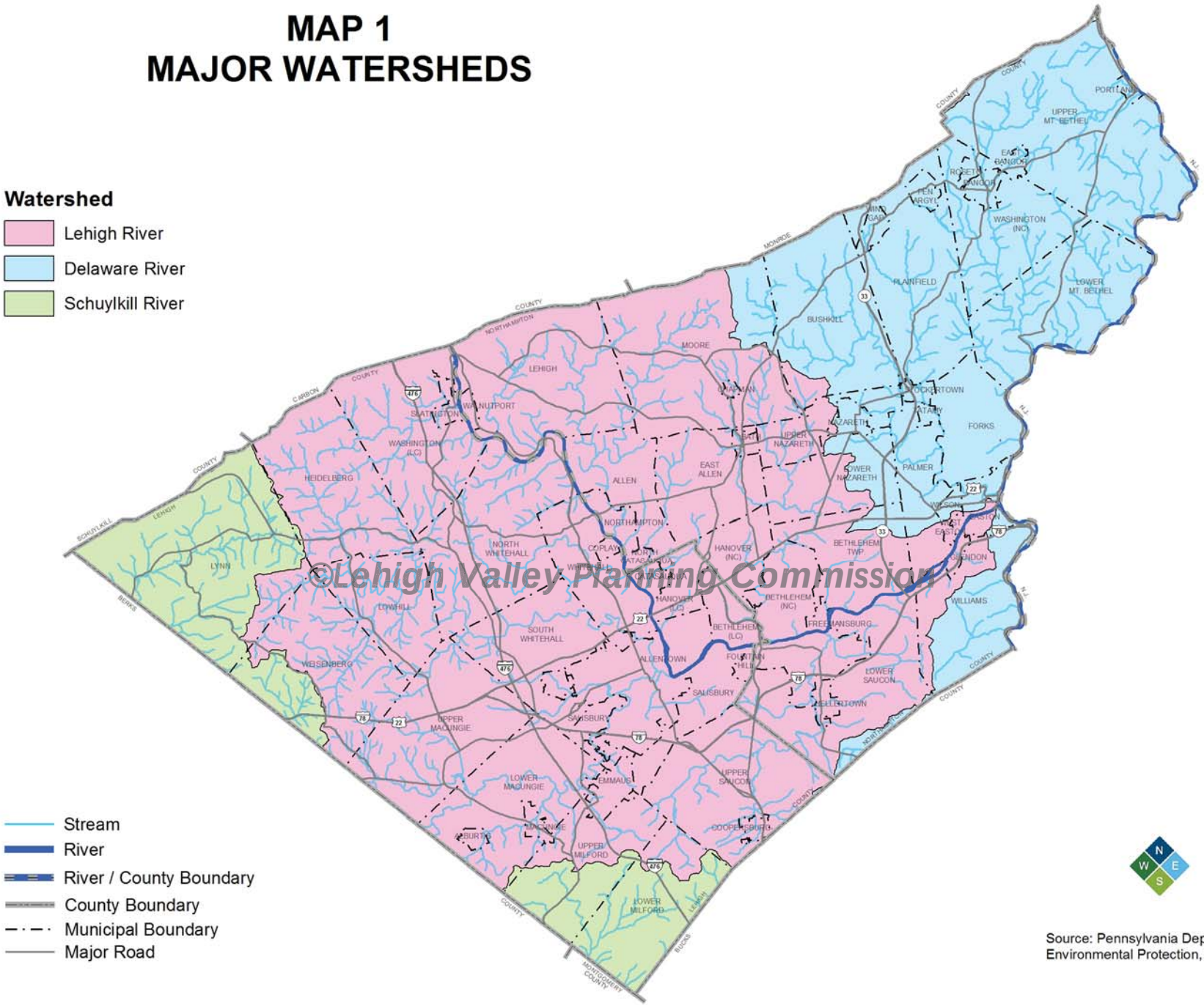
The Lehigh Valley's air quality problem is partially due to natural circumstances. Valleys tend to accumulate air pollutants, and the region's climate contributes to elevated levels of natural allergens. But the Lehigh Valley also has many industrial air emission sites, and traffic congestion is ever growing.

Water Quality

Lehigh and Northampton counties collectively contain slightly more than 1,000 miles of streams. Most of both counties drain to the Lehigh River (79% of Lehigh and 47% of Northampton), while the western parts of Lehigh County are in the Schuylkill River Watershed. The eastern portion of Northampton County drains directly to the Delaware River (Map 1). The Lehigh River forms part of the boundary between the two counties, and the Delaware River forms the boundary between Northampton County and New Jersey.

Chapter 93 of the Pennsylvania Code sets forth water quality standards for the waters of the Commonwealth that are based on water uses that are to be protected. Protected uses are: aquatic life, water supply, recreation and special protection. The aquatic life classifications of waterways are described in Table 1. In addition, streams can be afforded special protection if they are classified as *Exceptional Value* or *High Quality*. About a third of Lehigh Valley streams are classified as *High Quality-Cold Water Fisheries*, and about 50% are classified as *Cold Water Fisheries* (Figure 3). The Pennsylvania Department of Environmental Protection's (DEP) classifications for the waterways of the Lehigh Valley are shown in Map 2.

MAP 1
MAJOR WATERSHEDS



Source: Pennsylvania Department of Environmental Protection, 2013

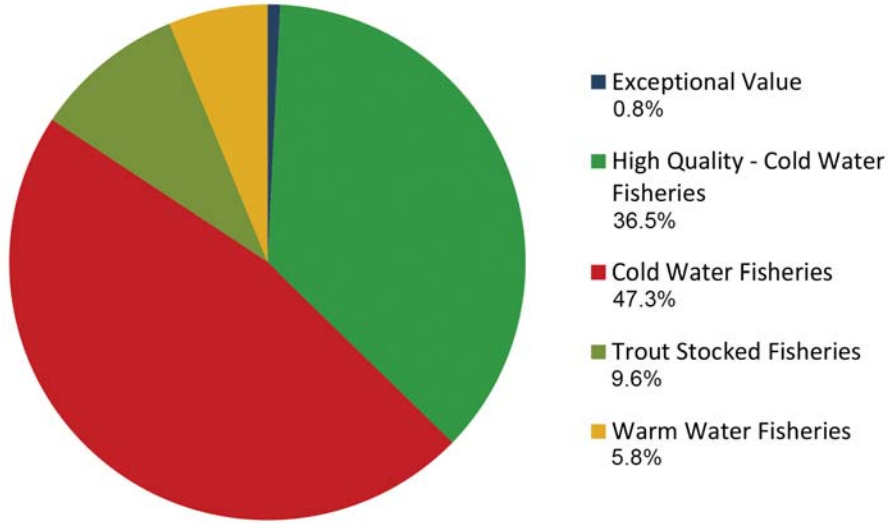
LVPC
Lehigh Valley Planning Commission

Table 1
Water Quality Classification Descriptions

Exceptional Value (EV)	waters that support high quality biological communities, waters classified by the Fish & Boat Commission as "wilderness trout streams" or class A wild trout streams, waters located in national and state parks, or waters with exceptional recreational significance
High Quality (HQ)	waters that have quality that exceeds levels necessary to support propagation of fish, shellfish, and wildlife, and recreation in and on the water
Cold Water Fisheries (CWF)	waters suitable for the maintenance and/or propagation of fish species and flora and fauna that are native to cold water habitats
Trout Stocked Fisheries (TSF)	waters suitable for the maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and flora and fauna which are native to warm water habitats
Migratory Fisheries (MF)	waters suitable for the passage, maintenance and propagation of fishes which ascend to flowing waters to complete their life cycle
Warm Water Fisheries (WWF)	waters suitable for maintenance and propagation of fish species and flora and fauna that are native to warm water habitats

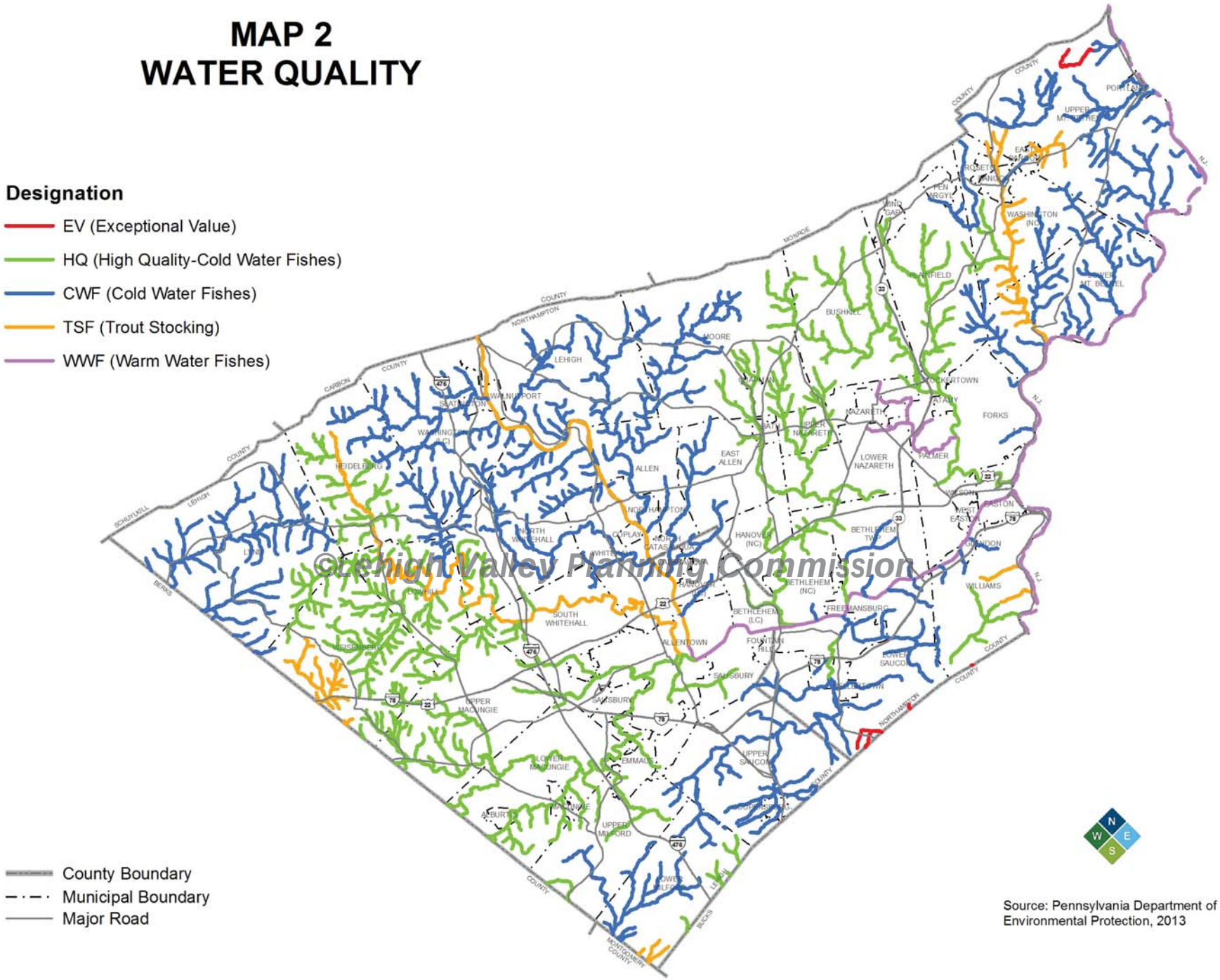
Source: Pennsylvania Department of Environmental Protection

Figure 3. Water Quality Classifications



Source: Pennsylvania Department of Environmental Protection

MAP 2
WATER QUALITY



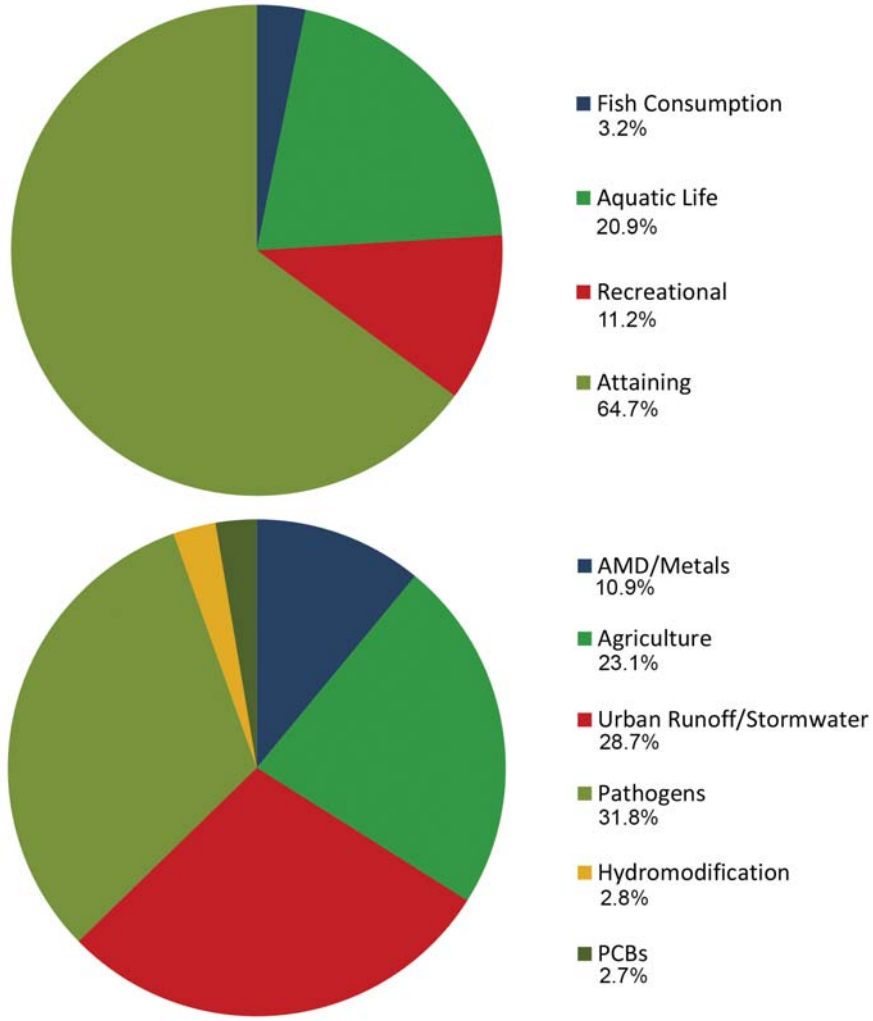
Source: Pennsylvania Department of Environmental Protection, 2013

Lehigh Valley Planning Commission

DEP has an ongoing program to assess the quality of Pennsylvania's waters. Water bodies that do not meet the water quality standards necessary to protect them for their designated use are classified as "impaired." More than a third of Lehigh Valley streams are classified as impaired (Map 3, Figure 4). Of these, roughly 60% are impaired for aquatic life and 30% are impaired for recreational uses. The major sources of impairment to tributary streams are pathogens, urban runoff and stormwater, and agriculture (Map 3, Figure 4). Abandoned mine drainage (AMD) emanating from the Eastern Middle and Southern coalfields in Carbon and Luzerne counties adversely impacts the Lehigh River to the extent that, as it flows through the Valley, it is still classified as *impaired* by AMD and does not meet standards for the protection of aquatic life. Much of the Delaware River in Northampton County is classified as impaired by mercury and does not meet standards for fish consumption.

Throughout the two counties, 34 stream miles are designated by the Pennsylvania Fish & Boat Commission as Class A Wild Trout Streams (Map 4). These waters are considered those that "support a population of naturally reproducing trout of sufficient size and abundance to support long-term and rewarding sport fishery." Class A waters are not stocked. In the Lehigh Valley, 137 miles of streams are trout-stocked.

Figure 4. Major Sources of Impairment to Streams

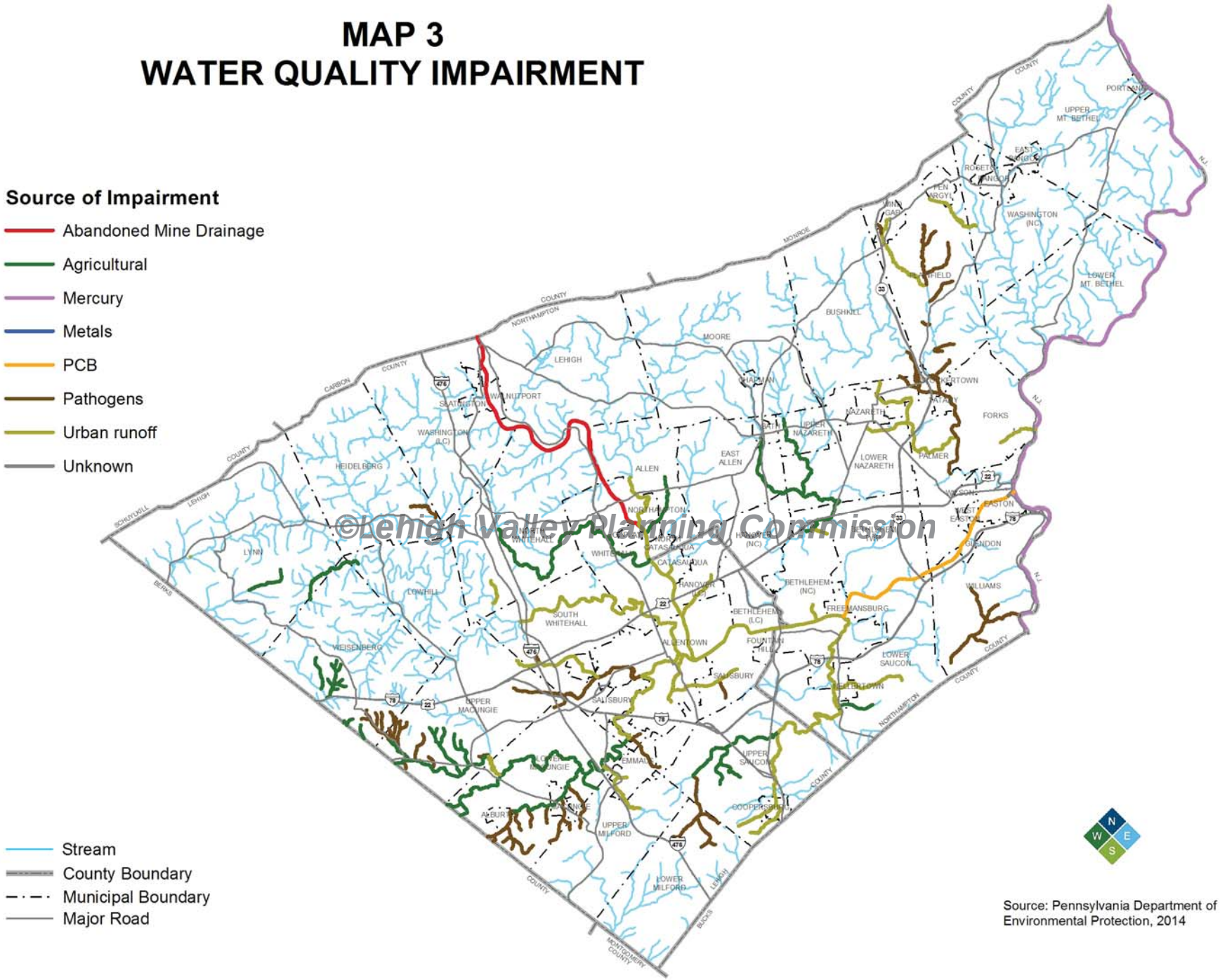


Source: Pennsylvania Department of Environmental Protection

Aquatic Communities

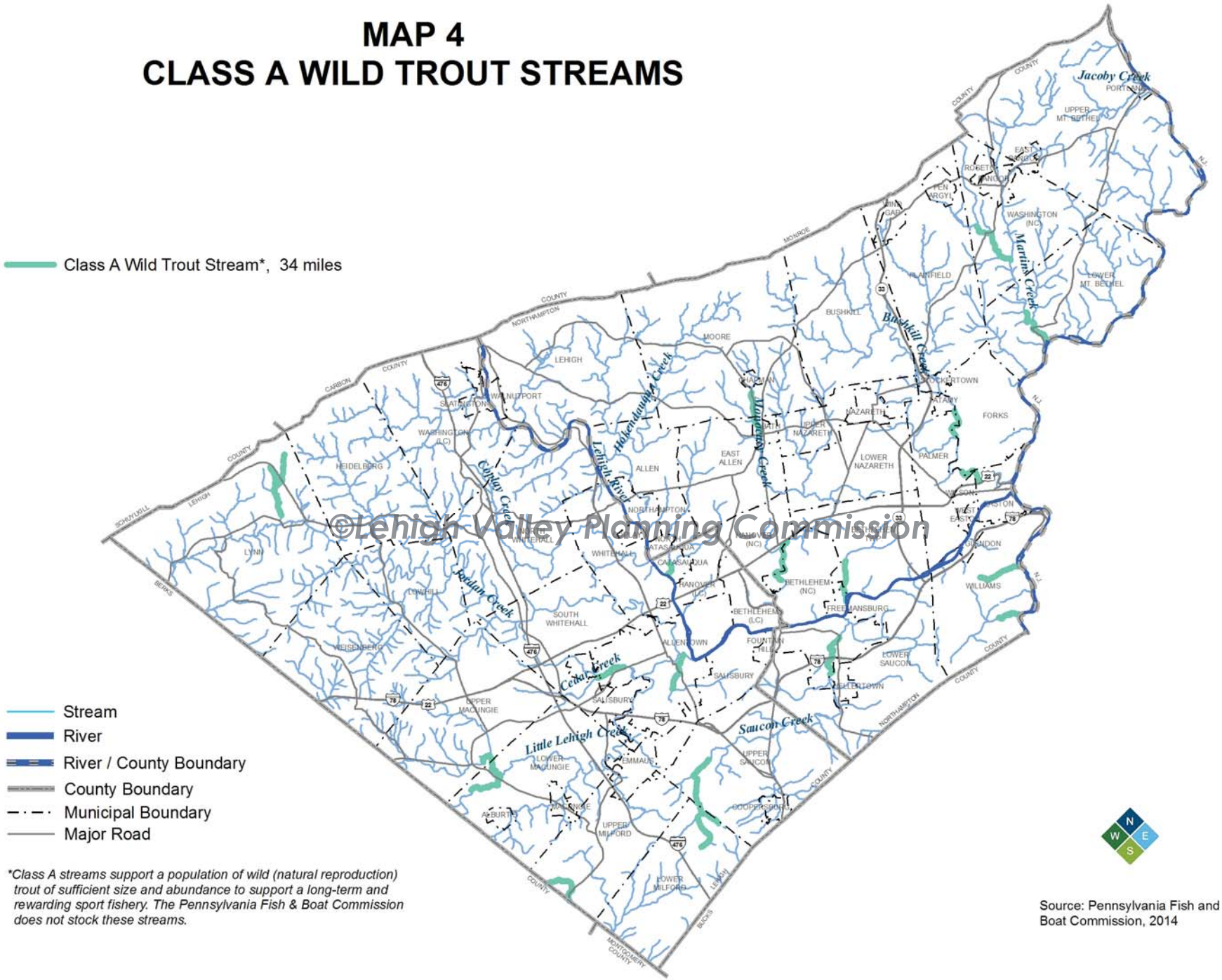
In 2013 the Western Pennsylvania Conservancy completed an update to the Natural Heritage Inventory for Lehigh and Northampton counties. The report included an analysis of stream quality in which Lehigh Valley streams were scored based on eight variables related to surrounding land use, road crossings and point source discharges. Stream reaches were classified as highest and second highest conservation priority (meaning best potential quality and second-best potential quality, respectively), and secondary restoration priority and highest restoration priority (meaning second-worst potential quality and worst potential quality, respectively). In general, the headwater streams that originate on the Kittatinny Ridge are ranked as the highest conservation priority, while much of the Little Lehigh,

MAP 3
WATER QUALITY IMPAIRMENT



Lehigh Valley Planning Commission

MAP 4
CLASS A WILD TROUT STREAMS



*Class A streams support a population of wild (natural reproduction) trout of sufficient size and abundance to support a long-term and rewarding sport fishery. The Pennsylvania Fish & Boat Commission does not stock these streams.

Source: Pennsylvania Fish and Boat Commission, 2014

Monocacy, Jordan and Coplay creeks are of poor quality and are most in need of restoration.

Restoration Needs and Strategies

Some sources of in-stream habitat degradation and water quality impairment can be addressed with relatively easy to implement, targeted restoration strategies, specifically dam removal and riparian buffer re-establishment.

***Dam Removal**:* More than 50 dams are located in the two counties, including four on the main stem of the Lehigh River and multiple dams on every major tributary to the Lehigh and Delaware rivers (Map 5). The vast majority of these dams no longer serve any purpose. Dams are such a common feature of streams and rivers, but they can degrade the health of flowing water ecosystems. Dams convert lotic (fast moving) environments to lentic (still) ones, and the result is increased water temperature, decreased dissolved oxygen, increased sediment and degradation of spawning habitat and structural habitat. Dam removal is a relatively easy and cost-effective way to improve water quality, while restoring connectivity of aquatic habitats. With so many small, obsolete dams in the Lehigh Valley, there is ample opportunity to pursue removal as a water quality and aquatic habitat improvement strategy.

Beyond environmental reasons, other benefits to dam removal are better recreational fishing and better, safer paddling opportunities. Dams are also dangerous, and removing them eliminates substantial public safety hazards and liability concerns for dam owners. Also, dams do not last forever—many of the dams in the Lehigh Valley are more than 100 years old. Removing dams eliminates the potential for an unplanned, and in some cases potentially catastrophic, failure. Dams also exacerbate flooding. Removing dams and restoring floodplains can return rivers and streams to their natural width and depth and allow them to rise and fall at a slower, more natural rate.

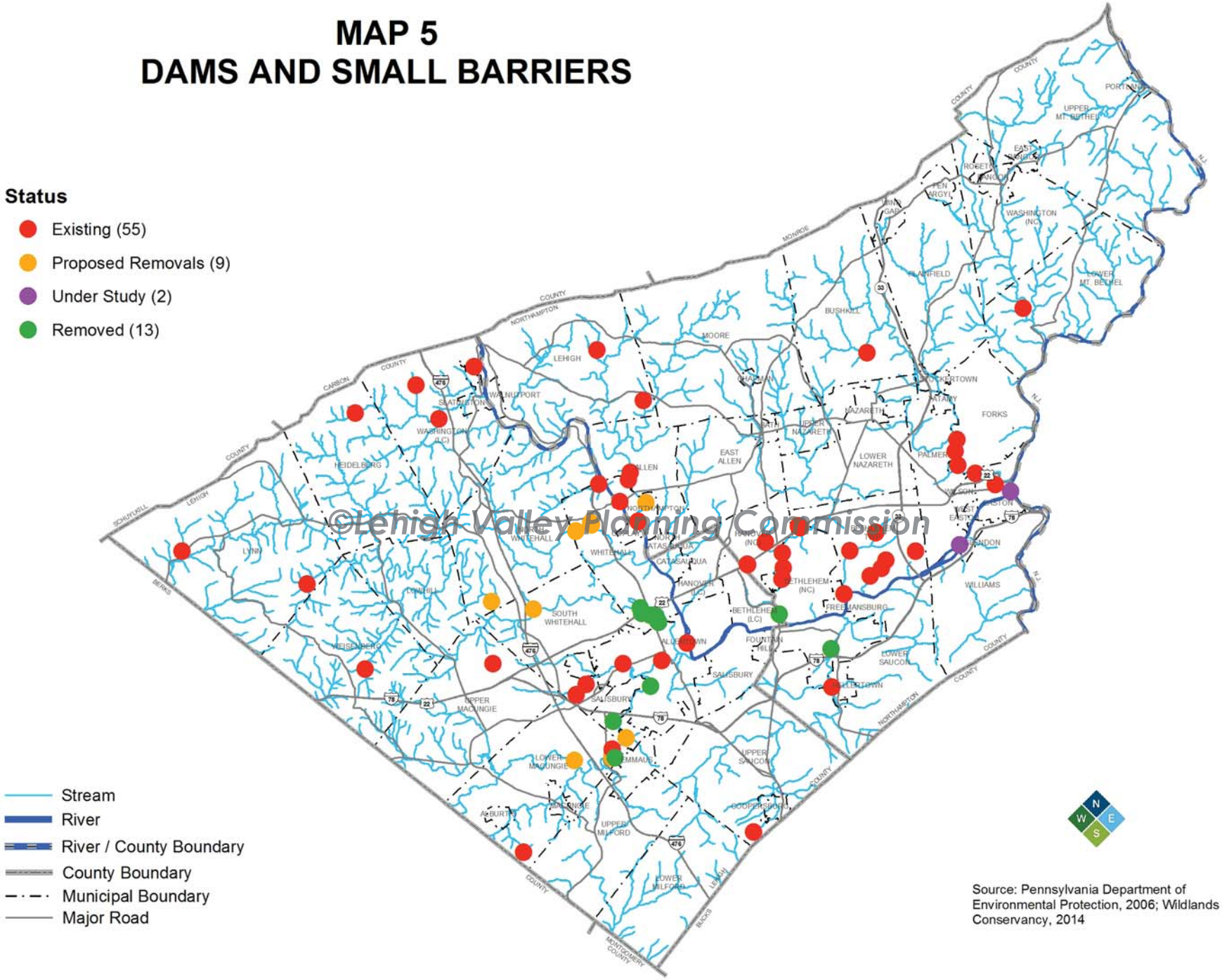
The Lehigh Valley is a leading region for dam removal. In the past few years, 13 dams have been removed on the Little Lehigh, Jordan, Monocacy, Saucon and Trout creeks.

***Riparian Buffer Re-Establishment**:* Many opportunities exist throughout the Lehigh Valley to re-establish riparian buffers. Intact riparian buffer zones absorb sediments, nutrients and other nonpoint source pollutants contained in runoff before they can enter streams. They also prevent stream bank erosion and provide shade to keep water temperatures low. Wide riparian corridors provide habitat to a wide array of aquatic and terrestrial species and can act as wildlife corridors between larger habitats.

Roughly one-third of Lehigh Valley stream miles have riparian zones that are too narrow or completely lack riparian vegetation. Generally, riparian buffers are lacking along streams in the urban Allentown, Bethlehem and Easton areas; in agricultural areas and along many headwater streams (Map 6).

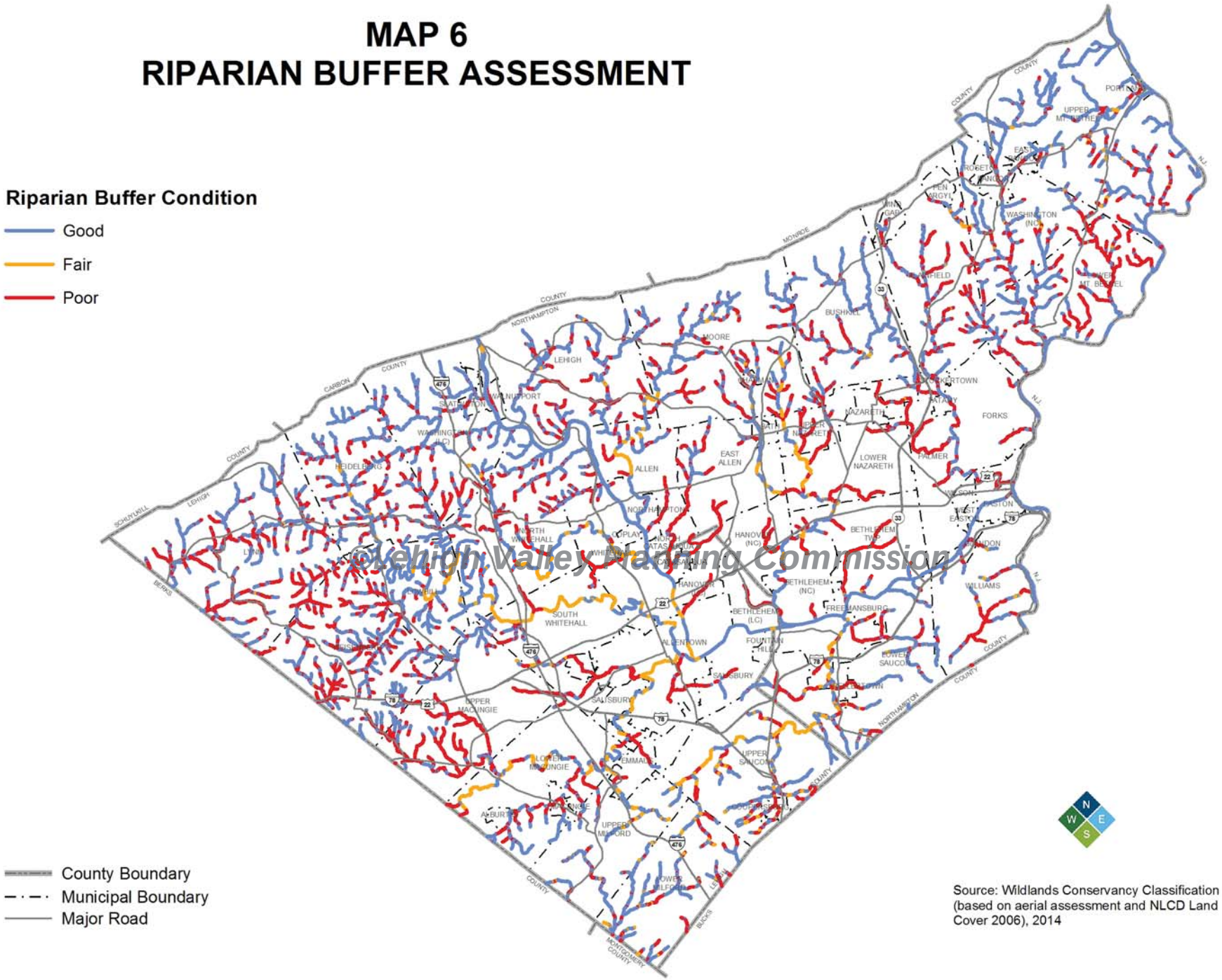
The effects of restoring riparian buffers on fish and wildlife communities are dramatic. Stream bank erosion is reduced, streams become narrower, water flow increases in velocity and critical spawning habitat once smothered by sediment is restored. In the summer, the shade provided by streamside trees keeps the water cool enough to support cold water fish like trout, and the leaves that fall into the stream feed the aquatic insects that fish eat. As trees and shrubs age, die and fall into the stream, they create refuges for fish, amphibians and reptiles.

MAP 5
DAMS AND SMALL BARRIERS



Source: Pennsylvania Department of Environmental Protection, 2006; Wildlands Conservancy, 2014

MAP 6
RIPARIAN BUFFER ASSESSMENT



Source: Wildlands Conservancy Classification (based on aerial assessment and NLCD Land Cover 2006), 2014

LVPC Lehigh Valley Planning Commission

Land Cover and Habitat

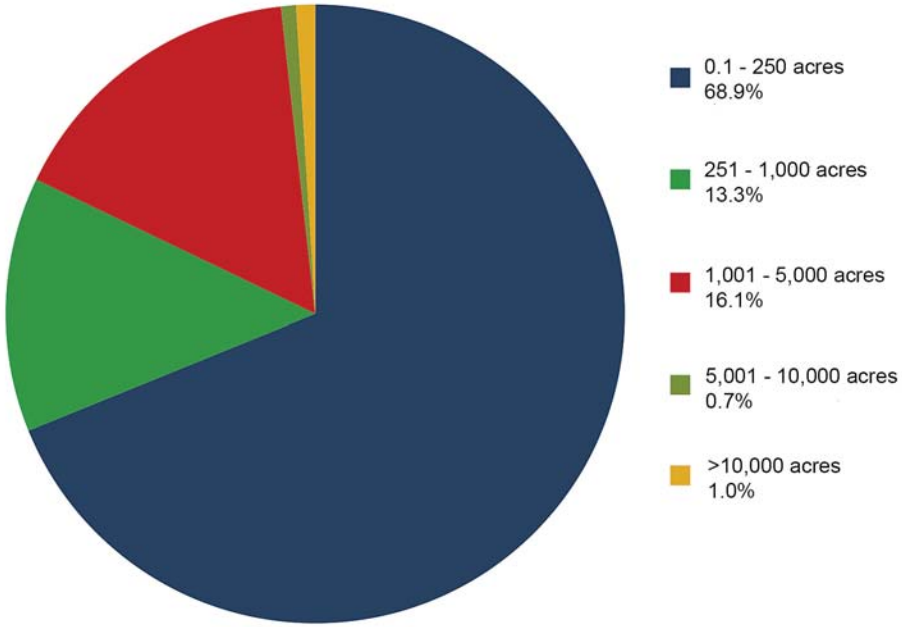
General Description

The Lehigh Valley is bordered to the north by the Kittatinny Ridge, more often locally referred to as the Blue Mountain, and to the south by South Mountain, considered part of the Highlands region. The major metropolitan areas of Allentown, Bethlehem and Easton are highly urbanized, with development growing to expand and connect the three cities over the past couple of decades. Much of Upper and Lower Macungie townships to the west of the greater Allentown area have also recently been extensively developed, as has much of Upper and Lower Saucon townships. Roughly one-third of the Lehigh Valley's land is now developed (Map 7). Fortunately, more than 300,000 acres can still be classified as open space. Approximately one-quarter of the Valley's land use is classified as forest. The largest contiguous forests are found along the Kittatinny Ridge and are primarily owned and managed by the Pennsylvania Game Commission. Fairly large blocks of forest can also be found in the Highlands Region, specifically in Williams and Upper and Lower Milford townships. Agriculture remains the predominant land cover in the Valley (approximately 37%, Map 8). Townships in northwestern and southwestern Lehigh County are primarily a mosaic of forest and agriculture, as are the townships in northern and southeastern Northampton County. Over the last quarter of a century, land use has changed substantially, as farms and forests have been converted to developed uses. This trend is certain to continue. The LVPC projects that the Lehigh Valley's population will continue to grow, adding roughly 250,000 people over the next 30 years.

Forest Fragmentation & Wildlife Impacts

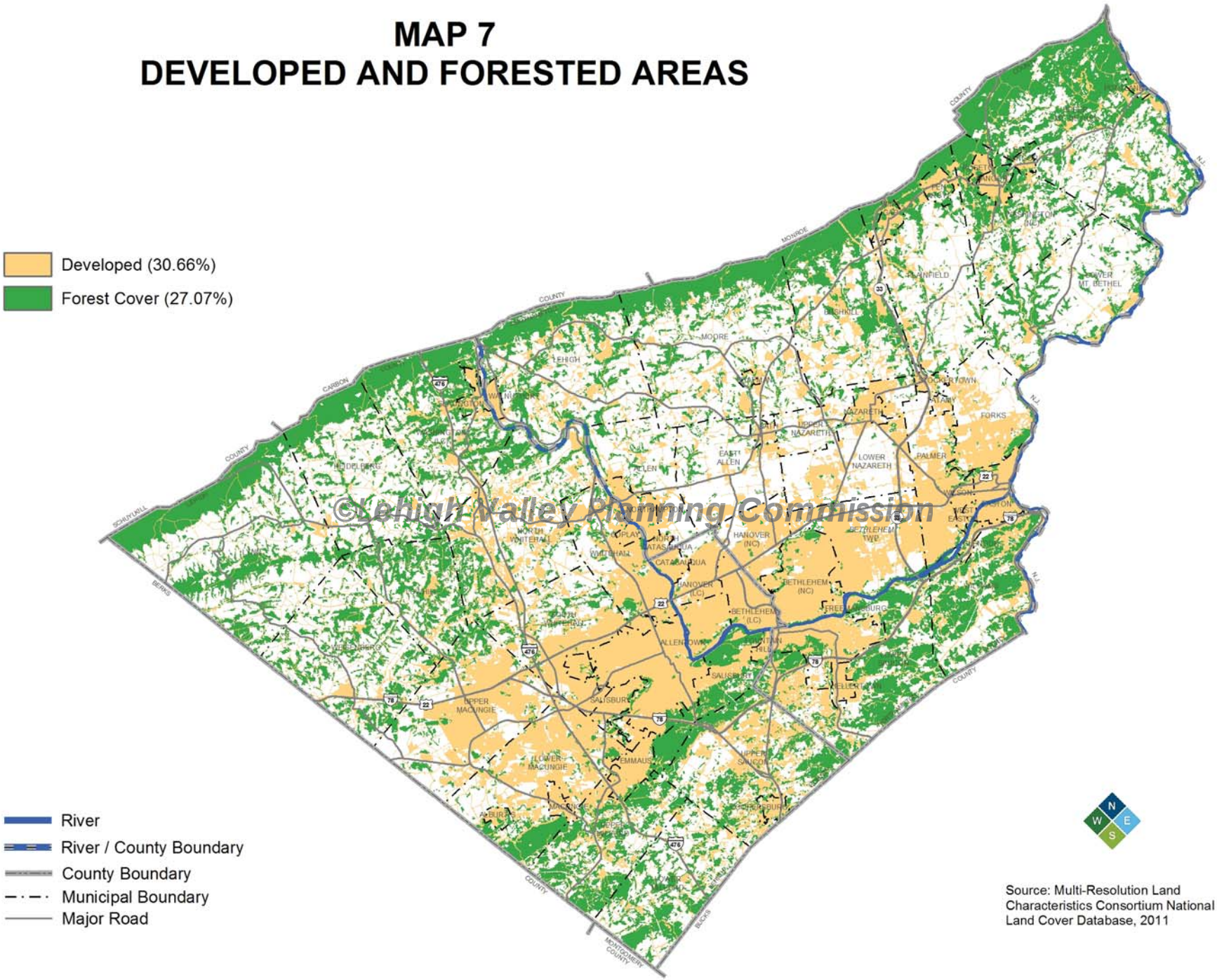
The Lehigh Valley's forests are very fragmented (Map 9, Figure 5). Roughly 70% of our remaining forests are found in blocks smaller than 250 acres. This poses very big problems for wildlife. Roads, utility lines and development fragment previously contiguous forests into smaller and smaller blocks.

Figure 5. Forest Block Acreages



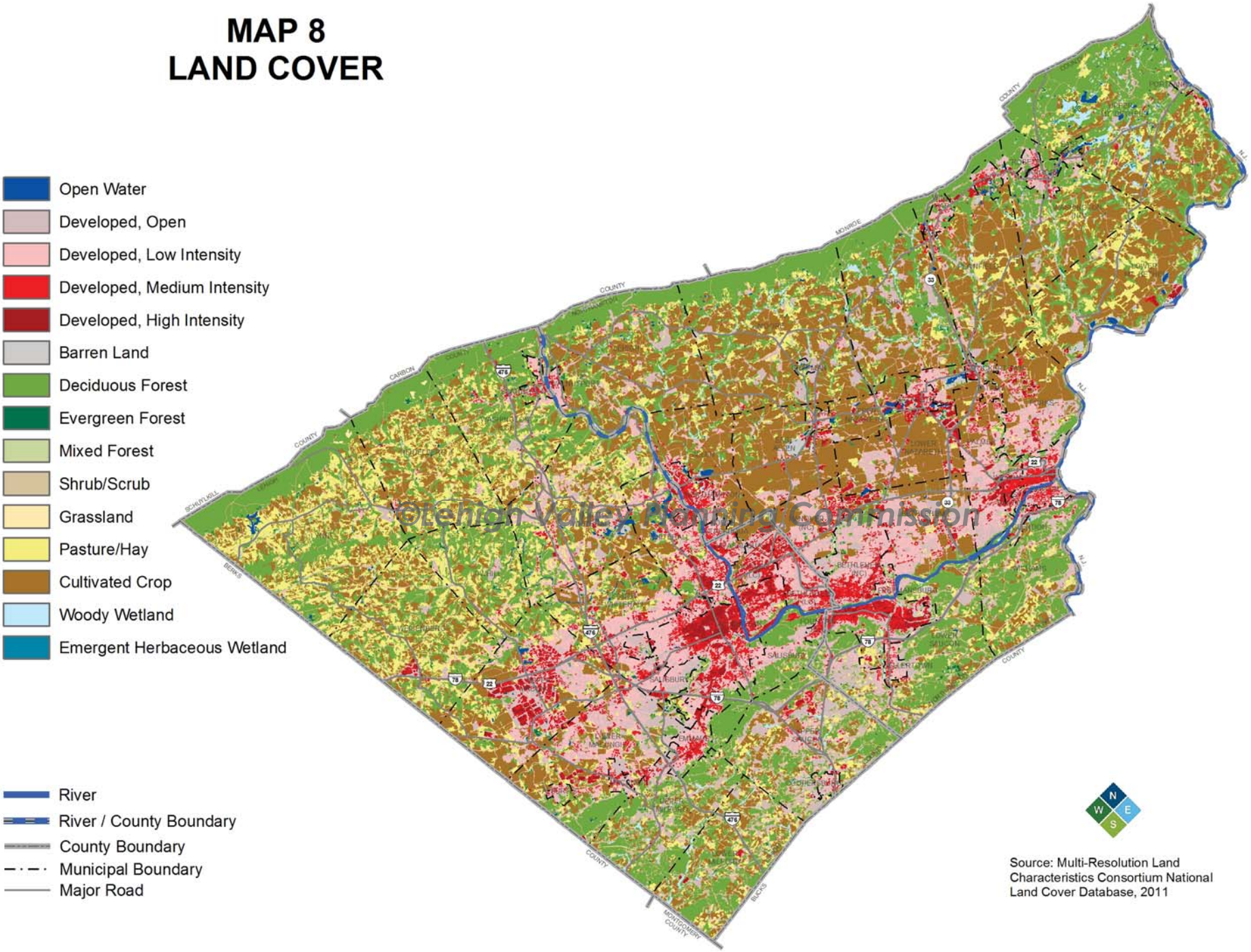
Sources: Western Pennsylvania Conservancy and The Nature Conservancy (using 2006 National Land Cover Database), 2011

MAP 7
DEVELOPED AND FORESTED AREAS



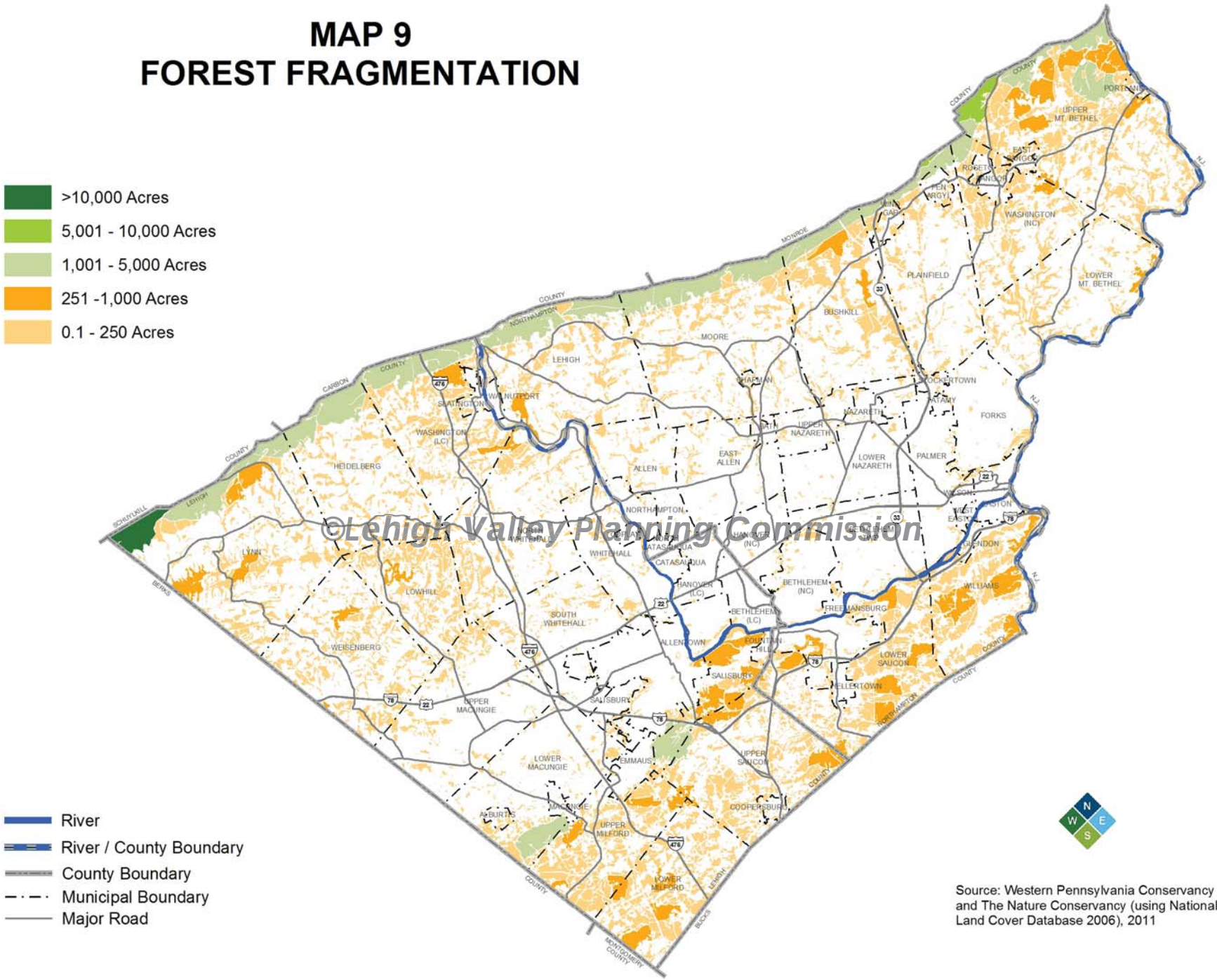
Lehigh Valley Planning Commission

MAP 8
LAND COVER



Source: Multi-Resolution Land Characteristics Consortium National Land Cover Database, 2011

MAP 9
FOREST FRAGMENTATION



Source: Western Pennsylvania Conservancy and The Nature Conservancy (using National Land Cover Database 2006), 2011

Lehigh Valley Planning Commission

Many species need large blocks of forest to survive and reproduce, and the long-term viability of all wildlife populations is contingent on the ability of at least some individuals to move from one block to another (to reduce the effects of inbreeding and genetic isolation). Some species have the ability to persist or even thrive in fragmented landscapes. Whitetail deer for example, are considered "edge" species and can do well in the land use mosaic that exists in the Lehigh Valley. Deer are reasonably successful at moving from one habitat patch to another, usually crossing roads successfully. Other species cannot persist in small habitat patches. The Scarlet tanager, a rare and welcome sighting for birdwatchers, is sensitive to forest fragmentation. Scarlet tanagers breed in forest interiors and suffer high mortality and nest parasitism when they are forced to occupy smaller, marginal quality forest fragments.

Reptiles and amphibians, which are usually overlooked when the general public thinks about wildlife, are especially susceptible to forest fragmentation. These animals are small and slow moving, making their likelihood of surviving a journey across a road or other dangerous open area extremely low. Moreover, the biology of many of these species compels them to move regularly. Amphibians move to find the suitable wet habitats required to complete parts of their annual lifecycles, and reptiles move to open areas (often roads) to meet their thermal requirements (i.e., the females of most snake species in Pennsylvania must bask in warm, open areas to facilitate embryo development).

Forest Health and Natural Resource Management

The Lehigh Valley still has roughly 125,000 acres of forest land. Note that this acreage was calculated using the Multi-Resolution Land Characteristics Consortium's (MRLC) National Land Cover Database, which classifies land cover in 30x30 meter blocks, so this number includes any woodland greater than 900 m^2. Beyond the issue of how much forest land remains, is the question of the health of our forests. Even if no more woodland is lost to development, are our existing forests self-sustaining? One of the most reliable indicators of a healthy forest is the understory—the young trees and shrubs, and the herbaceous plants and wildflowers that cover the ground and occupy the first few vertical feet of the forest. A healthy forest has a dense understory that is vertically stratified and consists of many different native species. A well-developed understory provides good habitat diversity and is the indicator of a forest's ability to regenerate and sustain itself.

Unfortunately, in the Lehigh Valley most of our forests lack a high quality understory and, therefore, lack the ability to sustain themselves. As old trees die and fall to the ground, there are not enough young trees, or trees of a variety of ages, to replace them. Many factors interact to influence forest health. The predominance of invasive plants and abundant deer populations are two key factors that greatly impact the Lehigh Valley's forests. A typical Lehigh Valley forest is characterized by one of two conditions: either the understory is essentially absent, where a person can stand at the edge and see far into the woods, seeing nothing but tree trunks; or, the understory is nearly solid, where a person standing at the edge would not be able to see into the woods at all, but upon closer evaluation would see that all of the understory plants are the same species (or the same 2-3 species). Both conditions indicate very poor forest health.

Deer feed predominantly on buds and new shoots from young trees and plants. When there are more deer than a landscape can sustainably support, the understory is quickly over-browsed, and young trees and shrubs and herbaceous plants are largely eliminated. When deer populations are in balance with their environment, forest regeneration can keep pace with deer browsing, and enough young trees and shrubs can persist and grow tall enough to avoid being eaten. A self-sustaining forest provides reliable food and shelter for a wide variety of animals.

Invasive plants are usually not native and have the ability to spread rapidly and displace native species. Because they are not native (did not co-evolve with native wildlife), they are usually not suitable sources of food and, therefore, escape the pressures of herbivory. Invasive plants are usually very good at capitalizing on degraded habitats and often tolerate a wider range of conditions (water, light, soil quality, temperature) than native species. Once an invasive species colonizes an area, it often quickly out-competes the native vegetation. Throughout the Lehigh Valley, the predominance of invasive plants is seriously degrading wildlife habitat and forests' capacity for regeneration. Some of the most wide-spread invasive plants dominating Lehigh Valley habitats include autumn olive, Japanese barberry, purple loosestrife, multiflora rose, and Tartarian honeysuckle.

Photo courtesy of Wildlands Conservancy

Photo courtesy of Michael Kaiser

Wetlands

Wetlands are extremely important for water quality protection and for wildlife habitat. Roughly two-thirds of Pennsylvania's rare, threatened and endangered species depend on wetland and riparian habitats. Little less than 4,700 acres are classified as wetlands in the two counties (Map 10). Major wetland complexes are located along the base of the Kittatinny Ridge and in Upper Mount Bethel Township.

According to the U.S. Geological Survey website, Pennsylvania has lost more than half of its wetland acreage in the last 200 years. Filling and development of wetlands is regulated at the federal, state and local levels. Pennsylvania requires mitigation in the form of wetland creation at a 1:1 ratio when impacts to an existing wetland cannot be prevented, but created wetlands seldom match the full ecological function of naturally occurring wetlands.

Steep Slopes

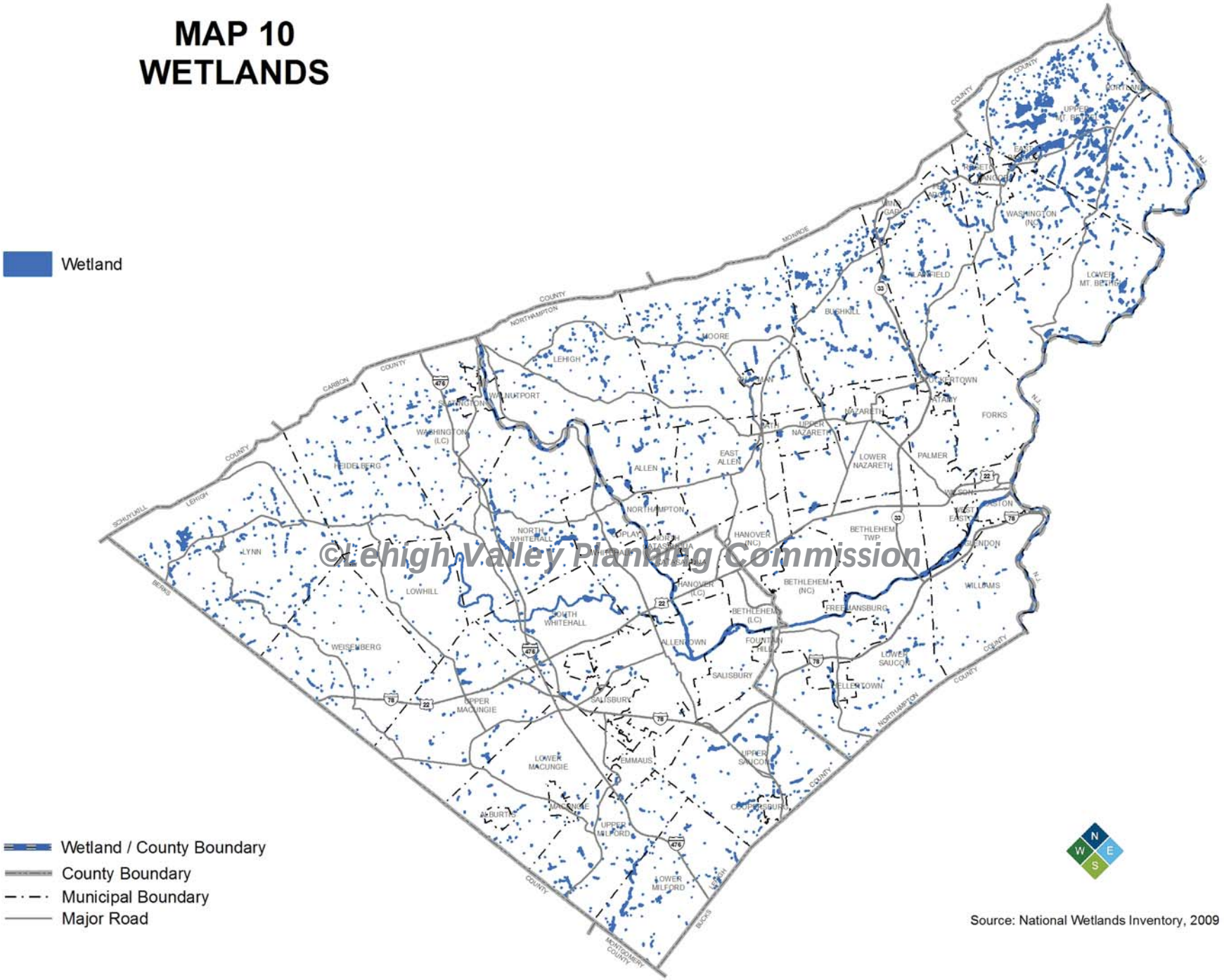
Conservation of steep slopes is important for the prevention of erosion and the protection of water quality. Steeply sloped areas also tend to be areas of high biodiversity, largely related to the presence of the micro-habitat and microclimate gradients. Fifty-one of the 107 identified Natural Heritage Areas are located on steep slopes. Steep slopes also add greatly to the scenic character of the region. South Mountain and Blue Mountain provide picturesque backdrops to Lehigh Valley communities (Map 11). The contrast of the steep hillsides and flatter, rolling farmland in western Lehigh County and eastern Northampton County make these areas particularly scenic and desirable. Fortunately, steep slopes also tend to be unsuitable for development and agriculture, but as population and resultant development pressure grow, there is more and more impetus to build into these areas. The majority of Lehigh Valley municipalities have regulations in place to protect steep slopes, and the LVPC offers a steep slope model regulation.

Important Natural Areas

The 2013 update to the Natural Heritage Inventory (NHI) identified 123 sites in Lehigh and Northampton counties (Map 12), with 107 sites having a core habitat and supporting landscape boundary and 16 sites having only a watershed supporting landscape boundary. These sites are known to contain the plants, animals, natural communities and habitats most at risk of extinction at the local or global level. The study identified 111 species of concern, including several of global conservation concern and eight high quality natural community types. Not surprisingly, the majority of sites identified in the Inventory are associated with wetlands, riparian zones, floodplains and vernal pools. Many other sites are located on steep slopes.

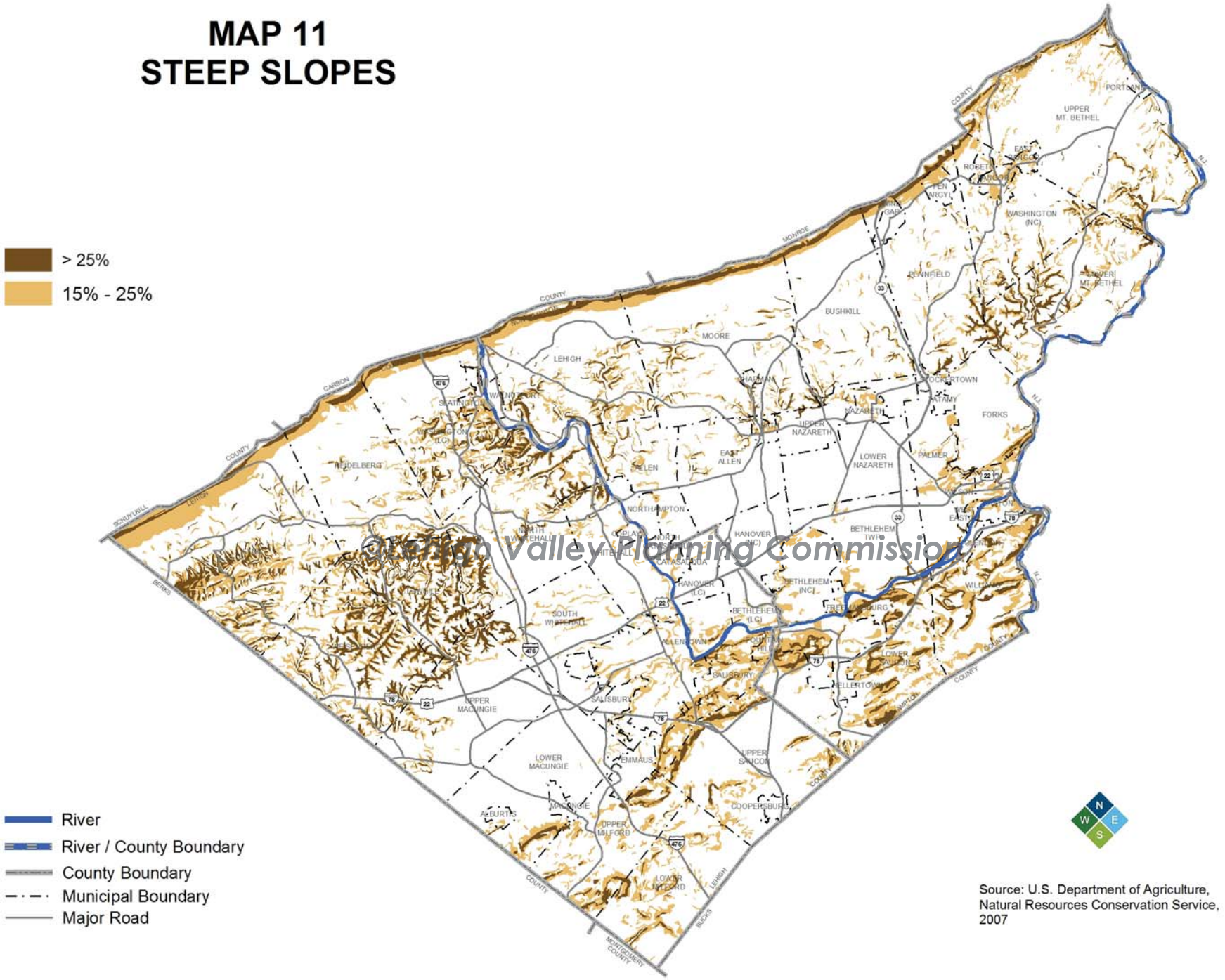
The Kittatinny Ridge is classified by the Audubon Society as an Important Bird Area, which means it has been identified as critical migratory, wintering and breeding habitat for a wide variety of birds. The Cherry Valley National Wildlife Refuge extends into northeastern Northampton County (the entire refuge encompasses more than 20,000 acres in Northampton and Monroe counties). The refuge area is home to several rare species and is identified by the Pennsylvania Game Commission as an Important Mammal Area. Together these areas support species of concern and contain exemplary natural communities and broad expanses of intact natural ecosystems that support Pennsylvania's native species biodiversity.

MAP 10
WETLANDS



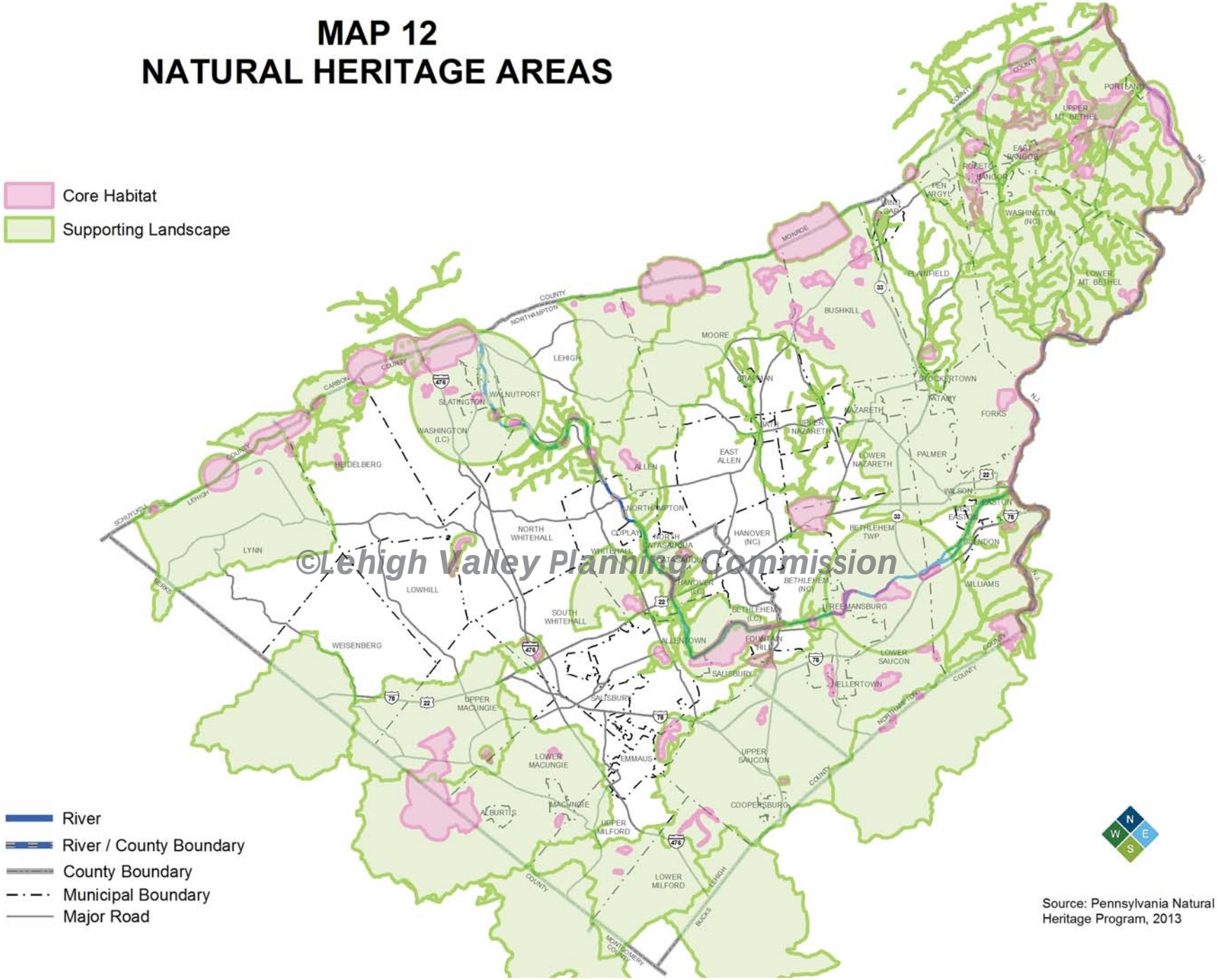
Lehigh Valley Planning Commission

MAP 11
STEEP SLOPES



Source: U.S. Department of Agriculture, Natural Resources Conservation Service, 2007

MAP 12
NATURAL HERITAGE AREAS



Source: Pennsylvania Natural Heritage Program, 2013

Lehigh Valley Planning Commission

Land Protection

The Lehigh Valley is fortunate to have more than 80,000 acres of permanently protected open space (Map 13). The largest protected land use is agriculture, with a little more than 34,000 acres (nearly 400 farms) protected by easements (Map 14). Approximately 30,000 acres are dedicated to local parks. The Valley has about 12,000 acres of game lands (mostly along the Kittatinny Ridge) and two state parks—Delaware Canal State Park, 136 acres, and Jacobsburg Environmental Education Center, 1,146 acres. Approximately 2,500 acres are protected as nature preserves or with conservation easements. Large nature preserves in the Lehigh Valley include the Robert Rodale Reserve (portions owned by Wildlands Conservancy and the City of Allentown), the Trexler Nature Preserve (owned by Lehigh County), and Lehigh Mountain (owned by the City of Allentown, Lehigh County and Salisbury Township).

Land Preservation Strategies

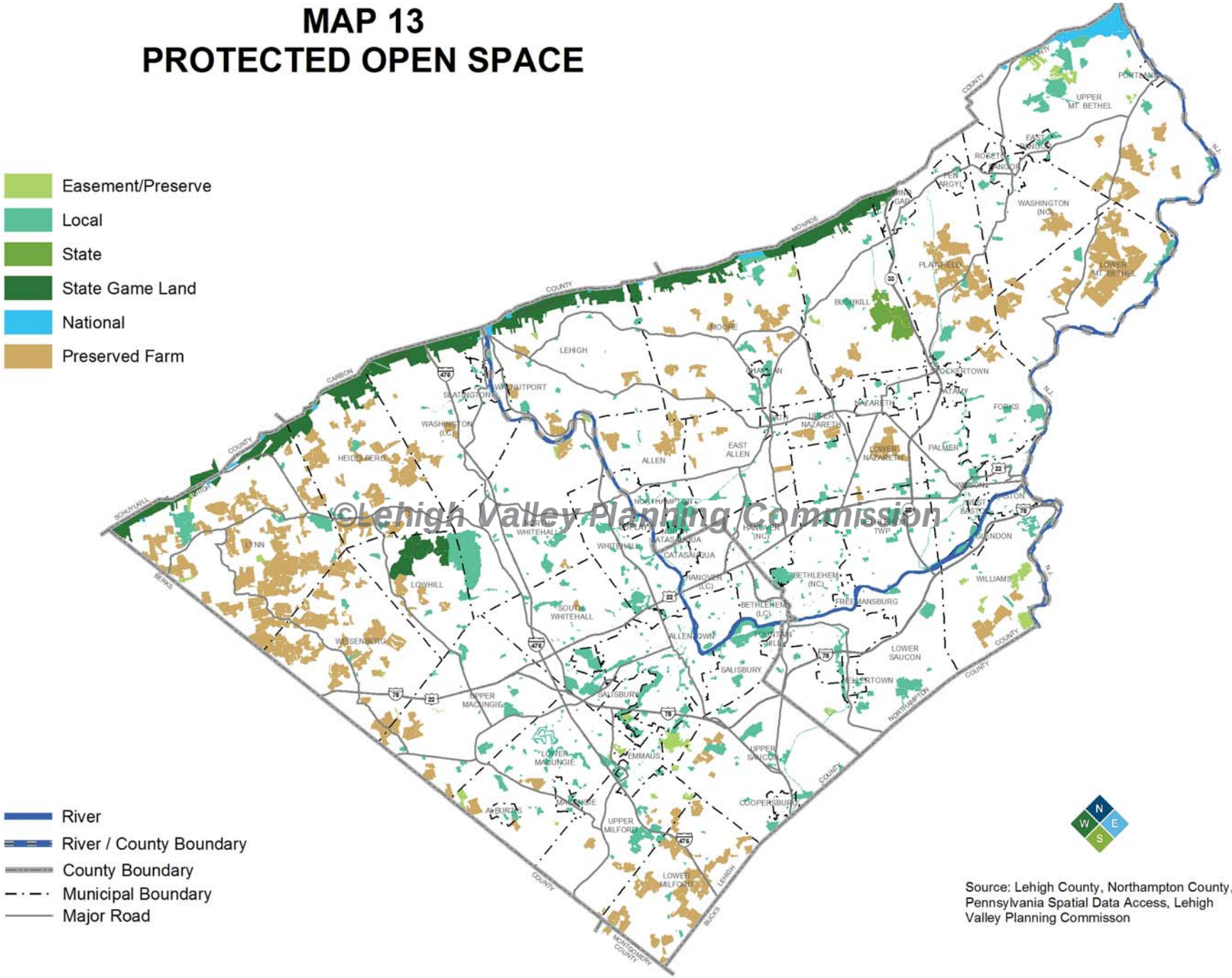
***Connectivity*:** A principal strategy employed when deciding where to focus land preservation efforts is to try to enhance habitat connectivity. In the face of increasing development, conservation efforts usually focus on adding acreage to already protected lands and on connecting large protected lands to each other. In the Lehigh Valley, land preservation efforts aimed at improving habitat connectivity are principally focused on the Kittatinny Ridge and on South Mountain. Ensuring that there are large blocks of permanently preserved lands allows populations of species with large home ranges to persist. Connecting smaller preserved lands with habitat corridors gives satellite populations of species with small home ranges the opportunity to periodically exchange individuals (gene flow), which is critical to the long-term persistence of resident populations. Maintaining connectivity also allows limited-range species to shift to nearby areas in the event of localized habitat degradation or destruction.

Enhancing the connectivity of protected lands, especially those lands that are publically accessible, has another potential benefit beyond water quality and habitat protection. Large expanses of contiguous open space create opportunities to establish and expand recreational trail networks. High quality nature trails bring economic benefits to communities, which may bolster local government investment in open space protection. More opportunities for people to connect with nature may help create a community that values, and is willing to invest in, the protection of natural resources.

***Rare, Threatened and Endangered Species Protection*:** Conservation organizations also focus protection efforts on securing properties that are known to contain, or be critical to, rare plants and threatened and endangered animals. Of the 107 sites with core habitats identified in the 2013 Natural Heritage Inventory, 67 sites are entirely, or at least partially, located on protected land, while the remaining 40 are located on private, unprotected land. The Natural Heritage Inventory program is designed to provide information to local communities about where sensitive species and habitats are found. Just because a property contains an identified species or feature, does not necessarily mean there are any regulatory controls in place to protect the property or the species.

Conservation organizations often seek to preserve NHI properties through acquisition or easement to ensure proper stewardship and permanent protection. It should also be understood that the inventory process is not exhaustive and is limited to properties that had owners willing to grant access and, based on aerial photography analysis, were most likely to contain species and features of interest. Undoubtedly, other important biological features were not documented because access was not permitted.

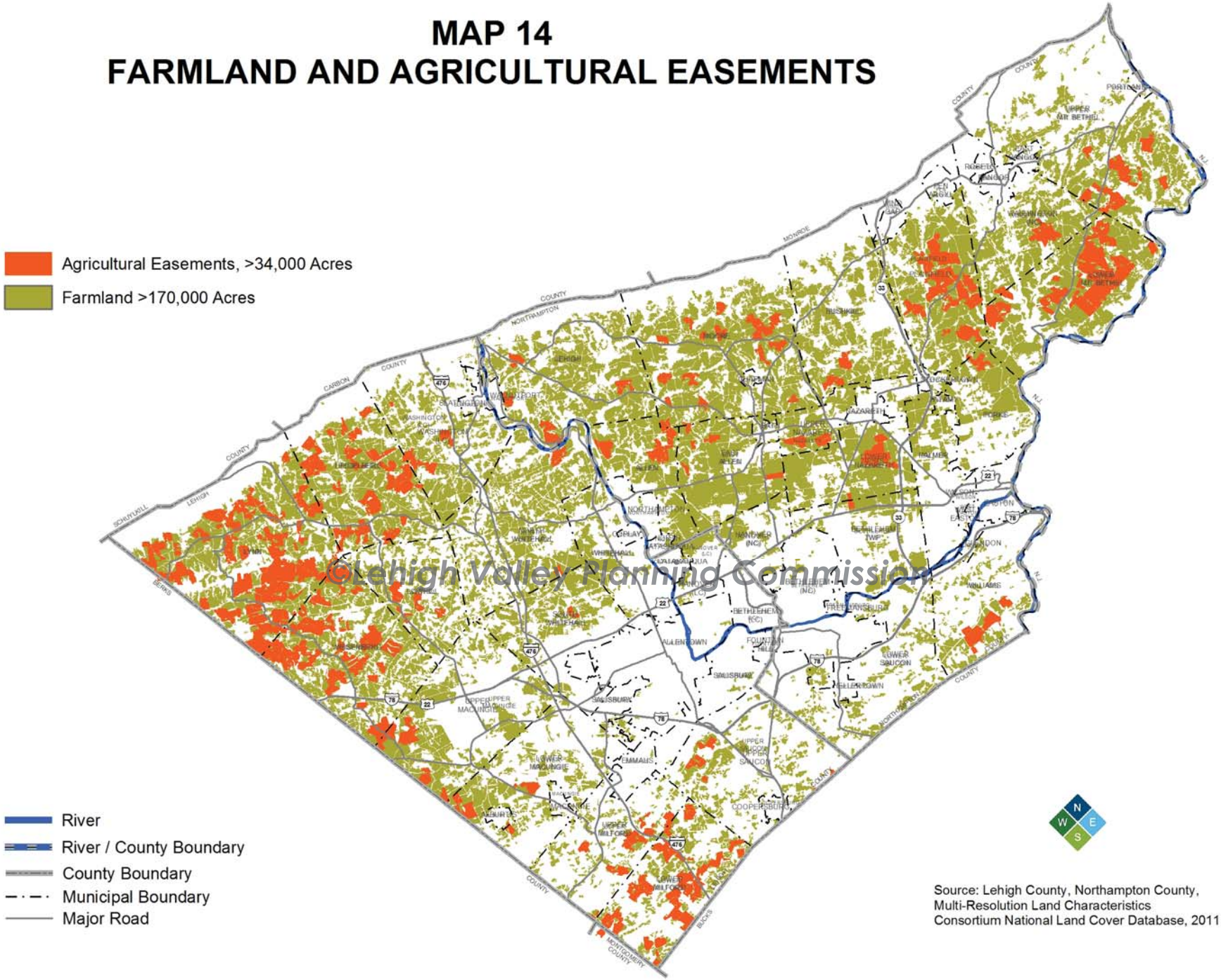
MAP 13
PROTECTED OPEN SPACE



Source: Lehigh County, Northampton County, Pennsylvania Spatial Data Access, Lehigh Valley Planning Commisson

LVPC Lehigh Valley Planning Commission

MAP 14
FARMLAND AND AGRICULTURAL EASEMENTS



Source: Lehigh County, Northampton County, Multi-Resolution Land Characteristics Consortium National Land Cover Database, 2011

***Water Quality Protection*:** Land preservation strategies can also be focused on protecting and improving water quality. When forests and wetlands remain intact, water quality is protected. Conversely, when wetlands are destroyed, forests are fragmented and riparian corridors are developed, water quality declines rapidly. Municipalities can have big impacts on water quality by choosing to adopt regulations like the Lehigh Valley Planning Commission's model regulation for riparian buffer protection. The ongoing efforts of watershed groups, environmental advisory councils, nonprofit organizations and others to restore and promote riparian buffers have been effective in many instances, but these efforts are often quite expensive and time-consuming. Without regulation, restored and established buffers can be cut down at the property owner's whim.

Land trusts have long understood the importance of riparian zones and have focused on securing them via conservation easement and acquisition. In the Lehigh Valley, 98 stream miles are surrounded by protected land. In addition, county and local parks can often be found along stream corridors. Local governments can have a very big influence on water quality just by committing to properly stewarding their streamside property. More than 85 miles of streams in the Lehigh Valley flow through county and municipal parks.

Private Lands and Conservation

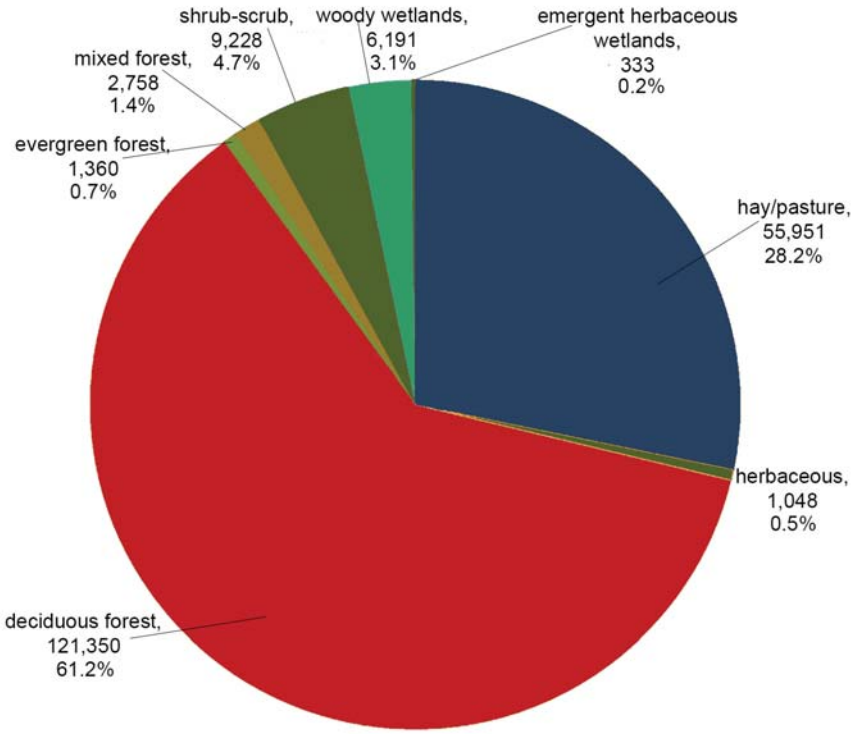
While the Lehigh Valley is fortunate to have so much open space in public ownership (i.e., game lands; federal, state, county and local parks) and in privately-owned but publically accessible preserves, the vast majority of open space is privately-owned. Roughly 60% of the Lehigh Valley's remaining forests are privately-owned. Many large private properties have good potential for permanent land preservation, but many do not. Ultimately, how private landowners choose to manage their property has, and will continue to have, enormous impacts on the overall state of the Lehigh Valley's environment, as well as the overall character of the region. Programs and resources are available to help private landowners properly steward their properties, but in general, funding for work on private lands is scarce.

Wildlife

Habitat Types

Wildlife habitats in the Lehigh Valley today are dominated by forests, which cover about 125,000 acres (Figure 6) and represent 27% of the total land cover. The majority of the forests (97% of total forest cover) are primarily deciduous. Roughly 2,750 acres are classified as mixed forest (deciduous and evergreen), and the Valley only has 1,300 acres of evergreen forest. The Valley has about 9,250 acres of shrub-scrub habitat and about 1,000 acres of grassland. Regarding aquatic habitats, the Lehigh

Figure 6. Land Cover Acreages



Source: Multi-Resolution Land Characteristic Consortium National Land Cover Database, 2011

Valley has 1,032 miles of streams and rivers and approximately 650 acres of wetlands, lakes and ponds (Map 8).

Habitat Loss & Degradation

Maintaining wildlife diversity and abundance requires conserving all habitat types in sufficient amounts and in strategic configurations. Habitat loss due to development and degradation are the primary causes of species decline. The consumption of open space, and hence the destruction of wildlife habitat, in the Lehigh Valley has historically far outpaced population growth. The Lehigh Valley has been losing roughly 2,000 acres of open space to development per year over the past ten years. In the Lehigh Valley, development primarily occurs on, but is certainly not restricted to, farmland and grassland. Grassland habitats, and consequently grassland species, have declined most dramatically, as have wetland habitats and wetland-dependent species. The effects on wildlife habitat from sprawl extend far beyond the direct consumption for development. Sprawl also causes the indirect degradation of remaining habitat through runoff, pollution, invasive species spread, and of course, fragmentation.

Mammals

There are 67 species of mammals thought to occur in Pennsylvania. While the state's large mammals are easily recognizable and well-studied, the majority of Pennsylvania's mammal species are small and have not been extensively studied. The Pennsylvania Game Commission lists 25 mammal species that are in need of enhanced conservation measures in the state's *Wildlife Action Plan*. Many of these species are bats, rodents and shrews. The decline of these populations are directly linked to the declining availability of specialized habitat types, particularly grasslands, wetlands and interior forests.

Birds

Birds tend to be behaviorally charismatic and brightly colored and are, therefore, easily observed and of interest to many people. Birds are exceptionally diverse. More than 400 species of birds can be found in Pennsylvania. Maintaining species diversity requires maintaining habitat diversity. Unfortunately, many of the habitat types that support large numbers of bird species are in dramatic decline throughout the state, most notably grasslands, wetlands, riparian forests and early successional habitats. The Pennsylvania Game Commission lists 80 bird species that warrant enhanced conservation measures. The vast majority of these species are dependent on grassland, wetland and interior forest habitats.

Reptiles & Amphibians

Reptiles and amphibians are perhaps the most sensitive and vulnerable groups to the environmental issues facing the Lehigh Valley, namely habitat fragmentation, declining water quality and wetland degradation/loss. Illegal collection and road mortality are also significant sources of population decline among reptiles and amphibians. Twenty-three species of salamanders, 14 species of frogs and toads, 16 species of turtles, 20 species of snakes and four species of lizards can be found in Pennsylvania. The state's *Wildlife Action Plan* lists 17 amphibian species (nearly half) and 29 reptile species (nearly 75%) that warrant enhanced conservation measures in Pennsylvania. Reptiles and amphibians are far more cryptic in nature than birds and mammals. As a result, far less is known about their abundance, distribution and habitat requirements.

Fish

Pennsylvania is home to a great diversity of fish species (more than 200 species), in part because Pennsylvania has more stream miles than any other state in the continental U.S., but nonpoint source pollution, stream channel modification and habitat destruction threaten the state's fish populations. Eighty species of fish are listed in the state *Wildlife Action Plan* that are in need of enhanced conservation measures. The majority of these species are found in watersheds west of the Lehigh Valley and in Lake Erie, but several species of concern are found in the Delaware River basin. Of most interest to Lehigh Valley anglers is probably the recent addition to the *Wildlife Action Plan* of the native Eastern Brook Trout as a species of greatest conservation need.

OPEN SPACE TRENDS

Mark Twain's statement, "If you don't know where you are going, you may not like it when you get there," helps us understand the relevance of trends and forecasts on our future.

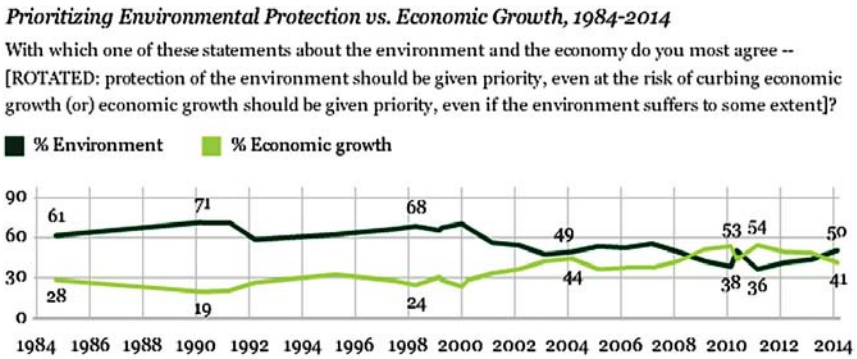
While every facet of the economy has emerging trends, several trends relate directly to natural systems, open space and economic development. These trends help us explain the world in which the trends exist, why different trends have not emerged, what new trends and patterns might arise, and how designing new outcomes can have a positive influence on our culture and future. Paraphrasing Mark Twain, we don't want to just see trends, we want to use trends to understand our future quality of life, economy and cost of living. In this section, ten interrelated trends that relate to the role of the environment in the Lehigh Valley's future are examined.

1. Attitudes about environmental protection and economic growth are evolving.

For more than 30 years, the Gallup organization has conducted surveys about people's attitudes toward the environment and economic growth. The Gallup poll posed the question as a choice between protecting the environment or economic growth. From 1985 until the early 2000s, there was a significant favoring of environmental protection, with mixed results from more recent polls (Figure 7). Beyond the overall result, Gallup reports age-specific survey results. (7)

Americans, ages 18 to 29, are most likely to say the environment should be given priority over economic growth, by a 60% to 30% margin. Americans, ages 65 and older, say economic growth should be prioritized, by a margin of 50% to 39%. Both the 30 to 49 and 50 to 64 age groups prioritize the environment over economic growth, but the gap between the two topics narrows as the age group becomes older.

Figure 7. Environmental Protection and Economic Growth



Source: Gallup, Inc., 2014

Without better public understanding of the extent to which a healthy, protected environment contributes to the economy, it may be difficult to convince people that the protection and restoration of open space is extremely important. Local decision-makers need educational tools to stay informed to make sound decisions on development, environmental protection and investment issues.

2. Attachment to where people live and their quality of life is positively impacting economic development.

While quality of life has been a traditional public policy goal, there is no commonly-understood definition. The concept exists in a wide range of contexts, including standard of living and employment, but also the built environment, physical and mental health, education, recreation, leisure time and social belonging.

What makes a community a desirable place to live? Gallup and the John S. and James L. Knight Foundation launched the Knight *Soul of the Community* project in 2008 with this question in mind. Interviewing almost

43,000 people in 26 communities over three years, the study found that three main qualities attach people to place: (8)

- **Social Offerings** – Places for people to meet each other and the feeling that people in the community care about each other.
- **Openness** – How welcoming the community is to different types of people, including families with young children, minorities and talented college graduates.
- **Aesthetics** – The physical beauty of the community, including the availability of parks and green spaces.

The main drivers of attachment show little difference across communities. In addition, the same drivers rose to the top in every year of the study. Open spaces with scenic views, tree-lined streets, parks, trails and other recreation opportunities create a sense of place and attachment for people to a town or region. Attachment to place is an important metric for communities, since it links to key outcomes like local economic growth.

3. The "green business" trend is tied to open space.

What do Air Products, Coca Cola, Waste Management Corporation, Knoll Furniture and Chipotle restaurants all have in common? They all want to be the "greenest" provider in their respective market sector for two reasons. First, being "green" increasingly follows the trends in their customers' values, and second, it saves money. At the corporate level, even during the recession, "going green" increased rather than decreased. (9) PricewaterhouseCoopers expects this trend to continue for years to come. (10) PricewaterhouseCoopers notes that companies reporting sustainability efforts have a greater return on assets than companies that do not. For example, installing solar panels may cost more, but monthly savings on energy bills add up quickly. (11)

Many sustainable companies have a longer-term vision and have committed to both natural and social capital. "Social capital" is networking among people and organizations that leads to accomplishing a goal of mutual social benefit. Many green corporations are looking for places to share their social capital. Open space is good social capital and helpful in recruiting—many young professionals want access to quality open space. (10)

Consumer goods giant, Unilever, demonstrates how to progress past tracking sustainability trends to impacting company culture. Paul Polman, CEO, has established a vision to double growth and cut environmental impact in half over the next five years. (12) Corporate executives like Polman report that sustainability is an important site location factor. Some regions, like the Tennessee Valley, are actually certifying regions as sustainable, using independent consultants to make them more competitive as part of their economic development strategy. (13) A local example is Bethlehem Authority, which is raising money and being "green" by managing a watershed and selling carbon credits. (S. Repasch, personal communication, July 24, 2014)

4. A growing body of evidence shows nature's positive impact on stress management, healthy lifestyles and well-being.

Access to open space improves not just the bottom line, but our waistlines, general health and breathing. Nature impacts our health in three important ways—provides opportunities for exercise and outdoor activities, provides contact with nature and provides cleaner air. Open space provides the venue for healthy lifestyles and inspires people to get outdoors.

Exercise is medicine, according to the American College of Sports Medicine. Research has shown that adequate exercise can cut rates of heart disease, diabetes, colon cancer and Alzheimer's by at least 40%, improving quality of life and saving on healthcare costs. (14)

Our children may be the first generation at risk of having a shorter lifespan than their parents. (15) Sedentary lifestyles and physical inactivity have contributed greatly to the numerous health problems plaguing today's children and adults. Chronic conditions, such as childhood obesity, asthma, attention-deficit disorder and vitamin D deficiency have all increased over the past few decades. (16) These conditions lead to pulmonary, cardiovascular and mental health problems in adulthood. Outdoor activity in the natural environment has taken a backseat to television, video games, the computer, and demanding schoolwork and extracurricular schedules. (17)

"Being physically active is one of the most important things people of all ages can do for their health," according to Joan Dorn of the Centers for Disease Control and Prevention (CDC). She noted that walking is rated as American adults' favorite physical activity. As little as 30 minutes every day is one way to achieve significant health benefits. (18)

Richard Louv, in his book *The Nature Principle* explains there is a growing body of evidence that contact with nature reduces stress and depression; reduces blood pressure; increases concentration, creativity and learning; and connects people to their community. (19) Other studies have made similar conclusions:

- More than two-thirds of people choose a natural setting to retreat to when stressed. (20)
- Ninety-five percent of those interviewed said their mood improved after spending time outside, changing from depressed, stressed and anxious to more calm and balanced. (21)
- Time in nature or scenes of nature are associated with psychological well-being, meaningfulness and vitality. (22, 23, 24, 25)
- Time in nature or viewing nature scenes increases our ability to pay attention. (23)
- Time spent in nature connects us to each other and the larger world. (26)
- Residents in Chicago public housing who had trees and green space around their building reported knowing more people, having stronger feelings of unity with neighbors, being more concerned with helping and supporting each other, and having stronger feelings of belonging than tenants in buildings without trees. (26, 27) In addition to this greater sense of community, they had a reduced risk of street crime, lower levels of violence and aggression between domestic partners, and a better capacity to cope with life's demands, especially the stresses of living in poverty. (26, 27)

5. People are increasingly interested in outdoor recreation.

Outdoor recreation is a larger and more critical sector of the American economy than most people realize. An analysis of comparable activities demonstrates that the outdoor recreation economy grew approximately 5% annually between 2005-2011—this during an economic recession when many industries contracted. (28)

The U.S. Forest Service reported that participation in several activities increased between 1999-2001 and 2005-2009: viewing or photographing birds (22.8%), viewing wildlife besides birds and fish (25.4%), viewing wildflowers/trees (29.4%), viewing natural scenery (17.9%) and viewing salt/freshwater fish (21.4%). (95) The report stated that while traditional forms of outdoor recreation, such as hunting and fishing, have been declining or are experiencing very slow growth, viewing and photographing nature activities have increased dramatically. (29)

The Pennsylvania Department of Conservation and Natural Resources (DCNR) conducted a survey in 2009 to determine participation rates and levels of spending on outdoor recreation in Pennsylvania. Thirty-one percent of the respondents said they planned to increase their outdoor activity over the next five years. Younger people (ages 6-16) and those with higher incomes said they were more likely to increase their outdoor recreation. About half of baby boomers (age 44-62) expected to increase their outdoor activity, compared to 25% of their older counterparts. (30)

The reasons why people participate in outdoor recreation vary; however, nature and health are the primary reasons. (4, 31)

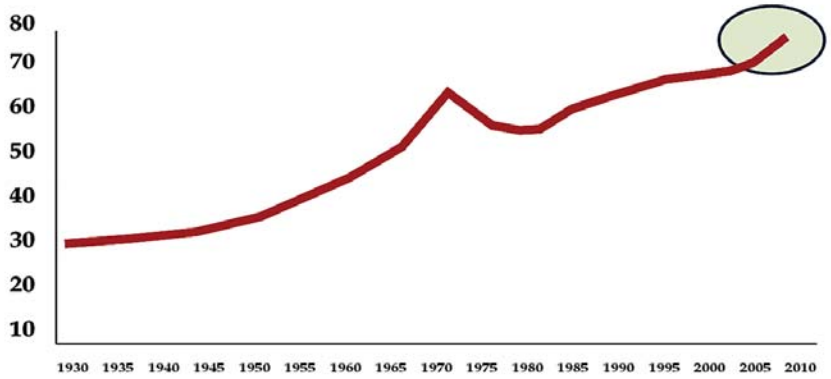
The Lehigh Valley has a wonderful variety of trail experiences. Walking, running and bicycling on trails are the top crossover activities. People who do these activities are most likely to try other activities.(31) In 2012, the D&L Trail within the Lehigh Valley had approximately 68,327 users who spent about $2.5 million. (32)

The rate of participation and levels of spending depend on the activity. Many activities are increasing. The fastest growing outdoor recreational activities in recent years in the Lehigh Valley are wildlife watching, birding, kayaking, running and hiking. (4, 29, 33)

Demand for high quality outdoor recreation remains high even in difficult times. The participation rate at Berks County's Hawk Mountain increased during the recent recession. Visitor numbers increased at a faster rate during the last recession than at any time in the last 30 years (Figure 8). (33)

Outdoor recreation is no longer a "nice to have," but is now a "must have," according to the Outdoor Industry Association, as leaders recognize the economic, social and health benefits of outdoor recreation. Local resident participation in outdoor recreation and ecotourism will likely increase due to population growth, a growing interest in exercise and getting outdoors, the region's environmental quality and close proximity of the area to millions of people.

Figure 8. Number of Annual Visitors to Hawk Mountain (thousands)

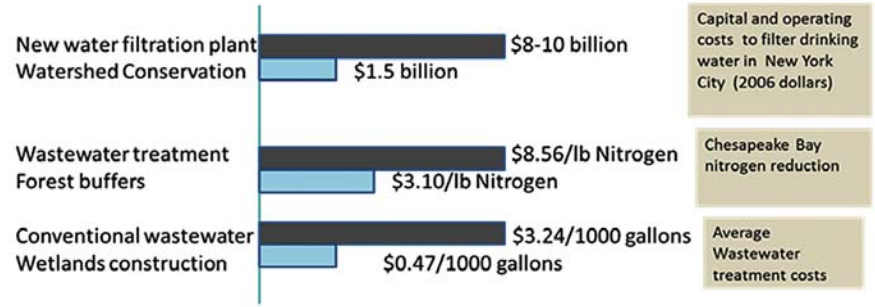


Source: Hawk Mountain Return on Conservation, 2012

6. *Investing in green infrastructure can be very cost-effective.*

Numerous examples exist of how local decision-makers have elected to restore the environment instead of spending more money on traditional gray infrastructure (e.g., pipes and treatment plants). In some cases, decision-makers have found that the environment creates green infrastructure solutions that are less expensive and more reliable. (34) The natural environment can help keep the cost of living low. The World Resources Institute shows comparisons between green and gray infrastructure costs (Figure 9).

Figure 9. Watershed Protection Costs Compared to Gray Infrastructure



Source: Hanson, et al. 2011 (34)

Many gray infrastructure projects are very expensive to engineer. An engineered natural system service like stormwater management or flood control may only provide a fraction of the services provided by natural system services.

In a study of 27 U.S. water suppliers, researchers found that protecting forested watersheds used for drinking water sources can reduce capital, operational and maintenance costs for drinking water treatment. (35) Researchers found that watersheds with greater percentages of protected forest correlate to fewer water treatment expenditures: for each 10% increase in watershed forest cover, there is about a 20% decrease in treatment costs (Table 2). An Environmental Protection Agency (EPA) study of drinking water source protection efforts concluded that, for every $1 spent on source-water protection, an average of $27 was saved in water treatment costs. (36)

Table 2
Impacts of Forest Cover on Water Treatment

Watershed Forest Cover	Average Annual Water Treatment Cost	Incremental Cost Decrease as Forest Cover Increases
10%	$923,450	-19.1%
20%	$746,790	-21.5%
30%	$586,190	-20.5%
40%	$465,740	-20.7%
50%	$369,380	-19.6%
60%	$297,110	

Source: Ernst, et al. 2002 (35)

Headwater protection is essential to control surface water treatment costs and maintain basic water quality and the health of aquatic organisms. Wetlands, riparian forests and headwaters provide some of the highest value to the local economy based on Robert Costanza's work on natural capital. (37)

Maintaining green infrastructure in riparian areas provides a supporting network for ecological integrity, ensuring the sustainable and cost-effective provision of clean water over time. Watersheds that maintain protected riparian corridors are expected to be more resilient to the anticipated effects of climate change. Riparian areas that are connected by groundwater to their landscape can maintain their functionality, are more adaptable to change, and are better equipped to handle large storm events. (38)

A growing movement exists to reduce infrastructure costs and maintain a low cost of living by protecting wetlands, forests and wooded areas along streams. Green infrastructure is often the least cost and most reliable solution to watershed protection. This saves taxpayer money. The greatest return on investment is the leverage created by maintaining and restoring headwaters.

7. The pattern, size and connectivity of open space and native habitat is increasingly important.

Mountains, forests and streams are the historic, natural hallmarks of every regional landscape in Pennsylvania. Existing open space serves as habitat for a diverse array of native plants and animals. Habitat is the place in which an organism or population normally lives. It is made up of abiotic factors such as soil, moisture, range of temperature and availability of light, as well as biotic factors such as the availability of food and the presence of predators. A substantial amount of scientific literature is available about the habitat requirements of individual species, as well as groups of species. Habitat size, shape and location matters in developing sustainable populations of wildlife, and open space corridors provide connectivity for many species. (39) More than just green infrastructure, the approach to habitat management requires knowledge of species' needs for habitat size and connectivity to sustain healthy wildlife populations. This is especially critical as land development may reduce and fragment open spaces.

Riparian forests—forests found adjacent to streams—offer a tremendous diversity of habitat. The layers of habitat provided by trees, shrubs and grasses and the transition of habitats from aquatic to upland make these areas critical to the life stages of more than one-half of all native species. Protecting stream corridors is very important in maintaining habitat. (39)

Streams that travel through woodlands provide spawning habitats for fish. Trees and woody debris provide valuable cover for small fish and other aquatic organisms along the water's edge. Degradation of any portion of a stream can have profound effects on living resources downstream. While the overall impact of these riparian forest corridors is greatest in headwaters and smaller order streams, a clear link exists all the way downstream. (39) Riparian areas also provide critically important opportunities as wildlife corridors to interconnect larger habitat areas.

The size, quality, location and connectivity of open space will determine how well our quality of life and cost of living will be maintained. The full value of open space cannot be realized unless the open space system of large habitat areas and riparian or upland corridors are intact.

8. Creating stewardship zones along open space boundaries increases natural system services.

Over 85% of land in Pennsylvania is privately-owned. (40) Finding ways to improve environmental stewardship on private land helps significantly expand open space and natural system services. The Conservation by Design concept focuses on creating higher-quality developments by clustering home sites to preserve open space and environmentally-sensitive areas and maintaining landscape connectivity. These practices often save money and increase home values when compared to traditional development.

An increasing number of programs are available to help landowners become better stewards of developed properties, including Audubon's *Bird Town* and *Important Bird Areas Program*, the U.S. Fish and Wildlife Service's *Backyard Habitat Program*, *Urban and Community Forestry-USDA*, and EPA's *Healthy Watershed Program*.

The headwaters, wetlands, riparian areas and larger forests and fields (over 150-200 acres) are where the majority of natural system services are provided in any watershed. (37) The closer an area is to top quality streams, the higher the value. Increasing the size and connectivity of these open space areas, along with conservation design and stewardship efforts, improves natural systems, increases the tax base, reduces infrastructure costs and helps maintain the community's sense of place.

Where properties abut natural areas, planting native plants and implementing best management practices will also substantially increase natural system services. This is an important consideration when compared to traditional development. (41)

The Costs Related to Traditional Development Compared to Conservation Development

Traditional development requires intensive and costly additions of gray infrastructure to connect new neighborhoods to road and utility networks. In a review of 98 communities across 21 states, research found that, for every dollar received from residential development revenues, an average of $1.16 was spent on providing services to the new community by the local government. Conservation development provides economic benefits to communities because it consumes less land, needs fewer roads, resources and utility infrastructure. Additionally, studies have shown that people are willing to pay a premium to live in conservation developments; these premiums provide greater revenues to local communities. (41)

Creating private property stewardship areas (green corridors) along open space areas can significantly increase natural system services at a very low cost. Conservation design is less expensive and provides greater ecological benefit than traditional patterns of development. Stewardship of public and private properties adjacent to open space areas increases the size and connectivity of natural systems and the critical services they provide.

Backyard Conservation Actions

- Plant native trees, shrubs, grasses and flowers (60% canopy cover and 60% native plants)
- Reduce the size of your manicured lawn
- Reduce mowing frequency
- Create flower beds on the perimeter of the lowest areas of your property and consider rain gardens
- Avoid using toxic chemicals
- Use slow release fertilizers at one-fourth the dose
- Create berms on slopes to slow runoff
- Plant trees and grasses in riparian zones

9. Property values are positively impacted by open space.

Beginning in the 1970s, studies that focus on the role of more traditional forms of open space, such as parks, have determined positive impacts on property values, urban aesthetics and the environment. These studies have established that natural amenities tend to have a positive impact on property values. In these studies, green space can be defined as trees, urban forestry, parks, wetlands, community gardens, water or other natural amenities. Most of this work has focused on the impact of green space

on residential properties, rather than commercial or industrial properties. Parks and open space studies have established the positive impacts on property values based on proximity. The specific impacts of proximity to open space on property values for the Lehigh Valley are discussed in a later section of this report.

10. Americans are showing a growing interest in organic, locally-grown food.

The Lehigh Valley's 1,002 farms on 153,000 acres of remaining farmland produce a market value of agricultural products of $134.4 million annually. Lehigh County produces $90.8 million and Northampton County produces $43.5 million, which only provides food for 24% of the current local population, so food needs to be imported for residents to eat. Approximately $17 million is the actual economic activity generated by the local food economy. Lehigh Valley farms have the potential to produce an increased amount of food. (42) The reproduction, productivity and quality of both native plants and agricultural crops are impacted by natural pollination and biological controls. These services help lower the cost of food. (W. Mondjock, personal communication, August 5, 2014)

One of every three bites of food eaten depends on pollinators, especially bees, for a successful harvest. (43) However, honeybee numbers in Pennsylvania have been declining over the past several years. Beekeepers recorded overwinter losses of 26% to 48% in Pennsylvania between 2006 and 2014. (44) These losses are much higher than seen in previous years. A rebounding of the bee population will be important for sustaining local agriculture.

ECONOMIC VALUE ANALYSIS

The economic value of the Lehigh Valley's open spaces is estimated by measuring the impact in four areas:

1. The avoided costs associated with natural system services provided by the Lehigh Valley's open spaces.
2. The avoided costs associated with air pollution removal by trees and natural vegetation on health, agriculture and buildings.
3. The value of outdoor recreation that occurs on open space lands.
4. The effects of open space on residential property values.

Open space creates economic value in four ways: via revenue generation (e.g., sale of goods and services), wealth generation (e.g., higher property values and earnings from open space-related activities), increased tax revenues (e.g., increased property tax collections due to higher property values), and avoided costs (e.g., dollars that would be spent on the provision of environmental services, such as improving water quality and removing air pollution in the absence of protected open space).

The process of estimating the value of natural system services begins by defining natural capital. Natural capital is the Lehigh Valley's portfolio of natural assets including geology, soil, air, water and all living things. The most obvious benefits provided by natural system services include food and water for human consumption and plant materials used for fuel, building materials and medicines.

There are also many less-visible natural system services such as climate regulation and natural flood defense provided by forests. Over time, billions of tons of carbon are stored in forests. Forests and meadows also support natural pollination and biological control of insects and rodents. Additional benefits are increased property values and scenic views.

Conservative approaches were used to estimate monetary values, meaning that they intentionally produce somewhat lesser values than reality to be careful not to overstate benefits. For example, not all outdoor recreational activities were included, nor were all natural system services. Even with this conservative approach, however, the analysis is subject to caveats common to any economic valuation or impact analysis regarding substitution effects, double counting and value estimation.

Substitution effects – An effect caused by a rise in price that induces a consumer (whose income has remained the same) to buy more of a relatively lower-priced good and less of a higher-priced one.

Double counting – Double counting occurs when a value is overstated due to it being accounted for in two separate analyses. While this study aims to minimize any double counting, it is expected that some exists in the evaluation of property values (i.e., people include the convenience of recreational use on nearby open space in home sales prices). It is expected that smaller double counting may occur between the natural system services and property value impacts and the recreational cost savings. (37)

Value estimation – Value transfer methods are utilized where data collection is too costly or time consuming. In surveying existing studies for benefit transfer values (e.g., How much is a ton of carbon dioxide removed from the atmosphere worth?), a range of plausible values are available to choose from within the research literature. This study draws upon leading researchers that have evaluated a large number of studies and, in most cases, uses an average value among the existing research to apply to the Lehigh Valley analysis. The values calculated in this economic research are based on the average consumer's activity. (45)

It is important to note that the economic benefits presented in this study are meant to serve as estimates, not exact values. While approximations, they are based on defensible estimation methods and represent a vast improvement over attempting to make economic judgments regarding open space preservation without such data.

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 given too little weight in policy decisions. (38)

The natural landscapes of the Lehigh Valley's open space provide many environmental benefits to the residents and businesses in Lehigh and Northampton counties. This component of the study estimates the avoided costs associated with seven natural system services provided by the Lehigh Valley's open space, including water supply, water quality, disturbance (flood) mitigation, wildlife habitat, pollination, biological control and soil formation/retention. These represent natural system functions that, if lost, would require costly measures to replicate.

The natural system services provided by the natural land cover of Lehigh and Northampton counties vary depending on the type of land cover, with substantial differences in service values based on the type of land cover considered.

The United Nation's Millennium Ecosystem Assessment (MEA) groups natural system services into the following main categories: (46)

- Provisioning Services: the products obtained from ecosystems, such as food and water, provided by the hydrologic services of water supply and water quality.
- Regulating Services: the benefits obtained from the regulation of ecosystem and biotic processes, specified as disturbance (flood) mitigation and biological control.
- Cultural Services: the non-material benefits that people obtain from nature, such as aesthetic experiences.
- Supporting Services: those that are necessary for the production of all other natural system services. These services differ from provisioning, regulating and cultural services in that their impacts on people are either indirect or occur over a very long period of time, and include wildlife habitat, soil formation/retention and pollination.

The seven specific natural system services are included in the economic valuation process. Cultural Services are not assigned an economic value.

Methodology

In this analysis, value transfer is used to estimate the ecosystem services discussed above. Value transfer involves the adaptation of existing valuation or data from one location to a similar location. Value transfer is typically used as an alternative strategy when primary research is not possible or justified because of time or budget constraints. Value transfer has become a very important tool for policy makers since it can be used to reliably estimate the economic values associated with a particular landscape, based on existing research, for considerably less time and expense than a new primary study. (37)

Costanza, et al. (2006) compiled and summarized over 100 academic studies comprised of 210 individual value estimates for the types of ecosystems present in the state of New Jersey. Due to similarities between the climate, land cover and ecosystems of New Jersey and the Lehigh Valley, the Costanza, et al. (2006) data and model was applied in this study. Table 3 includes data on the number of studies reviewed by Costanza, et al. (2006) as well as the minimum, mean and maximum value of natural system service benefits per acre of open space. Please note that per acre values for the different ecosystem services vary by the type of land cover, and Table 3 is an aggregate of all of the land cover values for a given ecosystem service.

The natural system service benefits by service area are as follows:

Water Supply – Many land cover types (e.g., forests and wetlands) and their underlying soils help ensure that rainwater is stored and released gradually rather than being allowed to immediately flow downstream as runoff. Approximately 60% of the residents of the Lehigh Valley get their drinking water from wells or community systems that partly rely on groundwater. The quality of the groundwater is high and attracts beverage companies like Nestlé Waters. The Lehigh Valley is one of the fastest growing regions in the state. The value of water to existing and future residents is very high.

Water Quality – Forests and wetlands also provide a natural protective buffer between anthropogenic activities and water supplies, helping to filter out pathogens, excess nutrients, metals and sediments.

Disturbance (Flood) Mitigation – Many natural landscapes help provide a buffering function that protects humans from destructive events. Forest, wetlands and floodplains help mitigate the effects of floods by trapping and containing stormwater.

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

Wildlife Habitat – Contiguous patches of land cover with sufficient area to hold naturally functioning ecosystems support a diversity of 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.

Soil Formation/Retention – Soils provide many of the services mentioned above, including water storage/filtration, water quality 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 by precipitation.

Pollination – Pollination is essential for many agricultural crops, and substitutes for local pollinators are increasingly expensive. Pennsylvania has been experiencing a severe “bee collapse”. Forests and meadows provide pollination service benefits that provide a form of insurance for farmers and nature should the collapse continue for an extended period of time.

Since most services are natural functions, well-functioning markets for these services do not exist. When no explicit markets exist for the services, more indirect means of assessing values must be utilized. The studies analyzed by Costanza, et al. (2006) utilized a variety of non-market techniques (the list of techniques used for each natural system service is included in Table 3). The techniques are defined as follows:

- Avoided Cost (AC): some of the ecosystem services allow society to avoid costs that would have been incurred in the absence of those services. An example is flood control provided by intact riparian buffers that helps avoid property damage downstream.
- Replacement Cost (RC): some of the ecosystem services could be replaced with man-made systems. For example, the water quality service provided by wetlands could be replaced with chemical or mechanical alternatives (such as wastewater treatment plants).
- Travel Cost (TC): provision of services may require travel, the cost of which can reflect the implied value of the service.
- Hedonic Pricing (HP): an economic analysis valuation method that determines value for specific services based on prices people are willing to pay.
- Contingent Valuation (CV): a service pricing method involving customer responses to surveys, willingness to pay for services and acceptable compensation for altered services.
- Value Transfer (VT): a method used to estimate economic values for ecosystem services by transferring available information from studies already completed in another location and/or context.

- Direct Market (DM): an economic valuation analysis based on the principle of substitution whereby services may be valued based on the established value of equally desirable substitutions.

Table 3
Studies Reviewed by Costanza, et al. 2006

Natural System Service	Number of Studies	Minimum (per acre/ year)	Mean (per acre/ year)	Maximum (per acre/ year)	Valuation Methods
Water Supply	23	$3	$1,102	$3,839	AC (2), CV (12), HP (1), RC (1), TC (5), VT (2)
Water Quality	3	$44	$309	$838	VT (3)
Disturbance (Flood) Mitigation	5	$6	$768	$3,657	AC (3), VT (2)
Biological Control	3	$2	$9	$12	VT (3)
Wildlife Habitat	12	$1	$772	$3,883	CV (11), VT (1)
Soil Formation/ Retention	3	$1	$3	$6	DM (1), VT (2)
Pollination	4	$2	$56	$265	AC (1), DM (1), RC (1), VT (1)

Source: Costanza, et al. 2006 (37)

Table 4 lists the different land covers that provide the various ecosystem services. To estimate the amount of natural system services provided by the natural areas of Lehigh and Northampton counties, 2011 (the most recent year available) satellite-derived land cover data from the Multi-Resolution Land Characteristics (MRLC) Consortium was obtained, and ArcGIS was used to calculate the acreage of 11 different land cover types located in the two counties.

Table 4
Natural System Services Provided by Different Land Cover Types

Natural System Service	Land Cover(s) Associated with the Ecosystem Service
Water Supply	Forests, Freshwater Wetlands, Open Freshwater, Riparian Buffers
Water Quality	Forests, Freshwater Wetlands, Pasture
Disturbance (Flood) Mitigation	Freshwater Wetlands, Riparian Buffers, Developed Open Space, Pasture
Biological Control	Cropland, Forests, Pasture
Wildlife Habitat	Cropland, Forests, Freshwater Wetlands
Soil Formation/Retention	Forests, Pasture
Pollination	Cropland, Forests, Pasture

Source: Costanza, et al. 2006 (37)

Table 5 summarizes the land cover acreages in each of the counties. The amount of intact riparian buffers was calculated by creating 50 foot buffers around all of the stream segments that flow through each county and calculating the amount of the various land cover types in the buffer. For the forest and pasture land cover types found in the riparian buffers, the riparian natural system service values were applied rather than the natural system service value for that land cover type. Note that the developed land uses of various intensities are not open space categories.

Once specific land cover types were identified, economic values for each land cover type were calculated by multiplying the acreage of each land cover type by its annualized dollar value per acre as reported by Costanza, et al. (2006). Minimum, mean and maximum annualized values are calculated as represented by Figure 10. The total natural system service

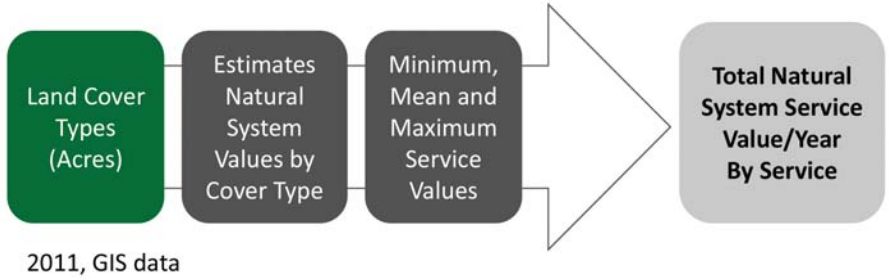
Table 5
Land Cover Acreages by County

Land Use	Lehigh County	Northampton County
Barren	781	1,232
Cultivated Crops	48,994	76,973
Developed High Intensity	3,842	3,397
Developed Medium Intensity	9,865	10,217
Developed Low Intensity	24,105	21,828
Developed Open Space	22,837	32,272
Forest	60,637	62,771
Open Water	1,369	2,394
Pasture	44,494	22,696
Wetlands	2,424	5,081
Riparian	3,491	2,630
Total	**222,839**	**241,492**

Source: Econsult Solutions, Inc., 2014

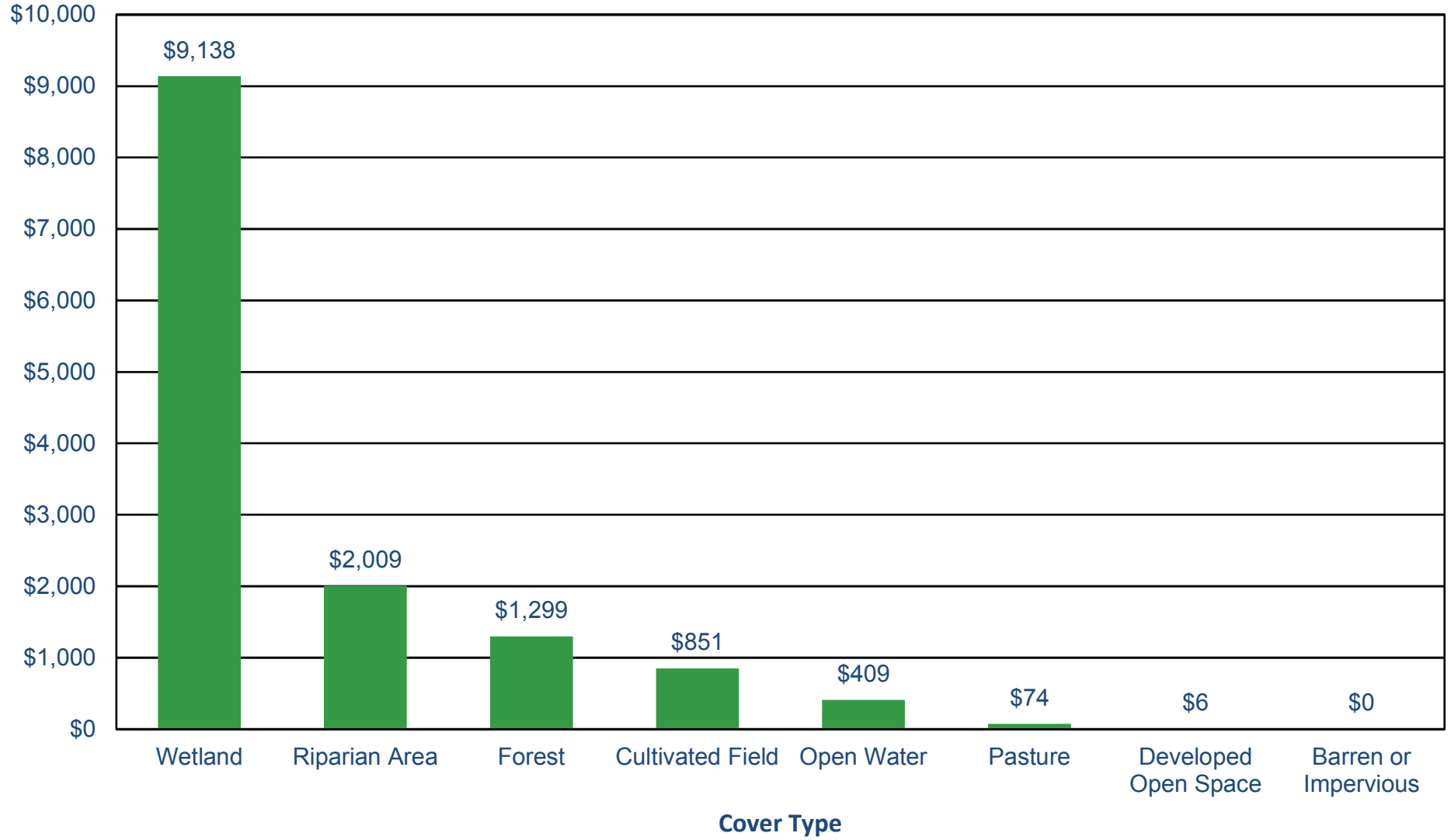
value of a given type of open space in dollars per acre per year was determined by aggregating the individual natural system service values associated with each land cover type. The mean values by cover type are shown in Figure 11. Note that wetlands provide by far the largest economic value of natural system services on a per acre basis, about four-and-one-half times the next largest value for riparian areas, and nearly twice all other land cover types combined. Also, there is a significant range of values for each land cover associated with the minimum, mean and maximum for the studies compiled by Constanza, et al. (2006). Wetlands, for example, range from $4,515 to $14,613 per acre per year for the minimum and maximum values. Reasons for this range include simply different results for similar studies as well as variations in the purpose associated with different studies and the natural system services that were valued.

Figure 10. Value Transfer Model for Natural System Services



Source: Costanza, et al. 2006 (37)

Figure 11. Natural System Services Mean Economic Value Per Acre of Land Per Year by Cover Type



Source: Econsult Solutions, Inc., 2014

Results

Table 6 presents the natural system service benefit estimates for Lehigh and Northampton counties calculated using the mean, minimum and maximum values from Costanza, et al. (2006). The ecosystems of Lehigh County currently generate an average of $153.8 million in annual natural system service benefits, while the ecosystems of Northampton County generate $201.7 million of natural system services per year. The Lehigh Valley totals an average value of $355.5 million per year in natural system services benefits. (37)

Caveats

The estimates presented in Table 6 are likely a conservative estimate (smaller than actual) of the value of the services provided by the ecosystems of Lehigh and Northampton counties. Not all land cover types have been well-studied, and some gaps exist in the valuation literature. More complete coverage would almost certainly increase the values.

Table 6
Natural System Service Benefits Calculated Using the Minimum, Mean and Maximum Values (millions/year)

Natural System Service	Minimum	Mean	Maximum
Lehigh County			
Water Supply	$0.60	$20.90	$72.40
Water Quality	$4.70	$6.70	$6.70
Disturbance (Flood) Mitigation	$9.10	$16.60	$24.20
Biological Control	$1.20	$1.20	$1.20
Wildlife Habitat	$20.60	$97.00	$266.50
Soil Formation/Retention	$0.30	$0.40	$0.60
Pollination	$4.30	$11.00	$17.20
Total	**$40.90**	**$153.80**	**$388.80**
Northampton County			
Water Supply	$0.60	$24.10	$74.60
Water Quality	$7.00	$8.00	$8.00
Disturbance (Flood) Mitigation	$18.70	$34.00	$49.60
Biological Control	$1.30	$1.30	$1.30
Wildlife Habitat	$32.30	$122.50	$309.10
Soil Formation/Retention	$0.30	$0.40	$0.50
Pollination	$4.20	$11.40	$17.80
Total	**$64.50**	**$201.70**	**$460.80**
Lehigh Valley Total	**$105.40**	**$355.50**	**$849.60**

Source: Costanza, et al. 2006 (37)

Case Studies

Lehigh County Authority Large Water Users

Many companies in the Lehigh Valley rely on water for their business. The groundwater is very clean and desirable, particularly to beverage companies. Groundwater treatment costs are approximately half the cost of treating surface water. (A. Arndt and L. Adam, personal communication, June 27, 2014) The top industrial and commercial users of Lehigh County Authority water are strong, local companies that employ local residents. (47)

- Samuel Adams Brewery
- Nestlé Waters
- Niagara Bottling
- Coca-Cola
- Nestlé Waters (Perrier)
- Kraft Foods
- Hamilton Tech Partners
- Amcor Pet Packaging
- Air Products and Chemicals
- CH2MHill Waste Water Treatment

Nestlé Waters is one company that relies on the clean water provided by Lehigh Valley's natural groundwater system. The company is actively helping to protect groundwater supplies with sound watershed practices.

Nestlé Waters

"The abundance and availability of high quality water resources is one of the main reasons that Nestlé Waters established a bottling facility in the Lehigh Valley, currently employing about 475 people. Protection of the water resources that supply water to the community and our business is important to Nestlé Waters future in the Lehigh Valley. Appropriate land conservation and management of the groundwater recharge areas is critical to maintain the water quality of the aquifers for generations to come."

Eric Andreus, Nestlé Waters, August 11, 2014

Conservation of the Kittatinny Ridge

The Kittatinny Ridge, which is often locally referred to as "Blue Mountain," is the expansive green landscape that forms the northern edge of the Lehigh Valley. Formed over 400 million years ago, the 1,800 foot high ridge provides a dramatic green backdrop to the two-county region. The Kittatinny Ridge provides critical habitat for a wide array of species. It is a major flyway for raptors and is one of Pennsylvania's Important Bird Areas. Blue Mountain also provides the platform for the Appalachian Trail, which runs from Maine to Georgia, and is a destination for many hikers, bird watchers and hunters.

The ridge has long been the subject of intensive conservation efforts. The mountain, most of which is publicly accessible, remains largely forested thanks to the collaborative efforts of many conservation organizations working in the Lehigh Valley. Conservation of the ridge is a top priority from a planning perspective locally, regionally, state-wide and nationally.

The core of the ridge top is owned by the National Park Service. With the Appalachian Trail as the spine, additional land has been, and continues to be, protected on both the northern and southern wooded slopes. To date, over 110,000 acres have been protected on the ridge throughout Pennsylvania. In the Lehigh Valley, nearly 10,400 acres have been protected by the Pennsylvania Game Commission in cooperation with organizations like Wildlands Conservancy and The Nature Conservancy. Conservation of the ridge provides an excellent connective corridor and provides resilience against climate change.

Air Quality

The Lehigh Valley faces substantial air quality challenges. Poor air quality is a common problem in many urban and suburban areas and can lead to a variety of human health problems, including asthma and other respiratory ailments. The incidence of childhood asthma worldwide has paralleled the sharp increase in carbon dioxide (CO_2) emissions, over at least the last two decades, in part due to climate-related factors. (48) Additionally, air pollution can damage buildings and plants, disrupt many natural system services, and can cause reduced visibility and smog. Trees remove significant amounts of air pollution and consequently improve environmental quality and human health. Trees 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. (49) In particular, trees remove significant amounts of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter from the atmosphere. (49)

Trees in urban and suburban areas also help mitigate climate change by removing CO_2 from the air and sequestering the carbon in new biomass each year. As trees grow, they store carbon by holding it in their accumulated tissue. As trees die and decay, they release much of the stored carbon back to the atmosphere. (50) Carbon storage is an estimate of the total amount of carbon that is currently stored in the above and below ground biomass of the forest, while carbon sequestration is a measure of how much new carbon dioxide is taken up by the forest each year through new growth.

Methodology

The i-Tree Vue model, developed by the U.S. Forest Service, was used to estimate the air pollution removal and carbon sequestration and storage benefits of the tree cover of Lehigh and Northampton counties. (51) The model uses National Land Cover Datasets (NLCD) to estimate the amount of tree canopy cover for each land cover type (Table 7) and then uses pollution removal rates per acre to estimate the total amount of pollutant removal. Note that the tree canopy cover has a different acreage than the "forest" land cover listed in Table 5. This is based on an actual tree canopy assessment for each land cover (Table 7) whereby all categories except open water have tree canopy assigned, yet forest cover itself has a lesser tree canopy assignment. The NLCD data will also capture larger patches of non-tree vegetation, such as shrub cover, that are included in the air quality benefit calculations. The i-Tree Vue model (Figure 12) has the advantage of allowing adjustment of the national per acre pollutant removal values to more localized values. For the purposes of this analysis, a range of pollutant removal values from the academic literature was used. Table 8 presents the pollutant removal values that are specific for the greater Philadelphia region.

Results

Table 9 shows the amount of pollutants removed, in tons per year, calculated using the tree canopy data from Table 7 and the pollutant removal rates from Table 8.

Pollution removal values were estimated using national median externality values. Externality values can be considered the estimated costs of pollution to society that is not accounted for in the market price of the goods or services that produced the pollution. (51) The externality costs include the costs associated with human health impacts, changes in agricultural productivity and property damage. For simplicity, these costs are

Table 7
Tree Canopy Cover by Land Cover
(Acres)

Cover Type	Lehigh County	Northampton County
Barren	15	9
Cultivated Crops	862	462
Developed High Intensity	4	14
Developed Medium Intensity	128	480
Developed Low Intensity	1,808	3,449
Developed Open Space	4,613	7,648
Forest	46,383	53,390
Open Water	0	0
Pasture	185	425
Wetlands	12,055	3,461
Total	**66,053**	**69,337**

Source: Econsult Solutions, Inc., 2014

Figure 12. i-*Tree Model Process*

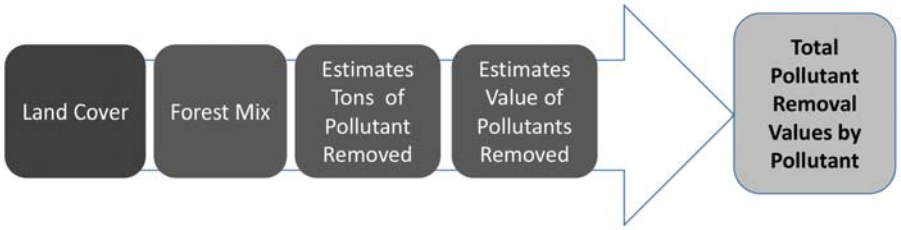


Table 8
Pollutant Removal Rates for Greater Philadelphia Region
(pounds/acre of tree canopy)

Pollutant	Low	Expected	High
Carbon Sequestration	n/a	2,676.53	n/a
Carbon Storage	n/a	81,188.30	n/a
Ozone	8.17	30.83	39.83
Particulate Matter 10	12.66	32.33	50.33
Nitrogen Dioxide	7.67	15.5	20.5
Sulfur Dioxide	3.67	6.83	11.33
Carbon Monoxide	1.67	1.67	1.67

Source: Nowak, et al. 2006 (49)

Table 9
Pollutant Removal Amounts
(Tons/year)

Pollutant	Low	Average	High
Lehigh County			
Ozone	270	1,018	1,315
Particulate Matter 10	418	1,068	1,662
Nitrogen Dioxide	253	512	677
Sulfur Dioxide	121	226	374
Carbon Monoxide	55	55	55
Northampton County			
Ozone	283	1,069	1,381
Particulate Matter 10	439	1,121	1,745
Nitrogen Dioxide	266	537	711
Sulfur Dioxide	127	237	393
Carbon Monoxide	58	58	58

Sources: Econosult Solutions, Inc., 2014

described herein as avoided healthcare costs, since the health impacts are the dominant portion of the costs.

The values were based on the median monetized dollar per ton externality values used in energy decision-making from various studies. These values in dollars per metric ton are: NO_2 = $10,200, PM_{10} = $6,820, SO_2 = $2,500, and CO = $1,450. The externality values for O_3 were set to equal the value for NO_2.

The total pollutant removal values for each pollutant will vary depending on the amount of tree canopy cover; increased tree cover leads to greater total removal and greater pollutant removal values. (49)

Table 10
Pollutant Removal Economic Values (millions/year)

Pollutant	Low	Average	High
Lehigh County			
Ozone	$2.80	$10.40	$13.40
Particulate Matter 10	$0.20	$7.30	$11.30
Nitrogen Dioxide	$2.60	$5.20	$6.90
Sulfur Dioxide	$0.30	$0.60	$0.90
Carbon Monoxide	$0.10	$0.10	$0.10
Total	**$6.00**	**$23.50**	**$32.70**
Northampton County			
Ozone	$2.90	$10.90	$14.10
Particulate Matter 10	$0.30	$7.60	$11.90
Nitrogen Dioxide	$2.70	$5.50	$7.30
Sulfur Dioxide	$0.30	$0.60	$1.00
Carbon Monoxide	$0.10	$0.10	$0.10
Total	**$6.30**	**$24.70**	**$34.30**
Lehigh Valley Totals	**$12.30**	**$48.20**	**$69.00**

Source: Econsult Solutions, Inc., 2014

Table 10 includes the low, average and high value of the pollutant removal benefits. The pollutant removal benefits generated by the tree cover in Lehigh County range between $6 million and $32.7 million per year, and in Northampton County range between $6.3 million and $34.3 million per year.

Table 11
Carbon Storage and Sequestration

Pollutant	Amount of Carbon (tons)	Economic Value (millions)
Lehigh County		
Carbon Sequestration Annually	88,397	$1.70
Carbon Storage	2,681,374	$52.10
Northampton County		
Carbon Sequestration Annually	92,792	$1.90
Carbon Storage	2,814,695	$59.10
Lehigh Valley		
Carbon Sequestration Annually	181,189	$3.60
Carbon Storage	5,496,069	$111.20

Source: Econsult Solutions, Inc., 2014

Table 11 shows the Lehigh Valley carbon sequestration in tons per year and total carbon storage in tons. The tree cover of the Lehigh Valley sequesters about 181,200 tons of carbon each year and generates $3.6 million in annual benefits. The tree cover of the Lehigh Valley stores nearly 5.5 million tons of carbon worth over $110 million. This value could be roughly annualized by dividing by the average tree life in the forest cover. If a tree life of 50 years is assumed, this translates into about $2.2 million per year in carbon storage benefits.

The dollar value estimates were determined by using the social cost of carbon. Please see: https://www.itreetools.org/resources/manuals/Vue_Manual_v5.pdf and http://www.epa.gov/climatechange/EPAactivities/economics/scc.html for additional information.

Caveats

Please note that NLCD provides tree cover estimates with a 30-meter pixel resolution for the contiguous United States. The national database provides important information on our national tree resources, but has limitations, particularly at the local scale. Tree cover estimates from the NLCD cover maps are believed to underestimate tree cover by an average of about 10%. (52) Thus, the tree cover, and consequently the ecosystem service estimates at the local level, are likely underestimated, but the exact degree of underestimation in specific areas is currently not known. (53)

Case Study

Bethlehem Authority – Maintaining Water Quality, Selling Carbon Credits and Helping Children with Asthma

The Bethlehem Authority's (Authority) watershed management program is an excellent example of how to get a very good return on the environment. The Authority's main priority is the protection of the watershed and the quality of the drinking water. It also strives for reasonable rates. To do this, the Authority stewards their forested property within their source watershed in the Pocono Mountains.

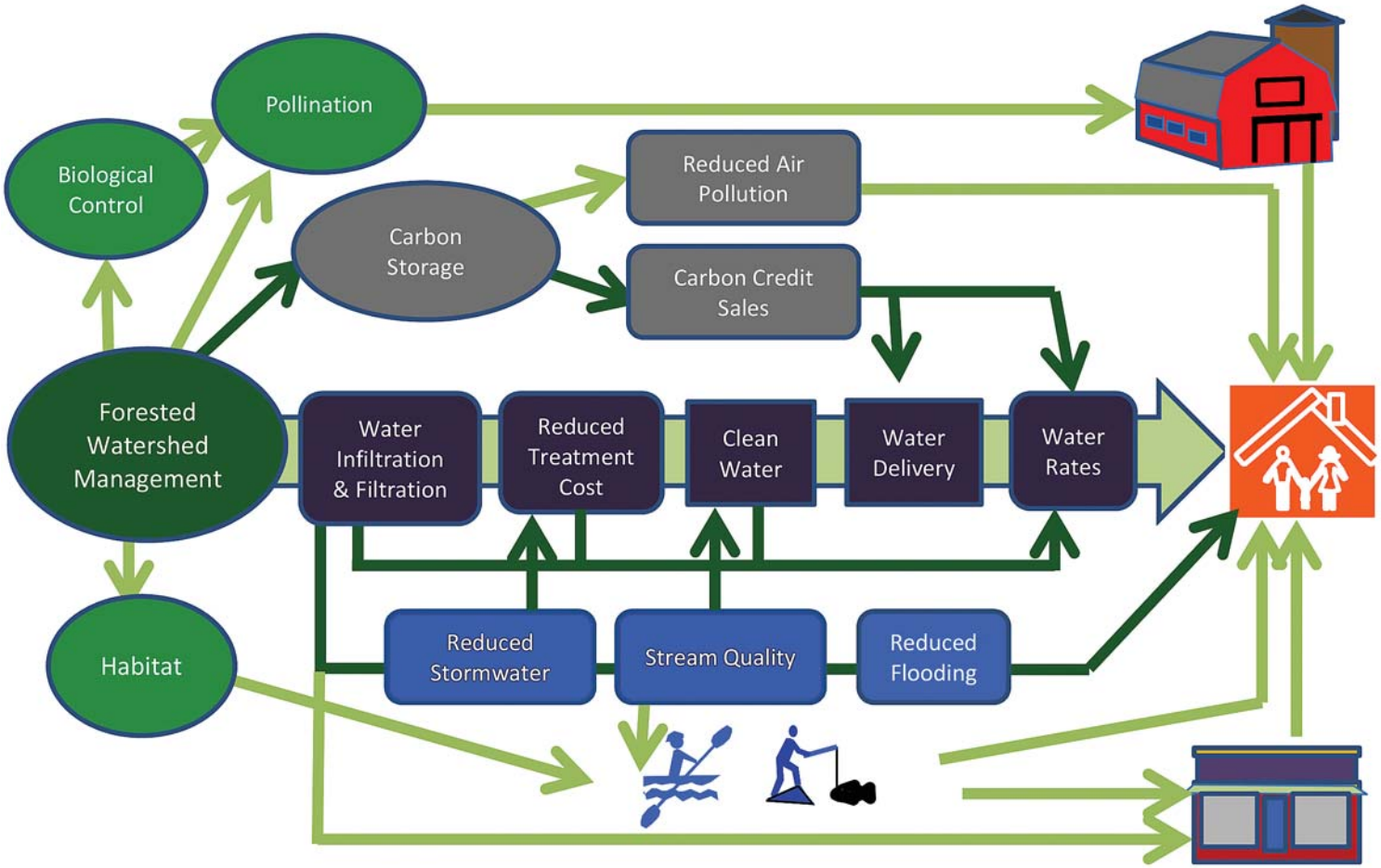
Several years ago, the Authority underwent a detailed process to qualify for selling carbon credits as part of their forest management process. In 2012, the Authority entered into a voluntary carbon market with Chevrolet as its first customer. Trees remove CO_2 from the air through photosynthesis, and carbon is stored in the trees. Less CO_2 in the air benefits people with asthma and other pulmonary diseases. The Authority received $65,000 for six months' worth of carbon credits in 2012 from Chevrolet, and the amount received in 2014 will be more than $105,000.

The contract with Chevrolet ends in the summer of 2015, as a four-year contract with Disney begins (spring 2015). The Authority estimates this partnership will bring in $140,000 to $170,000 annually. These collaborations will help the Authority address needed capital improvements for its aging water system and will help protect the watershed's fragile forest.

Last year, companies around the globe bought more than $379 million in carbon credits to offset 76 metric tons of greenhouse gases they emitted, according to the Annual State of Voluntary Carbon Markets Report. Google, General Motors and Disney are some of the most significant participants in the voluntary carbon market. (54)

The Authority's forest management program is depicted in the Return on Environment diagram shown in Figure 13. The figure identifies natural system services provided by the program and interrelated revenue impacts for the Authority and Authority customers. The light green lines in the diagram represent avoided natural system service costs. The dark green lines are revenue generators.

Figure 13. Bethlehem Authority Return on Environment



Outdoor Recreation

Open space in the Lehigh Valley provides a desirable place for many free and low-cost recreational activities that enhance the quality of life and health for area residents and visitors. Levels of participation and direct annual spending by residents were tracked for 11 outdoor recreational activities. This list does not include every activity that could be recognized as outdoor recreation. Based on published information, those activities with the highest participation rates were included. Also, the activities are associated with Lehigh Valley residents recreating on Lehigh Valley open space. One example is skiing. Many local residents may downhill ski, but the facilities are located outside the Valley. Some residents cross-country ski locally, but the participation numbers are small relative to other activities. Further, motorized activities such as motorcycling, snowmobiling and driving for pleasure were not included, as these are long distance activities more associated with tourism than outdoor recreation. The working definition for tourism activities is that they involve a 50-mile one-way trip. The outdoor recreational activities studied 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 or RV)
- Water-based recreation (kayaking, recreational/sea/whitewater, rafting and canoeing)
- Trail-based recreation (hiking on an unpaved trail, backpacking and climbing natural rock)
- Wildlife viewing (wildlife watching and photography, except birds)
- Birding (near home and away from home, bird feeding, watching and photography)
- Nature Study/Outdoor education

The Lehigh Valley has the highest recreation rate for tourism of any region in Pennsylvania. Annual tourism amounts to about $1.03 billion for Lehigh County and $827 million for Northampton County. Recreation accounts for 25% of tourism dollars, or more than $466 million annually. (55)

Methodology

Economic contributions are usually expressed as jobs, income, retail sales (expenditures) and tax revenues. Economic contributions or impacts, for the purpose of economic modeling, can be divided into three standard components: direct, indirect and induced. Direct impacts are the monies spent in the local economy. The indirect and induced impacts are the two components of the “multiplier” or “ripple” effect. Each of these is considered when estimating the overall impacts of any activity on the economy.

Direct impacts are the initial purchases made by the consumer and are found by multiplying the number of participants by the participant’s average annual spending for a particular activity. Participation is the number of people who engage in a given activity at least once a year. Spending is the amount a participant spends on recreational trips, clothing, equipment and fees every year. Fees include license fees, such as fishing and hunting, plus activity fees, such as entry fees for events.

Indirect impacts measure how sales in one industry affect the various other industries providing supplies and support. For example, a fisherman buys fishing rods, hats, hip boots, gasoline and food. These items may be made in other parts of the state, country or elsewhere.

An induced impact results from the wages and salaries paid by directly and indirectly-impacted industries. The employees of these industries spend their incomes. These expenditures are induced impacts that, in turn, create a continual cycle of indirect and induced impacts. The sum of the

direct, indirect and induced impacts is the total economic impact or contribution.

The IMPLAN economic model was used to analyze economic and demographic data for Lehigh and Northampton counties. Indirect and induced economic impacts, plus employment and state and local taxes, were analyzed for the 11 outdoor recreational activities.

Data Collection: The first phase of the process focused on data gathering that included:

- Research of existing published surveys, gathering information on regional, state and national outdoor recreation participation.
- Estimates of the total annual expenditures made by recreationists at the local, regional and national levels for each category.
- Interviews with local experts in each activity to validate the survey data for participation and spending for the Lehigh Valley.
- A set of expected estimates for participation and spending was created from the data collected in surveys.

Not all surveys collected information in the same data categories; however, there were consistencies among the surveys. Most surveys had information on a majority of activities, provided participation rates and, in some cases, provided information on spending.

The rate of participation and levels of spending depend on the recreational activity. Statistics on the different activities need to be used cautiously. Recreation surveys generally accept respondents' estimates without validation, and since outdoor recreation is considered a desirable activity, respondents may overestimate their participation. Additionally, most surveys asked people about their activities over the previous seven days, two weeks or even a year. A natural inability to recall behavior over long periods of time, combined with a general tendency to remember more recent events more accurately, can lead to overestimates. Nevertheless, surveys did indicate trends, several surveys had similar outcomes, and local experts and users helped validate survey results. For recreation spending data, transaction receipts on these activities are very impractical, if not impossible to collect, so the primary sources of information were surveys. Creating scenarios allowed us to bracket the results and present a reasonable range of economic impacts.

Figure 14 compares the participation rates from five surveys. Preliminary results from the 2014 initial, non-random survey conducted for the update to the Northampton County open space plan (B. Cope, personal communication, August 6, 2014) had the highest participation rates in walking, fishing, bicycling, bird watching, wildlife watching, kayaking and nature study. Table 12 identifies the local experts who were interviewed in each of these areas to validate the survey findings. In several cases, adjustments were made.

Table 13 shows the participation data from different survey sources. Colored boxes identify the participation rates used in the IMPLAN model. The three colors identify the low (tan), expected (green), and low and expected (blue) values, which were then used in the second phase of the process.

Figure 14. Outdoor Recreation Participation Rate Comparison from National, State and Local Surveys

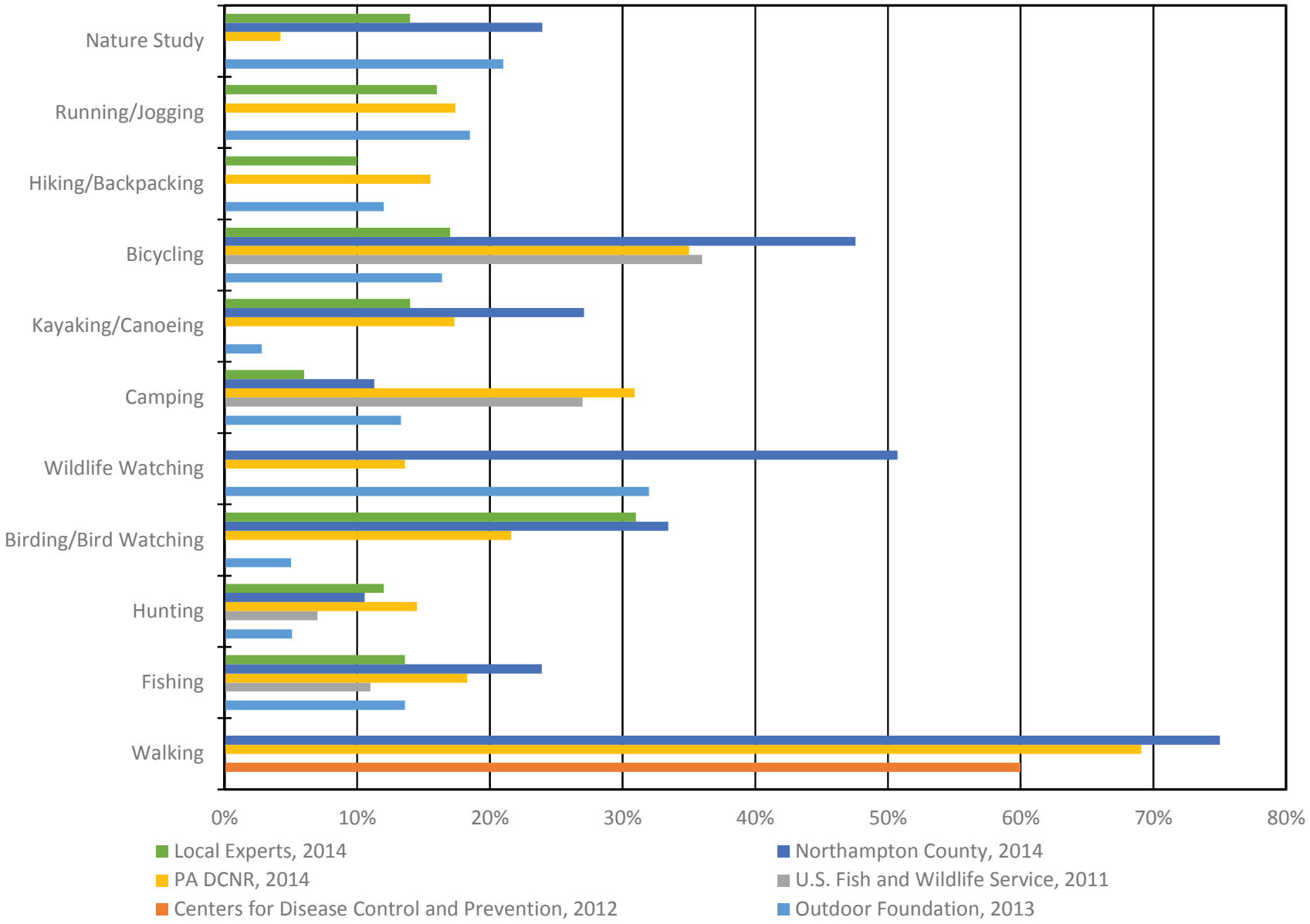


Table 12
Local Experts Interviewed

Walking	No interviews
Fishing	John Tunney, Trout Unlimited, Little Lehigh Chapter Norb Szymanski, Trout Unlimited, Monocacy Chapter Mike Topping, Northampton County Federation of Sportsmen's Clubs John Berry, Delaware River Shad Fishermen's Association
Hunting	Cheryl Trewella, Pennsylvania Game Commission
Birding/Bird Watching	Peter Saenger, Lehigh Valley Audubon Society
Wildlife Watching	No interviews
Camping	Steve Johnson, L.L. Bean Inc.
Kayaking/Canoeing	Steve Johnson, L.L. Bean Inc.
Bicycling	Michael Yozell, Bicycling Magazine; Rob McVeigh, Genesis Bike Shop
Hiking/Backpacking	John Brunner, Appalachian Mountain Club
Running/Jogging	Budd Coates, Lehigh Valley Road Runners and Rodale Inc. Jill Forsythe, Lehigh Valley Running Scene Neal Novak, Lehigh Valley Road Runners Laurie Reinhart, Lehigh Valley Road Runners
Nature Study	Dan Kunkle, Lehigh Gap Nature Center

Source: Keystone Conservation Trust, 2014

Table 13
Outdoor Recreation Participation Rates (%)

Outdoor Recreational Activity	Outdoor Foundation, 2013 (31)	U.S. Fish and Wildlife Service, 2011 (56)	PA DCNR, 2014 (4)	Northampton County, 2014 (*)	Interviews With Local Experts	Centers for Disease Control, 2012 (57)
Walking			69.1	75.0		60.0
Fishing	13.6	11.0	18.3	23.9	13.6	
Hunting	5.1	8.0	14.5	10.6	8.0	
Birding/Bird Watching	5.0	27.0	30.9	33.5	30.0	
Wildlife Watching	7.7	36.0	35.0	50.7		
Camping	13.3		15.5	11.3	6.0	
Kayaking/Canoeing	2.8		17.4	27.1	14.0	
Bicycling	16.4		21.6	47.5	17.0	
Hiking/Backpacking	15.1		13.6		10.0	
Running/Jogging	18.5		17.3		16.0	
Nature Study			9.2	23.9	14.0	

*B. Cope, personal communication August 6, 2014

Legend:

Low
Expected
Low and Expected

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

Very few studies give spending ranges. One study on running asked the question "How much does running cost over a lifetime?" Using reasonable assumptions, three runner spending level categories were identified—Least Expensive, Average and Most Expensive—and amounts were totaled by four expense categories (Table 14). The costs on a per day basis range from $0.69 to $10.22, which corresponds to an annual expenditure ranging from $252 to $3,734. (58)

Table 14

How Much Does Running Cost Over a Lifetime?

Expenditure	Least Expensive	Average	Most Expensive
Clothing	$11,196.43	$22,392.86	$50,485.71
Races	$0.00	$17,670.00	$51,642.00
Food	$3,145.12	$11,145.54	$88,838.75
Fluid	$15.70	$3,834.06	$16,205.63
Total	**$14,357**	**$56,942**	**$212,872**

Source: Warrenfeltz, Jim, 2013 (58)

Spending can vary by region. As an example, the 2009 DCNR statewide *Outdoor Recreation Resident Survey* (30) estimated annual spending for running/jogging for an individual to be $238 per year, yet interviews with local experts indicated it was closer to $900 per year.

Table 15 shows several spending estimates. The three colors identify the low (tan), expected (green), and low/expected (blue) values, which were then used in the second phase of the process.

Analysis: The second phase focused on analysis as follows:

- Estimates from existing surveys were reviewed for low and expected participation and spending.
- Scenarios were developed to illustrate a conservative range of economic impacts. The low economic contribution scenario included the lowest participation rate of all surveys reviewed and the lowest spending rate of all surveys reviewed. The expected economic contribution scenario included participation and spending rates estimated to better reflect the current levels of use and spending in the Lehigh Valley. The values were chosen based on three criteria: 1) the local survey data being consistent with other surveys, 2) local experts' estimates were given priority, and 3) a conservative choice was made when possible.
- Direct impact numbers were developed and entered into a spreadsheet for each recreational activity for both scenarios.
- Direct impact data was used in the IMPLAN model to create estimates of induced and indirect effects, jobs, and state and local taxes.

Table 16 shows the direct economic impacts for the Lehigh Valley. Table 17 shows the results of the IMPLAN model—the total annual economic impact for the Lehigh Valley for both the low and expected economic contribution scenarios for all 11 outdoor recreational activities.

Results

According to this analysis, the $240.4 million per year low economic direct contribution scenario for the Lehigh Valley would result in over $340 million in total economic impact, sustain 4,300 jobs, and approximately $24.5 million in state and local taxes. The $555.8 million per year expected economic direct contribution scenario would result in nearly $796 million in total economic impact, sustain 9,600 jobs, and $60 million in state and local taxes. Appendix A shows results for both Lehigh and Northampton counties individually.

Table 15
Outdoor Recreation Annual Spending

Outdoor Recreational Activity	U.S. Fish and Wildlife Service, 2011 (56)	PA DCNR, 2009 (30)	Outdoor Industry Association, 2013 (59)	Runner's World, 2013 (58)		Local Experts Estimates
Walking		$96				
Fishing	$409	$831				
Hunting	$1,207	$687				
Birding/Bird Watching	$329	$211				
Wildlife Watching	$308					
Camping		$2,529	$2,009			$600
Kayaking/Canoeing			$482			$375
Bicycling		$453	$1,196			$600
Hiking/Backpacking		$280	$1,115			$458
Running/Jogging		$238		$252	$3,734	$900
Nature Study						$150

Legend:
Low
Expected
Low and Expected

Table 16
Outdoor Recreation Direct Economic Impacts

Outdoor Recreational Activity	Low Economic Contribution Scenario				Expected Economic Contribution Scenario			
	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)
Walking	60	388,339	$96	$37.3	60	388,339	$96	$37.3
Fishing	11	71,196	$409	$29.1	14	90,612	$409	$37.1
Hunting	5	32,362	$687	$22.2	11	71,196	$1,207	$85.9
Birding/Bird Watching	5	32,362	$211	$6.8	31	200,642	$329	$66.0
Wildlife Watching	8	51,779	$308	$15.9	35	226,531	$308	$69.8
Camping	6	38,834	$600	$23.3	6	38,834	$600	$23.3
Kayaking/Canoeing	3	19,417	$375	$7.3	14	90,612	$375	$34.0
Bicycling	16	103,557	$453	$46.9	17	110,029	$600	$66.0
Hiking/Backpacking	10	64,723	$280	$18.1	10	64,723	$458	$29.6
Running/Jogging	16	103,557	$238	$24.6	16	103,557	$900	$93.2
Nature Study	9	58,251	$150	$8.7	14	90,612	$150	$13.6
Totals				**$240.4**				**$555.8**

Source: Keystone Conservation Trust and Lehigh Valley Planning Commission, 2014

Table 17
Outdoor Recreation Annual Economic Contribution

Outdoor Recreational Activity	Low Economic Contribution Scenario					
	Direct Impact (millions)	Indirect Impact (millions)	Induced Impact (millions)	Total Impact (millions)	Employment	State and Local Taxes (millions)
Walking	$37.3	$5.8	$11.3	$53.3	741	$4.1
Fishing	$29.1	$4.6	$8.8	$41.6	579	$3.2
Hunting	$22.2	$3.4	$6.7	$31.7	442	$2.4
Birding/Bird Watching	$6.8	$1.8	$1.1	$9.7	78	$0.7
Wildlife Watching	$15.9	$4.4	$2.7	$22.6	181	$1.7
Camping	$23.3	$7.4	$6.7	$36.6	376	$1.5
Kayaking/Canoeing	$7.3	$1.2	$2.2	$10.8	144	$0.8
Bicycling	$46.9	$7.3	$14.1	$67.0	932	$5.1
Hiking/Backpacking	$18.1	$2.9	$5.5	$22.6	318	$2.0
Running/Jogging*	$24.6	$3.9	$7.4	$33.1	381	$2.2
Nature Study	$8.7	$2.4	$1.5	$12.5	99	$0.9
Totals	**$240.4**	**$45.2**	**$67.8**	**$346.1**	**4,334**	**$24.5**
	Expected Economic Contribution Scenario					
Walking	$37.3	$4.8	$7.9	$53.3	741	$4.1
Fishing	$37.0	$5.8	$11.1	$53.0	736	$4.0
Hunting	$85.9	$13.5	$25.9	$122.8	1,708	$9.3
Birding/Bird Watching	$66.0	$18.3	$10.9	$93.5	746	$6.9
Wildlife Watching	$69.8	$19.3	$11.4	$98.8	788	$7.3
Camping	$23.3	$7.4	$6.7	$36.6	376	$1.5
Kayaking/Canoeing	$34.0	$5.3	$10.3	$48.5	675	$3.7
Bicycling	$66.0	$10.4	$19.9	$94.4	1,313	$7.2
Hiking/Backpacking	$29.6	$4.6	$9.0	$42.4	590	$2.8
Running/Jogging	$93.2	$14.6	$28.1	$133.2	1,852	$6.5
Nature Study	$13.6	$3.8	$2.2	$19.3	154	$1.4
Totals	**$555.8**	**$108.9**	**$146.7**	**$795.7**	**9,678**	**$58.9**

Source: 4ward Planning Inc., 2014

Note: The individual columns are a combination of 2014 model input and inflation-adjusted 2015 model output such that they should not be summed. The "Total Impact" column represents the true model output total economic impact.

*The Indirect Impact, Induced Impact and Total Impact for Running/Jogging for this scenario were adjusted by the Lehigh Valley Planning Commission based on updated annual spending estimates than originally run through the model ($238/year instead of $196/year).

Case Studies

L.L. Bean located in the Lehigh Valley

L.L. Bean Inc. opened a retail store in Center Valley in 2006. L.L. Bean chose the Lehigh Valley for several compelling reasons: the outdoor heritage of L.L. Bean and the outdoor heritage in the Lehigh Valley, a strong local engagement with outdoor activities, and the Center Valley's proximity to many outdoor opportunities.

The retailer also likes to open stores in areas where they are known, and the population has an affinity for the brand. The Lehigh Valley offers easy access to the Appalachian Trail, the Lehigh and Delaware rivers, the D&L Trail, the Little Lehigh Parkway, Nockamixon State Park, Lehigh Gap Nature Center and South Mountain Preserve, to name a few. There is a strong heritage in the Lehigh Valley of engaging in outdoor recreation, such as fly fishing, hiking, hunting, canoeing and kayaking, running, backpacking, biking and camping. All of these outdoor pursuits align with L.L. Bean's mission to engage people in the outdoors.

L.L. Bean engages people in the outdoors through their Outdoor Discovery Schools. The Outdoor Discovery School in Center Valley teaches Fly Casting, Archery, Kayaking and Stand-Up Paddle Boarding. They also offer free clinics and product demonstrations weekly and have built a following around the Valley as a resource in outdoor expertise. (S. Johnson, personal communication, October 23, 2014)

The Lehigh Valley has a population of approximately 650,000 (5), as well as its proximity to Philadelphia and New York City, yet has great open spaces and outdoor recreational opportunities.

D&L Trail Economic Impact Analysis

The D&L Trail is a multi-use trail in eastern Pennsylvania, running from Wilkes-Barre to Bristol, east of Philadelphia. The trail anchors the Delaware and Lehigh National Heritage Corridor (DLNHC), an area encompassing the historic Delaware and Lehigh canals. The area is overseen by a nonprofit organization dedicated to conserving the cultural and natural resources of a five-county region. Both Lehigh and Northampton counties make up the central region of the trail.


Photo courtesy of Delaware & Lehigh National Heritage Corridor

An analysis of data gathered from infrared counters located along the D&L Trail and from completed user surveys indicate an estimated 282,796 annual user visits on the five sections of the trail, resulting in a total economic impact in 2012 of $19.1 million. During the same time period, in the Lehigh Valley sections of the trail, approximately 68,327 people spent $2.5 million along the trail. Most of these dollars were spent by local residents rather than tourists.

The major activities recorded along the trail were biking (46.9%), walking (29.7%) and jogging (6.2%). (32)

The majority of trail users were 46 years of age and older. Ages 46 and younger represent just 19% of the respondents. Less than 12% reported having younger children with them on the trail. The gender split among respondents was 44.5% female and 55.5% males.

Wildlands Conservancy's Outdoor Education Programming

Walk for Wellness: There are many benefits of walking, including improving heart health, reducing stress and anxiety, preventing diseases and losing weight. Getting closer to nature also has many benefits. The Lehigh Valley has many parks and trails. The Wildlands Conservancy and the Lehigh Valley Health Network began a local program of helping people find places close to home to walk and enjoy nature. These places are easy to find, and they are a free path to physical fitness and enjoyment of nature. Initially, 25 trails were mapped and described. The first program was so

successful that 35 more trails were described and mapped. These added trails are more adventurous and intended for people with a spirit for hiking. Map sets are available for purchase from the Wildlands Conservancy.

***Bike & Boat*:** The Wildlands Conservancy's *Bike & Boat* program is an educational program designed to provide school children, community groups and the general public with an environmental education experience that promotes conservation and responsible stewardship of the Lehigh River Watershed's natural resources. *Bike & Boat* features a "hands-on" and empowering approach to watershed education. The program includes curriculums that are aligned to current Pennsylvania Academic Standards and that have associated pre-trip and post-trip activities designed to promote parental involvement.

Participants engage in a daylong exploration of the Lehigh River by canoe with built-in educational stops on river islands that are used as laboratory locations to conduct chemical, physical and biological assessments of the health of the waterway. After canoeing, participants bicycle along the Lehigh Navigational Canal towpath for additional activities, focusing on the unique cultural, historical, natural science and ecological aspects of the watershed. The *Bike & Boat* program activities are designed to demonstrate the relevance of textbook activities and class work to the student's everyday life.

The Wildlands Conservancy's approach to this program encourages intellectual and ethical development, personal growth, civic and social responsibility, and career exploration and serves as an introduction to lifelong, healthy recreational activities such as canoeing, hiking and biking. Over the past eleven years, more than 30,000 students have participated in the *Bike & Boat* program.

***Adventure Camp*:** The Wildlands Conservancy, in partnership with DCNR and the cities of Allentown and Bethlehem, developed and implemented a week-long adventure camp for Allentown and Bethlehem area youth. The highly successful program is in its 4th year. All activities are infused with hands-on environmental education programs designed to increase stewardship of our natural resources. The participants enjoyed canoeing, fishing, rock climbing, hiking, camping and other outdoor activities. The activities all included a discussion on the cultural and historical importance of the area.

Property Value

A recent analysis conducted by the Delaware Valley Regional Planning Commission (DVRPC, 2011) found that homeowners in southeastern Pennsylvania are willing to pay a premium to live within close proximity to protected open space. (44)

DVRPC's analysis found that homes located within one mile of protected open space captured a measurable increase (up to 14.4%) in their property value. The report also found that average value added and percent value findings for these homes ranged by county and type of municipality. DVRPC organized the data into the following planning areas: Core City, Developed/Mature Suburb, Growing Suburb and Rural Area.

Methodology

To estimate the property value specifically attributed to proximity to open space in the Lehigh Valley, a value transfer analysis was conducted of single family properties located within ¼ mile from protected open space. The Lehigh Valley assessment was done using percent value transfer assumptions adapted from the DVRPC study findings.

Existing property value data was prepared by the LVPC from county assessment data by planning area—cities and boroughs, suburban townships and rural townships—and distance to protected open space—directly adjacent and within ¼ mile. Multifamily properties were omitted from the analysis to avoid property value differences associated with property type and unit count. Protected open space includes: 1) parks, natural areas and outdoor recreation sites that are owned by federal, state, county, municipal governments or conservancies; or privately-owned property with a conservation easement, and 2) agricultural easements.

Since the LVPC planning areas consist of three categories (vs. four in the DVRPC analysis), an average of the Developed/Mature Suburb and Growing Suburb percent value from DVRPC's analysis was used for the Suburban Townships planning area.

Table 18 presents the percent property value premiums applied to single family homes located immediately adjacent to or within ¼ mile of protected open space within the Lehigh Valley. Since the analysis looked specifically at homes located less than ¼ mile from protected space (vs. one mile used by DVRPC), the percent value assumptions are adjusted slightly higher than the findings in the 2011 DVRPC analysis based on a trend analysis conducted from 2008 to 2011.

Table 18
Percent Property Value Premium

Planning Area	Properties Adjacent to Open Space	Properties within ¼ mile of Open Space
Cities and Boroughs	17.0%	16.0%
Suburban Townships	5.0%	5.0%
Rural Townships	1.0%	0.9%

Source: 4ward Planning Inc., 2014

The LVPC existing property value calculated from county assessment data for cities and boroughs, suburban townships and rural townships for properties directly adjacent and within ¼ mile of protected open space were combined with the values from Table 18 to determine actual dollar property value premiums for the Lehigh Valley.

Results

Table 19 presents the property value premium amounts associated with being within ¼ mile of open space by planning area and overall for Lehigh County, Northampton County and the Lehigh Valley.

Table 19
Property Value Premiums per Single Family Home Within ¼ Mile of Open Space

Planning Area	Lehigh County	Northampton County	Lehigh Valley
	Average		
Cities and Boroughs	$19,900	$23,100	$21,500
Suburban Townships	$10,200	$10,700	$10,400
Rural Townships	$2,200	$2,100	$2,200
Overall	$13,900	$15,400	$14,600
	Total (millions)		
Cities and Boroughs	$607.8	$704.4	$1,312.0
Suburban Townships	$312.2	$210.7	$522.9
Rural Townships	$12.8	$22.6	$35.5
Total	**$932.8**	**$937.8**	**$1,871.0**

Source: 4ward Planning Inc., 2014

- ***127,850 single family homes are within ¼ mile of protected open space.*** According to property data from the Lehigh and Northampton counties' assessment records, there are 127,850 single family homes located within ¼ mile of protected open space in the Lehigh Valley.

- ***$185,100 in average assessed value.*** The average property value for a single family home located within the Lehigh Valley was $185,100 and ranged widely by municipal classification. The average property value was much lower in the cities and boroughs ($134,300) than in the suburban and rural townships ($231,000 and $232,800, respectively).

- ***An average open space premium of $14,600.*** The average real estate premium attributed to their proximity to protected open space for all single family homes located within ¼ mile of protected open space in the Lehigh Valley is $14,600. This number is lowest for homes located in rural townships ($2,600) and highest for homes located in cities and boroughs ($28,200).

- ***More than $1.8 billion impact on property values.*** The total real estate premium attributed to proximity to protected open space for all single family homes located within ¼ mile of protected open space in the Lehigh Valley is $1.8 billion.

APPENDIX A

Outdoor Recreation Direct Economic Impacts – Lehigh County

Outdoor Recreational Activity	Low Economic Contribution Scenario				Expected Economic Contribution Scenario			
	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)
Walking	60	209,698	$96	$20.10	60	209,698	$96	$20.10
Fishing	11	38,445	$409	$15.70	14	48,930	$409	$20.00
Hunting	5	17,475	$687	$12.00	11	38,445	$1,207	$46.40
Birding/Bird Watching	5	17,475	$211	$3.70	31	108,344	$329	$35.60
Wildlife Watching	8	27,960	$308	$8.60	35	122,324	$308	$37.70
Camping	6	20,970	$600	$12.60	6	20,970	$600	$12.60
Kayaking/Canoeing	3	10,485	$375	$3.90	14	48,930	$375	$18.30
Bicycling	16	55,920	$453	$25.30	17	59,414	$600	$35.60
Hiking/Backpacking	10	34,950	$280	$9.80	10	34,950	$458	$16.00
Running/Jogging	16	55,920	$238	$13.30	16	55,920	$900	$50.30
Nature Study	9	31,455	$150	$4.70	14	48,930	$150	$7.30
Totals				**$129.80**				**$300.10**

Source: Keystone Conservation Trust and Lehigh Valley Planning Commission, 2014

Outdoor Recreation Direct Economic Impacts – Northampton County

Outdoor Recreational Activity	Low Economic Contribution Scenario				Expected Economic Contribution Scenario			
	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)
Walking	60	178,641	$96	$17.10	60	178,641	$96	$17.10
Fishing	11	32,751	$409	$13.40	14	41,683	$409	$17.00
Hunting	5	14,887	$687	$10.20	11	32,751	$1,207	$39.50
Birding/Bird Watching	5	14,887	$211	$3.10	31	92,298	$329	$30.40
Wildlife Watching	8	23,819	$308	$7.30	35	104,207	$308	$32.10
Camping	6	17,864	$600	$10.70	6	17,864	$600	$10.70
Kayaking/Canoeing	3	8,932	$375	$3.30	14	41,683	$375	$15.60
Bicycling	16	47,638	$453	$21.60	17	50,615	$600	$30.40
Hiking/Backpacking	10	29,774	$280	$8.30	10	29,774	$458	$13.60
Running/Jogging	16	47,638	$238	$11.30	16	47,638	$900	$42.90
Nature Study	9	26,796	$150	$4.00	14	41,683	$150	$6.30
Total				**$110.60**				**$255.70**

Source: Keystone Conservation Trust and Lehigh Valley Planning Commission, 2014

Outdoor Recreation Annual Economic Contribution – Lehigh County

Outdoor Recreational Activity	Direct Impact (millions)	Indirect Impact (millions)	Induced Impact (millions)	Total Impact (millions)	Employment	State and Local Taxes (millions)
	Low Economic Contribution Scenario					
Walking	$20.1	$3.4	$6.8	$29.8	391	$2.2
Fishing	$15.7	$2.7	$5.3	$23.2	305	$1.7
Hunting	$12.0	$2.0	$4.0	$17.7	233	$1.3
Birding/Bird Watching	$3.7	$1.1	$0.7	$5.4	43	$0.4
Wildlife Watching	$8.6	$2.7	$1.6	$12.6	100	$0.9
Camping	$12.6	$4.5	$3.8	$20.5	214	$0.8
Kayaking/Canoeing	$3.9	$0.7	$1.3	$5.8	76	$0.4
Bicycling	$25.3	$4.3	$8.5	$37.4	491	$2.7
Hiking/Backpacking	$9.8	$1.7	$3.3	$14.5	190	$1.0
Running/Jogging*	$13.3	$2.3	$4.5	$19.6	213	$1.2
Nature Study	$4.7	$1.4	$0.9	$7.0	55	$0.5
Totals	**$129.8**	**$26.8**	**$40.7**	**$193.5**	**2,309**	**$13.2**
	Expected Economic Contribution Scenario					
Walking	$20.1	$2.4	$3.4	$29.8	391	$2.2
Fishing	$20.0	$3.4	$6.7	$29.6	388	$2.1
Hunting	$46.4	$7.9	$15.6	$68.6	900	$5.0
Birding/Bird Watching	$35.6	$11.1	$6.5	$52.3	412	$3.9
Wildlife Watching	$37.7	$11.7	$6.8	$55.3	435	$4.1
Camping	$12.6	$4.5	$3.8	$20.5	214	$0.8
Kayaking/Canoeing	$18.3	$3.1	$6.2	$27.1	356	$2.0
Bicycling	$35.6	$6.1	$12.0	$52.7	692	$3.8
Hiking/Backpacking	$16.0	$2.7	$5.4	$23.7	311	$1.3
Running/Jogging	$50.3	$8.6	$16.9	$74.4	976	$1.7
Nature Study	$7.3	$2.3	$1.3	$10.8	85	$0.8
Totals	**$300.1**	**$64.8**	**$88.1**	**$444.6**	**5,160**	**$31.8**

Source: 4ward Planning Inc., 2014

Note: The individual columns are a combination of 2014 model input and inflation-adjusted 2015 model output such that they should not be summed. The "Total Impact" column represents the true model output total economic impact.

*The Indirect Impact, Induced Impact and Total Impact for Running/Jogging for this scenario were adjusted by the Lehigh Valley Planning Commission based on updated annual spending estimates than originally run through the model ($238/year instead of $196/year).

Outdoor Recreation Annual Economic Contribution – Northampton County

Outdoor Recreational Activity	Low Economic Contribution Scenario					
	Direct Impact (millions)	Indirect Impact (millions)	Induced Impact (millions)	Total Impact (millions)	Employment	State and Local Taxes (millions)
Walking	$17.1	$2.4	$4.5	$23.5	350	$1.9
Fishing	$13.4	$1.9	$3.5	$18.4	274	$1.5
Hunting	$10.2	$1.4	$2.7	$14.0	209	$1.1
Birding/Bird Watching	$3.1	$0.7	$0.4	$4.3	35	$0.3
Wildlife Watching	$7.3	$1.7	$1.1	$10.0	81	$0.7
Camping	$10.7	$2.9	$2.9	$16.1	162	$0.7
Kayaking/Canoeing	$3.3	$0.5	$0.9	$5.0	68	$0.4
Bicycling	$21.6	$3.0	$5.6	$29.6	441	$2.4
Hiking/Backpacking	$8.3	$1.2	$2.2	$11.4	170	$0.9
Running/Jogging*	$11.3	$1.6	$2.9	$15.6	191	$1.0
Nature Study	$4.0	$1.0	$0.6	$5.5	44	$0.4
Totals	**$110.6**	**$18.3**	**$27.2**	**$153.0**	**2,025**	**$11.3**
	Expected Economic Contribution Scenario					
Walking	$17.1	$2.4	$4.5	$23.5	350	$1.9
Fishing	$17.0	$2.4	$4.4	$23.4	348	$1.9
Hunting	$39.5	$5.6	$10.3	$54.2	808	$4.4
Birding/Bird Watching	$30.4	$7.2	$4.4	$41.2	334	$3.1
Wildlife Watching	$32.1	$7.6	$4.6	$43.5	353	$3.3
Camping	$10.7	$2.9	$2.9	$16.1	162	$0.7
Kayaking/Canoeing	$15.6	$2.2	$4.1	$21.4	319	$1.7
Bicycling	$30.4	$4.3	$7.9	$41.7	621	$3.4
Hiking/Backpacking	$13.6	$1.9	$3.6	$18.7	279	$1.5
Running/Jogging	$42.9	$6.0	$11.2	$58.8	876	$4.7
Nature Study	$6.3	$1.5	$0.9	$8.5	69	$0.6
Totals	**$255.7**	**$44.0**	**$58.7**	**$351.2**	**4,518**	**$27.1**

Source: 4ward Planning Inc., 2014

Note: The individual columns are a combination of 2014 model input and inflation-adjusted 2015 model output such that they should not be summed. The "Total Impact" column represents the true model output total economic impact.

*The Indirect Impact, Induced Impact and Total Impact for Running/Jogging for this scenario were adjusted by the Lehigh Valley Planning Commission based on updated annual spending estimates than originally run through the model ($238/year instead of $196/year).

APPENDIX B

Property Value Estimates – Lehigh County

	Adjacent Properties	1/4 Mile	Total
Property Value (millions)			
Cities and Boroughs	$97.7	$3,694.7	$3,792.4
Suburban Townships	$527.3	$6,409.9	$6,937.2
Rural Townships	$315.2	$1,076.2	$1,391.4
Total	$940.3	$11,180.8	$12,121.1
Single Family Housing Units			
Cities and Boroughs	554	30,053	30,607
Suburban Townships	2,048	28,620	30,668
Rural Townships	1,130	4,680	5,810
Total	3,372	63,353	67,085
Average Property Value - Weighted			
Cities and Boroughs	$176,400	$122,900	$123,900
Suburban Townships	$257,500	$224,000	$226,200
Rural Townships	$278,900	$230,000	$239,500
Total	$712,800	$576,900	$589,600
Average Premium per Housing – Weighted			
Cities and Boroughs	$30,000	$19,700	$19,900
Suburban Townships	$11,600	$10,100	$10,200
Rural Townships	$2,800	$2,100	$2,200
Total	$44,400	$31,900	$32,300
Total Premium (millions)			
Cities and Boroughs	$16.6	$591.2	$607.8
Suburban Townships	$23.8	$288.4	$312.2
Rural Townships	$3.2	$9.7	$12.8
Total	$43.5	$889.3	$932.8

Source: Lehigh Valley Planning Commission and 4ward Planning Inc., 2014

Property Value Estimates – Northampton County

	Adjacent Properties	1/4 Mile	Total
Property Value (millions)			
Cities and Boroughs	$72.5	$4,325.8	$4,398.2
Suburban Townships	$237.0	$4,444.0	$4,681.0
Rural Townships	$411.5	$2,058.0	$2,469.5
Total	$721.0	$10,827.8	$11,548.8
Single Family Housing Units			
Cities and Boroughs	472	29,905	30,377
Suburban Townships	989	18,629	19,618
Rural Townships	1,692	9,078	10,770
Total	3,153	57,612	60,765
Average Property Value – Weighted			
Cities and Boroughs	$153,600	$144,700	$144,800
Suburban Townships	$239,700	$238,600	$238,600
Rural Townships	$243,200	$226,700	$229,300
Total	$228,700	$187,900	$190,100
Average Premium per Housing – Weighted			
Cities and Boroughs	$26,100	$23,100	$23,100
Suburban Townships	$10,800	$10,700	$10,700
Rural Townships	$2,400	$2,000	$2,100
Total	$8,600	$15,800	$15,400
Total Premium (millions)			
Cities and Boroughs	$12.3	$692.1	$704.4
Suburban Townships	$10.7	$200.0	$210.7
Rural Townships	$4.1	$18.5	$22.6
Total	$27.1	$910.6	$937.8

Source: Lehigh Valley Planning Commission and 4ward Planning Inc., 2014

REFERENCES

1. Lehigh Valley Planning Commission. 2010. *2010 Lehigh Valley Land Use Public Opinion Survey Results and Analysis*.
2. Lehigh Valley Planning Commission. 2005. *Comprehensive Plan The Lehigh Valley…2030*.
3. National Audubon Society. 2011. *Annual Report*.
4. Department of Conservation and Natural Resources and Pennsylvania State University. 2014. *Outdoor Recreation in Pennsylvania A Resident Survey*. Available at http://www.paoutdoorrecplan.com/tab3/DCNR_20029635.
5. Lehigh Valley Planning Commission. 2012. *Population Projections for Lehigh and Northampton Counties: 2010-2040*.
6. U.S. Department of Commerce, Census Bureau, American FactFinder. Profile of General Population and Housing Characteristics: 2010.
7. Gallup, Inc. 2014. "Americans Again Pick Environment Over Economic Growth." Available at http://www.gallup.com/poll/168017/americans-again-pick-environment-economic-growth.aspx.
8. John S. and James L. Knight Foundation and Gallup, Inc. 2011. *Knight Soul of the Community 2010*.
9. Haanaes, Knut, David Arthur, Balu Balagopal, Ming Teck Kong, Martin Reeves, Ingrid Velken, Michael S. Hopkins, and Nina Kruschwitz. 2011. "Sustainability: The 'Embracers' Seize Advantage." *MIT Sloan Management Review.*
10. PricewaterhouseCoopers. 2012. "Going green is becoming increasingly attractive as a business strategy."
11. Michigan Economic Development Corporation. 2004. *Michigan Cool Cities Survey: Summary of Findings.*
12. Unilever. 2012. *Unilever sustainable Living Plan Progress Report 2012*. Available at http://www.unilever.co.uk/Images/USLP-Progress-Report-2012-FI_tcm28-352007.pdf.
13. Tennessee Valley Authority Economic Development. Sustainable Development, Valley Sustainable Communities Program. Available at http://www.tvaed.com/sustainability.htm.
14. American College of Sports Medicine. 2014. Exercise is Medicine. Available at http://www.exerciseismedicine.org/assets/page_documents/EIM%20Fact%20Sheet%202014.pdf.
15. Ludwig, David S. 2007. "Childhood Obesity – The Shape of Things to Come." *New England Journal of Medicine*, 357:2325-2327.
16. Perrin, James M., Sheila R. Bloom, and Steven L. Gortmaker. 2007. "The Increase of Childhood Chronic Conditions in the United States." *Journal of the American Medical Association* 297:2755-2759.
17. Committee on Environmental Health. 2009. "The Built Environment: Designing Communities to Promote Physical Activity in Children." *Pediatrics* 123:1591-1598.
18. Walljasper, Jay. 2013. *A Walking Revolution The Movement Making Americans Happier & Healthier*. Every Body Walk. Available at http://www.everybodywalk.org/media_assets/EBW_WALKING_REVOLUTION.pdf.
19. Louv, Richard. 2005. *The Nature Principle*. Chapel Hill, North Carolina: Algonquin Press.

20. Marcus, Clare Cooper and Marni Barnes, eds. 1999. *Healing Gardens Therapeutic Benefits and Design Recommendations* (Trans). New York, NY:John Wiley and Sons.

21. Mind Organization. 2007. *Ecotherapy: The green agenda for mental health*. UK: Mind Publications.

22. Cervinka, Renate, Kathrin Röderer, and Elisabeth Hefler. 2012. "Are nature lovers happy? On various indicators of well-being and connectedness with nature." *Journal of Health Psychology* 17:379-388.

23. Ulrich, Roger S. 1984. "View through a Window May Influence Recovery From Surgery." *Science* 224:420-421.

24. Kim, Tae-Hoon, Gwang-Woo Jeong, Han-Su Baek, Gwang-Won Kim, Thirunavukkarasu Sundaram, Heoung-Keun Kang, Seung-Won Lee, Hyung-Joong Kim, and Jin-Kyu Song. 2010. "Human brain activation in response to visual stimulation with rural and urban scenery pictures: A functional magnetic resonance imaging study." *Science of the Total Environment* 408:2600-2607.

25. Ulrich, Roger S., Robert F. Simons, Barbara D. Lostio, Evelyn Fiorito, Mark A. Miles, and Michael Zelson. 1991. "Stress Recovery During Exposure to Natural and Urban Environments." *Journal of Environmental Psychology* 11:201-230.

26. Coley, Rebekah Levine, William C. Sullivan, and Frances E. Kuo. 1997. "Where does community grow? The social context created by nature in urban public housing." *Environment and Behavior* 29:468-494.

27. Kuo, Frances E. and William C. Sullivan. 2001. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" *Environment and Behavior* 33:343-367.

28. Bowler, Diana E., Lisette M. Buyung-Ali, Teri M. Knight, and Andrew S. Pullin. 2010. "A systematic review of evidence for the added benefits to health of exposure to natural environments." *BMC Public Health* 10:456.

29. Cordell, H. Ken. 2012. *Outdoor Recreation Trends and Futures A Technical Document Supporting the Forest Service 2010 RPA Assessment*. Gen. Tech. Rep. SRS-150. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station, 167 p.

30. Department of Conservation and Natural Resources and Pennsylvania State University. 2009. *Outdoor Recreation in Pennsylvania Resident Survey*.

31. Outdoor Foundation. 2013. *Outdoor Participation Report*.

32. Rails to Trails Conservancy. 2012. *D & L Trail 2012 User Survey and Economic Impact Analysis*.

33. Hawk Mountain. 2012. *Return on Conservation Study*. Keystone Conservation Trust.

34. Hanson, Craig, John Talberth, and Logan Yonavjak. 2011. *Forests for Water: Exploring Payments for Watershed Services in the U.S. South*. World Resources Institute Issue Brief 2.

35. Ernst, Caryn, Richard Gullick, and Kirk Nixon. 2004. "Conserving Forests to Protect Water." *Opflow* 30:1,4-7.

36. U.S. Environmental Protection Agency. 2012. *The Economic Benefits of Protecting Healthy Wa*tersheds. EPA 841-N-12-004.

37. Costanza, Robert, Matthew Wilson, Austin Troy, Alexey Voinov, Shuang Liu, and John D'Agostino. 2006. *The Value of New Jersey's Ecosystem Services and Natural Capital*. New Jersey Department of Environmental Protection.

38. Costanza, Robert, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton, and Marjan van den Belt. 1997. "The Value of the World's Ecosystem Services and Natural Capital." *Nature* 387:253-260.

39. Newbold, J. Denis, Susan Herbert, Bernard. W. Sweeney, Paul Kiry, and Stephen J. Alberts. 2010. "Water quality functions of a 15-year-old riparian forest buffer system." *Journal of the American Water Resources Association* 46:299-310. DOI: 10.1111/j.1752-1688.2010.00421.x.

40. Natural Resources Council of Maine. *Public Land Ownership by State.* Available at http://www.nrcm.org/documents/publiclandownership.pdf

41. Crompton, John L. 2007. "The impact of parks and open spaces on property taxes." In *The Economic Benefits of Land Conservation* edited by Constance T.F.de Brun, 1-12. The Trust for Public Land.

42. Michigan State University, Land Policy Institute. 2008. *Economic Valuation of Natural Resource Amenities: A Hedonic Analysis of Hillsdale and Oakland Counties*, Report #3 Series on Economic Impact and Valuation Studies In Natural Resources and Conservation Hannah Professor Research Program, Land Policy Institute, LPI Report # 2007-09.

43. Gorssman, Elizebeth. 2013. "Declining Bee Populations Pose A Threat to Global Agriculture." *Yale Environment 360*.

44. Bryn Mawr College and Rutgers University. 2009. *Native Bee Benefits*.

45. Delaware Valley Regional Planning Commission and Green Space Alliance. 2011. *Return on Environment The Economic Value of Protected Open Space in Southeastern Pennsylvania*.

46. United Nations. 2001. Millennial Ecosystem Assessment. Available at http://www.unep.org/maweb/en/Index.aspx.

47. Lehigh County Authority. 2012. *Comprehensive Annual Financial Report*.

48. Zwillich, Todd. 2004. "High Carbon Dioxide Levels May Up Asthma Rate." Web MD Health News, April 29, 2004. Available at http://www.webmd.com/asthma/news/20040429/high-carbon-dioxide-levels-may-up-asthma-rate.

49. Nowak, David J., Daniel E. Crane, and Jack C. Stevens. 2006. "Air Pollution Removal by Urban Trees and Shrubs in the United States." *Urban Forestry and Urban Greening* 4:115-123.

50. Nowak, David J., Robert E. Hoehn III, Daniel E. Crane, Jack C. Stevens, and Jeffrey T. Walton. 2007. *Assessing Urban Forest Effects and Values, Philadephia's Urban Forest*. Resourc. Bull. NRS-7. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

51. U.S. Department of Agriculture, Forest Service. 2014. i-Tree Vue User's Manual, version 5.0.

52. Greenfield, Eric, David J. Nowak, and Jeffrey T. Walton. 2009. "Assessment of 2001 NLCD Percent Tree and Impervious Cover Estimates." *Photogrammetric Engineering and Remote Sensing* 75:1279-1286.

53. Murray, F. J., L. Marsh, and P. A. Bradford. 1994. *New York State Energy Plan*, Vol. II: Issue Reports. New York State Energy Office, Albany, NY.

54. Radzievich, Nicole. 2014. "Disney enchanted by Bethlehem." *The Morning Call,* July 22.

55. Tourism Economics. 2013. *The Economic Impact of Travel and Tourism in Pennsylvania. Tourism Satellite Account Calendar Year 2012*.

56. U.S. Department of the Interior, FIsh and Wildlife Service, and U.S. Department of Commerce, Census Bureau. *2011 National Survey of Fishing, Hunting and Wildlife-Associated Recreation—Pennsylvania*.

57. Centers for Disease Control and Prevention. 2012. “More People Walk to Better Health.” *Vitalsigns.*

58. Warrenfeltz, Jim. 2013. “How Much Does Running Cost Over a Lifetime?” *Runner’s World*, July 22, 2013.

59. Outdoor Industry Association. 2013. *The Economic Contributions of Outdoor Recreation: Technical Report on Methods and Findings*.