

Worcester Township Return on Environment Study

An Approach to Develop a Sustainable Environment and Economy

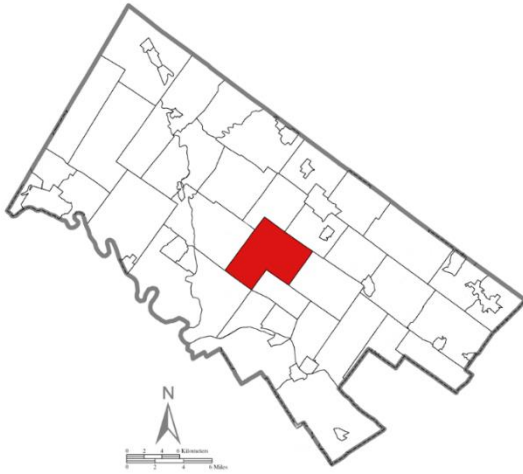


Bean Road

Photograph by Scott Berman

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Our thanks to Friends of Worcester for their interest, participation, and support, and to others who attended the ROE Workshop. Also, to Jeanne Ortiz, of Audubon Pennsylvania, who provided leadership and support.



A strong economy includes a healthy environment and plenty of open space.

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See <https://kittatinnyridge.org/explore/roe/>

01. EXECUTIVE SUMMARY

Most if not all of us appreciate the serenity and beauty that nature brings to our lives. But, we are less certain regarding its tangible value - the commercial aspects of natural resources and their financial impact.

This Return on Environment (ROE) Study addresses the financial benefit of Worcester's natural resources - its woods, meadows, riparian buffers/corridors, water, wildlife, and its existing farms and open spaces.

Study methods and findings draw from national, state, and regional research and analysis, applying these methods and data to Worcester's unique attributes. Both revenue and avoidance of costs attributed to nature and environmental features will be quantified. A full list of study references and resources are attached, along with an overview of methods presented within the Report itself.

This ROE establishes a financial case for protecting, connecting and restoring open space and nature in Worcester Township.

Nature is Serious Business

Worcester's open spaces provide **natural systems services, recreational benefits, and healthcare cost savings estimated at approximately \$21.1 million**

A summary of findings follows:

- 1) Tangible benefits from Worcester Township's forests is valued at **\$6.01 million**
- 2) Tangible benefits from Worcester Township's water resources is valued at **\$4.72 million**

When nature is disrupted or destroyed, we, the residents of Worcester and surrounding areas, must spend money to address the loss in natural systems services these resources provide

- 3) Financial value of existing riparian buffers is **\$2.5 million**. These buffers can be further enhanced and expanded, increasing their value to Worcester
- 4) Outdoor recreational benefits are **\$4.4 Million** and health care cost savings attributed to recreation - extrapolated figures from national and state studies - is **\$3.4 million**
- 5) Enhanced property values - **the value of homes within a ¼ mile of open space increases by an estimated 10% in suburban areas like Worcester Township**

With these tangible benefits, **the total financial value to Worcester of preserving open space is conservatively about \$21.1 million.**

How do we continue to realize these benefits?

- **Protect** our open spaces and natural resources
- **Connect** and expand our existing networks of preserved open space
- **Restore** our natural resources, such as riparian buffers and woodlands, to maximize their ecological value - subsequently increasing their financial value, and monetary savings, to Worcester

Investing in these efforts is critical to maintaining Worcester's quality of life and financial sustainability. Supporting all methods of preserving open space including the passage of an open space referendum are important action steps Worcester can take. Resident approval of an open space referendum will authorize the creation of a dedicated source of funding that can only be used to Protect, Connect, and Restore these natural resources, and help the Township save money as a

result of preserving and expanding the environmental and aesthetic benefits of open space.

02.

INTRODUCTION

Worcester Township, a rural place with rural values, is facing the winds of change.

This report analyzes the financial value of nature in Worcester Township. Nature has been part of the township's heritage, culture, economy, and sense of place since it was founded in the early 1700s.

Green, rolling hills and streams create beautiful vistas and reflect the township's rural character and values. However, the loss of farmland and scenic views, fragmentation of forests, continued residential development, and increasing traffic are harbingers of change.

Nature is the lifeblood of our culture and economy. Meadows and woods provide many recreational opportunities, from hunting and fishing to hiking trails, bicycling, and horseback riding.

Nature also provides crystal clean water, stormwater management and flood protection, pollination, nutrient absorption, aquatic and terrestrial habitat, carbon sequestration, air pollutant removal, erosion control, and biological control, all of it free of charge. Once disrupted or destroyed, nature's services must be replaced at the taxpayers' expense.¹

Nature is an invisible economy. More than just pretty places, nature provides millions of dollars each year to Worcester Township in the form of avoided costs for natural system services, decreased health care costs, and revenues from outdoor recreation (See *Figure 1*).

"Return on Environment" or ROE estimates the economic value of nature. The estimates are not about intrinsic value, but rather an explanation of what governments and people have paid for nature's services once nature has been disrupted or destroyed. As an example, avoided costs mean taxpayers won't have to pay to construct new infrastructure to manage stormwater and treat drinking water and, as long as nature is intact, won't incur greater clean-up costs from natural disasters.

Nature is serious business. ROE is real and significant, and it impacts a wide range of stakeholders. Placing a dollar value on nature's services helps policymakers, businesses, and residents understand nature as a portfolio of financial assets rather than an invisible commodity or an added expense.¹

FIGURE 1 Worcester Township's Annual Return on Environment **\$21.1 Million**

\$10.8 million
Natural system services
\$2.5 million
Value of existing riparian buffers
\$4.4
Outdoor recreation annual revenues
46-155
Jobs related to recreation
\$3.4 million
Health care cost savings
attributed to open space and exercise

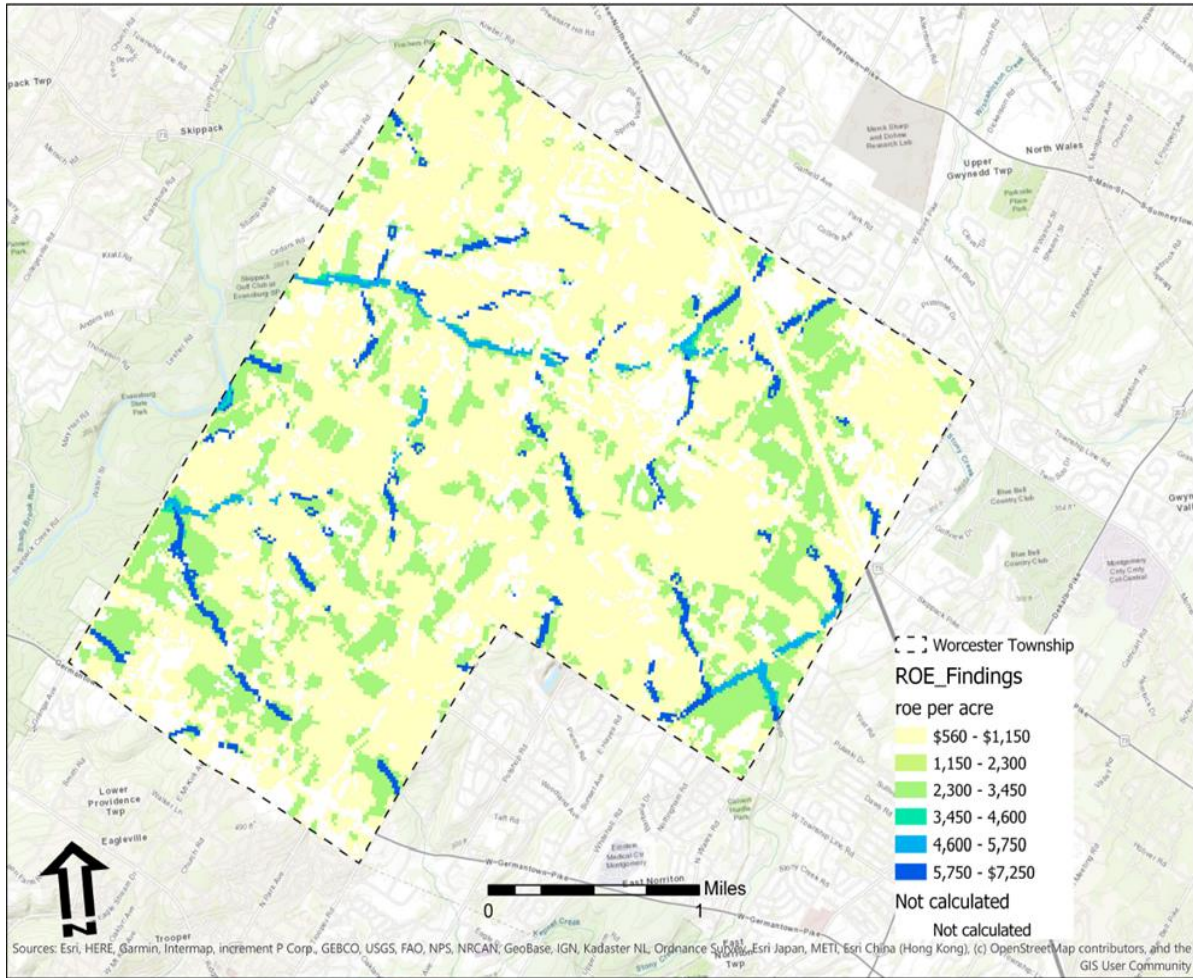
Figure 1 is a summary of the ROE value model for Worcester Township. [For Methodology information see "Methodology" Section:](https://kittatinnyridge.org/explore/roe/) <https://kittatinnyridge.org/explore/roe/>

Because Mother Nature doesn't write receipts, nature's economy is often overlooked or undervalued in policy debates, business and land use decisions, and personal choices. How land is used has a direct impact on water quality and a healthy environment.

¹

Unfortunately, over the past 30 years, Pennsylvania has consumed more land per person than any other state. Sprawl is accelerating the fragmentation and depletion of forests, wetlands, and other open areas where natural system services occur.²

MAP 1. ROE Values for Worcester Township



Map 1 shows the ROE analysis for Worcester Township. The ROE map is the base map for the ROE Interactive Map Series. The purpose of the ROE Interactive Map Series is to show the relationship between different data layers related to the use of land and natural system services.

2

A major challenge for Worcester Township is balancing growth with the community's existing quality of life, health, sense of place, and the economic value provided by open space.

Another impact from sprawl and climate change is the loss of critical habitat. Bird populations in North America are in a freefall. A study published in the journal *Science* found that North America has lost 29% of its avian population (nearly 3 billion birds) since 1970 and many species are in "conservation need," or lack adequate habitat.³

The National Audubon Society published *Survival by Degrees: 389 Bird Species on the Brink* stating, "The fate of birds and humans are deeply connected. If an ecosystem is broken for birds, it is—or soon will be—for people as well. And right now, in no uncertain terms, we're facing a bird emergency. We now know that a majority of North American bird species—even familiar and beloved birds like the Wood Thrush and American Robin—are at risk of extinction from climate change."⁴ The authors of this recent research say, "The best time to plant a tree was 20 years ago. The next best time is now."⁵

Understanding a community's ROE can help businesses, policy makers, and residents make informed decisions on land use, infrastructure, economic development, and recreation. Every resource-based decision process should begin with a clear understanding of Worcester Township's ROE.

Although nature can replace itself eventually, once disrupted or destroyed, natural system services will be diminished for 50 to 120 years until they reach full capacity. In the meantime, residents will have to assume the tax burden of replacing the services once provided by nature, free of charge. Clearly, preserving open space and protecting our natural resources are good business strategies for current and future generations.

The highest value land cover types for providing nature's services are wetlands, riparian woods, floodplains, and large forests, but all open space

contributes to a healthy local economy. Land use decisions are strategic for today's economy and for the future. Protected and connected stream corridors and forests can ensure a sustainable environment and economy.

If Worcester Township expects to have a sustainable economy that also preserves quality of life, it must move forward now to protect, connect, and manage these areas sustainably.



A headwaters tributary of the Stony Creek, as seen from Bean Road.

03. WHY ROE?

ROE informs decisions on land use, tourism, infrastructure, economic development, and recreation.

Just as return on investment (ROI) tools are important to assess the value of investment decisions, we now have a way to estimate the return on environment, or ROE. By understanding what nature is worth, policy makers and businesses can better understand how to maximize benefits with minimum investment.⁶

ROE financial data support a businesslike approach to economic development, infrastructure, water management, tourism, and land use planning. Worcester Township's open spaces supply clean water, critical wildlife habitat, flood protection, stormwater management, and significant recreation and tourism opportunities. By understanding nature's financial value, Worcester Township is better equipped to strike an effective balance

³

between protection of natural systems and supporting smart growth.

To ensure responsible stewardship of the environment, every resource-based decision process should begin with a clear understanding of Worcester Township's ROE.

The Benefits of Return on Environment Valuations

1. Explanation of nature's complex system in a simple, easy-to-understand concept, accessible to a wide range of audiences.
2. Dollars convey a level of significance or priority to allow for decisions.
3. Dollars, as a financial measure, underscore nature's connection to our quality of life, health, cost of living, economy, and sense of place.
4. Monetary estimates of the value of natural system services can be applied within decision frameworks related to land use and economic development.
5. Discussion of natural system services and their values engages key stakeholders in an educational process that can help organizations execute their missions.

Every company with a discharge permit is dependent on clean water. Pure, naturally filtered water is critical to bottling, pharmaceutical, and technology companies in their business processes. Many Worcester home owners rely on well systems located on their property. Many businesses today want employees to have healthy lifestyles because active employees are happier, more creative, more productive, and miss less work.⁷

Two of the fastest growing sectors of the economy are retirees and people working in knowledge-based industries. Increasingly, they are selecting communities with protected land and natural amenities when determining where to make their home.⁸

Since 1990, 90% of new jobs with good salaries are in the service sector. Many of these are flexible, able to locate anywhere. The quality of the environment impacts business location, attracts investment, stimulates tourism and recreation sectors, and attracts wealth.⁹

Although any numeric model will attract healthy skepticism, the discussion of nature's value puts this issue on the table in full view, so policy makers and residents are aware of nature's relative significance and its impact on our quality of life, health, cost of living, sense of place, and economy.

04. ECO-PRICING

What have governments and taxpayers been willing to pay for the services that nature provides free of charge?

The value placed on nature's services in this report is not intrinsic, but rather a value that government, businesses, and individuals have paid for these services once nature has been disrupted or destroyed. In this way, the full cost of habitat loss or retention is understood, and communities can begin to see nature's services as financial assets to be managed.

Eco-pricing is the process used to determine the price people and government have been willing to pay to maintain or restore services. The eco-price method documents instances in which society has paid for an increase in nature's services, avoided their loss, or restored damage to those services. For example, many restoration practices are focused on reducing the amount of nitrogen entering waterways. The cost of this remediation can be expressed in terms of \$/pound of nitrogen removed.

Natural systems such as wetlands, forests, and riparian areas remove nitrogen naturally at varying rates on an annual basis. Using the average cost of nitrogen reduction practices, an annual eco-price benefit can be calculated for each natural system.¹⁰

Building on previous valuation studies and using standard economic analysis techniques, this study estimated the economic value to Worcester Township of natural system services. Data for these estimates were provided by the Pennsylvania Fish and Boat Commission, Pennsylvania Game Commission, Pennsylvania Bureau of Forestry, PA DCNR and the Maryland Department of Natural Resources. For more information on eco-pricing see <https://kittatinnyridge.org/explore/roe/>

05. A SENSE OF PLACE

Worcester Township's rural character and values are feeling the pressures of development.

Situated in the heart of Montgomery County, Worcester Township offers an abundance of outdoor activities, such as walking, jogging, and horse-back riding. The Perkiomen Trail and the trails at Evansburg State Park are just minutes away.

Nature's value-added amenities like greenery, outdoor recreation opportunities, and abundant open space elevate community pride and appreciation and make Worcester a "preferred destination." Driving along Worcester's roads confirms that the community looks different than its more developed neighbors. Meadows, woods, and streams are evident everywhere.¹¹ Development-related issues such as sprawl, flooding, stormwater, and water pollution, and traffic are significant and important issues with fiscal consequences that threaten the township's quality of life. Identifying areas with the highest ROE can demonstrate the significance of nature's financial role in the economy, both now and into the future.

06. BIOLOGICAL DIVERSITY IS CRITICAL TO OUR SURVIVAL

Biological diversity is central to maximizing nature's ecological and financial value.

Worcester Township is located in the Eastern Deciduous Forest Biome. The soils and climate of this region have been growing trees for 14,000 years, since the last Ice Age. In Pennsylvania, biological diversity is the sum of all plants, animals, and insects that live in a forest environment. Native plants are the foundation for all life and control local biodiversity.

Nature helps drive natural system services like photosynthesis, pest control, pollination, erosion control, soil formation, water purification, and the generation of oxygen and clean air.

Keystone Conservation Trust November 2019

FIGURE 2

Worcester Township's Annual Benefits from Forests

\$4.8 million

Habitat

\$.28 million

Pollination

\$.34 million

Biological Control

\$.18 million

Carbon Sequestration

\$.41 million

Air Pollutant Removal

For more information see:
<https://kittatinnyridge.org/explore/roe/>

Natural system services work 24 hours a day, 365 days a year. Forests provide source water protection to keep our groundwater and streams clean. Every dollar spent on planting and caring for a community tree yields benefits that are seven times that investment.¹² In many instances, nature can outperform engineered solutions.¹³



Louisiana Waterthrush

The Louisiana Waterthrush (*Parkesia motacilla*) breeds in eastern North America and winters in the West Indies and Central America. The Louisiana Waterthrush is a biological indicator of water quality. The Pennsylvania Game Commission formally recognized the Louisiana Waterthrush as a "Species of Greatest Conservation Need" in its Wildlife Action Plan, and as an indicator of high-quality forested headwaters in the state. Similarly, the National Park Service employed the Waterthrush as a "vital sign" of stream ecosystem integrity across its entire Eastern Rivers and Mountain Network. Its presence is a strong indicator of good water quality.¹⁴

Forests over 500 acres provide the size necessary for breeding populations of songbirds like Scarlet Tanager, Wood Thrush and Louisiana Water Thrush.^{15, 16}

Forests over 750 acres provide the size necessary for breeding populations of raptors like eagles and hawks.¹⁷ Currently there are no forests over 500 acres in Worcester Township. The forests at Evansburg State Park are the primary source of songbirds and raptors in Worcester Township. Small forests provide good sites for nesting.

Worcester Township's primary habitat is in the small forests and riparian areas including Scarlet Tanager and Wood Thrush. Evansburg State Park provides a major forest habitat for wildlife that frequent Worcester Township. Even smaller area forests are important habitat for birds and other wildlife.

The two major causes of biodiversity loss are forest fragmentation and non-native, invasive plants. Habitat size, shape, and topography all play a role in sustaining biodiversity. Connecting and expanding habitat size creates healthy and resilient biological systems that boost the performance of natural system services.¹⁸

Figure 2 shows the benefits Worcester Township annually receives from forests. These numbers were estimated by the ROE value model.

Tips for managing forests:

1. Protect forests. The larger the forest, the better.
2. Protecting round forests versus linear forests provides habitat for indigenous species in the forest core.

3. Connect forests with riparian or upland corridors, allowing for movement of species and genetic drift.
4. Practice good stewardship of forested land by ensuring 60% in canopy cover and 60% native plants. See Designing with Natives at DWTN.net for more detail.
5. Leave dead trees for habitat.



Skipack Creek ([Grange Avenue](#))

Photo: Scott Berman

07. WE NEED TO KEEP WATER CLEAN AT THE SOURCE
Every 10% increase in forest cover in a watershed decreases water treatment costs by 20% to 10%.¹⁹

The most efficient way to avoid excessive future costs is to increase the flexibility of ecosystems now so that they may function and retain resiliency under a wider range of climatic conditions. Townships that have protected riparian corridors are expected to be more resilient to the anticipated effects of climate change. Expenses associated with recovery from extreme weather impacts increased by a factor of six between 1997 and 2007.²⁰

Figure 3 shows Worcester Township's annual water resources benefit from ROE. These numbers were estimated using the ROE Value Model. For more

information see:
<https://kittatinnyridge.org/explore/roe/>

FIGURE 3.

Worcester Township's Annual Water Resources Benefits

\$2.6 million

Stormwater and flood control

\$.84 million

Water supply

\$1 million

Nutrient absorption

\$.28 million

Aquatic resources

Riparian Buffers

The land adjacent to a stream is called the riparian buffer. Healthy streams and rivers are vital and valuable natural resources that support a wide variety of living things, as well as a multitude of outdoor activities.

Scientific research has strongly established the harm to water quality, increased flooding, and the damage to the ecosystem that results from failure to protect riparian buffers.

Riparian buffers, particularly when forested, effectively prevent pollutants from roads and fields from degrading these resources. Extensive scientific research documents that undisturbed, vegetated buffers provide extensive water quality and other benefits:²¹

- Prevent stream bank erosion;
- Act as shock absorbers that diffuse the energy of floodwaters, thus reducing damage downstream;
- Protect natural stream morphology (i.e., broad meanders with maximum stream bottom habitat);

- Remove excess nitrogen, phosphorus, and sediment from surface water runoff;
- Reduce downstream flooding;
- Provide thermal protection to adjoining streams, wetlands, and water bodies; trees cast shade that cools the water, reduces the growth of algae, and improves fish habitat.
- Infiltration of rainwater helps prevent flooding and provides clean water to streams at a consistent temperature of 55 degrees Fahrenheit, the temperature most suitable for aquatic life;
- Provide food and habitat for wildlife;
- Provide food and habitat for fish and amphibians;
- Form corridors for habitat conservation and greenways;
- Protect associated wetlands.

Headwater streams are critical repositories of biodiversity, especially aquatic insects (macro invertebrates), which play such a vital role in aquatic eco-systems and in the in-stream processing discussed above.²²

New research shows an even higher ecological value for riparian buffers in headwaters, or first-order streams (See *Map 2*).

First order streams are part of a scientific stream classification system. They are the smallest of the world's streams and consist of small tributaries. These are the streams that flow into and "feed" larger streams but do not normally have any water flowing into them. First and second order streams generally form on steep slopes and flow quickly until they slow down and meet the next order waterway. These areas should be protected from disturbance or degradation.²³

Headwater streams are primary food/fuel production areas and have been found to be essential to the health of the entire aquatic system.²⁴

Stroud Water Research Center, an independent, 501(c)(3) not-for-profit organization that seeks to advance knowledge and stewardship of freshwater systems, has demonstrated that the aquatic insect community is remarkably abundant in headwaters zones, which contributes greatly to downstream stream energy and nutrient processing.

In-stream processing needs “fuel.” Maximum fuel is provided in a variety of ways in these headwater streams, from algae, aquatic mosses, rooted aquatic plants, trees, understory shrubs, and other herbaceous vegetation. ²⁵

Forested riparian buffers in headwaters generate high levels of organic inputs directly from land to water, which in turn maximize in-stream processing functions that provide the “fuel” needed for downstream energy and nutrient processing.

Buffers absorb nutrients and pollutants, slow the runoff of rainwater, and filter sediment.

They also provide important habitat and wildlife corridors for mammals and birds. Trees and shrubs with deep root systems hold the soil and resist stream bank erosion.

How we manage the land around streams directly affects their health for better or worse. When crafting effective riparian buffer ordinances, buffer width is important. Recommended minimum width depends, to some extent, on which benefits, or eco-services are deemed important to protect, although virtually all sources acknowledge that the wider the buffer, the better the eco-services’ performance.

Map 2. Headwaters

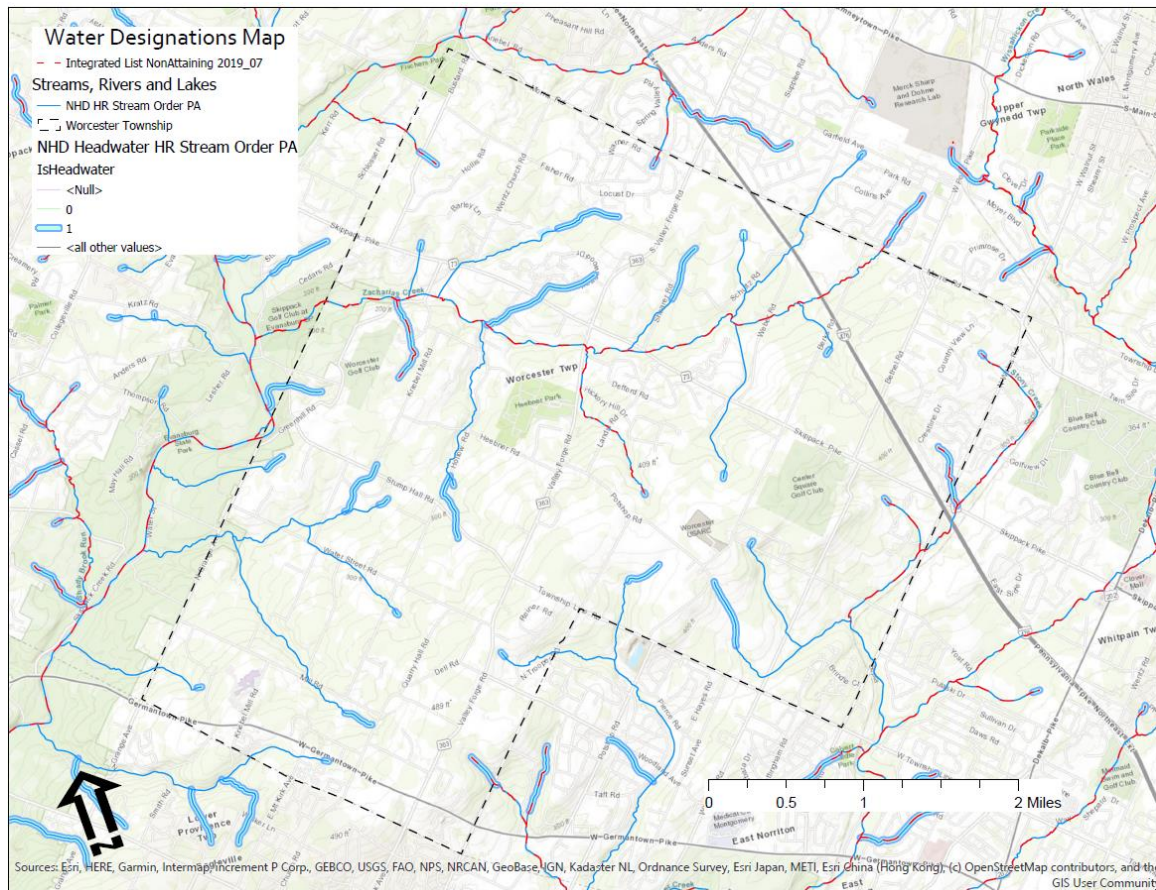
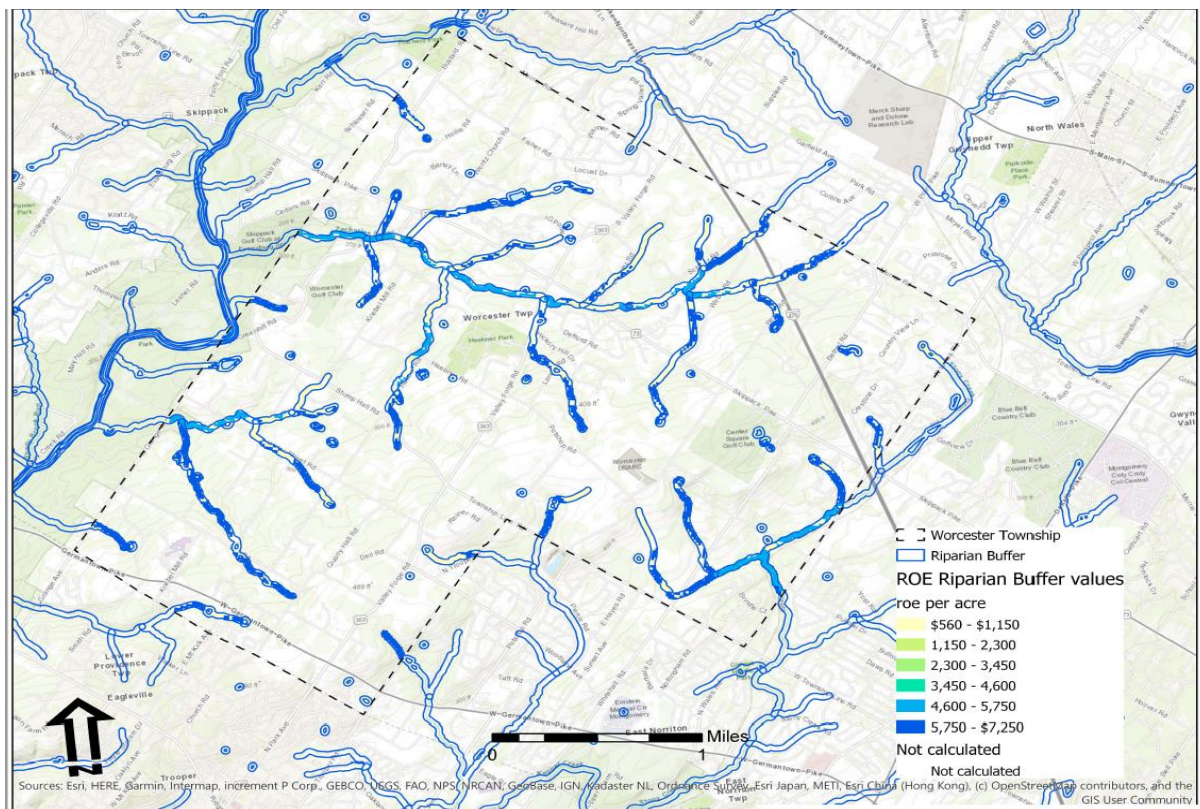


TABLE 2.

In Riparian Buffer Zones: Functions and recommended width studies have been summarized. ²⁶

Erosion/sediment control:	30 to 98 feet
Water quality:	
Nutrients	49 to 164 feet
Pesticides	49 to 328 feet
Bio-contaminants (fecal, etc.)	30 feet or more
Aquatic habitat:	
Wildlife	33 to 164 feet
Litter/debris	50 to 100 feet
Temperature	30 to 230 feet
Terrestrial habitat:	150 to 330 feet

MAP 3. ROE Riparian Buffers



Map 3 shows the value of the riparian buffer on a per acre basis. Many of the riparian buffers need to be restored. Those areas needing to be restored are colored in blue to yellow. Riparian areas not colored need to be restored if they are needed to enhance water quality and habitat. This will significantly increase the riparian buffer ROE.

Tips for a Riparian Buffer:

1. Begin a “no mow/no graze zone” along stream banks. An ideal buffer is 100 feet wide. The wider the buffer, the more positive the impact on water quality in the stream.²⁷
2. Plant trees and shrubs in your buffer zone. They provide many long-lasting benefits and can be inexpensive to establish and maintain. Start with shrubs. They give a buffer a quick start and many reach full size in just a few years.
3. Maintain slopes of streambanks to approach 1 foot of rise over a 4-foot length where possible, to eliminate bank erosion and increase surface area.



Evansburg State Park woods as seen from the road in Worcester Township

Photo: Scott Berman

08. OUTDOOR RECREATION AND REDUCED HEALTH CARE COSTS

Demand for outdoor recreation is increasing.

The outdoor recreation industry is strong and growing, generating \$646 billion annually in the United States. By comparison, gasoline and other fuels yield \$354 billion annually.²⁸

According to the Outdoor Industry's Pennsylvania Fact Sheet, Pennsylvania residents spend over \$29.1 billion annually on outdoor recreation.²⁹ This includes sports events, driving for pleasure, and golf. Outdoor recreation sustains as many jobs in Pennsylvania as the natural gas industry.³⁰

This study focuses only on outdoor recreation activities that enhance residents' quality of life without disturbing or destroying the environment.

31% of Pennsylvanians surveyed during the DCNR 2014 *Outdoor Recreation Participation Survey of Pennsylvania* said they planned to spend more time outdoors.³¹

About half of the region's baby boomers plan to increase their outdoor activity, compared to 25% of their older counterparts. By 2025, millennials will make up 75% of the workforce, and these young professionals enjoy the outdoors and seek healthy and adventurous lifestyles.³²

Nature provides the venues for outdoor activities, free of charge. *Table 3* shows the direct recreation economic impacts for Worcester Township.

\$4.4 Million

Outdoor recreation annual revenues

**TABLE 3.
Worcester Township
Recreation Direct Economic Impact**

Activity	
Walking	\$603,994
Fishing	\$471,765
Hunting	\$505,740
Birding/Bird Watching	\$172,495
Wildlife Watching	\$452,156
Camping	\$377,496
Kayaking/Canoeing	\$157,290
Bicycling	\$754,992
Horseback Riding	\$100,666
Hiking	\$293,608
Jogging/Running	\$363,969
Nature Study	\$125,517
Total	\$4,379,688

While not all activities are available in the township, people in the township also participate in outdoor recreation in other places. Given the number of people in the township, these numbers represent their level of spending on outdoor recreation. For **more** information see: <https://kittatinnyridge.org/explore/roe/>

A 2018 report by the Outdoor Industry Association found that the following outdoor activities have been increasing:

- paddle sports
- mountain biking
- cross-country skiing
- day hiking
- bird watching
- bicycling

Local outdoor recreation experts add fishing, running, and nature study to the list.³³

The trend for current residents is to spend more time outdoors, and this will continue with future growth. Many people participate in more than one outdoor activity. They also participate on different lands such as old fields, trout streams, roads and forests. On protected lands, the Chester County ROE study estimates that people spend \$656 per household per year.³⁴

Numerous studies have shown that easy access to outdoor recreation inspires more people to exercise. The more they exercise, the healthier they are, with less money spent on healthcare costs.³⁵

Worcester Township’s healthcare savings were derived by applying DCNR outdoor exercise participation rates to the conclusions of four recent medical research studies on the impact of open space on exercise and the impact of exercise on health care costs.^{36,37, 38,39}

\$2.6 million annually
Dollars saved each year from
reduced health care costs for men
and women over 19 years of age

The EPA and other public health organizations have long acknowledged the link between water and air quality, and human health. There are social and health benefits related to the proximity of people to nature.

09. PROPERTY VALUE

Homeowners are willing to pay a premium to live near protected open space.

Chester County, Pennsylvania's Return on Environment Study: *The Economic Value of Protected Open Space in Chester, County Pennsylvania* shows that homeowners are willing to pay a premium to live near protected open space.

Results indicate that proximity to protected open space contributes a significant positive impact to residential property values.³⁷ As a result, the existing protected open space in Chester County adds to the overall value of its housing stock. This increased wealth is captured by citizens through higher sale values of homes near protected open space. This generates increased government revenues via larger property tax collections and greater transfer taxes at time of sale.

The Chester County report analyzed approximately 98,000 home sales in Chester County from 1981 to 2017 to estimate the effect of protected open space on residential property values and the attendant fiscal impacts.

The closer a home is to protected open space, the more value it captures. Approximately 3.6% of the value of a home located between 0 and ¼ mile of protected open space can be attributed to its proximity to that protected open space.⁴⁰

The increase in value for homes ¼ mile to ½ mile away is about 2.3%. When added together, the increments of value that homes within a half-mile of Chester County's protected open space captured as a result of their proximity to protected open space totaled \$1.65 billion. In other words, if all the protected open space in Chester County were eliminated, the total value of the housing stock would decrease by \$1.65 billion. For homes within a ½ mile of protected open space, this represents an average property value increase of almost \$11,380,

and nearly \$13,120 for homes within ¼ mile of protected open space.⁴¹

A similar but less rigorous approach was used for Dauphin, Lehigh, and Northumberland Counties and showed that the value of homes within a ¼ mile of open space varied, depending on the land use setting.⁴²

- Lakes – 22% increase
- Urban areas – 15% increase
- Suburban areas – 10% increase
- Rural areas – less than 1% increase

10. CREATING A SUSTAINABLE ENVIRONMENT AND ECONOMY

The first rule of ecology is that everything is connected to everything else. Whatever we do to natural habitats—good or bad, big or small—ripples through the economy.

Land use decisions are, by far, the greatest opportunity to create ecological and financial change. Currently, development proposals do not include an estimate of their impact on stormwater, flooding, or loss of wetland functions. The actual impact of new development should include the cost of services as well as the loss of ROE. Preventing impairments to natural systems protects the services they provide, which in turn provides economic benefits to communities and prevents expensive replacement and restoration costs.

The most effective way to realize the full value of natural system services is to connect larger, native forests and grassland habitats with green corridors. Maintaining connected, healthy riparian areas, headwaters, wetlands, and larger upland habitats—as well as parks, trails, wooded public property, and areas protected as open space—creates a supporting network of biological sustainability and better enables a community's ability to adapt to climate change, which provides long-term financial benefits.

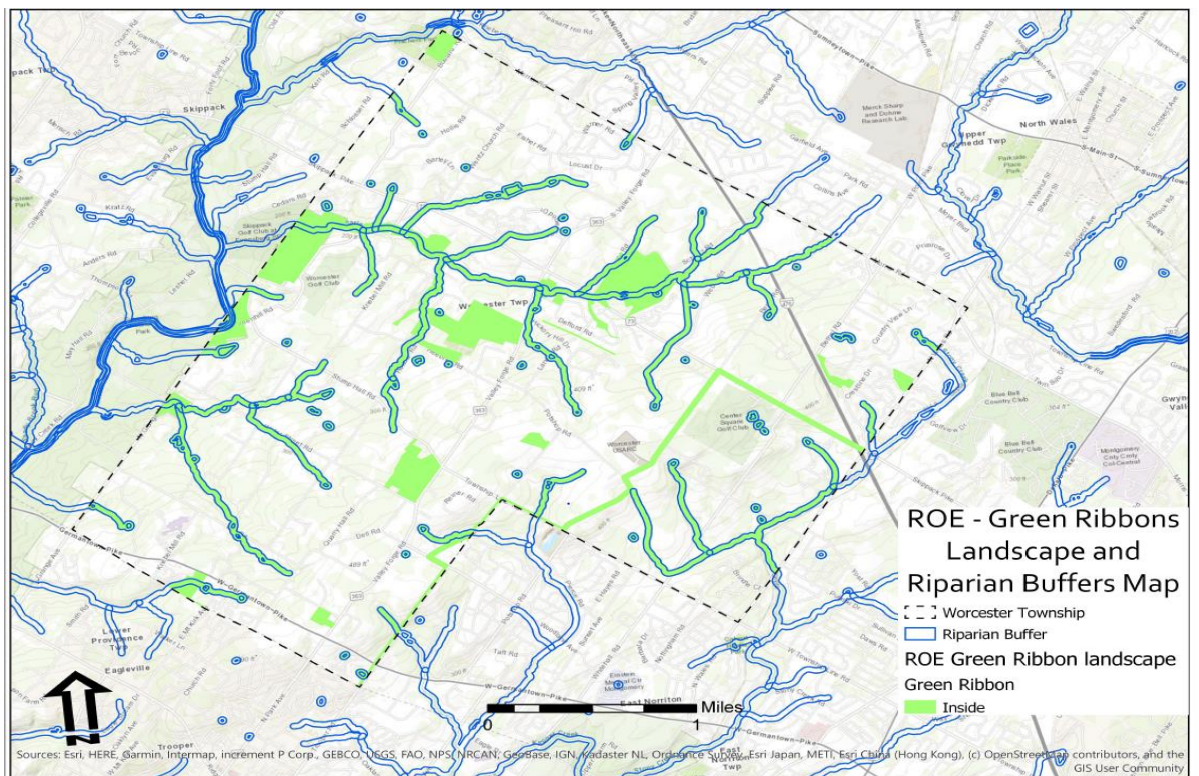
Green Ribbon Landscapes

The most effective way to realize the full value of natural system services is to connect larger, native forests and grassland habitats with green corridors. These landscape patterns are called Green Ribbon Landscapes (GRL).

GRLs are the highest value ROE areas and are the backbone for biological diversity and a healthy environment and sustainable economy. This connectivity can potentially moderate some of the worst effects of habitat fragmentation and severe weather effects by promoting connectivity of

habitats and wide-ranging biodiversity.⁴³ *Map 4*, shows Worcester Township's Green Ribbon Landscapes.

Map 4: Worcester Township's Green Ribbon Landscapes



Restoring and maintaining connected, healthy riparian areas, headwaters, wetlands, and larger upland habitats expands ROE and biological diversity. GRL is a voluntary approach to help residents understand how important these areas are.

A GRL is a linear, 300-foot setback that expands ROE along parks, trails, preserves, riparian areas, and large forests (over 200 acres). The 300-foot distance

protects the core forest from light that enables invasive species.⁴⁴ Invasive species often out compete native species and destroy native habitat. 300 feet is the distance that light can penetrate a forest edge do to sun angles.⁴⁵ Planting 60% canopy cover and 60% native plants within the 300-foot setback helps protect the core forest and biological diversity.⁴⁶ These plantings can be done in parks, trails, preserves, riparian areas and on private land.

84% of land in Pennsylvania is privately owned.⁴⁷ To be able to have an impact, particularly in *Map 4* provides a landscape pattern that can be used to restore connectivity. The Green Ribbon high ROE areas, homeowners need to practice good stewardship on their property and plant 60% in canopy cover and 60% in native plants (refer to the Green Ribbon Map to note priority areas (green areas) for backyard stewardship).⁴⁸

Landscape map shows the patterns of large forests connected by riparian corridors. This creates a sustainable environment and economy.

Tips for creating a sustainable environment and economy

1. Protect water quality at its source in headwaters and wetlands, and along riparian areas.
2. Protect regional, sub-regional, and local wildlife corridors as shown on the Green Ribbon Map.
3. Control invasive plants by minimizing disturbance (edges, clearings).
4. Minimize impervious surfaces and limit turf grass to areas essential for recreation.
5. Practice good stewardship and incentivize the use of native plants in the landscape.

11. PUTTING RETURN ON ENVIRONMENT STUDIES TO WORK

A blueprint for action

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

The first step to putting ROE studies to work is articulating the ways in which open space provides natural system services. Placing a dollar value on different types of land cover helps decision makers understand what is critical to the environment and the economy and which lands can be developed. Mapping the pattern of connected habitat creates a baseline for determining what actions are needed to sustain the environmental and economic benefits.

Map 5 shows the current protected parcels in Worcester Township. *Map 6* shows Worcester Township's high-valued ROE vulnerability analysis.

Many of the remaining forests have been protected, but there is much to do regarding restoring headwaters and riparian areas.

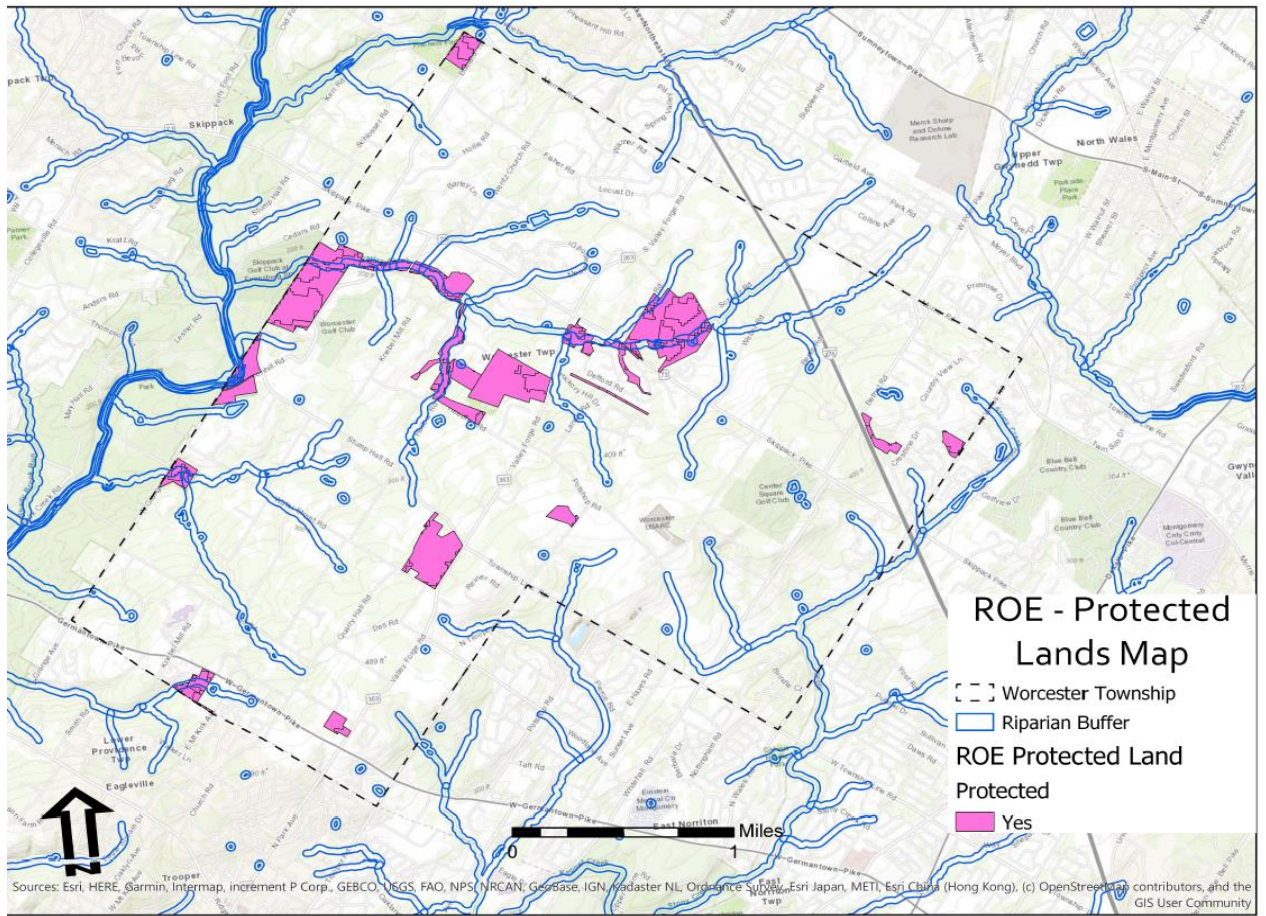
All Stakeholders Play a Part

Environmental stewardship must become part of Worcester Township's everyday culture. Strong alignment between residents, planners, nonprofits, land trusts, businesses, and policy makers are essential for the township to continue to thrive. Utilizing the ROE process can help ensure this commitment to collective responsibility.

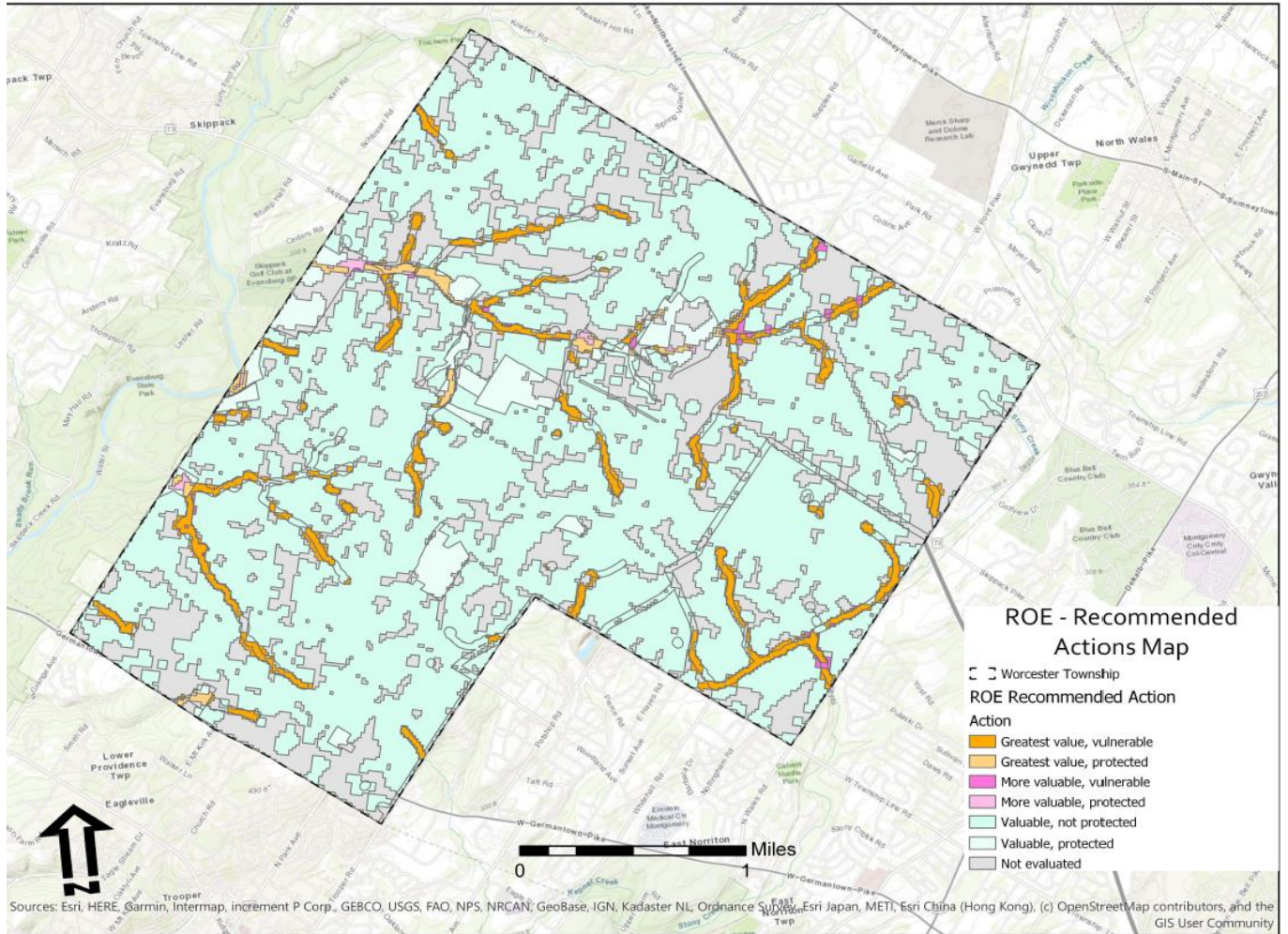
- Include ROE in decision-making. Begin every land-use, economic development, and recreation-planning process with a clear understanding of the financial value of nature's current assets.
- Include ROE data in your comprehensive plan, zoning, and site-plan review.
- Develop strategies to maintain, restore, and enhance them.
- Restore riparian areas where necessary. 100-foot wide buffers are the most effective. Headwater protection is critical.
- Determine if highly valued areas are vulnerable to disruption.
- Protect and restore riparian buffers and wetlands from disturbance and connect and restore upland wooded corridors.
- Retain as much of the pre-existing natural landscape as possible during any new construction. Pass a native plant ordinance to ensure all future development primarily uses native plant species.
- Estimate the financial savings each year when Riparian Buffer and Official Map Ordinances are in place.
- Expand natural habitat by developing Green Ribbon Landscapes along riparian areas and around parks, trails, and natural preserves.
- Teach the principles of good stewardship to landowners. Create good habitat and use native plants in your own backyard.
- Teach your park maintenance staff how to naturalize designated areas of the park system.

- Involve schools. Initiate environmental education programs with multidisciplinary applications that will help students appreciate the value of nature.

MAP 5. Worcester Township's Protected Land Map



MAP 6. Worcester Township's high-valued ROE areas vulnerability analysis



References

1. Rogers, John, 2018. The Value of Nature. Pennsylvania Township News.
2. Clarion Associates, Inc. 2000. *Cost of Sprawl Pennsylvania*. Prepared for 10,000 Friends of Pennsylvania and Sponsoring Organization.
3. Kenneth V. Rosenberg et al. 2019. Decline of the North American avifauna. *Science* 19 eaaw1313
4. Wilsey, C, B Bateman, L Taylor, JX Wu, G LeBaron, R Shepherd, C Koseff, S Friedman, R Stone. Survival by Degrees: 389 Bird Species on the Brink. National Audubon Society: New York.
5. Kenneth V. Rosenberg et al. 2019. Decline of the North American avifauna. *Science* 19 eaaw1313
6. Rogers, John. 2016. Can Money Grow on Trees? Pennsylvania Recreation and Parks Magazine,
7. Kathy Henderson, 2018. Director of Carbon County Economic Development.
8. Headwater Economics, 2019. Public Lands Essay.
9. IBID.
10. Elliott Campbell, 2016. Maryland Department of Natural Resources.
11. The Friends of Worcester Township Workshop, August 2019.
12. KeystoneFund.org . Fact Sheet
13. Economic Benefits of Protecting Healthy Watersheds. EPA: 841- N-12-004, 1.
14. <https://www.aviary.org/media/news-releases/waterthrush-study>
15. Jones, C., J. McCann, and S. McConville. 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*. Chesapeake Bay Critical Area Commission, Annapolis, MD. 63 pp.
16. Rosenberg, K.V., R.S. Hames, R.W. Rohrbaugh, Jr., S. Barker Swarthout, J.D. Lowe & A.A. Dhondt. 2003. *A Land Manager's Guide to Improving Habitat for Forest Thrush*.
17. Laurie Goodrich. 2017. Hawk Mountain Director of Long-Term Monitoring.
18. Rosenberg, K.V., R.S. Hames, R.W. Rohrbaugh, Jr., S. Barker Swarthout, J.D. Lowe & A.A. Dhondt. 2003. *A Land Manager's Guide to Improving Habitat for Forest Thrush*.
19. Ernst, Caryn. 2004. Protecting the Source. Land Conservation and the Future of America's Drinking Water. The Trust for Public Land and the American Water Works Association. San Francisco, CA. .
20. Economic Benefits of Protecting Healthy Watersheds. EPA: 841- N-12-004, 1.
21. [Kaplan, L.A., T.L. Bott, J.K. Jackson, J.D. Newbold, and B.W. Sweeney](#). 2008. Protecting headwaters: scientific basis for safeguarding stream and river ecosystems. Research synthesis from Stroud Water Research Center, Avondale, Pennsylvania.
22. Sweeney, Bernard W. and J. Dennis Newbold. 2014. "Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review." *Journal of the American Water Resources Association* 50:560-584.
23. https://personal.utdallas.edu/~brikowi/Teaching/Applied_Modeling/SurfaceWater/LectureNotes/Watershed_Dynamics/Horton_s_Laws_Stream.html [Kaplan, L.A., T.L. Bott, J.K. Jackson, J.D. Newbold, and B.W. Sweeney](#). 2008. Protecting headwaters: scientific basis for safeguarding stream and river ecosystems. Research synthesis from Stroud Water Research Center, Avondale, Pennsylvania.
24. IBID.
25. Ellen Hawes and Marcelle Smith. 2005, Yale School of Forestry.
26. Sweeney, Bernard W. and J. Dennis Newbold. 2014. "Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review." *Journal of the American Water Resources Association* 50:560-584.
27. Outdoor Recreation Industry. 2018 Annual Report.
28. IBID.
29. Outdoor Recreation Industry. 2018 Pennsylvania Report.
30. Pennsylvania Department of Conservation and Natural Resources. 2014 *Outdoor Recreation Participation Survey*.
31. <http://www.senseandsustainability.net/2014/08/08/sustainable-millennials/>
32. Bass Pro Shop Interview. 2016.
33. Chester County, 2019. *Return on Environment Study: The Economic Value of Protected Open Space in Chester County, Pennsylvania*.
34. U.S Center for Disease Control and Prevention. 2016. *Inadequate Physical Activity and Health Care Expenditures in the United States*. <https://www.cdc.gov/nccdphp/dnpao/docs/carlson-physical-activity-and-healthcare-expenditures-final-508tagged.pdf>
35. Holohan, E. 2012. "Fitness in middle age lowers medical costs later." *HealthDay*. Available from [lowers-medical-costs-later-study](http://consumer.healthday.com/fitness-information-14/gum-health-news-253/fitness-in-middle-age) <http://consumer.healthday.com/fitness-information-14/gum-health-news-253/fitness-in-middle-age> .
36. Burton W.N., CY Chen, X. Li, A.B. Schultz, and H. Abrahamson. 2014. "The association of self-reported employee physical activity with metabolic syndrome, health care costs, absenteeism, and presenteeism." *Journal of Occupational and Environmental Medicine* 56:919-26. Available from <https://www.ncbi.nlm.nih.gov/pubmed/25153302>
37. Carlson, S., J. Fulton, M. Pratt, Z. Yang and K. Adams. 2012. "Inadequate physical activity and health expenditures in the United States." *Progress in Cardiovascular Diseases* 57:315-323. Available from <https://www.sciencedirect.com/science/article/pii/S0033062014001236?via%3Dihub>.
38. USCDC (United States Center for Disease Control and Prevention). 2016. "Inadequate Physical Activity and Health Care Expenditures in the United States." <https://www.cdc.gov/nccdphp/dnpao/docs/carlson-physical-activity-and-healthcare-expenditures-final-508tagged.pdf>
39. Chester County, 2019. *Return on Environment Study: The Economic Value of Protected Open Space in Chester County, Pennsylvania*.
40. IBID.
41. 4WARD Planning, 2017. *Carbon County Return on Environment Study*.
42. <http://content.yardmap.org/learn/habitat-connection/>
43. Jones, C., J. McCann, and S. McConville. 2000. *A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area*. Chesapeake Bay Critical Area Commission, Annapolis, MD. 63 pp.
44. IBID.
45. Rogers, John. 2016. Can Money Grow on Trees? Pennsylvania Recreation and Parks Magazine

46. <https://www.summitpost.org/public-and-private-land-percentages-by-us-states/186111>
 47. Rogers J. *Designing With Natives*, 2011

Glossary

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

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

Biological connectivity The ability of individual plants and animals to move across complex landscapes, maintaining regional populations in the short term and allowing species to shift their geographic range in response to habitat needs and climate change.

Biological control The dynamic regulation of species populations, including the control of invasive species and unwanted species—such as pests, weeds, and disease vectors (e.g., mosquitoes)—by beneficial insects.

Carbon sequestration The process of carbon capture and long-term storage of atmospheric carbon dioxide (CO₂) through photosynthesis. Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change.

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

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

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

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

Cost of damage (CD) An estimate of monetized damages associated with the release of carbon or other pollutants.

Cost of regulation (CR) Fines and procedures.

Direct market valuation (DM) Obtaining values for the provision of services.

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

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

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

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

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

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

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

National Pollutant Discharge Elimination System (NPDES) permit The NPDES permit program addresses water pollution by regulating point sources that discharge pollutants to waters of the United States.

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

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

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

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

Outdoor recreation Activities that can be performed in natural settings, without causing harm.

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

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

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

Soil retention A system that creates and enriches soil through weathering and decomposition, preventing it from being washed away. **Tax benefits (TB) Adjustment benefiting a taxpayer's** tax liability.

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

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

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

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

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

APPENDIX A. Pennsylvania Wildlife Action Plan, 2019Wildlife Action Plan, Conservation Opportunity Area Tool
Results Worcester Township.

SGCN Name	SGCN Season	Priority Score	Occurrence	Habitat Macrogroup(s)	Specific Habitat Requirements
Willow Flycatcher <i>(Empidonax traillii)</i>	Breeding	1	Likely	Wet Meadow / Shrub Marsh	Low-elevation shrub swamp, wet meadow, and brushy habitats along streams and the edges of ponds and marshes; sometimes dry upland sites
Purple Martin <i>(Progne subis)</i>	Breeding	2	Likely	Agricultural	Having nearby water sources is not necessary in a Purple Martin habitat, however it can be helpful as a food source. Martin housing should be placed in the most open spot available (at least 40 feet, but preferably 60 feet from trees or buildings) and within 100 feet of human housing or activity. Proximity to humans and a wide-open location and flight area.

					will help protect the martins from predators.
Wood Thrush <i>(Hylocichla mustelina)</i>	Breeding	1	Likely	Northern Hardwood & Conifer	Second-growth deciduous forest and forest-edge habitats; often with available fruit. 500 acres and larger.
Gray Catbird <i>(Dumetella carolinensis)</i>	Breeding	4	Likely	Urban/Suburban Built	Dense, shrubby vegetation, including thickets, hedgerows, woodland edges, and regenerating clear-cuts.
Louisiana Waterthrush <i>(Parkesia motacilla)</i>	Breeding	1	Likely	Hardwood & Conifer	Mature, forested watersheds with med-high gradient. 250 acres and larger. headwater (1st-3rd order) streams, with well-developed banks (ravines) and/or plentiful overturned trees with exposed root masses. High-quality stream indicator.
Scarlet Tanager <i>(Piranga olivacea)</i>	Breeding	1	Likely	Northern Hardwood & Conifer	A wide variety of mature deciduous and mixed-deciduous forest types. 500 acres and larger.
Northern Field Sparrow <i>(Spizella pusilla)</i>	Breeding	1	Likely	Agricultural	Mixture of grasses and shrub.
Grasshopper Sparrow	Breeding	1	Likely	Agricultural	Indicator for large-scale grasslands;

<i>(Ammodramus savannarum)</i>					grassland obligate specie.
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Action Impact Score: Recommended Conservation Actions Benefiting SGCN Species. The PA Game Commission can help with more information.

Land use planning	Action	Priority Score	Species
	Cluster development, utilities, and associated infrastructure to reduce impacts to species.		Grasshopper Sparrow, Field Sparrow
	Implement land use best management practices• (e.g., riparian buffers) and erosion and sedimentation plans to protect water quality.	1	Louisiana Waterthrush
Wildlife damage management	Manage deer for healthy and sustainable forest habitat.	1	Willow Flycatcher
Fire management	Create or maintain grassland habitat, particularly warm season grasses.	1	Field Sparrow
Conservation area designation	Conserve trees along streams and rivers, and around wetlands.	1	Louisiana Waterthrush
	Identify and conserve unprotected large >247 acres (>100 hectares) forest blocks.	1	Scarlet Tanager
Species and habitat management planning	Manage deer for healthy and sustainable forest habitat.	1	Scarlet Tanager
Create new habitat or natural processes	Identify areas of unnaturally acidified soils and restore using terrestrial lime application.	1	Wood Thrush
Vegetation management	Conserve, create, or restore habitat for this species.	1	Willow Flycatcher

Private Sector Standards and Codes	Reduce straight, 'hard edges' between field and forest by creating a young forest transition between the habitats.	1	Willow Flycatcher
Water management	Determine the impact of pesticide use and contaminant bioaccumulation.	2	Purple Martin
Vegetation management	Create patches of forest openings and young forest habitat (i.e., multiple age stands) through best management practices (e.g., controlled burns or timber harvest).	4	Gray Catbird
	Create or maintain grassland habitat, particularly warm season grasses.	1	Field Sparrow
Land use planning	Cluster development, utilities, and associated infrastructure to reduce impacts to species.	1	Wood Thrush
State Regulations	Cluster development, utilities, and associated infrastructure to reduce impacts to species.	1	Scarlet Tanager
Fire management	Conserve grassland habitat using best management practices (e.g., controlled burns) to prevent conversion to non-grassland habitat.	1	Grasshopper Sparrow
	Maintain or create habitat mosaics, including shrubs, with fire.	1	Field Sparrow
Partner/stakeholder engagement	Develop education curriculum about the species and threats facing the species.	2	Purple Martin
Legislation	Monitor climate change indicators, such as water temperature and prey populations.	1	Louisiana Waterthrush