A NATURAL HERITAGE INVENTORY OF DELAWARE COUNTY, PENNSYLVANIA
June 2011

Submitted to:

Delaware County Planning Department
201 West Front Street,
Media, Pennsylvania 19063
610-891-4000

Prepared by:

Pennsylvania Natural Heritage Program
Western Pennsylvania Conservancy
208 Airport Dr.
Middletown, Pennsylvania 17057



Copies of this document may be obtained from:

Delaware County Planning Department
or
from the web in electronic format at:
http://www.naturalheritage.state.pa.us/CNAI_Download.aspx

This project was funded through grants provided by the DCNR Wild Resource Conservation Program and Delaware County.

This reference may be cited as:

Pennsylvania Natural Heritage Program. 2011. A Natural Heritage Inventory of Delaware County, Pennsylvania – Update 2011. Western Pennsylvania Conservancy. Middletown, Pennsylvania.

PREFACE

The Delaware County Natural Heritage Inventory Update is a document compiled and written by the Pennsylvania Natural Heritage Program (PNHP) of the Western Pennsylvania Conservancy (WPC). It builds on the original Natural Areas Inventory of Delaware County completed in 1992 by the Pennsylvania Science Office of The Nature Conservancy. This document contains information on the locations of rare, threatened, and endangered species and of the highest quality natural areas in the county; it is not an inventory of all open space. It is intended as a conservation tool and should in no way be treated or used as a field guide. Accompanying each site description are general management recommendations that would help to ensure the protection and continued existence of these natural communities, rare plants, and animals. The recommendations are based on the biological needs of these elements (communities and species). The recommendations are strictly those of WPC and do not necessarily reflect the policies of the state or the policies of the county or townships for which the report was prepared.

Managed areas such as state, county and township lands as well as those of various conservation organizations and homeowner associations are also provided on the maps based on information obtained from the Delaware County GIS Department. This information is useful in determining where gaps occur in the protection of land with ecologically significant habitats, natural communities, and rare species. The mapped boundaries are approximate and our list of managed areas may be incomplete, as new sites are always being added.

Implementation of the recommendations is up to the discretion of the landowners. However, cooperative efforts to protect the highest quality natural features through the development of site-specific management plans are greatly encouraged. Landowners working on the management of, or site plans for specific areas described in this document are encouraged to contact the PNHP for further information.

The Pennsylvania Natural Heritage Program is responsible for collecting, tracking, and interpreting the information regarding the Commonwealth's biological diversity. County Natural Heritage Inventories (CNHIs) are an important part of the work of PNHP. Since 1989, PNHP has conducted county inventories as a means to both gather new information about natural resources and to pass this information along to those responsible for making decisions about the resources in the county. This County Natural Heritage Inventory focuses on the best examples of living ecological resources in Delaware County. The county must address historic, cultural, educational, water supply, agricultural and scenic resources through other projects and programs.

Natural Heritage Inventories and Environmental Review

The results presented in this report represent a snapshot in time, highlighting the sensitive natural areas within Delaware County. The sites in the Delaware County Natural Heritage Inventory have been identified to help guide land use and county planning. The Delaware County Natural Heritage Inventory is a planning tool, but is not a substitute for environmental review, as information is constantly being updated as natural resources are both destroyed and discovered. Applicants for building permits and Planning Commissions can conduct free, online, environmental reviews to inform them of project-specific potential conflicts with sensitive natural resources. Environmental reviews can be conducted by visiting the Pennsylvania Natural Heritage Program's website, at http://www.naturalheritage.state.pa.us/. If conflicts are noted during the environmental review process, the applicant is informed of the steps to take to minimize negative effects on the county's sensitive natural resources. If additional information on species of concern becomes available during environmental review, the review may be reconsidered by the jurisdictional agency.

Particular species names, common and scientific, are provided in coordination with the appropriate jurisdictional agency. Some species are especially vulnerable to disturbance or unauthorized collection and are therefore not identified in the text of this report at the request of the agencies, in order to provide some measure of protection. Plants and terrestrial invertebrates are under the jurisdiction of the Pennsylvania Department of Conservation and Natural Resources (DCNR). Mammals and birds are under the jurisdiction of the Pennsylvania Game Commission (PGC). Aquatic animals, reptiles, and amphibians are under the jurisdiction of the Pennsylvania Fish and Boat Commission (PFBC).

Although the inventory was conducted using a tested and proven methodology, it is best viewed as a preliminary report on the county's natural heritage. Further investigations could, and likely will, uncover

previously unidentified areas of significance. More in-depth investigations of sites listed in this report could reveal features of further or greater significance than have been documented. Likewise, as land use patterns in the county change, species may be lost, changing the significance of already documented sites. We encourage additional inventory work across the county to further the efforts begun with this study. Keep in mind that that this document can be updated as necessary to accommodate new information.

Consider this inventory as an invitation for the people of Delaware County to explore and discuss their natural heritage and to learn about and participate in the conservation of the living ecological resources of the county. Ultimately, it will be up to the landowners, residents, and officials of Delaware County to determine how to use this information. Several potential applications for the information within the County Natural Heritage Inventory for a number of user groups follow:

Planners and Government Staff: Typically, the planning office in a county administers county inventory projects. Often, the inventories are used in conjunction with other resource information (agricultural areas, slope and soil overlays, floodplain maps, etc.) in review for various projects and in comprehensive planning. Natural Heritage Areas may be included under various categories of zoning, such as conservation or forest zones, within parks and greenways, and even within agricultural security areas. There are many possibilities to provide for the conservation of Natural Heritage Areas within the context of public amenities, recreational opportunities, and resource management.

County, State and Federal Agencies: In many counties, Natural Heritage Areas lie within or include county, state, or federal lands. Agencies such as the Pennsylvania Game Commission, the Pennsylvania Bureau of Forestry, County Parks and Township Parks can use the inventory to understand the extent of the resource. Agencies can also learn the requirements of the individual plant, animal or community elements, and the general approach that protection could assume. County Conservation Districts may use the inventories to focus attention on resources (high diversity streams or wetlands) and as a reference in encouraging good management practices.

Environmental and Development Consultants: Environmental consultants are called upon to plan for a multitude of development projects including road construction, housing developments, commercial enterprises, and infrastructure expansion. Design of these projects requires that all the resources impacted be known and understood. Decisions made with inadequate information can lead to substantial and costly delays. County Natural Heritage Inventories (CNHIs) provide a first look at biological resources, including plants and animals listed as rare, threatened, or endangered in Pennsylvania and/or at the federal level. Consultants can then see potential conflicts long before establishing footprints or developing detailed plans and before applying for permits. This allows projects to be changed early on when flexibility is at a maximum.

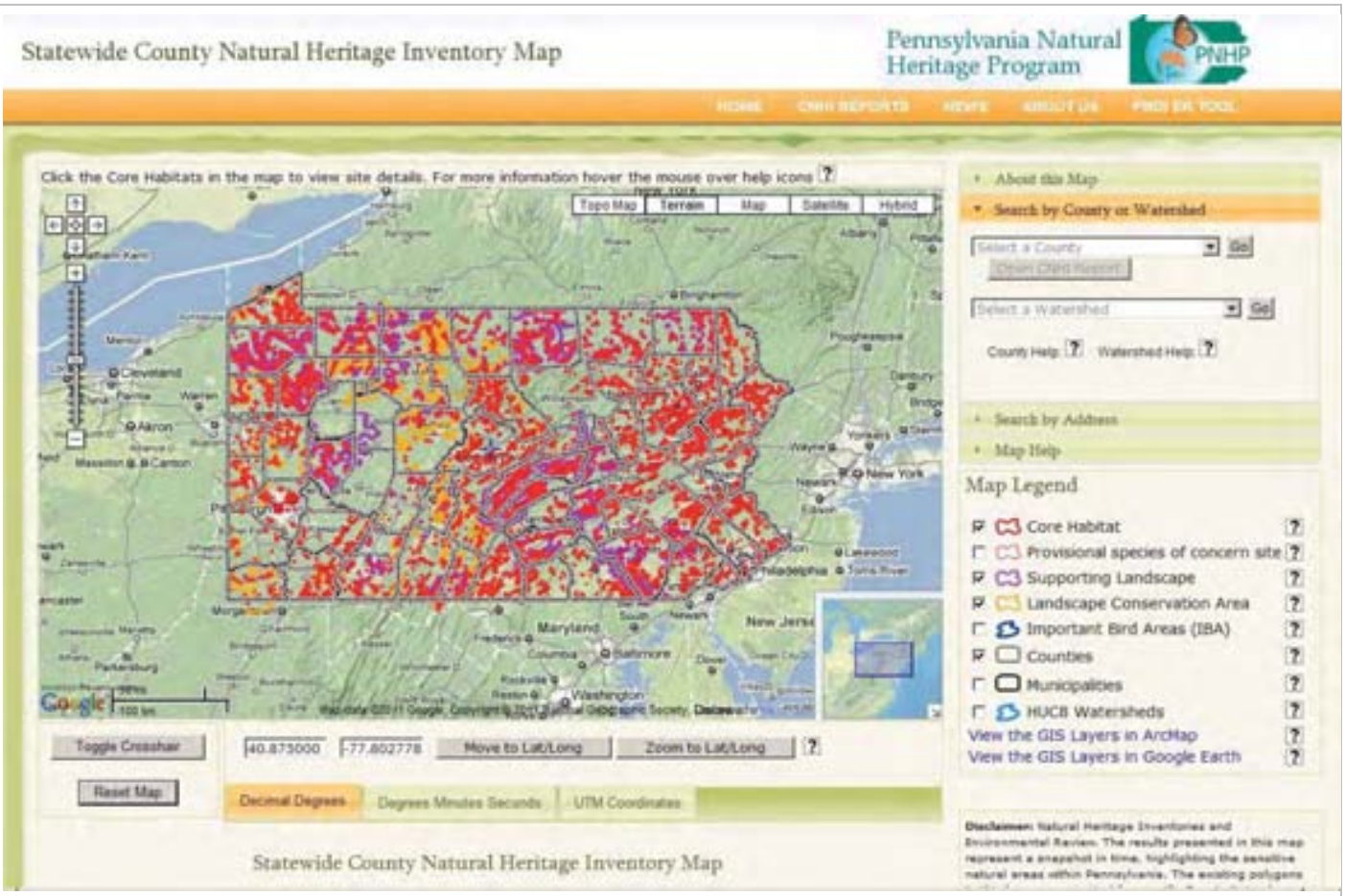
Environmental consultants are increasingly called upon to produce resource plans (e.g. River Conservation Plans, Parks and Open Space Plans, and Greenways Plans) that must integrate a variety of biological, physical, and social information. CNHIs can help define watershed-level resources and priorities for conservation and are often used as the framework for these plans.

Developers: Working with environmental consultants, developers can consider options for development that add value while protecting key resources. Incorporating green-space, wetlands, and forest buffers into various kinds of development can attract homeowners and businesses that desire to have natural amenities nearby. Just as parks have traditionally raised property values, so too can natural areas. CNHIs can suggest opportunities where development and conservation can complement one another.

Educators: Curricula in primary, secondary and college level classes often focus on biological science at the chemical or microbiological level. Field sciences do not always receive the attention that they deserve. Natural areas can provide unique opportunities for students to witness, first-hand, the organisms and natural communities that are critical to maintaining biological diversity. Educators can use CNHIs to show students where and why local and regional diversity occurs, and to aid in curriculum development for environment and ecology academic standards. With proper permission and arrangements through landowners and the Pennsylvania Natural Heritage Program, students can visit Natural Heritage Areas and establish appropriate research or monitoring projects.

Conservation Organizations: Organizations that have a mission related to the conservation of biological diversity can turn to the inventory as a source of prioritized places in the county. Such a reference can help guide internal planning and define the essential resources that can be the focus of protection efforts. Land trusts and conservancies throughout Pennsylvania have made use of the inventories to do just this sort of planning and prioritization, and are now engaged in conservation efforts on highly significant sites in individual counties and regions.

Statewide Coverage: The information depicted in this report will be integrated into the PNHP "Statewide County Natural Heritage Inventory Map", a web-based application of all existing PA CNHI information (http://www.naturalheritage.state.pa.us/cnhi/cnhi.htm).
The areas highlighted in the CNHIs representing sensitive natural features within each county have been merged into a single layer to provide a seamless statewide coverage. Until now, one would have to sift through the various CNHI projects to get a preview of the primary locations for species of concern and other sensitive natural features prior to submitting a project for environmental review. This statewide layer of existing CNHI sites allows for a landscape level review of the sensitive ecological features of the state.



ACKNOWLEDGEMENTS

We would like to acknowledge the citizens and landowners of Delaware County and surrounding areas who volunteered information, time, and effort to the inventory and granted permission to access land. A special thank-you goes to the people of Delaware County for their interest and hospitality. A big thank you goes to those who suggested areas of interest and assisted with field surveys, including: Janet Ebert, Jack Holt, Steve Johnson (independent biological consultants); Roger Latham (Continental Conservation); Tim Block, Ann Rhoads (Morris Arboretum); Robert Lonsdorf, Tom Larson, Kevin Fryberger, Tara Tracy, Estelle Wynn Dolan (Brandywine Conservancy); Scott Wendle, Joe Vinton, David Steckel (Natural Lands Trust); Rick Colbert, Andy Brundage, Dick Cloud (Tyler Arboretum); Mark McAlpine (Pennsylvania Game Commission); Danielle Kreeger, Krista Laudenbach-Nelson (Partnership for the Delaware Estuary); Brendalee Phillips (John Heinz National Wildlife Refuge at Tinicum); Sara Strassman (American Rivers), Kitt Heckscher, (Delaware State University); Robert Coxe, (Delaware Natural Heritage Program).

The Delaware County Planning Department provided much support and guidance with the inventory including Karen Holm, Zachary Barner, Julie Del Muto, Shaun Bollig, Rachelle Green, Steven Beckley, Andrew Adams and Timothy Lucas. The Delaware County Natural Heritage Inventory has benefited greatly from your input, and we thank you for your assistance.

We want to recognize the Pennsylvania Natural Heritage Program and NatureServe for providing the foundation for the work that we perform for these studies. Current and former PNHP staff that contributed to this report include JoAnn Albert, Jake Boyle, Tony Davis, Alice Doolittle, Charlie Eichelberger, Rocky Gleason, Susan Klugman, Matt Kowalski, John Kunsman, Betsy Leppo, Sally Ray, Erika Schoen, Andrew Strassman, Christopher Tracey, Jeff Wagner, Mary Walsh, Denise Watts and Peter Woods.

The species information utilized in the inventory came from many sources as well as our own field surveys. We wish to acknowledge all of those who carried out botanical and zoological survey work over the years. Without their contributions, this report would have been far less complete.

Finally, we especially wish to thank the landowners who granted us permission to conduct inventories on their lands. The task of inventorying the natural heritage of Delaware County would have been far more difficult without this tremendous pool of information gathered by many people over many years.

This project was funded through grants provided by the Pennsylvania Department of Conservation and Natural Resources, Wild Resources Conservation Program, and Delaware County.

We encourage comments and questions. The success of the report will be measured by the use it receives and the utility it serves to those making decisions about resources and land use throughout the county. Thank you for your interest.

The Pennsylvania Natural Heritage Program (PNHP) is a partnership between the Western Pennsylvania Conservancy (WPC), the Pennsylvania Department of Conservation and Natural Resources (DCNR), the Pennsylvania Game Commission (PGC), and the Pennsylvania Fish and Boat Commission (PFBC). PNHP is a member of NatureServe, which coordinates natural heritage efforts through an international network of member programs—known as natural heritage programs or conservation data centers—operating in all 50 U.S. states, Canada, Latin America and the Caribbean.

The Western Pennsylvania Conservancy served as the principal investigator, prepared the report, and created the maps for this study. Established in 1932, WPC is a private non-profit conservation organization headquartered in Pittsburgh. WPC's mission is to save the places we care about by connecting people to the natural world. As part of its mission, WPC works to sustain the natural heritage of the Commonwealth: its native plant, animal, and habitat resources. To reach these goals, WPC initiates conservation projects independently, and establishes partnerships with like-minded agencies and organizations.

TABLE OF CONTENTS

How to Use This Document
This County Natural Heritage Inventory is designed to provide information about the biodiversity of Delaware County. The introduction of the report has an overview of the process behind this inventory as well as an overview of the natural history of Delaware County. A section on natural history includes information about the common plants, animals, and communities that one would expect in the County followed by a section on inventory methodology. Results are presented at the broad landscape view, then moving into finer scale Natural Heritage Areas followed by conclusions and general recommendations.

Preface iii
Acknowledgements vi
Table of Contents 1
Site Index 3
Executive Summary 11
INTRODUCTION 25
Natural History Overview of Delaware County 31
Bedrock and Soils 32
Watersheds 35
Natural Communities of Delaware County 37
Landscape-scale Conservation 43
Disturbance in Delaware County 47
Invasive Species 50
A Review Of The Animals Of Delaware County 57
Mammals of Delaware County 57
Birds of Delaware County 61
Reptiles and Amphibians of Delaware County 66
Fish of Delaware County 70
Insects of Delaware County 74
"Orphan Taxa" of Delaware County 78
METHODS 79
PNHP Data System 79
Field Work 81
Data Analysis and Mapping 82
Site Mapping and Ranking 82
Greenspace Analysis 84
Aquatic Community Classification 85
Stream Reach Quality Assessment 88
RESULTS 89
Aquatic Community Classification Results 90
Stream Reach Quality Assessment 92
Greenspace Analysis 93
Natural Heritage Areas 96
Airport Tidal Wetlands 99
Beaver Valley Woods 105
Bonner Park Woods 113
Brandywine Creek Corridor 117
Brandywine Summit 123
Brinton Lake Wetland 129
Chadds Ford Old Fields 133
Chadds Ford Swamp 137
Clayton Park, Shavertown Woods 143

Cobbs Creek 149
Crum Creek Floodplain and Reservoir 153
Crum Woods of Swarthmore College 159
Darby Creek Mouth Mudflat 167
Harvey Run Powerline ROW 173
Haverford State Hospital Borrow Field 177
Ithan - Darby Creek Wetlands 181
John Heinz National Wildlife Refuge 187
Johnsons Corner, Naamans Creek Road 195
Little Tinicum Island 203
Marcus Hook to Commodore Barry Bridge 209
Martin Forest 213
Media Wetlands 221
Mineral Hill 227
Naamans Creek near Ogden 233
Naamans Creek Woods 237
Pink Hill Serpentine Barrens 243
Riddle Hospital Serpentine Barrens 249
Ridley Creek - Crum Creek Mouth Tidal Wetlands 257
Ridley Creek Headwaters 261
Ridley Creek Woods 267
Skunk Hollow Woods 271
Springton Reservoir 275
Sun Oil Woods 279
Tinicum Woods 283
Todd Woods 287
Tyler Arboretum Fields 291
Tyler Arboretum, Ridley Creek SP Woodland 295
CONCLUSIONS AND RECOMMENDATIONS 299
Glossary 306
References and Literature Cited 308
GIS Data Sources 311
APPENDIX I: Species and Communities of Concern in Delaware County 312
APPENDIX II: EZ EO Form 314
APPENDIX III: PNHP Program ranks and State and Federal Status 315
APPENDIX IV: Greenspace Analysis 318
APPENDIX V: Aquatic Community Classification Fact Sheets 321
APPENDIX VI: Selected Species of Concern Fact Sheets 333

Delaware County Natural Heritage Inventory Site Index

#	Natural Heritage Area Name	#	Natural Heritage Area Name
1	Skunk Hollow Woods	19	Harvey Run Powerline ROW
2	Ithan - Darby Creek Wetlands	20	Brandywine Summit
3	Haverford State Hospital Borrow Field	21	Chadds Ford Old Fields
4	Cobbs Creek	22	Chadds Ford Swamp
5	Crum Woods of Swarthmore College	23	Brandywine Creek Corridor
6	Martin Forest	24	Beaver Valley Woods
7	Crum Creek Floodplain and Reservoir	25	Johnsons Corner, Naamans Creek Road
8	Media Wetlands	26	Clayton Park, Shavertown Woods
9	Mineral Hill	27	Sun Oil Woods
10	Riddle Hospital Serpentine Barrens	28	Naamans Creek near Ogden
11	Pink Hill Serpentine Barrens	29	Naamans Creek Woods
12	Tyler Arboretum, Ridley Creek SP Woodland	30	Marcus Hook to Commodore Barry Bridge
13	Springton Reservoir	31	Ridley Creek - Crum Creek Mouth Tidal Wetlands
14	Ridley Creek Woods	32	Darby Creek Mouth Mudflat
15	Ridley Creek Headwaters	33	Tinicum Woods
16	Bonner Park Woods	34	Little Tinicum Island
17	Brinton Lake Wetland	35	Airport Tidal Wetlands
18	Todd Woods	36	John Heinz National Wildlife Refuge

Initial	Name	Initial	Name
C	Colwyn Boro	PS	Parkside Boro
CH	Clifton Heights	R	Rutledge Boro
EL	East Lansdowne Boro	RV	Rose Valley Boro
M	Millbourne Boro	S	Springfield
MO	Morton Boro	UD	Upper Darby

Site Identification # and Significance

- *exceptional significance*
- *high significance*
- *notable significance*
- *local significance*

- Core Habitat
- Supporting Landscape
- Subwatershed
- TOWNSHIP BOUNDARIES
- *USGS Quadrangles*

Scale 1:114,000

0 0.5 1 2 3 4 5 Miles

0 0.5 1 2 3 4 5 Kilometers

Delaware County Natural Heritage Inventory, Update 2011

A County Natural Heritage Inventory (CNHI) is designed to identify and map areas that support species of concern, exemplary natural communities, and broad expanses of intact natural ecosystems that support important components of Pennsylvania's native biodiversity. In addition, this project has identified the most intact natural connections between and among these rare species habitats as a means to help prevent their isolation from the natural landscape. While the habitats of species of concern are a primary focus of this project, many other ecological factors were weighed when defining the "Green Infrastructure" of Delaware County and the surrounding area. These include: steep slopes; intact forests; interior forests; native habitat quality; wetlands, floodplains of streams and rivers; riparian buffer width and quality. These natural attributes, or the "green infrastructure" of the area was compared to the built landscape, or "gray infrastructure" to highlight those areas that are most in need of conservation action. In order to connect the larger, more intact pieces of the landscape, a series of corridors will be necessary as potential migratory pathways to help facilitate animal and plant movement in a rapidly changing environment. The restoration of streamside vegetation, or riparian buffers, may have the most significant effect on improving habitat connections while simultaneously improving water quality passing through the county to the Delaware River. Conservation Value Summary: While all of the natural habitats within the county contribute to the overall health of the County's ecological systems, the highest priority natural habitats and the potential connections between them become evident by combining the landscape features discussed above.

The map on the right indicates the potential natural value of all areas within the county. Darker colors indicate a higher relative ecological value than lighter colors. The primary connecting features within the county are the contiguous forested areas and the network of streams and rivers in the county. Many streams will require restoration of the riparian buffer area to fully function as habitat and migratory corridors within the county.

Large natural landscapes of the county that contain concentrations of high quality habitats and Natural Heritage Areas are the primary areas with highest relative ecological value in the County. In addition to those areas containing species of concern, the analysis of the combined landscape features helped to determine the most intact habitats as well as the most likely potential linkages. These habitat linkages are necessary to help keep natural habitats from becoming isolated islands in a sea of human modified landscape.

These areas currently provide habitat and regional migratory potential for most of the County's native plants and animals and are the primary components of the County's natural environments. Corridors are those areas identified as contributing to the local migratory potential within the County that help to bridge the gaps between the larger pieces of the landscape. These areas were typically highlighted because of the presence of existing fragments of linking habitats such as smaller patches of forest, woodlots, and stream corridors. In most cases, these corridors are in need of restoration to improve their utility as habitats and migratory potential.

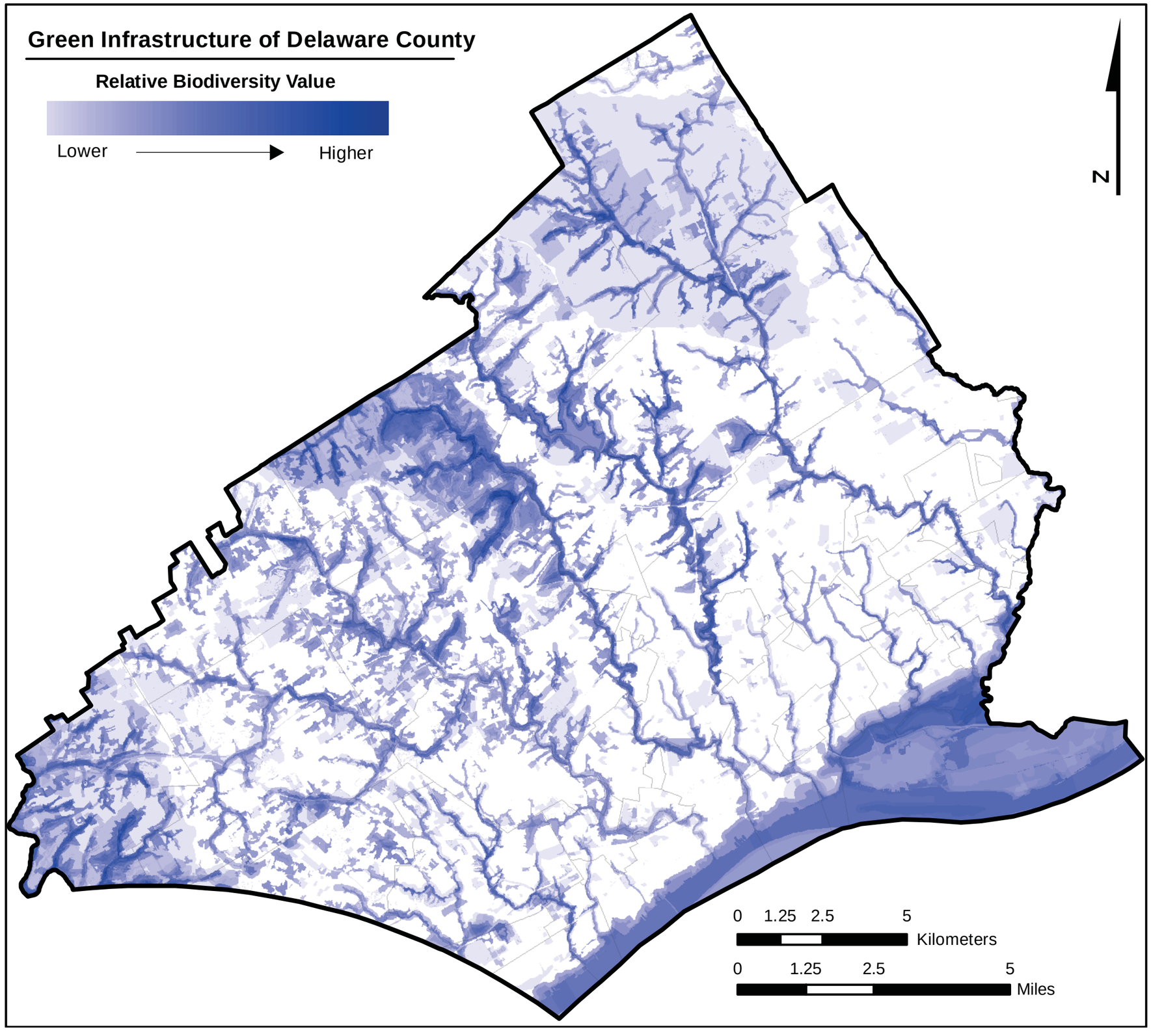


Table 1: Site Index Table arranged alphabetically by site name.

Site Number	Site Name	Municipalities	USGS Quadrangles	Page
35	Airport Tidal Wetlands	Tinicum Township, and Philadelphia County	Bridgeport, Philadelphia, Woodbury	Pg 99
24	Beaver Valley Woods	Chadds Ford and Concord Townships Delaware County; Newcastle County in the State of Delaware	Wilmington North	Pg 105
16	Bonner Park Woods	Thornbury Township	West Chester, Media	Pg 113
23	Brandywine Creek Corridor	Chadds Ford Township	Wilmington North	Pg 117
20	Brandywine Summit	Chadds Ford Township	Wilmington North	Pg 123
17	Brinton Lake Wetland	Thornbury Township	West Chester	Pg 129
21	Chadds Ford Old Fields	Chadds Ford Township	Wilmington North	Pg 133
22	Chadds Ford Swamp	Chadds Ford Township, Delaware County; Birmingham & Pennsbury Townships, Chester County	West Chester, Wilmington North	Pg 137
26	Clayton Park, Shavertown Woods	Bethel and Concord Townships	Marcus Hook, Wilmington North	Pg 143
4	Cobbs Creek	Haverford Township and Philadelphia County	Lansdowne	Pg 149
7	Crum Creek Floodplain and Reservoir	Marple, Nether Providence, Springfield and Upper Providence Townships	Lansdowne, Media	Pg 153
5	Crum Woods of Swarthmore College	Nether Providence and Springfield Townships; Swarthmore Borough	Lansdowne	Pg 159
32	Darby Creek Mouth Mudflat	Ridley and Tinicum Townships	Bridgeport	Pg 167
19	Harvey Run power line ROW	Chadds Ford Township	West Chester, Wilmington North	Pg 173
3	Haverford State Hospital Borrow Field	Haverford Township	Lansdowne, Norristown	Pg 177
2	Ithan-Darby Creek Wetlands	Haverford, Marple, Radnor Townships	Lansdowne, Norristown	Pg 181
36	John Heinz National Wildlife Refuge	Darby, Norwood, Ridley, and Tinicum Townships, and Colwyn, Folcroft, Norwood, Prospect Park, Sharon Hill Boroughs	Bridgeport, Lansdowne	Pg 187
25	Johnsons Corner, Naamans Creek Road	Bethel and Concord Townships	Wilmington North	Pg 195
34	Little Tinicum Island	Tinicum Townships	Bridgeport	Pg 203
30	Marcus Hook to Commodore Barry Bridge	Chester City; Marcus Hook and Trainer Boroughs	Bridgeport, Markus Hook	Pg 209
6	Martin Forest	Nether Providence and Springfield Townships	Lansdowne	Pg 213

Site Number	Site Name	Municipalities	USGS Quadrangles	Page
8	Media Wetlands	Middletown and Upper Providence Townships	Media	Pg 221
9	Mineral Hill	Middletown Township	Media	Pg 227
28	Naamans Creek near Ogden	Upper Chichester Township	Marcus Hook	Pg 233
29	Naamans Creek Woods	Lower Chichester and Upper Chichester Townships	Marcus Hook	Pg 237
11	Pink Hill Serpentine Barrens	Middletown Township	Media	Pg 243
10	Riddle Hospital Serpentine Barrens	Middletown Township	Media	Pg 249
31	Ridley Creek - Crum Creek Mouth Tidal Wetlands	Chester City, Eddystone Borough and Ridley Township	Bridgeport	Pg 257
15	Ridley Creek Headwaters	Edgmont Township, Delaware County; East Goshen, Westtown, Willistown Townships, Chester County	Media, West Chester	Pg 261
14	Ridley Creek Woods	Edgmont Township	Media	Pg 267
1	Skunk Hollow Woods	Newtown and Radnor Townships	Valley Forge	Pg 271
13	Springton Reservoir	Edgmont, Marple, Newton, and Upper Providence Townships	Media	Pg 275
27	Sun Oil Woods	Bethel, Upper Chichester Townships	Marcus Hook	Pg 279
33	Tinicum Woods	Tinicum Township	Bridgeport, Lansdowne	Pg 283
18	Todd Woods	Chadds Ford Township	West Chester	Pg 287
11	Tyler Arboretum Fields	Middletown Township	Media	Pg 291
12	Tyler Arboretum, Ridley Creek SP Woodland	Edgmont and Middletown Townships	Media	Pg 295

Table 2. Natural Heritage Areas categorized by significance. Significance ranks are Exceptional, High, Notable, and County (for a full explanation of these ranks, see page83). Sites are arranged alphabetically within each category.

Site Name	Municipality	Description	Page
Exceptional Significance			
Darby Creek Mouth Mudflat	Ridley and Tinicum Townships	Remnant tidal flat wetland at the confluence of Darby Creek and the Delaware River shoreline supports fourteen species of concern.	167
John Heinz National Wildlife Refuge	Darby, Norwood, Ridley, Tinicum Townships, and Colwyn, Folcroft, Norwood, Prospect Park, Sharon Hill Boroughs	Tidal estuary along Darby Creek before it meets the Delaware River supports numerous plant and animal species of concern and provides essential migratory habitat for waterfowl. This area is designated as a National Wildlife Refuge.	187
Little Tinicum Island	Tinicum Township	Island within the Delaware River is flanked by a "Freshwater Intertidal Mudflat Natural Community". The upland and aquatic habitats support numerous plant and animal species of concern.	203
Pink Hill Serpentine Barrens	Middletown Township	A small, but intact serpentine barrens habitat within a forested context supports five species of concern that are characteristic of serpentine habitats.	243
High Significance			
Airport Tidal Wetlands	Tinicum Township and Philadelphia County	Fragments of freshwater tidal marsh among the mostly bulk-headed shoreline of the Delaware River provide suitable habitat for numerous species of concern.	99
Beaver Valley Woods	Chadds Ford and Concord Townships Delaware County; Newcastle County in the State of Delaware	A mosaic of upland forest, forested wetlands, open wetlands, spring seeps, successional old fields and pipeline rights-of-way within an agricultural and residential context supports five species of concern.	105
Chadds Ford Swamp	Chadds Ford Township, Delaware County and Birmingham, Pennsbury Townships, Chester County	Wetland, floodplain and old field habitats along the Brandywine Creek provide habitat for six species of concern and essential migratory habitat for waterfowl.	137
Clayton Park, Shavertown Woods	Bethel and Concord Township	Mixed hardwood forest bisected by utility rights of way contains seeps and springs. Powerline maintenance keeps the corridor in a state of early succession. These habitats support eight plant species of concern.	143
Crum Woods of Swarthmore College	Nether Providence and Springfield Townships and Swarthmore Borough	Forested riparian corridor and adjacent uplands along Crum Creek supports two species of concern.	159
Haverford State Hospital Borrow Field	Haverford Township	Successional woodland and meadow-like openings support three plant species of concern.	177

Site Name	Municipality	Description	Page
High Significance (Continued)			
Johnsons Corner, Naamans Creek Road	Bethel and Concord Townships	Remnant coastal plain forest and old field habitat fragmented by roads, utility rights-of-way and residential development supports thirteen species of concern including a tree species only recently documented in the state.	195
Martin Forest	Nether Providence and Springfield Townships	This mature old-growth forested area with dramatic cliffs and rock outcrops provides an essential part of a nearly continuous habitat connection along Crum Creek between Chester County to the north and the Delaware River to the south. Floodplain habitat at this location also supports a plant species of concern.	213
Naamans Creek Woods	Upper Chichester and Lower Chichester Townships	Remnant coastal plain forest is fragmented by Interstate 95 and utility rights of ways. A mixture of forest, old fields, spring seeps and a small open wetland provide habitat for eight plant species of concern.	237
Riddle Hospital Serpentine Barrens	Middletown Township	Development pressure has greatly reduced this former serpentine barren natural community to a few scattered remnants that still manage to support six plant species of concern.	249
Ridley Creek - Crum Creek Mouth Tidal Wetlands	Chester City, Eddystone Borough and Ridley Township	This highly industrialized portion of the Delaware River shoreline contains remnant freshwater tidal marsh and mudflat habitats in a much degraded context. These habitats support three species of concern.	257
Ridley Creek Headwaters	Edgmont Township, Delaware County; East Goshen, Westtown, Willistown Townships, Chester County	Small wetlands, spring seeps and successional old fields occurring along and adjacent to the creek floodplain support four species of concern.	261
Springton Reservoir	Edgmont, Marple, Newton and Upper Providence Townships	Aquatic and riparian habitats associated with the reservoir provide habitat for two species of concern.	275
Tyler Arboretum, Ridley Creek SP Woodland	Edgmont and Middletown Townships	Rich, moist, forested ravine and adjacent slopes along Ridley Creek support five species of concern.	295
Notable Significance			
Bonner Park Woods	Thornbury Township	Mixed hardwood forest provides habitat for a plant species of concern.	113
Brandywine Creek Corridor	Chadds Ford Township	This wide forested area adjacent to the Brandywine Creek provides and essential buffer for the creek, a continuous habitat corridor and supports a plant species of concern.	117
Brandywine Summit	Chadds Ford Township	Mixed age hardwood forest provides buffer for two headwater streams and provides habitat for a plant species of concern.	123
Brinton Lake Wetland	Thornbury Township	A combination of active farm fields, seepy wet woods and wet meadows has recently been developed for residential uses. Two plant species of concern manage to persist is roadside habitat.	129
Chadds Ford Old Fields	Chadds Ford Township	Forested floodplain and old field habitats supports a plant species of concern.	133

Site Name	Municipality	Description	Page
Notable Significance (Continued)			
Cobbs Creek	Haverford Township and Philadelphia County	Scattered habitats along the floodplain and adjacent wooded slopes of Cobbs Creek support a plant species of concern.	149
Crum Creek Floodplain and Reservoir	Marple, Nether Providence, Springfield and Upper Providence Townships	A mix of open water ponds and marshy wetlands and the adjacent wooded uplands provides habitat for a species of concern.	153
Harvey Run power line ROW	Chadds Ford Township	Early successional habitat sustained by utility rights of way maintenance supports two plant species of concern.	173
Ithan-Darby Creek Wetlands	Haverford, Marple and Radnor Townships	A mix of old fields, wet meadows, riparian corridor and forested habitats support a species of concern.	181
Marcus Hook to Commodore Barry Bridge	Chester City, Marcus Hook and Trainer Boroughs	Small pockets of freshwater tidal marsh and appropriate nesting structures provide habitat for four species of concern.	209
Mineral Hill	Middletown Township	Interesting bedrock outcrops at this old quarry site indicate the unusual geology that underlies this early successional forest is of serpentine origin. The mix of habitats at this site supports two plant species of concern.	227
Naamans Creek near Ogden	Upper Chichester Township	Narrow disturbed riparian corridor along Naamans Creek may still support a plant species of concern.	233
Ridley Creek Woods	Edgmont Township	Mixed hardwood forest within Ridley Creek State Park supports a plant species of concern.	267
Sun Oil Woods	Bethel, Upper Chichester Townships	Fragmented forested habitat supports one species of concern.	279
Tinicum Woods	Tinicum Township	Small patches of forest and open field within a highly developed context reflect a coastal plain affinity and support three plant species of concern.	283
Todd Woods	Chadds Ford Township	A well forested buffer surrounding an unnamed tributary to Harvey Run supports a species of concern.	287
Tyler Arboretum Fields	Middletown Township	Early successional open meadow habitat maintained by a periodic mowing regime supports a plant species of concern.	291
Local Significance			
Media Wetlands	Middletown and Upper Providence Townships	Floodplain forest and open wetlands along Ridley Creek provide a refuge and habitat corridor for common species.	221
Skunk Hollow Woods	Newtown and Radnor Townships	Mixed hardwood forest has in the past supported a plant species of concern. The species has not been relocated in several subsequent surveys and may not longer occur at this location.	271

EXECUTIVE SUMMARY

Preface

The ability of a community to bring its vision for the future to fruition depends on its capacity to assemble information that will enable it to act effectively and wisely. Since 1989, County Natural Heritage Inventories (CNHIs) have served as a way to both gather new information and to pass along new and existing information to those responsible for land use decisions, as well as to all residents who wish to know more about the natural heritage of their county. The Delaware CNHI focuses on the best examples of *living ecological resources* in the county. This inventory presents the known outstanding natural features in the county.

The Pennsylvania Natural Heritage Program (PNHP) is a partnership between the Western Pennsylvania Conservancy (WPC), the Pennsylvania Department of Conservation and Natural Resources (DCNR), the Pennsylvania Game Commission (PGC), and the Pennsylvania Fish and Boat Commission (PFBC) and is responsible for collecting, tracking, and interpreting information regarding the Commonwealth's biological diversity. The Western Pennsylvania Conservancy (WPC) served as the principal investigator, prepared the report, and created the maps for this study.

Introduction

Our natural environment is key to human health and sustenance. A healthy environment provides clean air and water; supports fish, game, and agriculture; and furnishes renewable sources of raw materials for countless aspects of our livelihoods and economy.

An ecosystem is "the complex of interconnected living organisms inhabiting a particular area or unit of space, together with their environment and all their interrelationships and relationships with the environment" (Ostroumov 2002). All the parts of an ecosystem are interconnected—the survival of any species or the continuation of a given natural process depends upon the system as a whole, and in turn, these species and processes contribute to maintaining the system. An important consideration in assessing ecosystem health is the concept of biodiversity. Biodiversity can be defined as the full variety of life that occurs in a given place, and is measured at several scales: genetic diversity, species, natural communities, and landscapes. One of the first steps in ensuring protection of our natural environment is to recognize environmentally sensitive or ecologically important areas and to provide information regarding their vulnerability to various land use activities.

A County Natural Heritage Inventory (NHI) is designed to identify and map areas that support species of concern (those considered rare, threatened or endangered at state or federal level), exemplary natural communities, and broad expanses of intact natural ecosystems that support important components of Pennsylvania's native species biodiversity. In addition, this project has

Natural Heritage Inventories and Environmental Review

The results presented in this report represent a snapshot in time, highlighting the sensitive natural areas within Delaware County. The sites in the Delaware County Natural Heritage Inventory have been identified to help guide land use and county planning. The Delaware County Natural Heritage Inventory is a planning tool, but is not a substitute for environmental review, as information is constantly being updated as natural resources are both destroyed and discovered. Applicants for building permits and Planning Commissions can conduct free, online, environmental reviews to inform them of project-specific potential conflicts with sensitive natural resources. Environmental reviews can be conducted by visiting the Pennsylvania Natural Heritage Program's website, at http://www.naturalheritage.state.pa.us/. If conflicts are noted during the environmental review process, the applicant is informed of the steps to take to minimize negative effects on the county's sensitive natural resources. If additional information on species of concern becomes available during environmental review, the review may be reconsidered by the jurisdictional agency.

Particular species names, common and scientific, are provided in coordination with the appropriate jurisdictional agency. Some species are especially vulnerable to disturbance or unauthorized collection and are therefore not identified in the text of this report at the request of the agencies, in order to provide some measure of protection. Plants and terrestrial invertebrates are under the jurisdiction of the Pennsylvania Department of Conservation and Natural Resources (DCNR). Mammals and birds are under the jurisdiction of the Pennsylvania Game Commission (PGC). Aquatic animals, reptiles, and amphibians are under the jurisdiction of the Pennsylvania Fish and Boat Commission (PFBC).

mapped and described natural connections between and among these species of concern habitats as a means to help prevent their isolation from the natural landscape. The intended purpose of this report is to provide information to municipal, county, and state governments, local conservation organizations, private individuals, and business interests so that they may plan development with the preservation of an ecologically healthy landscape for future generations in mind.

Sixty-four of Pennsylvania's sixty-seven counties have completed Natural Heritage Inventories to date. The original Delaware County NHI, (originally called Natural Areas Inventory or NAI), was completed in 1992 and followed up by a "data-review update' in 1998 that highlighted the species of concern information documented since the original Delaware CNAI report was completed. This update is intended to build on the information generated in those reports and to provide Delaware County with additional knowledge useful for the conservation of its unique natural heritage.

A significant emphasis of this report is on identifying the connections between the high quality habitats of Delaware County, to provide a regional ecological framework for the County. Many mapping features were incorporated into the analysis to help identify and define the high priority natural habitats of Delaware County.

Methods

In order to determine the long-term needs of the priority landscapes of the County and their connections to the landscape, we conducted this assessment in three phases:

1) Reviewed and updated the status of species and natural communities of concern.
2) Conducted a landscape-level analysis to determine the role of individual natural areas within the larger ecological picture of southeastern Pennsylvania, their utility as components of Green Infrastructure, and to identify the natural connections between them.
3) Provided site-specific recommendations for the conservation of biodiversity within and between high priority landscapes.

Site selection for the CNHI was guided by information from a variety of sources including the Pennsylvania Natural Heritage Program database, aerial photographs, local citizens, academic institutions, conservation organizations, the Delaware County Planning Department, and state and federal agencies that steward natural resources. Areas identified as inventory sites were surveyed in 2009 and 2010 after permission was obtained from landowners. Areas that were denied sufficient survey access were not surveyed for this project. Sites were examined to evaluate the condition and quality of the habitat, and to classify the communities present with boundaries for each site drawn using computer mapping software (geographic information systems - GIS).

Information Gathering

A review of the Pennsylvania Natural Heritage Program (PNHP) database determined where locations for special concern species and important natural communities were known to exist in Delaware County. Since the original Delaware County NHI (NAI) was completed, many professional and recreational naturalists, including those from our own office, have visited and revisited many of the county's most significant natural areas. The data generated from these visits has accumulated over the years in the PHNP database. Field forms submitted from these visits were reviewed to determine if updates to the information was necessary or desirable.

Knowledgeable individuals were consulted concerning the occurrence of rare plants, animals and unique natural communities in the county. Voluminous GIS data sets were provided by the county for our analysis. Recent aerial photos, Geological maps, United States Geologic Survey (USGS) topographical maps, National Wetlands Inventory maps, United States Department of Agriculture (USDA) soil surveys and many other published materials were also used to identify and characterize areas of potential ecological significance.

Field Work

A limited number of ground surveys were conducted to collect detailed information on the status of the species and communities present at a location, and to identify the threats and management needed to preserve

the unique habitat. Inventory Ecologists concentrated on the areas with the most interesting, unique, diverse and suitable habitat for species of concern and exemplary natural communities. The flora, fauna, level of disturbance and local threats were among the most important data recorded for each site. Sites were not ground surveyed in cases where permission from private property owners to visit a site was not granted or when enough information was available from other sources.

Data Analysis

Data obtained during the field season was combined with prior existing data and summarized. All sites with species of concern and/or natural communities of statewide significance were selected for inclusion in Natural Heritage Areas. The Natural Heritage Areas are mapped to include both the immediate habitat (Core Habitat) and surrounding lands (Supporting Landscape) important in the support of these special elements as well as the natural corridors that connect them. The boundaries defining core habitat and supporting landscape for each Natural Heritage Area were based on physical and ecological factors, and specifications for individual species of concern protection developed by PNHP biologists based on scientific literature review and professional judgment.

Natural Heritage Areas are habitats that contain plant or animal species considered rare, threatened or endangered at state or federal levels. Natural Heritage Areas can also be delineated around high quality natural communities, which are those considered to be uncommon in the state, or among the best of their type within the state. The Natural Heritage Area is delineated into two zones based on its susceptibility to habitat disturbance:

- **Core Habitat** delineates the actual and adjacent similar habitat of individual species of concern (plants and/or animals considered rare, threatened or endangered at state or federal levels) exemplary natural communities, or exceptional native diversity. This level of mapping delineates essential habitat that cannot absorb significant levels of habitat-disturbing activity without substantial impact to the elements of concern.
- **Supporting Landscape** includes areas necessary to maintain vital ecological processes or secondary habitat that typically can accommodate some degree of low-impact activities, but intensive development of these areas could put the species of concern at risk. Much of the Supporting Landscape overlaps between the various Natural Heritage Areas creating a rather continuous and integrated area that should be considered the framework of the County's Greenways Infrastructure. Many of the Supporting Landscape areas were derived from the riparian corridor adjacent to the species of concern core habitat. Activities that occur within the upstream portions of the watershed can have a significant impact on the Natural Heritage Area Core Habitat.

The priority natural habitats identified in this report were designated and ranked according to their contribution to the biological diversity and ecological integrity of Delaware County to provide the information necessary to plan for the conservation at the species, natural community, and ecosystem levels. The sites were assigned a significance rank based on rarity of the species of concern or unique feature, and the size, condition, and quality of the immediate habitat and the surrounding landscape. Spatial data on the elements of concern were then compiled in a geographic information system (GIS) and combined with other available GIS layers for landscape analysis. For more information on specific descriptions or recommendations for an area, refer to the text for that Natural Heritage Area.

Results

Natural Heritage Areas

Thirty-seven Natural Heritage Areas are recognized in Delaware County for this NHI Update. The distribution of Natural Heritage Areas across the county is shown on the site index map. Documented are 214 individual occurrences of 84 species of concern including 62 plants, 11 birds, 4 reptiles, two amphibians, one fish, one dragonfly and 3 types of natural communities of state-wide significance. Many of these species have multiple population occurrences in the county. See Appendix I for a complete list of species of concern currently known to occur in Delaware County.

Significance ranks of Natural Heritage Areas (exceptional, high, notable and local) in order of their importance for the protection of the biological diversity and ecological integrity of the region are given

in Table 2: Delaware County Natural Heritage Areas Summary (page 7). The highest ranked Natural Heritage Areas in Delaware County for their contribution to Statewide and Global biodiversity include the tidally influenced wetlands along the shore of the Delaware River: "Darby Creek Mouth Mudflat", "John Heinz National Wildlife Refuge", "Little Tinicum Island"; the coastal plain remnant at "Johnson's Corner, Naaman Creek Road"; and the serpentine barren habitat at "Pink Hill".

Landscape Analysis

Combining ranked ecological variables can help reveal patterns and trends in the landscape. Several mapping elements went into determining and defining the ecological context that provides the framework for a network of natural habitats within Delaware County. The primary elements include:

- Species of Concern Habitat
- Forested Habitats
- Interior Forests
- Natural Communities
- Wetlands
- Riparian Corridors
- Floodplains (100 & 500-year)
- Steep Slopes (>15% & >25%)
- Trails & Abandoned Railways

Species of Concern Habitat - Relative Biodiversity Value

All of the Natural Heritage Areas are highly important for the species of concern they harbor, but ranking them based on number of species of concern and the degree of rareness of individual species helps to illustrate the relative importance of each area in relation to one another. This map integrates the number, quality and rarity of the species of concern in each area. Darker shading on the map represents areas where more species of concern 'stack up' and represent concentrations of species of concern into "hotspots".

Forested Habitats:

Through the conservation of large forested blocks, the necessary environmental conditions for whole suites of species both common and rare are preserved. The largest contiguous forest blocks of the county were identified and ranked according to size, with the assumption that bigger is better. These forest blocks and their natural habitats should be considered the backbone of wildlife habitat in the county. Conservation efforts in the County should concentrate on maintaining these large forest blocks by avoiding further fragmentation with additional roads, development, and utility rights-of-way. The largest forest blocks are concentrated within and around Ridley Creek Sate Park while other concentrations of forest blocks are primarily in the western section of the County.

Interior forests:

Interior forest, for this report, is defined as forest at least 100 meters in from the edge of any human-created opening such as a field, road, railway line or utility rights-of-way. Interior forest is an important habitat type for many species of plants and animals. The area between the forest edge and 100 meters into the forest is considered highly influenced by edge effects, such as increased levels of light, temperature, wind and dryness which create much different habitat conditions from those found in interior forest. Interior forest patches were ranked according to size with larger patches considered relatively more valuable than smaller patches. Interior forest patches smaller than five acres were dropped from the analysis as likely too small to be suitable habitat for forest interior species. As with the Forest Block analysis, the results reveal that the largest interior forest blocks in the county are concentrated within and around Ridley Creek Sate Park.

Natural Communities:

The natural habitats of Delaware County are not a uniform expanse of shrubs, trees and other plants, but instead contain species that reflect the environmental conditions found in that general location such as wetness, slope, sunlight, and bedrock geology. When plant distributions are examined at a finer level, patterns

of characteristic plant associations can be determined. A natural community is defined as a group of organisms occurring in a particular area based on the environmental conditions found there. The natural communities for this project were delineated from the inspection of aerial photographs taken in 2005 and followed up by selective targeted ground-truthing. All of the primary areas of natural vegetation have been classified based on "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999). All areas were given a quality rank based on the perceived degree of naturalness of the vegetation community present.

Natural communities were ranked by assigning a 3 (highest rank) to a habitat identified as a "natural community type" as in "Terrestrial & Palustrine Plant Communities of Pennsylvania" by Jean Fike, published by Pennsylvania DCNR in 1999. These were regarded as essentially 'natural' communities with little evidence of invasion by introduced species. Those habitat types identified as a natural community with a negative influence, such as "weedy" or "grazed", were given a rank of 2. At the low end of the scale, ranked 1, were those habitats considered in an early stage of succession, recovering from recent past disturbances such as farming or repeated timber harvest. These forests are typically highly invaded by introduced plants and are consequently a low quality natural community. Highly modified landscapes such as those dominated by agriculture or urban areas were not considered in this analysis.

Riparian Corridors:

Riparian areas are lands directly adjacent to streams, creeks, and rivers. Land adjacent to waterways and wetlands has an immediate influence on the quality of the water and the habitat it supports. Protect, enhance and restore riparian buffers to help improve water quality while also providing habitat and migratory corridors for many animals and plants through all parts of the county.

Riparian Buffer Quality: Each riparian buffer segment in the county, excluding the mainstem of the Delaware River, was analyzed using eight variables and ranked according to their potential cumulative effect on water quality. The cumulative scores were then sorted from best to lowest quality and represent four categories of potential conservation status:

1. Highest Restoration Priority (lowest potential quality)
2. Secondary Restoration Priority (second-lowest potential quality)
3. Secondary Conservation Priority (second-best potential quality)
4. Highest Conservation Priority (best potential quality)

This analysis helps to highlight those riparian areas that meet a goal for 100-meter vegetated buffers and should be considered priorities for preservation. This also highlights those that are furthest from meeting the 100-meter riparian buffer goal and should be considered priorities for restoration. However, another way to consider this analysis is to focus on those that fall in the middle of the spectrum. Those that are in the second-best potential quality would take much less effort and expense to raise them to the highest level of quality. Similarly, those that are in the second lowest quality category could be in danger of falling into the lowest quality category if they do not receive prompt restoration action.

Additional layers:

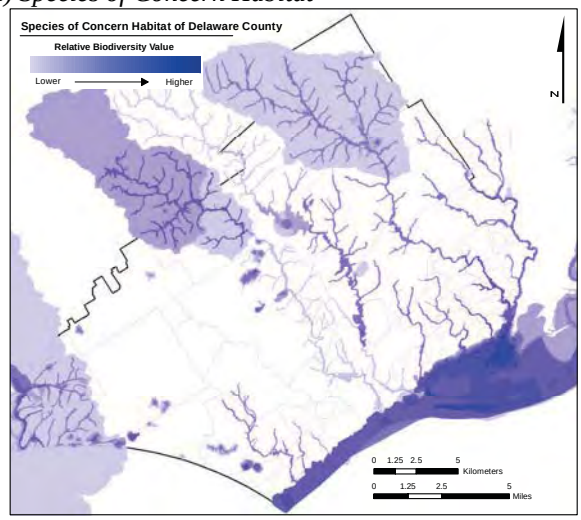
Steep slopes were considered within this analysis at two levels – slopes between 15 % and 25%, and slopes greater than 25%.

Floodplains were incorporated at two levels – the 100 year FEMA floodplain and the 500 year FEMA floodplain.

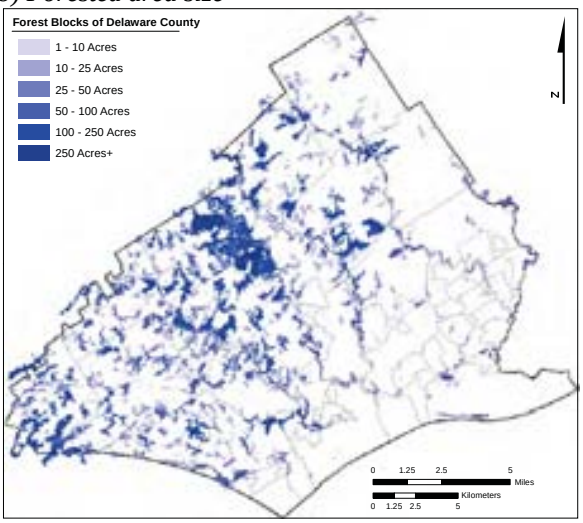
Wetlands from the National Wetland Inventory were incorporated and ranked according to degree of naturalness. Those that were the result of dams or artificial impoundments were considered of lower value than naturally occurring wetlands.

Existing trails and abandoned railways were incorporated into the analysis as narrow linear elements that typically support a fringe of natural habitat and connect larger habitats together.

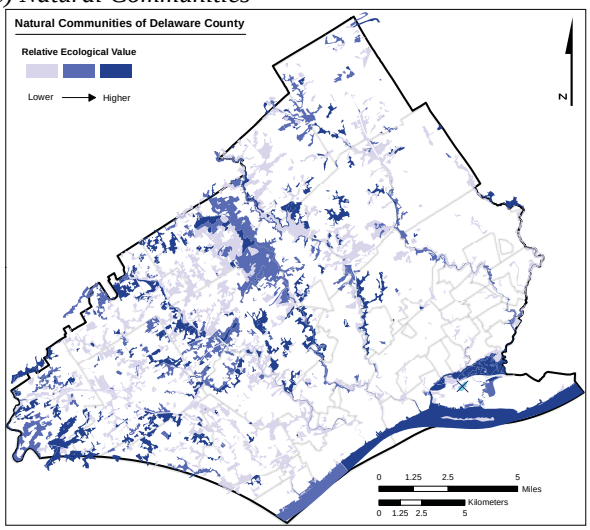
a) Species of Concern Habitat



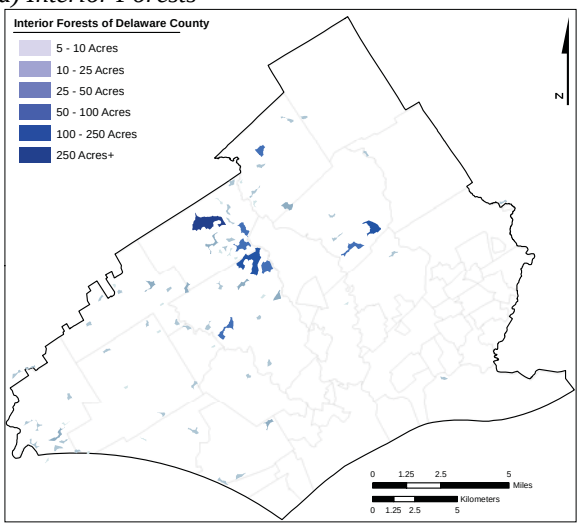
b) Forested area size



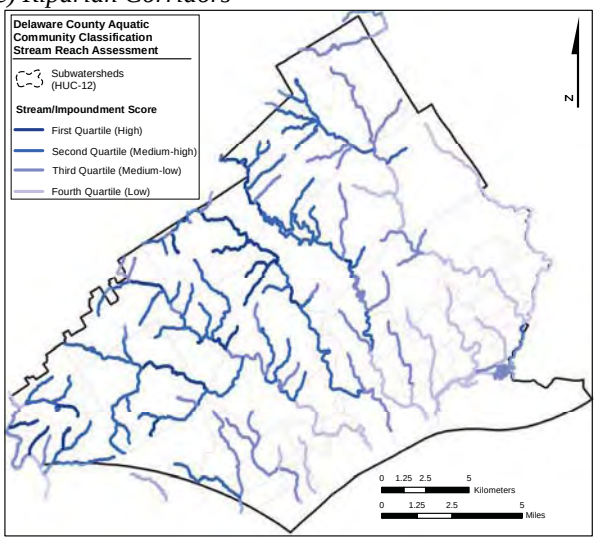
c) Natural Communities



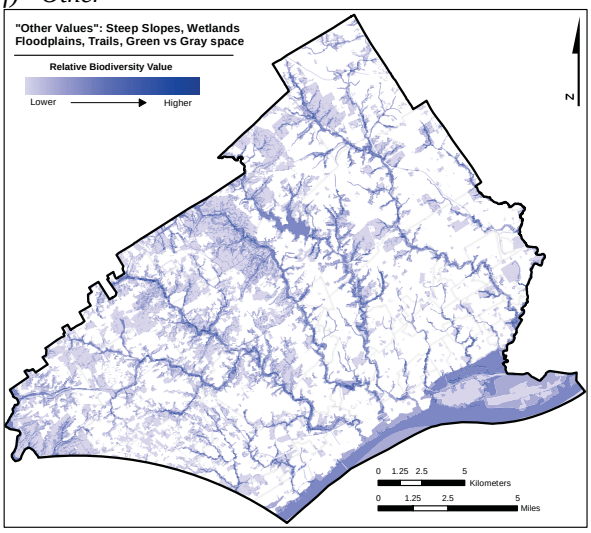
d) Interior Forests



e) Riparian Corridors



f) "Other"

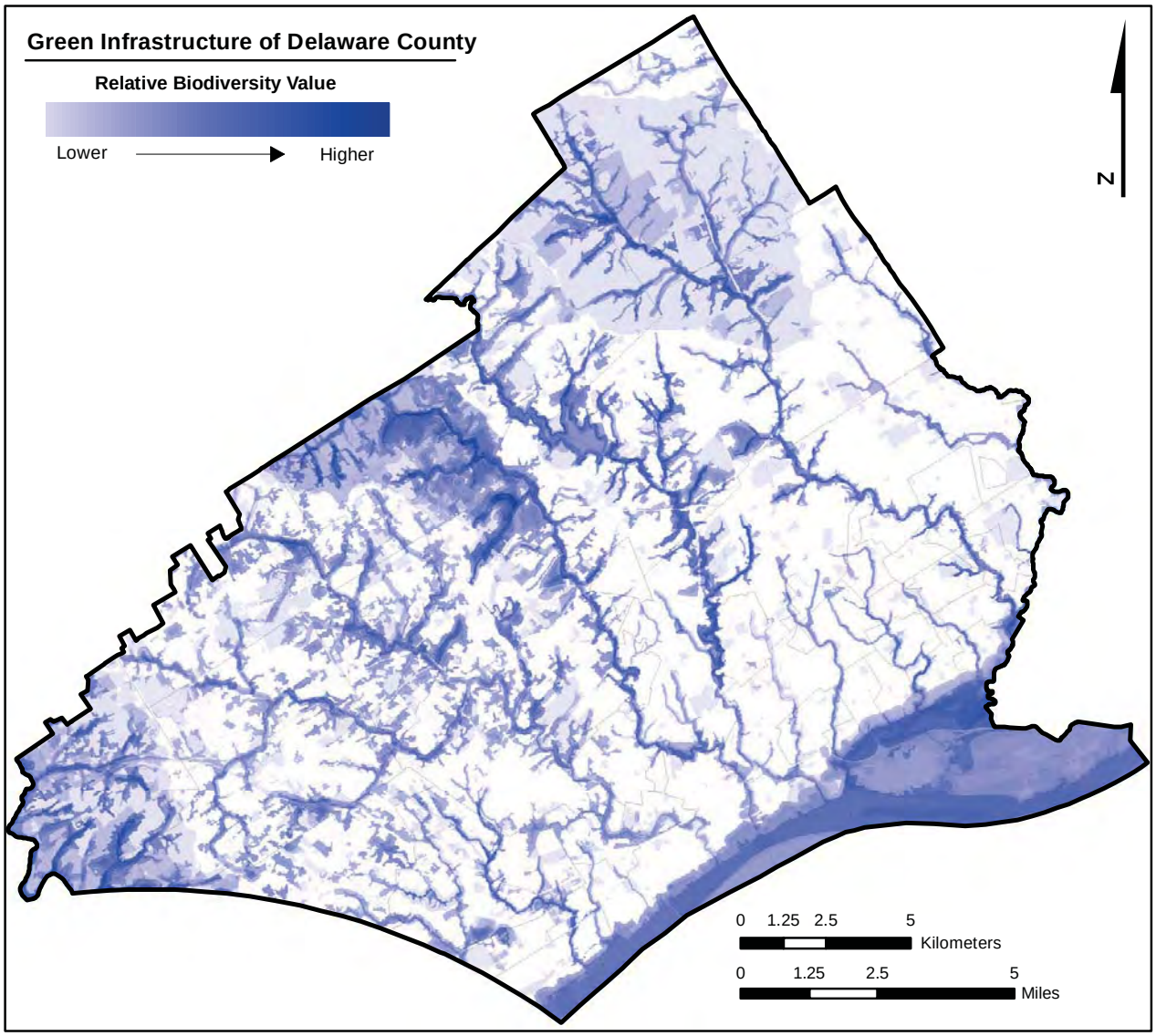


Landscape Analysis Results:

While all of the natural habitats within the County contribute to the overall health of the County's ecological systems, the highest priority natural habitats and the potential connections between them become evident by combining the landscape features discussed above.

The map below indicates the potential natural value of all areas within the County. Darker colors indicate a higher relative ecological value that lighter colors. The highest priority habitats in the County include the Delaware River tidal shoreline, including Little Tinicum Island and John Heinz National Wildlife Refuge Ridley Creek State Park, and the riparian corridors and adjacent forested uplands associated with Brandywine Creek, Chester Creek, and Crum Creek.

The primary connecting features within the County are the contiguous forested areas and the network of streams and rivers in the County. Many streams will require restoration of the riparian buffer area to fully function as habitat and migratory corridors within the County.



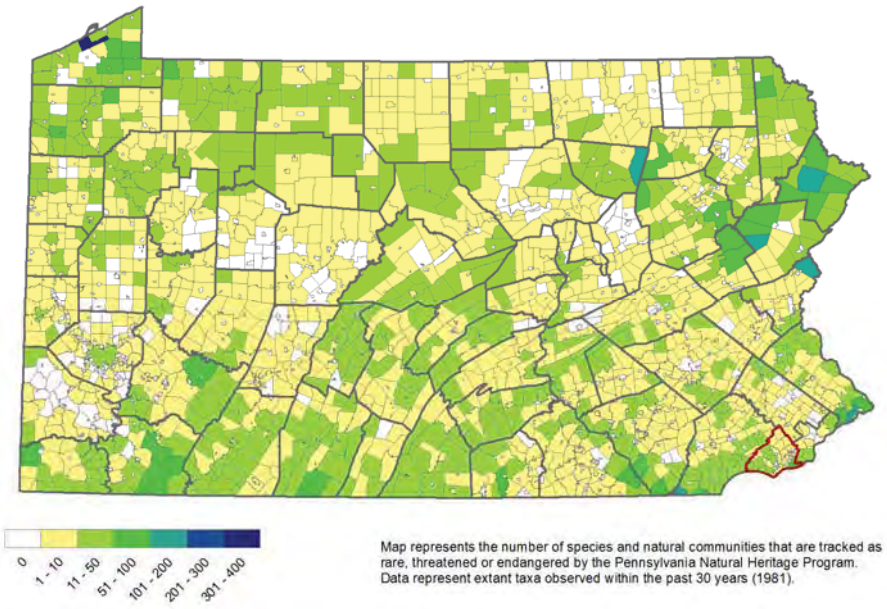
Discussion and General Recommendations

For this County Natural Heritage Inventory Report, the ecologists, zoologists, and botanists of the Pennsylvania Natural Heritage Program and partner organizations have explored the natural resources of Delaware County. This work represents an organized effort to inventory the biodiversity present throughout the County. Earlier survey work in this area was completed by botanists and other naturalists over the past several centuries. Records from these early explorers provided the baseline for this report.

Delaware County's contribution to biodiversity in Pennsylvania

Delaware County has 215 individual occurrences of species tracked by PNHP, including those listed as endangered, threatened, and rare species; it falls 19th out of the Commonwealth's 67 counties. The map below shows the distribution of these species by municipality across the Commonwealth.

Despite extensive land use changes in this heavily developed portion of the state Delaware County contains a significant number of rare species and communities that represent an important part of the Commonwealth's biodiversity. Two of these, bog turtle, and serpentine aster, are considered globally rare.



Future natural resource research in Delaware County

Though many hours of field research over multiple years were undertaken for this inventory, this is not a comprehensive, final word on Delaware County's natural resources. The data in this report represents a snapshot of Delaware County's natural resources at the time the report was written. Any further work in the County will likely yield additional records of species of concern while future land use changes may result in the extirpation of species documented in this report. This is partially due to the fact that natural systems are dynamic and constantly changing due to natural and human induced pressures. Also, sites were surveyed only when landowner permission was granted and access to some exemplary sites was restricted. Additional survey efforts are encouraged for these reasons. The PNHP sees this report as a working document – a guide for conservation of known rare, threatened, and endangered species, their habitats, and other resources of conservation importance in Delaware County.

Submitting Additional Data

As the state repository for biodiversity data, the Pennsylvania Natural Heritage Program appreciates all potential data regarding rare, threatened, and endangered species and potential survey sites. Species we currently track are listed on our website at: http//www.naturalheritage.state.pa.us/

A series of biodiversity and conservation planning services are available through the PNHP to supplement the results of this inventory. Please contact the Pennsylvania Natural Heritage Program for additional information regarding these services (http://www.naturalheritage.state.pa.us/).

A Final Note on Rare, Threatened, and Endangered Species

The rare, threatened, and endangered species highlighted in this report are some of the several hundred species in Pennsylvania that are threatened with extirpation or extinction. If a species becomes extinct, or is lost from a portion of its native range, the ecosystem in which it lived will lose an important element. Often the repercussions of extinctions are not known until the species is gone, and the species is generally irreplaceable in the system. This may be because the habitat has been altered to the point that the biological system no longer functions properly. Species of concern are often indicative of fragile ecosystems that easily degrade; their protection may help monitor the quality of Delaware County's ecosystems. A great example of a species of concern acting as an indicator of environmental quality is the bald eagle - a species which indicated the deleterious effects of the pesticide DDT in our environment. Banning DDT led to the eventual recovery of the species.

Another reason for protecting species of concern is for their value as unique genetic resources. Every species may provide significant information for future use in genetic research and medical practices. Beyond these practical considerations, perhaps the most compelling reasons for stewardship are the aesthetic and ethical considerations; there is beauty and recreational value inherent in healthy, species-rich ecosystems. The protection of rare, threatened, and endangered species depends on several factors, including increasing scientific knowledge and concerted efforts from government agencies, conservation organizations, educational institutions, private organizations, and individuals. The following section outlines general recommendations to begin to protect the species outlined in this report

Using the Natural Heritage Inventory in the Delaware County Planning Process

One of the main roles of this document is to integrate ecological and conservation information into the planning process. Through early integration, costly conflicts with rare, threatened and endangered species can be avoided and these resources can be protected for future generations. Comprehensive land use planning and its related ordinances can be effective tools for the conservation of Delaware County's biological diversity.

Land use planning establishes guidelines for the kinds of land uses that are suitable in an area and provides a basis for guiding public and private development to benefit communities, the local economy and the environment. Zoning and subdivision ordinances then set out rules that implement the land use plan. Planning, zoning and subdivision ordinances are not only valuable tools for urban and suburban areas where development pressures have already affected the use of open space and the integrity of the natural environment, but also for rural areas where current losses are less pronounced. These areas can apply planning to avoid the haphazard losses of valuable regional resources, while still achieving desirable levels of development. The following is a brief overview on land use tools available in Delaware County as well as a brief commentary of their relevance to the NHI:

- Comprehensive Plan - Delaware County is currently in the process of preparing a comprehensive plan. All of Delaware County's municipalities have individual comprehensive plans, some of which are several years old. The County should integrate information from this report into its new comprehensive plan, specifically in sections that involve development, natural resources, recreation, and open space. Municipalities should also consider integrating this information into their comprehensive plans and future updates.
- Zoning – All of Delaware County's municipalities currently have zoning ordinances and are encouraged to integrate Natural Heritage information into their zoning process. Zoning maps can be potentially amended to reflect conservation measures to help preserve Natural Heritage Areas presented in this report.
- Subdivision and Land Development Ordinances (SALDO) – SALDOs can be used as a conservation tool to draw attention to Natural Heritage Inventory information. Many Delaware County municipalities have their own SALDOs, and the County has a new SALDO currently being prepared

that will cover municipalities without their own. Both the County and the municipalities should consider incorporating a requirement that any CNHI areas identified in this report to be noted on subdivision and land development plans. The ordinance could also require developers to address potential impacts of their development on the resource/s.

Natural Heritage Areas identified in the County Natural Heritage Inventory reports have been used to form the backbone of many plans for Greenway and Open Space networks in the Commonwealth. After completion of the Greenway the CNHI should be further consulted for site-level planning and trail alignments as it can help decided the best compatibility of the resource with the designated use. Although many of the Natural Heritage Areas outlined in this report will likely be integrated into a greenway plan, additional planning and protection will ensure the viability of the conservation elements present at the site.

Planning for the land use decisions of today and those of the future is an important task and this Natural Heritage Inventory can serve as a useful tool. Pennsylvania Natural Heritage Program staff and expertise are available for additional technical assistance and planning for the conservation of these sites.

General Recommendations

The following are general recommendations for the protection of the Natural Heritage Areas within Delaware County. Approaches to protecting a Natural Heritage Area are wide ranging, and factors such as land ownership, time constraints, and tools and resource availability should be considered when prioritizing protection of these sites. Prioritization works best when incorporated into a long-term county or region-wide plan. Opportunities may arise that do not conform to a plan, and the decision on how to manage or protect a natural heritage area may be made on a site by site basis. Keep in mind that personnel in the Pennsylvania Natural Heritage Program and staff from state natural resource agencies are available to discuss more specific options for preservation. The following are approaches and recommendations for natural heritage area conservation.

1. **Consider conservation initiatives for natural heritage areas on private land.**
   Conservation easements protect land while leaving it in private ownership. An easement is a legal agreement between a landowner and a conservation or government agency that permanently limits a property's use in order to protect its conservation values. It can be tailored to the needs of both the landowner and the conservation organization, and will not be extinguished with new ownership. Tax incentives may apply to conservation easements donated for conservation purposes.

   Lease and management agreements also allow the landowner to retain ownership and temporarily ensure protection of land. There are no tax incentives for these conservation methods. A lease to a land trust or government agency can protect land temporarily, and ensure that its conservation values will be maintained. This can be a first step to help a landowner decide if they want to pursue more permanent protection methods. Management agreements require landowners and land trusts to work together to develop a plan for managing resources (such as plant or animal habitat, watersheds, forested areas, or agricultural lands) with the land trust offering technical expertise.

   Land acquisition by a conservation organization can be at fair market value or as a bargain sale where a purchase price is set below fair market value with tax benefits that reduce or eliminate the disparity. One strategy is to identify areas that may be excellent locations for new county or township parks. Sites that can serve more than one purpose such as wildlife habitat, flood and sediment control, water supply, recreation, and environmental education are ideal. Private lands adjacent to public lands should be examined for acquisition when a natural heritage area is present on either property, and there is a need of additional land to complete protection of the associated natural features.

   Fee simple acquisition is when a buyer purchases land outright, and has maximum control over the use and management of the property and its resources. This conservation initiative is appropriate

when the property's resources are highly sensitive, and protection cannot be guaranteed using other conservation approaches.

Unrestricted donations of land are welcomed by land trusts. The donation of land entitles the donor to a charitable deduction for the full market value, as well as a release from the responsibility of managing the land. If the land is donated because of its conservation value, the land will be permanently protected. A donation of land that is not of high biological significance may be sold, with or without restrictions, to a conservation buyer, and the funds used to further the land trust's conservation mission.

Land Trusts working in the Delaware County region: The Pennsylvania Land Trust Association website offers a search engine to find land trusts (http://conserveland.org). The primary land trusts operating in the Delaware County region include:

Brandywine Conservancy (http://www.brandywineconservancy.org/)
Delaware Nature Society (http://www.delawarenaturesociety.org/).
Heritage Conservancy **(**www.heritageconservancy.org**)**
Natural Lands Trust **(**www.natlands.org**)**
Radnor Conservancy **(**www.radnorconservancy.org**)**.
Willistown Conservation Trust **(**www.wctrust.org**)**

Local zoning ordinances are one of the best-known regulatory tools available to municipalities. Examples of zoning ordinances a municipality can adopt include: overlay districts where the boundary is tied to a specific resource or interest such as riverfront protection and floodplains, and zoning to protect stream corridors and other drainage areas using buffer zones. Often it is overlooked that zoning can prevent municipal or county-wide development activities which are undesirable to the majority of the residents, and allow for planning that can meet the goals of the county residents.

2. **Prepare management plans that address species of concern and natural communities.** Many of the natural heritage areas that are already protected are in need of additional management plans to ensure the continued existence of the associated natural elements. Site-specific recommendations should be added to existing management plans, new plans should be prepared. Recommendations may include: removal of invasive plant species; leaving the area alone to mature and recover from previous disturbance; creating natural areas within existing parks; limiting land-use practices such as mineral extraction, residential or industrial development, and agriculture; or implementing sustainable forestry practices. For example, some species simply require continued availability of a natural community while others may need specific management practices such as canopy thinning, mowing, or burning to maintain their habitat requirements.

   Existing parks and conservation lands provide important habitat for plants and animals at both the county level and on a regional scale. For example, these lands may serve as nesting or wintering areas for birds or as stopover areas during migration. Management plans for these areas should emphasize a reduction in activities that fragment habitat. Adjoining landowners should be educated about the importance of their land as it relates to habitat value, especially for species of concern, and agreements should be worked out to minimize activities that may threaten native flora and fauna.

3. **Protect bodies of water.**
   Protection of reservoirs, wetlands, rivers, and creeks is vital for ensuring the health of human communities and natural ecosystems; multiple qualities can be preserved by protecting aquatic habitats which harbor biodiversity, supply drinking water, and provide recreational resources. Many rare species, unique natural communities, and locally significant habitats occur in wetlands and water bodies; these are directly dependent on natural hydrological patterns and water quality for their continued existence. Ecosystem processes also provide clean water supplies for human communities and do so at significant cost savings in comparison to water treatment facilities; therefore, protection of high quality watersheds is the only way to ensure the viability of natural habitats and water quality. Scrutinize development proposals for their impact on entire watersheds, not just the immediate

project area. Cooperative efforts in land use planning among municipal, county, state, and federal agencies, developers, and residents can lessen the impact of development on watersheds.

4. **Provide for buffers around natural heritage areas.**
Development plans should provide for natural buffers between disturbances and natural heritage areas. Disturbances may include construction of new roads and utility corridors, non-sustainable timber harvesting, and fragmentation of large pieces of land. Storm runoff from these activities results in the transport of nutrients and sediments into aquatic ecosystems (Trombulak and Frissell, 2000). County and township officials can encourage landowners to maintain vegetated buffer zones within riparian zones. Vegetated buffers (preferably of Pennsylvania native plant species) help reduce erosion and sedimentation while shading and cooling the water. Preserving water quality in rivers and streams is important to fish as some species, such as brook trout and some darters, are highly sensitive to poor water quality. Sensitive fish are readily lost from streams when water quality starts to decline. Creating or maintaining a vegetated buffer benefits aquatic animal life, provides habitat for other wildlife species, and creates a diversity of habitats along the creek or stream. Staff at the Pennsylvania Natural Heritage Program (PNHP) or natural resources agencies can provide further guidance regarding buffer considerations appropriate for various kinds of natural resources.

   Waterways that include natural heritage areas, identified in the *Results* section of this report, are important, sensitive areas that should be protected. For example, conserving natural areas around watersheds that supply municipal water provides an additional protective buffer around the water supply, maintains habitat for wildlife, and may also provide (low impact) recreation opportunities.

5. **Reduce fragmentation of the landscape surrounding natural heritage areas.**
Encourage development in sites that have already seen past disturbances (especially mined and heavily timbered areas). Care should be taken to ensure that protected natural areas do not become islands surrounded by development. In these situations, the site is effectively isolated, and its value for wildlife is greatly reduced. Careful planning can maintain natural environments along with the plants and animals associated with them. A balance between growth and the conservation of natural and scenic resources can be achieved by guiding development away from the most environmentally sensitive areas.

   The reclamation of previously disturbed areas for commercial and industrial projects, also known as *brownfield development*, presents one way to encourage economic growth while allowing ecologically sensitive areas to remain undisturbed. For example, reclaimed surface mines can be used for development (potentially even wind development) when feasible. Cluster development can be used to allow the same amount of development on much less land, and leave the remaining land intact for wildlife and native plants. By compressing development into already disturbed areas with existing infrastructure (villages, roads, existing rights-of-way), large pieces of the landscape can be maintained intact. If possible, networks or corridors of woodlands or greenspace should be preserved linking natural areas to each other. Preserving greenspace around development can provide ample recreation opportunities, and potentially increase nearby property value.

6. **Encourage the formation of grassroots organizations.**
County and municipal governments can do much of the work necessary to plan for the protection and management of natural areas identified in this report; however, grassroots organizations are needed to assist with obtaining funding, identifying landowners who wish to protect their land, and providing information about easements, land acquisition, management, and stewardship of protected sites. Increasingly, local watershed organizations and land trusts are taking proactive steps to accomplish conservation at the local level. When activities threaten to impact ecological features, the responsible agency should be contacted. If no agency exists, private groups such as conservancies, land trusts, and watershed associations should be sought for ecological consultation and specific protection recommendations.

7. **Manage for invasive species.**
Invasive species threaten native diversity by dominating habitat used by native species and by disrupting the integrity of the ecosystems they occupy. Management for invasive species depends upon the extent of their establishment. Small infestations may be easily controlled or eliminated but larger, well established populations typically present difficult management challenges. The earlier exotic invasive species are identified and controlled, the greater the likelihood of eradication with the smallest expenditure of resources. Below is a list of sources for invasive species information.

The *Mid-Atlantic Exotic Plant Pest Council* (MA-EPPC) is a non-profit organization (501c3) dedicated to addressing the problem of invasive exotic plants and their threat to the Mid-Atlantic region's economy, environment, and human health by providing leadership, representing the mid-Atlantic region at national meetings and conferences, monitoring and disseminating research on impacts and controls of invasives, facilitating information development and exchange, coordinating the on the ground removal of invasives, and providing access to training on species identification and management. Information is available at http://www.ma-eppc.org.

Several excellent websites exist to provide information about invasive exotic species. The following sources provide individual species profiles for the most troublesome invaders, with information such as the species' country of origin, ecological impact, geographic distribution, and control techniques.

- The Nature Conservancy's Weeds on the Web at http://tncinvasives.ucdavis.edu/
- The Virginia Natural Heritage Program's invasive plant page at http://www.dcr.virginia.gov/natural_heritage/invspinfo.shtml
- The Missouri Department of Conservation's Missouri Vegetation Management Manual at http://mdc.mo.gov/nathis/exotic/vegman/
- U.S. Department of the Interior, National Park Service invasive species monitoring resources at http://www.nature.nps.gov/biology/invasivespecies/ or http://science.nature.nps.gov/im/monitor/invasives/
- Invasive species information clearinghouse listing numerous other resources on a variety of related topics at http://www.invasivespeciesinfo.gov/

INTRODUCTION

This project is a comprehensive update to the earlier Delaware County Natural Areas Inventory project of 1992 and the subsequent data review update of 1998. This current project was initiated to relocate previously known species of concern (those considered at risk of local or global extinction), to identify additional habitats supporting species of concern, and to provide conservation recommendations to help ensure their continued survival within the County. In addition to the habitats for species of concern, an emphasis has been on identifying and ranking other green spaces for their individual contribution towards the overall ecological continuity within the county and the southeastern Pennsylvania region.

The ability of a community to fulfill its vision for the future depends on its capacity to assemble information that will enable it to act effectively and wisely. Since 1989, County Natural Heritage Inventories (CNHIs) have served as a way to both gather and pass along new and existing information to those responsible for land use decisions, as well as to all residents who wish to know more about the natural heritage of their county. The Delaware County Natural Heritage Inventory focuses on the best examples of living ecological resources and outstanding natural features in the county. The Western Pennsylvania Conservancy (WPC) served as the principal investigator, prepared the report, and created the maps for this study. The Pennsylvania Natural Heritage Program (PNHP), of which WPC is a partner, is responsible for collecting, tracking, and interpreting information regarding the Commonwealth's biological diversity.

A healthy natural environment is essential to human health and sustenance. A healthy environment provides clean air and water; supports fish, game and agriculture; and furnishes renewable sources of materials for countless aspects of our livelihoods and economy. In addition to these direct services, a clean and healthy environment plays a central role in our quality of life, whether through its aesthetic value (found in forested ridges, mountain streams and encounters with wildlife), or in the opportunities it provides for exploration, recreation, and education. Finally, a healthy natural environment supports economic growth by adding to the region's attractiveness as a location for new business enterprises, and provides the basis for the recreation, tourism, and forestry industries, all of which have the potential for long-term sustainability. Fully functional ecosystems are the key indicators of a healthy environment and working to maintain ecosystems is essential to the long-term sustainability of our economies.

Planning for long-term sustainability can maintain open space, including natural environments and the plants and animals associated with them. Using this County Natural Heritage Inventory as a conservation tool can steer development away from environmentally sensitive areas, creating a needed balance between growth and the conservation of scenic and natural resources. It is important that the county and municipal governments, the public, developers and planners know the location of such environmentally sensitive areas in order to maintain and protect these areas. Knowing where these areas are located can help prevent potential land use conflicts, and help focus conservation efforts and limited funds on the most vulnerable areas. The Pennsylvania Natural Heritage Program, in cooperation with the Delaware County

Natural Heritage Inventories and Environmental Review

The results presented in this report represent a snapshot in time, highlighting the sensitive natural areas within Delaware County. The sites in the Delaware County Natural Heritage Inventory have been identified to help guide land use and county planning. The Delaware County Natural Heritage Inventory is a planning tool, but is *not* a substitute for environmental review, as information is constantly being updated as natural resources are both destroyed and discovered. Applicants for building permits and Planning Commissions can conduct free, online, environmental reviews to inform them of project-specific potential conflicts with sensitive natural resources. Environmental reviews can be conducted by visiting the Pennsylvania Natural Heritage Program's website, at http://www.naturalheritage.state.pa.us/. If conflicts are noted during the environmental review process, the applicant is informed of the steps to take to minimize negative effects on the county's sensitive natural resources. If additional information on species of concern becomes available during environmental review, the review may be reconsidered by the jurisdictional agency.

Planning Department, has undertaken this project to provide a document and maps that will aid in the identification of these important areas.

The Delaware County Natural Heritage Inventory represents the known outstanding natural features, including plants, animals, and natural communities in Delaware County. The inventory provides maps of the best natural communities (habitats) and the locations of animal and plant species of concern (rare, threatened, and endangered) in Delaware County. These maps do not pinpoint the exact location of the species of concern but rather represent a conservation zone that is critical to the preservation of the site (core habitat), and a zone of potential impacts within the site's watershed (supporting landscape) where applicable. A written description including threats and disturbances, conservation recommendations, and a summary table of the species of concern, including degree of rarity, last-observed date, and quality rank accompany each map. Potential threats and stresses, and suggestions for protection of the rare communities, plants, or animals at the site are included in the individual site descriptions. In addition, the inventory describes areas that are ecologically significant, but do not support currently known populations of species of concern. These areas were highlighted because of the function they provide in supporting general biodiversity at the county or local scale. These areas may represent relatively large forested areas or wetlands, or host a high degree of native biodiversity. Many of these sites were not surveyed during the field season due to time or access constraints. These sites are representative of habitats that are relatively rare in the county, support an uncommon diversity of species, and/or provide particularly valuable wildlife habitat.

The information and maps presented in this report provide a useful guide for planning residential and commercial developments, recreational parks or trails, for conserving natural areas, and for setting priorities for the preservation of the most vulnerable natural areas. An overall summary identifies the highest quality sites in the County. All of the sites in this report were evaluated for their importance in protecting biological diversity on a state and local level, but many also have scenic value, provide water quality protection, and are potential sites for low-impact passive recreation, nature observation, and/or environmental education.

The Delaware County Natural Heritage Inventory will be made available to each municipality through the Delaware County Planning Department. The Inventory is a conservation tool that will aid in the creation of municipal, county, and comprehensive plans. Its emphasis on biological diversity should inform County and regional open space plans already underway, or updates to those plans already completed. Delaware County, its municipalities, land trusts, and other organizations can also use the County Natural Heritage Inventory to identify potential protection projects that may be eligible for funding through state or community grant programs.

Landowners will also find this inventory useful in managing and planning for the use of their land; it gives them the opportunity to explore alternatives that will provide for their needs and still protect the species and habitats that occur on their land. For example, the Forest Stewardship Program, coordinated by the Pennsylvania Department of Conservation and Natural Resource's Bureau of Forestry, assists landowners in creating management plans. These plans incorporate landowner objectives (e.g. wildlife or timber management). Other programs include the USDA's Forest Legacy Program and the Pennsylvania Department of Agriculture's Agricultural Land Preservation Program (Appendix I). Land managers may wish to consult with this report and the environmental review tool found on the Pennsylvania Natural Heritage Program's website (www.naturalheritage.state.pa.us) in an effort to avoid potential conflicts in areas with species of concern and/or identify ways of enhancing or protecting these resources. Users of this document are encouraged to contact the Middletown office of the Pennsylvania Natural Heritage Program at (717) 948-3962 for additional information.

Primer on Biodiversity

An **ecosystem** is the complex of interconnected living organisms inhabiting a particular area or unit of space, together with their environment and all their interrelationships and relationships with the environment (Ostroumov 2002). All the parts of an ecosystem are interconnected, the survival of any species or the continuation of a given natural process depends upon the system as a whole, and in turn, these species and processes contribute to maintaining the system. An important consideration in assessing ecosystem health is the concept of biodiversity. **Biodiversity** can be defined as the full variety of life that occurs in a given place, and is measured at several scales: genetic diversity, species, natural communities, and landscapes.

Genetic diversity refers to the variation in genetic makeup between individuals and populations of organisms and provides a species with the ability to adapt successfully to environmental changes. In order to conserve genetic diversity, it is important to maintain natural patterns of gene flow through the migration of individual plants and animals across the landscape and the dispersal of pollen and seeds among populations (Thorne et al. 1996). Individual **species** play a role in sustaining ecosystem processes such as nutrient cycling, decomposition, and plant productivity; declines in native species diversity alter these processes (Naeem et al. 1999).

A **natural community** is an interactive assemblage of plant and animal species that share a common environment and occur together repeatedly on the landscape, such as a red maple swamp (Massachusetts Executive Office of Environmental Affairs 2001). Each type of natural community represents habitat for a different assemblage of species, hence identification and stewardship of the full range of native community types is needed to meet the challenge of conserving habitat for all species.

From an ecological perspective, a **landscape** is a large area of land that includes a mosaic of natural community types and a variety of habitats for many species (Massachusetts Executive Office of Environmental Affairs 2001). At this scale, it is important to consider whether communities and habitats are isolated or connected by corridors of natural landscape traversable by wildlife, and whether the size of a natural landscape is sufficient to support viable populations and ecosystems. Because the living and non-living elements of an ecosystem are interconnected and interdependent, it is essential to conserve native biodiversity at all of these scales, from genes through landscapes, if ecosystems are to continue functioning.

Pennsylvania's natural heritage is rich in biodiversity and the Commonwealth includes many examples of high quality natural communities and large expanses of natural landscapes. Over 20,000 species are known to occur in the state, and the extensive tracts of forest in the northern and central parts of the state represent a large portion of the remaining areas of suitable habitat in the mid-Atlantic region for many forest-dependent species of birds and mammals. Unfortunately, biodiversity and ecosystem health are seriously threatened in many parts of the state by pollution and habitat loss. Of all the animals and vascular plants that have been documented in the state, more than one in ten are imperiled; 156 have been lost entirely since European settlement and 351 are threatened or endangered (Pennsylvania 21st Century Environment Commission 1998). Many of these species are imperiled because available habitat has been reduced and/or degraded.

Fifty-six percent of Pennsylvania's wetlands have been lost or substantially degraded by filling, draining, or conversion to ponds (Dahl 1990). According to the Pennsylvania Department of Environmental Protection (DEP), sixty percent of those Pennsylvania lakes that have thus far been assessed for biological health are listed as impaired. Of 83,000 miles of streams in Pennsylvania, almost 70,000 miles has been assessed for water quality. From this, nearly 11,000 miles have been designated as impaired due to abandoned mine discharges, acid precipitation, and agricultural and urban runoff (PA DEP 2004). The species that depend on these habitats are correspondingly under threat: 58 percent of threatened or endangered plant species are wetland or aquatic species; 13 percent of Pennsylvania's 200 native fish species have been lost, while an additional 23 percent are imperiled. Among freshwater mussels, one of the most globally imperiled groups of organisms, 18 of

Pennsylvania's 67 native species are extirpated (meaning locally extinct) and another 22 are imperiled (Goodrich et al. 2003).

Prior to European settlement, over ninety percent of Pennsylvania's land area was forested. Today, sixty percent of the state is still forested, but much of this forest is fragmented by roads, utility rights-of-way, agriculture, and development. Only fourty-two percent is interior forest habitat; meaning that some of the species that depend upon interior forest habitat are in decline (Goodrich et al. 2003). In addition to habitat fragmentation, forest pests, acid precipitation (which causes nutrient leaching and stunted growth), overbrowsing by deer and invasive species also threaten forest ecosystem health.

The Pennsylvania Natural Heritage Program (PNHP) in cooperation with the Pennsylvania Biological Survey (PABS) assesses the conservation status of species of vascular plants, vertebrates, and a few of the invertebrate groups native to Pennsylvania. While Pennsylvania hosts a diversity of other life forms, such as mosses, lichens and fungi, and most insects, too little information is known of these species to assess their conservation status at this time. Without information about all of the species, it is possible to protect at least some rare species by conserving rare natural communities. Species tend to occur in specific habitats or natural communities, and by conserving examples of all natural community types we will also conserve many of the associated species, whether or not we even know what those species are. Thus, the natural community approach is a coarse filter for broad scale biodiversity protection, while the fine filter approach is used for those individual species for which it is feasible.

The goals of this report are to identify areas important in sustaining biodiversity at the species, natural community, and landscape levels and to provide that information to more fully inform land use decisions. County Natural Heritage Inventories (CNHIs) identify areas in the state that support Pennsylvania's rare, threatened, or endangered species as well as natural communities that are considered to be rare in the state or exceptional examples of the more common community types. A description of each area's natural features and recommendations for maintaining their viability are provided. Also, in an effort to provide information focused on planning for biodiversity conservation, this report includes species and natural community fact sheets, references, and links to information on invasive exotic species, and information from other conservation planning efforts such as the Pennsylvania Audubon's Important Bird Area project. Together, with the other land use information, this report can help guide the planning and land management necessary to maintain the ecosystems on which our natural heritage depends.

County Overview

History

The lands of Delaware County have hosted European settlements since the early 1600's, and Native American tribes long before then. Pennsylvania came into existence with William Penn's charter in 1681. Delaware County was split from the existing Chester County on September 26, 1789. Covering a little over 191 square miles, Delaware County is the third-smallest county in Pennsylvania, but one of the most populated with over 550,000 citizens per the 2000 census. Because of its small size and high population, Delaware County is the second-most densely populated county in the Commonwealth, behind only Philadelphia.

When the first Europeans stood at the edge of Penn's Woods, they encountered a wilderness so vast, deep and impenetrable that it instilled in many of them a sense of dread. Little by little the wilderness of Delaware County was transformed, first to agricultural then to suburban and urban uses. The existing land use patterns within the County have been largely influenced and shaped by the region's natural features such as the location of arable soils, steep slopes, deep valleys, wetlands, and waterways. Like most of southeastern Pennsylvania, very little of Delaware County's landscape has been left in a "natural" state.

Delaware County can be divided into three distinct regions: agricultural, suburban, and industrial, based on the prevalent land use in each region. The gradual settling of the County was at first oriented towards farming of the easily accessible tidal marshes. These marshes were gradually drained, filled, and developed to become the industrial waterfront associated with the city of Chester. The primeval forests were gradually replaced by ever expanding farmland that provided food and resources to the burgeoning population centers of Philadelphia and Wilmington. Existing forested areas and wood lots in the County are second, third, or even fourth growth trees from the time the virgin forests were first cut. Most of the relatively flat, fertile land in the western part of the County was converted to agricultural production long ago. Farms often represent many generations of cultural heritage and some farms contain a natural component or are adjacent to a natural area.

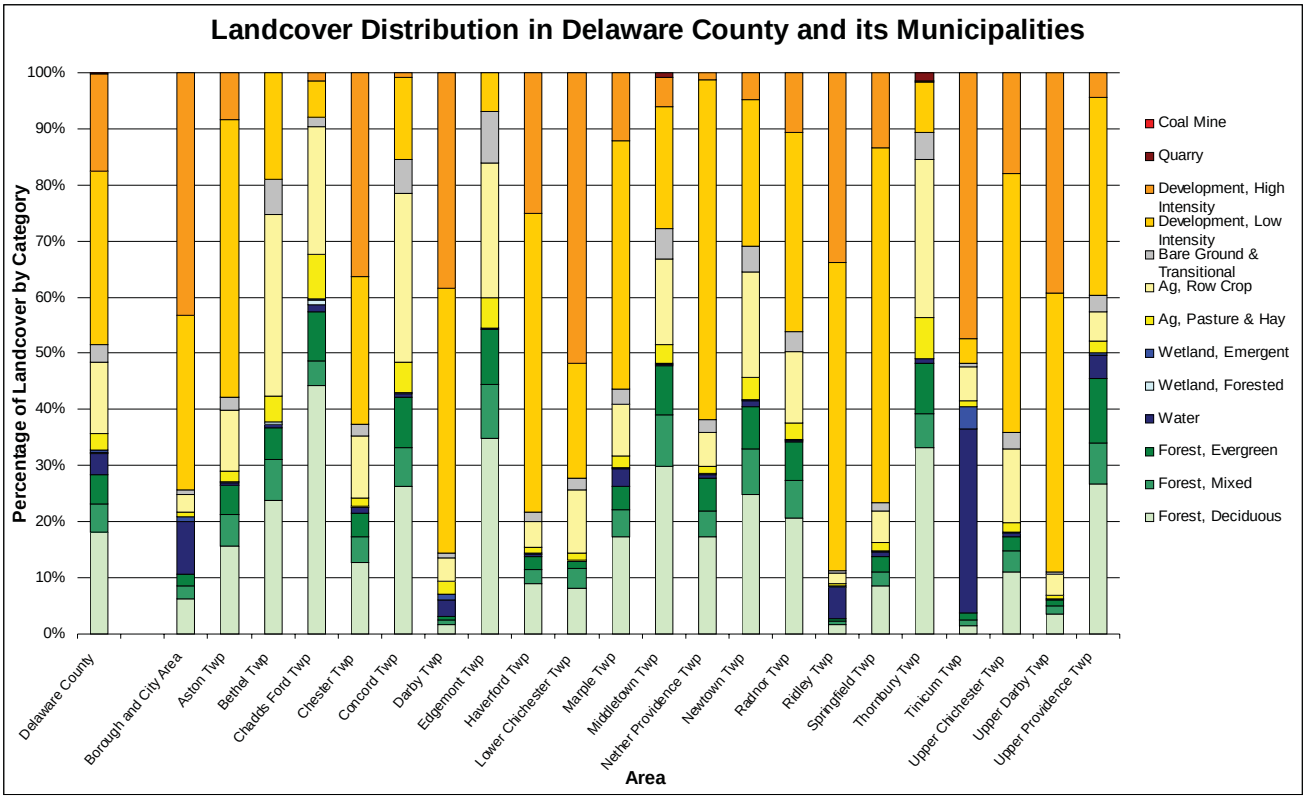
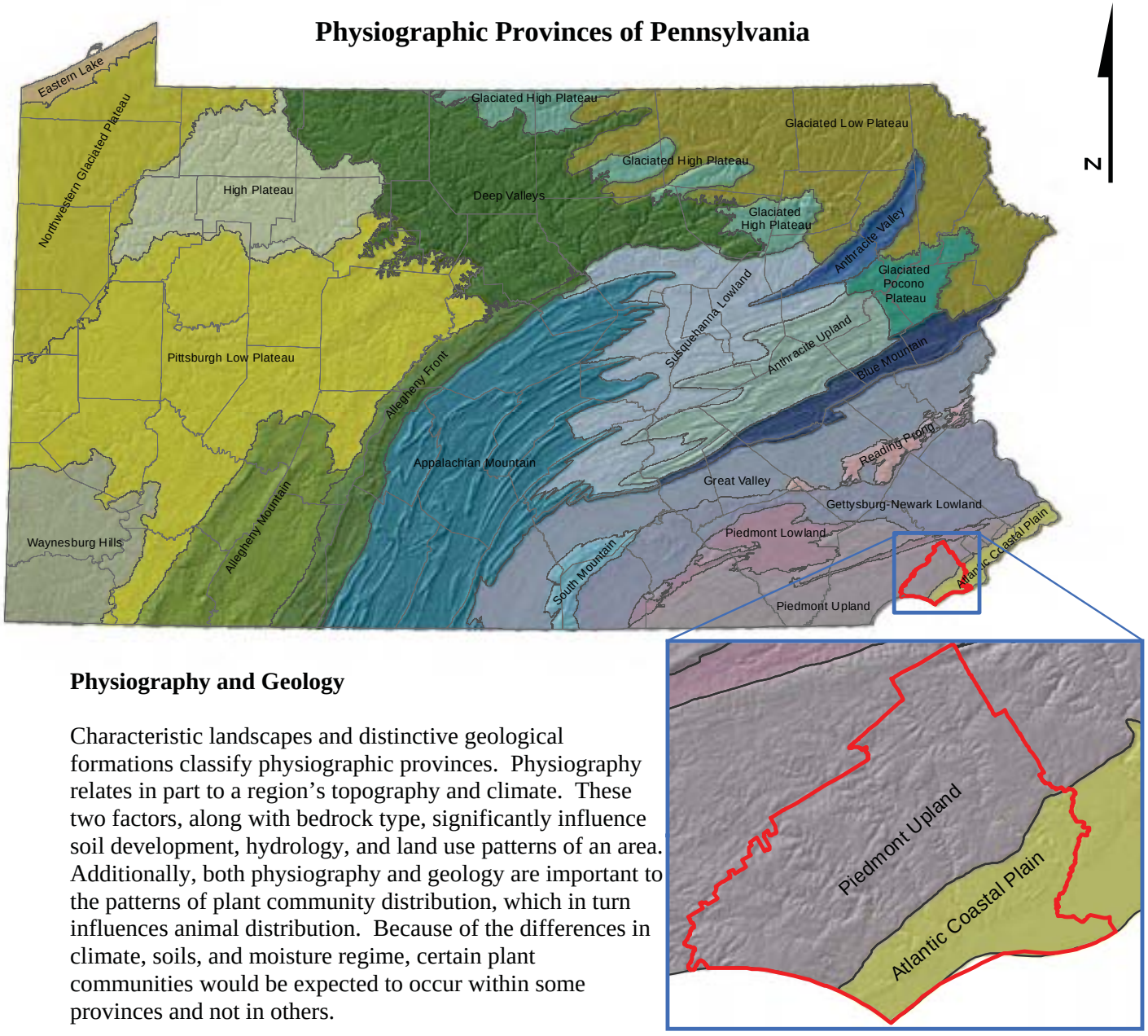


Figure 1: The land cover of Delaware County.

The slow, gradual development of the region is etched in the many small towns with abundant examples of historic architecture. While development patterns in earlier centuries had favored condensed population centers surrounded by agricultural landscapes, the later half of the 20th century has witnessed a much more widely dispersed population through an explosion of lower density housing aided by the automobile and its associated tangle of highways. Over time, much of the farmland of the County has been replaced by development of one sort or another, leaving a patchwork of urban and suburban development interspersed with relatively small patches of agricultural land and woodlots. Those areas that have been left with natural vegetation are typically those areas that were initially too steep, wet or stony to plow. These undeveloped lands are the primary locations for the native plants and animals of the County including those considered rare, threatened, or endangered at the state or federal level. The areas that comprise the natural heritage of Delaware County can be easily lost without careful planning of growth and development. Ironically, the scenic nature of these areas may make them prime targets for residential developments. Protecting the integrity of these natural systems provides benefits to humans as well as providing for the survival of all flora and fauna, both common and rare.

Physiographic Provinces of Pennsylvania



Physiography and Geology

Characteristic landscapes and distinctive geological formations classify physiographic provinces. Physiography relates in part to a region's topography and climate. These two factors, along with bedrock type, significantly influence soil development, hydrology, and land use patterns of an area. Additionally, both physiography and geology are important to the patterns of plant community distribution, which in turn influences animal distribution. Because of the differences in climate, soils, and moisture regime, certain plant communities would be expected to occur within some provinces and not in others.

Delaware County lies within two distinct physiographic provinces. Different provinces generally support different suites of species because of the characteristics of the landscape. These characteristics are based upon the topography and geologic structure of the landscape along with the history of land use within a province containing a set of characteristics significantly different from the characteristics of adjacent provinces.

<u>Piedmont Upland</u>

This province is composed of rolling hills surrounding around wide valleys, with the hills somewhat taller and steeper and the streams less wander-prone in their valleys than the adjacent province. A good example in this area is the Ridley Creek valley. The geologic structure is primarily a metamorphic rock called schist that does not have the water absorption properties or mineral content of the limestone karst found in the Piedmont Lowland physiographic province to the north. The lowlands of this area still contain deep soils that provide

excellent opportunities for agriculture, though to a lesser degree than the Piedmont Lowlands. This physiographic province stretches from near the Delaware River in Bucks County to the Adams-York Counties line.

Atlantic Coastal Plain

Referred to as the *Lowland and Intermediate Upland Section of the Atlantic Coastal Plain Province,* this area is characterized by two distinct areas: an upper flat terrace composed of sand and gravel derived from weathered metamorphic rocks, and the floodplain of the Delaware River, composed of deep alluvial sediments. The sand and gravel of this area allow for quick drainage to the water table in areas that are not covered with impermeable surfaces; a large portion of this province has been developed. This province is dissected by numerous short, narrow, steep-walled stream valleys in the terrace area that widen out as they enter the Delaware River floodplain. Darby Creek is a good example of this, with a much narrower valley upstream widening out as it approaches Tinicum Marsh and the Delaware River. A large portion of this province is near or at sea level and once supported extensive tidal marshlands.

Bedrock and Soils

Many of the soils of Delaware County are highly disturbed from the processes that cleared the land, and through farming, infill, excavation, and development. These soils are simply characterized as "Urban Land" meaning that the land is developed to the point that determining the underlying soil is impractical. This makes characterizing some of them in the traditional manner used by the US Department of Agriculture very difficult, but some general observations about their structure and function can be made.

A soil association is a group of soils with a distinctive, proportional pattern of occurrence in the landscape. This description of the soils of Delaware County comes from *Soil Survey of Chester and Delaware Counties, Pennsylvania* (USDA 1963), and State Soil Geographic (STATSGO) Data Base information provided by the U.S. Department of Agriculture, Natural Resources Conservation Service. There have been three soil associations mapped for Delaware County (Figure 2).

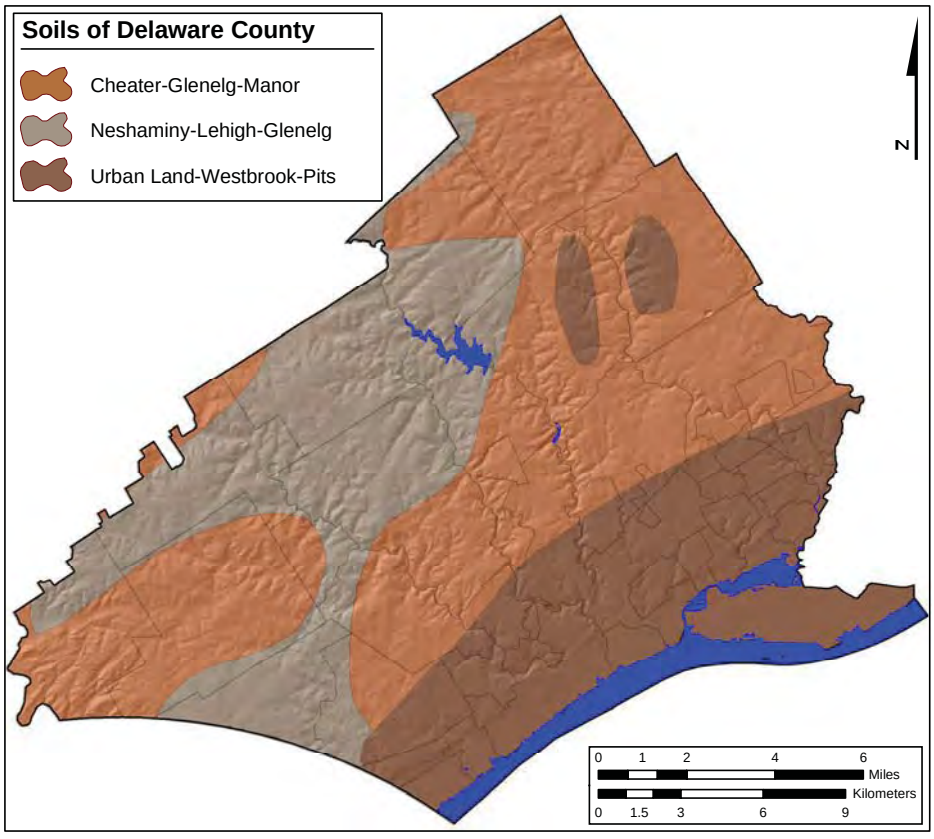


Figure 2: The soils of Delaware County.

In Delaware County the upland soils are very deep and well drained as a result of the parent material they are derived from. These soils are primarily composed of sand, silt, and gravel resulting from the weathering of very old Paleozoic and Precambrian metamorphic rocks. This makes them good for agriculture, but also makes the soil susceptible to erosion, especially on steep slopes. The soils within the floodplain of the Delaware River are also deep, but they have a higher proportion of

organic material from the tidal marshes that once covered the area and form alluvial materials deposited by the river since the last ice age.

The bedrock underneath the soil of Delaware County was originally laid down as sediments 438–1,600 million years ago during the Cambrian and Precambrian ages. Since then it has been modified by heat and pressure to form various metamorphic rocks. While some metamorphic rocks may be very hard, these varieties weather relatively easily including a variety of schist and gneiss. These rocks can be further described by the minerals they are composed of, the specific process that formed them, and their physical characteristics. The name, properties, type, and age of the general bedrock categories that underlie Delaware County are presented below (Table 3 and Fig. 3).

The Trenton Gravel area is unusual among the bedrocks. It is influenced by the Delaware River and is in a different group. It is composed of sand and gravel laid down by periodic flooding over the last 1.6 million years with additional silt and clay deposits where finer material was able to settle. These are termed alluvial deposits and allowed for the formation of a wide, flat floodplain with an abundance of tidal wetlands. The specific properties of the mixture are what dictate whether the site is very well drained (primarily gravel) or chronically waterlogged (primarily clay).

Historically, a few areas in the area of these alluvial deposits would have had a thick top-layer of organic matter, sometimes referred to as peat. These areas would have been most prominent in the tidal or continually wet areas where highly productive wetland or aquatic vegetation laid down material faster than it could decompose. The only place likely to still contain this type of soil is within the John Heinz National Wildlife Refuge.

Table 3. Delaware bedrock formations.

Formation	Description
Bryn Mawr	Reddish-brown gravelly sand and some silt deposits on high-level terrace of uncertain age.
Glenarm Wissahickon	Similar to the Wissahickon Formation, but with the inclusion of amphibolite bodies.
Felsic, Intermediate, Granite, and Mafic Gneiss	Light to dark, medium-grained gneiss with included sedimentary rocks and granitized components form other formations.
Octoraro	Includes albite-chlorite schist, phyllite, some hornblende gneiss, and granitized members
Pensauken and Bridgeton	A dark-reddish-brown quartz sand with some areas of fine gravel and rare areas of clay or silt.
Trenton Gravel	Deposited within the last 12,000 years, includes gravelly sand with crossbedded sand and clay-silt ranging form gray to pale-reddish-brown including alluvium and swamp deposits.
Anorthosite, Pegmafic, and Ultramafic Rocks	Igneous rocks with a very low silica content. Generally contains a high concentration of magnesium and iron and often a greenish color.
Wissahickon	A rich mix of metamorphic rocks including oligoclase-mica schist, hornblende gneiss, and augen gneiss, with varying degrees of quartz and feldspar depending upon granitization.

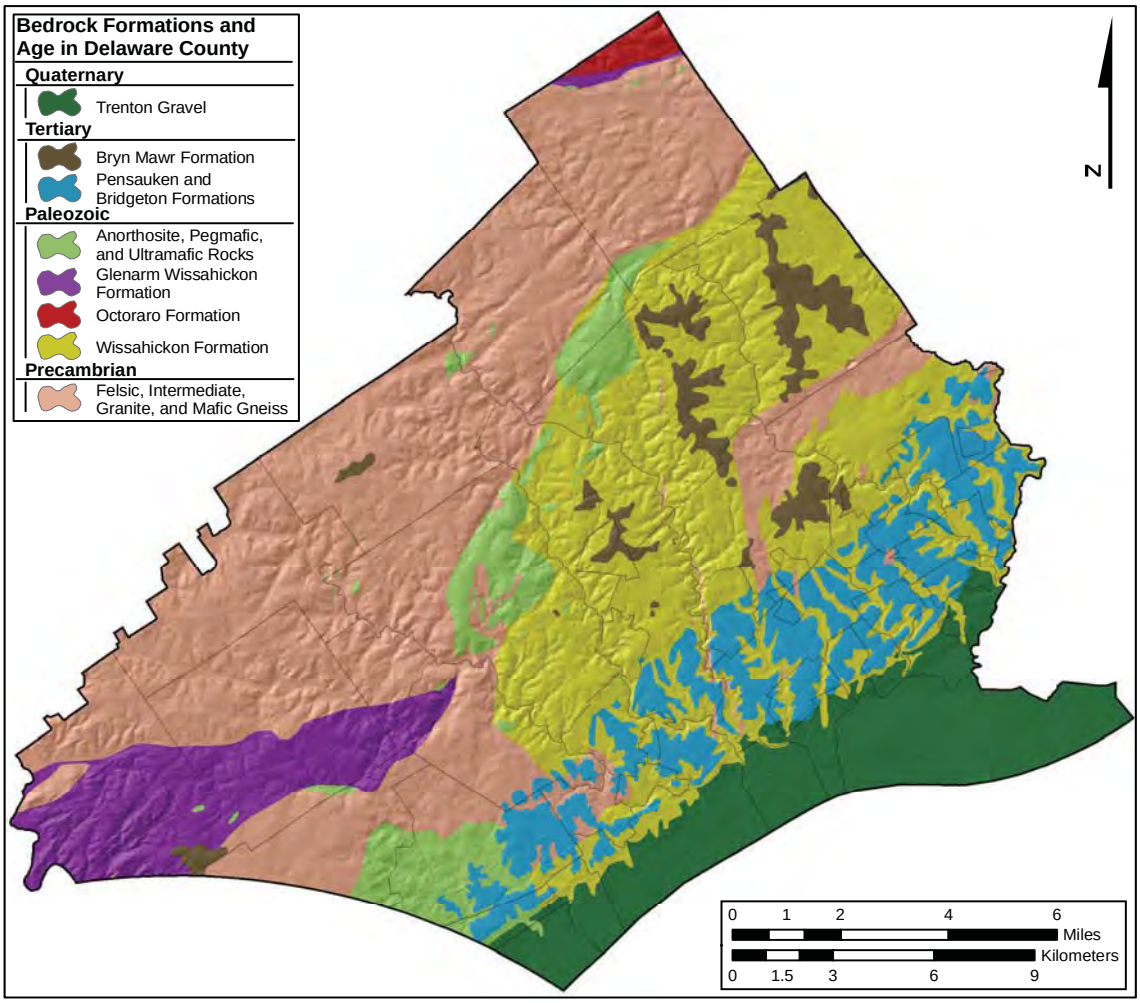


Figure 3. Bedrock geology of Delaware County.

Watersheds

Delaware County is completely within the Delaware River watershed. A watershed is defined by the local topography that dictates which way water will flow to the lowest point in an area. The water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways converge into streams and rivers, which become progressively larger as the water moves downstream, eventually reaching an estuary, such as the Delaware Bay, that is connected to a lake, sea, or ocean. Watersheds can be large, like that of the Delaware River, which covers approximately 14,200 square miles, or small like that of Namaan's Creek, which covers less than 19 square miles, but all land is part of a watershed (Fig. 4). Every stream, tributary, and river has an associated watershed, with small watersheds merging to become larger watersheds.

Floodplains are flat, often flooded, areas along streams and rivers. They are important terrestrial habitat areas tied to the flowing water system. Floodplains are typically inundated by water during the spring runoff and then remain dry after these floodwaters recede. The effects of water on these systems influence the vegetation communities that can persist there. These forested floodplains also serve as a protective buffer against

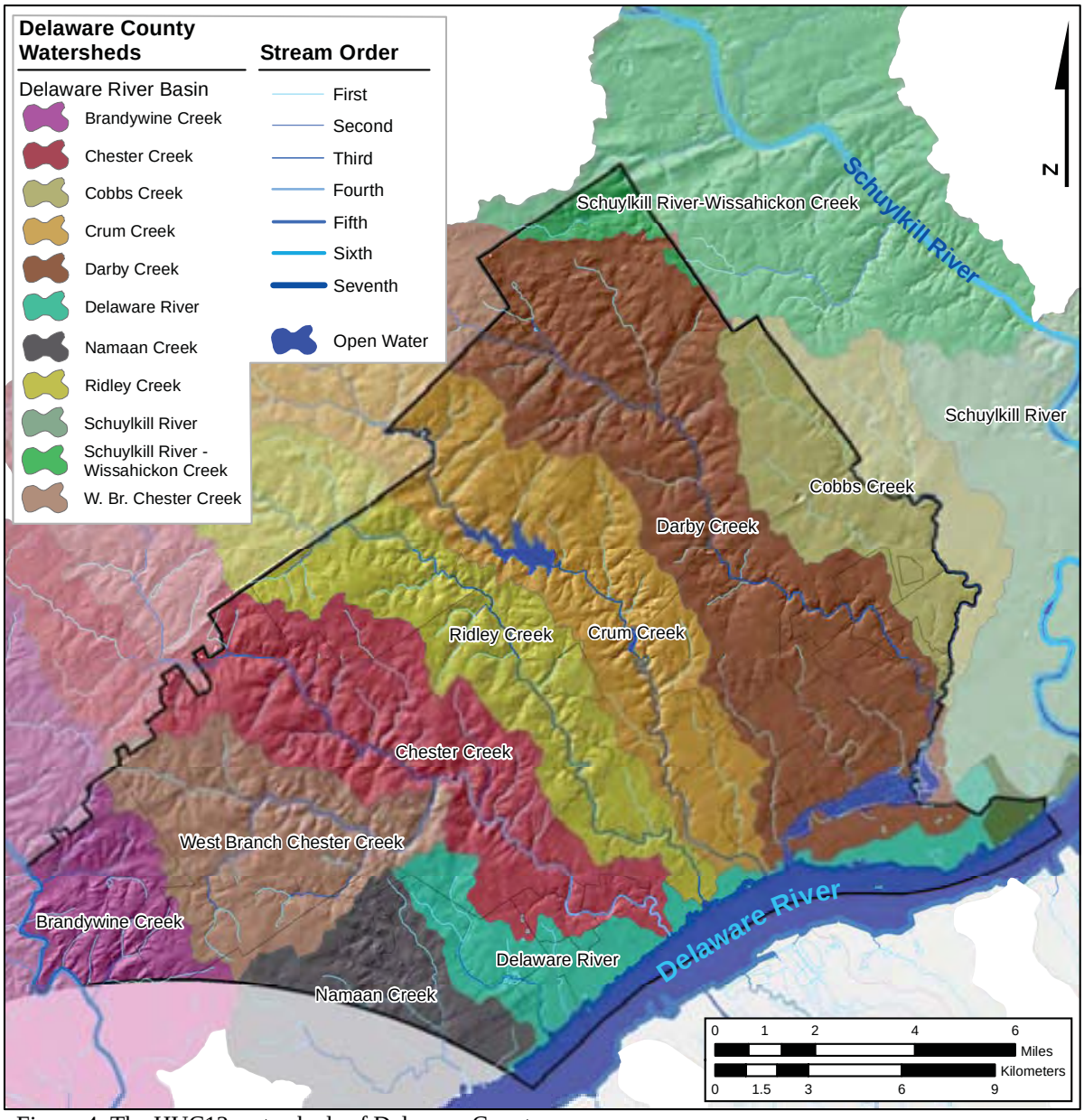


Figure 4: The HUC12 watersheds of Delaware County.

erosion, provide cooling shade to the waterway, filter pollutants and excessive nutrients from runoff, and help alleviate flood damage along many of the area's creeks.

In addition to naturally vegetated floodplains, vegetated riparian buffers along streams and other bodies of water provide vital benefits including protection of water quality, reduced erosion, flood control, and wildlife habitat. Elimination of riparian vegetation removes the capacity of this region to buffer the effects of the surrounding landscape and consequently reduces the water quality in the stream. Two major effects of the loss of riparian buffers are sedimentation and nutrient enrichment.

In Delaware County the watersheds have experienced various degrees of disturbance from moderate to very severe. The Ridley Creek watershed and associated streams remain relatively intact, with few of the streams lost to development and a large proportion of the watershed remaining in relatively natural cover, though the system is constrained by numerous dams and development around its edges. On the other hand, the Darby Creek watershed has had a large proportion of its watershed developed resulting in significant storm surge during rain events and numerous stretches of the channel have been armored with boulders or riprap.

The process of damming, channelizing, armoring, and burying streams has been occurring since shortly after colonization and has significantly impacted the ecological health of the streams in the area. A stream buried in a pipe loses most or all of its ecological function because of the lost sunlight, sediments, and air circulation among other things. Streams that are armored or channelized lose a significant amount of bank and stream-bottom habitat, reducing their ecological and riparian value. Streams that are dammed have modified habitats because of increased water temperatures and changes in the way sediment moves and is distributed in the river. Dams also act as barriers to fish migration.

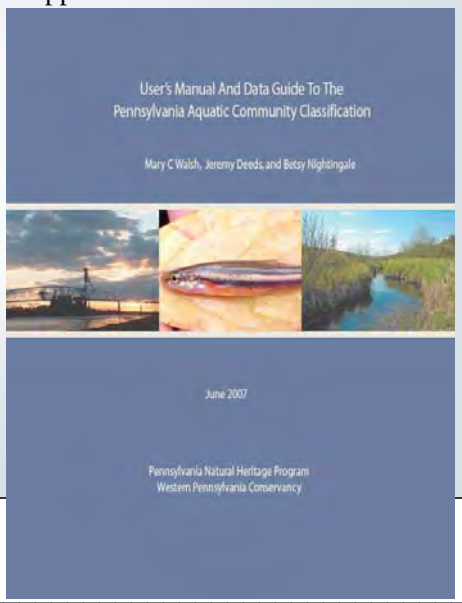
Industry, agriculture, urban development, road building, and maintenance, as well as other activities, have contributed to the degradation of water quality in many areas of the County. Protecting the quality and purity of surface and groundwater resources from degradation contributes to the future well-being of all plants and animals including human communities. The Pennsylvania State-wide Surface Waters Assessment Program can provide information on specific potential sources of water impairment within Delaware County. Much information on the water and geological resources of the County can be found on the Pennsylvania DEP eMap web page: http://www.emappa.dep.state.pa.us/emappa/viewer.htm. More complete information on the biological characteristics of Delaware County's watersheds can be found in the Aquatic Community Classification section on page #85.

Aquatic Community Classification

PNHP has recently completed an Aquatic Community Classification which describes predicted communities for all the waterways within Pennsylvania. Descriptions of the background, methodologies, and priority aquatic communities determined through this project, with fact sheets showing a more in depth perspective on each of those aquatic communities identified in Delaware County, can be found in Appendix VI.



The full versions of **Classifying Lotic Systems for Conservation: Project Methods and Results of the Pennsylvania Aquatic Community Classification Project** and **User's manual and data guide to the Pennsylvania Aquatic Community Classification** are available for download at: http://www.naturalheritage.state.pa.us/aquatics.aspx



Natural Communities of Delaware County

The interaction of geology and climate produces several critical functions in the landscape including the regulation of biogeochemical cycles (water, carbon, and nitrogen), soil formation, and ultimately wildlife habitat. The classification of vegetation communities typically revolves around the dominant species, habitat, and growth form. Boundaries between community types in the field are generally less distinct. A sampling of community types is presented below, with a more complete description of community types found in *Terrestrial and Palustrine Communities of Pennsylvania* (Fike 1999), a publication by the Pennsylvania Department of Conservation and Natural Resources. Print copies of this publication are no longer available, but the entire document is available in Adobe pdf format on the Pennsylvania Natural Heritage Program's website (www.naturalheritage.pa.state.us).

Unaltered natural communities are rare within Delaware County, but some examples exist. Since the colonization of the area, the landscape of southeastern Pennsylvania has experienced severe modification from both intentional land use changes, such as the conversion of forest to farm to village, town, and urban megalopolis, and unintentional impacts, such as the introduction of invasive species, removal of top predators, pollution, and recently, global climate change. This does not mean that Delaware County is devoid of natural communities or lacks the potential for their reestablishment or re-creation.

This section short-lists natural communities that were likely common within the Delaware County area 400 years ago and have the potential to be restored within existing natural areas or re-created anew (a process usually referred to as reclamation) in the County. This list should be looked at as the most general of guides, since site-specific conditions will dictate the restoration or reclamation potential of an individual site. Many community descriptions are referenced from Terrestrial & Palustrine Plant Communities of Pennsylvania, available at: http://www.naturalheritage.state.pa.us/fikebook.aspx.

Terrestrial Communities

The terrestrial landscapes of Delaware County today are vastly different from the systems that were there prior to colonization. While the species remain similar, the place of these species in the landscape and their stature has been greatly modified. The pre-colonization forest was a mixed-aged forest with trees ranging in size from inch-tall seedlings to centuries-old behemoths six or more feet in diameter (Latham 2008). This provided a wide range of habitats that supported many species of plants and animals no longer found in the southeastern corner of the Commonwealth. The various tree species were also found in predictable locations on the landscape based on soil, aspect, and hydrology.

While restoring the massive trees that dominated the landscape can only be accomplished with time, restoring the species composition of the forest is already ongoing. Active management by municipal and volunteer organizations is underway, with plans to restore the terrestrial landscape through the replanting of native species and the control and removal of invasive non-native species. Through relatively simple and inexpensive actions a great deal of forest restoration can be accomplished. This reforestation will contribute to the greening, cooling, and refreshing of the County along with increasing water recharge and habitat availability. Restoring terrestrial communities will be relatively inexpensive, but restoration efforts will need to be managed continually to prevent invasive species from taking over. Below are descriptions of forest types known in the area or believed to have historically occurred in the area that could be restored.

Upland Forest

The upland forest communities of the Delaware County area were and still are composed of a varied group of species. The species present reflect the combined influences of land use history, soil characteristics, and location within the greater landscape (Latham 2008). Today, many upland sites are dominated by tuliptree (*Liriodendron tulipifera*). Over successive cycles of timber harvest and forest regrowth this fast-growing,

deer-resistant species with low timber value came to dominate the area. In general, upland sites in Delaware County should be dominated by a mix of oaks (*Quercus* spp.) and hickories (*Carya* spp.), with individual species suited to different soil-moisture regimes from the wettest to the driest sites, in a wide range of soil types. However, because of heavy deer browsing and successive cycles of timber harvest these species are absent from many areas.

Additionally, many upland sites are pervaded by non-native invasive species that limit or prevent the regrowth of native tree species. Regeneration of the oak-hickory forest will take active management over a period of centuries, with replanting of trees from local seed sources, active management of invasive species, and reduction of deer herd size below carrying capacity to allow for natural recruitment and regrowth on the landscape.

Historic oak-hickory forest community species

Common Name	Scientific Name	Position
Scarlet oak	*Quercus coccinea*	Dry, poor soils
Chestnut oak	*Quercus montana*	Dry, thin soils
Sassafras	*Sassafras albidum*	Dry and disturbed soils
Pignut hickory	*Carya glabra*	Dry soils
American chestnut	*Castanea dentata*	Dry to dry-mesic soils
Shagbark hickory	*Carya ovata*	Dry to moist soils
Southern red oak	*Quercus falcata*	Dry, sandy soils
Hop-hornbeam	*Ostrya virginiana*	Dry-mesic, well-drained
American beech	*Fagus grandifolia*	Dry to moist soils
Mockernut hickory	*Carya tomentosa*	Moist well-drained soils
Black oak	*Quercus velutina*	Well-drained, rich soils
Northern red oak	*Quercus rubra*	Moist, rich soils
White oak	*Quercus alba*	Moist, rich soils
Bitternut hickory	*Carya cordiformis*	Moist, rich soils
Shellbark hickory	*Carya laciniosa*	Moist to wet, rich soils
Willow oak	*Quercus phellos*	Wet, rich soils
Pin oak	*Quercus palustris*	Seasonally flooded soils
Swamp-white oak	*Quercus bicolor*	Wet, rich soils

Coastal Plain Forest

The Atlantic coastal plain in Pennsylvania is a strip only 1 to 5 miles wide along the lower 50 miles of the state's Delaware River frontage. Nonetheless, the coastal plain forest type covered a significant portion of Delaware County, supporting a suite of species common further south, partly due to the sandy soils and partly because of the warm coastal air that blows up from the bay. This forest was dominated by sweet-gum and oaks intermixed with species such as American beech. The understory included many broadleaved evergreen small trees and shrubs such as American holly and fetter-bush, giving this community a distinctive shiny-green look throughout the year.

Historic coastal plain forest community species

Common Name	Scientific Name
American beech	*Fagus grandifolia*
American holly	*Ilex opaca*
Fetter-bush	*Leucothoe racemosa*
Southern red oak	*Quercus falcata*
Sweetbay magnolia	*Magnolia virginiana*
Sweet-gum	*Liquidambar styraciflua*
White oak	*Quercus alba*
Willow oak	*Quercus phellos*

Small, depauperate areas of this forest type remain in and around Delaware County and correspond with the sweet gum–oak coastal plain forest community type (Fike 1999). In areas where this forest type has been restored within the area it has done very well.

Floodplain Forest

Extensive development has occurred in Delaware County within the 100- and 500-year floodplains. Historically, parts of these areas would have been flooded on a yearly basis with higher areas flooded on a correspondingly less frequent basis. The frequency and duration of flooding strongly

Historic floodplain forest community species

Common Name	Scientific Name	Position
Blackgum	*Nyssa sylvatica*	Permanently wet
Red maple	*Acer rubrum*	Permanently wet
Pin oak	*Quercus palustris*	Backwaters
Swamp white oak	*Quercus bicolor*	Backwaters
Black walnut	*Juglans nigra*	Intermixed
Butternut	*Juglans cinerea*	Intermixed
Common hackberry	*Celtis occidentalis*	Intermixed
Eastern cottonwood	*Populus deltoides*	Intermixed
Box-elder	*Acer negundo*	Intermixed
Green ash	*Fraxinus pennsylvanica*	Yearly flooding
American elm	*Ulmus americana*	Yearly flooding
Silver maple	*Acer saccharinum*	Yearly flooding
Slippery elm	*Ulmus rubra*	Yearly flooding
Sycamore	*Platanus occidentalis*	Yearly flooding
Black willow	*Salix nigra*	River scours
River birch	*Betula nigra*	River scours
Smooth alder	*Alnus serrulata*	River scours
Box elder	*Acer negundo*	River edge

influenced the tree species that dominated the area. In the most frequently flooded areas, sycamore, silver maple, and American and slippery elm would dominate with eastern cottonwood, common hackberry, black walnut, butternut, green ash, and box-elder interspersed among them. More permanently wet areas, such as backwaters and stranded oxbows, would have supported swamp white oak, pin oak, and red maple. Areas where the river was actively scouring and rebuilding the bank would host fast-growing black willow, river birch, and smooth alder. Today very little floodplain forest remains along the Delaware River; small corridors remain along the smaller tributaries. These few remaining floodplain forests are generally dominated by non-native invasive species and are in need of immediate attention to prevent further degradation.

Atlantic White-cedar Forest

It is likely that areas of Atlantic white-cedar forest were present in Delaware County at the time of colonization (Smith 1886, Rhoads and Block 2005, Latham 2008). These forests, still present along the Atlantic coast from Florida to Maine, are a unique mix of evergreen and deciduous plant species that live in permanently saturated soils primarily composed of organic matter.

These forests were likely harvested quickly after colonization due to the properties of Atlantic white-cedar wood. Rot and insect resistant, easy to work, and fragrant, the lumber of Atlantic white-cedar is still prized for these qualities and used in a wide range of applications. An additional characteristic that likely contributed to the demise of Atlantic white-cedar forests around Delaware County is their susceptibility to fire and grazing. During the colonization period uncontrolled fires were set to maintain forest openings for livestock and after only a few repeated burns with no reforestation the seed bank in any remnant Atlantic white-cedar forest would have been exhausted, effectively extirpating the species from the Commonwealth (Latham 2008).

Historic Atlantic white-cedar community species

Common Name	**Scientific *Name***
Atlantic white-cedar	*Chamaecyparis thyoides*
Bayberry	*Myrica pensylvanica*
Black chokeberry	*Photinia melanocarpa*
Blackgum	*Nyssa sylvatica*
Bog sedge	*Carex atlantica*
Cinnamon fern	*Osmunda cinnamomea*
Collins's sedge	*Carex collinsii*
Dangleberry	*Gaylussacia frondosa*
Fetter-bush	*Leucothoe racemosa*
Highbush blueberry	*Vaccinium corymbosum*
Inkberry	*Ilex glabra*
Marsh fern	*Thelypteris palustris*
Pitch pine	*Pinus rigida*
Purple pitcher-plant	*Sarracenia purpurea*
Rose pogonia	*Pogonia ophioglossoides*
Sphagnum mosses	*Sphagnum* spp.
Swamp azalea	*Rhododendron viscosum*
Sweet pepperbush	*Clethra alnifolia*
Virginia chain fern	*Woodwardia virginica*
Winterberry	*Ilex verticillata*

Restoration of this forest type and its associated species poses a significant challenge, but the rewards will be substantial. The soil type this species prefers is no longer readily accessible within Delaware County and there is no local seed source for the primary members of this natural community, though there are seed sources in surrounding states. These are not insurmountable obstacles to a restoration project, but will necessitate proper planning to allow any restoration project to progress.

Grasslands, Meadows, and Old Fields

Grasslands and native meadows covered a significant proportion of the Delaware County area prior to colonization. However, it is unlikely that these were self-maintaining systems. There is extensive evidence that these meadows were managed by resident Native Americans who burned them on a periodic basis to prevent their succession back to forest and provide foraging areas for game species such as grouse, turkey, deer, and elk (Latham 2008). These systems supported species generally common to the extensive grasslands much further west despite their diminutive size. Delaware County still maintains some areas of agriculture and numerous old fields that provide a substitute for this type of habitat. Active management that includes the removal of non-native invasive species, replanting of lost native species, and control of woody species

through periodic burning or mechanical removal will need to be a part of management plans for them to succeed.

Serpentine Barrens

One exception to the above is the Serpentine Barrens natural community. This community only occurs in "islands" of habitat where serpentine bedrock is exposed and weathered at the surface. This soil is generally very poor in nutrients and somewhat toxic to a wide variety of plants providing habitat for a suite of species specialized to these environmental characteristics. Historically, there may have been up to a dozen serpentine barrens within Delaware County; today there are remnants of only three. These fire-dependent grassland systems are globally rare, and a good example of this community type in Delaware County is managed by the Tyler Arboretum.

Wetland Communities

Historically, the Delaware County area supported wetlands unique to the state in both their species makeup and their vastness. The combination of the large low-elevation outwash plain of the Schuylkill River and the tidal flow of the Atlantic Ocean up the Delaware River allowed the formation of a vast tidal marsh that covered 15 to 20 square miles from southern Philadelphia to west of the Darby Creek mouth. Around the edges of this marsh were likely enclaves of Atlantic white-cedar swamp, which is still found up and down the mid-Atlantic coast with the exception of Pennsylvania. Further inland along the river banks were backwater wetlands in old oxbows and dry channels, and on the hill slopes were spring seeps and headwater stream wetlands.

Today, with the exception of small patches of tidal mudflat, a smattering of ponds, and a few hidden spring seeps, these systems have been removed from the landscape. The removal of these wetlands has had a negative affect not only on the species that depended on these communities for their existence, but also on the regional economy. Wetlands work to purify water and facilitate ground-water recharge, they act as nurseries for many fish of economic importance, and they create a buffer against floods and tidal storm surges. The removal of these systems has shifted their formerly free ecological services into higher water bills, more expensive seafood, and increasingly damaging flooding.

Restoring wetlands is likely to take longer and be more expensive than restoring upland habitat, but it is vitally needed. Below are some communities known or believed to have been in the Delaware County area that have potential for restoration.

Freshwater Tidal Wetland

Delaware County once harbored an extensive area of freshwater tidal marsh. Covering between 10 and 20 square miles (6,400–12,800 acres), this area resembled a large flooded grassland full of wild rice interspersed with emergent and floating aquatic vegetation. This area would have been an important breeding spot for many bird, mammal, fish, and insect species as well as a critical stopover site for migratory waterfowl and shorebirds during the spring and fall. Smaller areas of tidal marsh would have been found all along the Delaware River shoreline up to the Fall Line on each of the tributaries.

Today, around ⅓ square-mile of tidal marsh remains. A remnant of Tinicum Marsh persists in the John Heinz

Historic freshwater tidal wetland community plant species

Common Name	Scientific Name
Annual wild rice	*Zizania aquatica*
Beggar-ticks	*Bidens spp.*
Broadleaf arrowhead	*Sagittaria latifolia*
Crimsoneyed rosemallow	*Hibiscus moscheutos*
Dotted smartweed	*Polygonum punctatum*
Green arrow-arum	*Peltandra virginica*
Halberdleaf tearthumb	*Polygonum arifolium*
Hemlock waterparsnip	*Sium suave*
Jewelweed	*Impatiens capensis*
Pickerelweed	*Pontederia cordata*
Primrose-willow	*Ludwigia peploides*
Rice cutgrass	*Leersia oryzoides*
River bulrush	*Schoenoplectus fluviatilis*
Salt-marsh water-hemp	*Amaranthus cannabinus*
Spatterdock	*Nuphar lutea*

National Wildlife Refuge, straddling the Philadelphia-Delaware County line. Even with its greatly reduced size it still acts as critical habitat for many species. Efforts are underway to restore parts of Tinicum Marsh and expand it as possible, but development pressure in the area has continued to nibble away at the edges and further degrade the system. There are also concerns for Tinicum Marsh from the continued expansion of the Philadelphia International Airport. This pattern of development, nearly a complete concrete ring around the Refuge, is severely degrading the marsh through air and water pollution and uncontrolled stormwater runoff.

Other remnant tidal marshes still exist in and around Delaware County and may be used as reference sites, or seed banks for restoration. These sites can be found in Neshaminy State Park, Quaker Penn Park, Bristol Marsh at the mouth of Otter Creek along the Delaware River, and along the Pennsylvania side of Little Tinicum Island (Latham 2008). One positive aspect is that tidal marsh restoration projects in and around the area have been generally successful. This success provides evidence that freshwater tidal marsh restoration projects in urban areas have a good possibility of success and should be pursued at every opportunity.

Spring Seeps

The spring seep community is common but almost always is very small in size and vulnerable to changes in local hydrology. Forming where ground water seeps to the surface and creates permanently saturated soils, these micro-wetlands are important landscape features for water recharge. During the spring they can also function as vernal pools, which are an essential component for reproduction in several species of reptiles and amphibians.

Historic spring seep community species

Common Name	Scientific Name
Bristlystalked sedge	*Carex leptalea*
Cinnamon fern	*Osmunda cinnamomea*
Clearweed	*Pilea pumila*
Golden saxifrage	*Chrysosplenium americanum*
Goldenthread	*Coptis trifolia*
Jewelweed	*Impatiens capensis*
Northern long sedge	*Carex folliculata*
Rough aster	*Eurybia radula*
Sensitive fern	*Onoclea sensibilis*
Skunk cabbage	*Symplocarpus foetidus*
Slender mannagrass	*Glyceria melicaria*
Spicebush	*Lindera benzoin*
Spinulose wood fern	*Dryopteris carthusiana*
Sweet-scented bedstraw	*Galium triflorum*
Weak stellate sedge	*Carex seorsa*

The dominant vegetation in spring seeps is usually skunk cabbage intermixed with a diverse range of herbs, ferns, sedges, and grasses. The exact mix of species present in the seep is highly variable but predictable, influenced by the pH and mineral content of the water feeding the seep.

Thus, these systems are very sensitive to disturbances that change the chemical composition, pH, or rate of flow to water feeding the seep. During times of low water, spring seeps will dry out and the plants will go dormant or die back until the water begins to flow again. However, springs can literally be sucked dry by excessive water withdrawal from the aquifer or inadequate water recharge due to too much impermeable surface in the watershed. If these seeps are left dry over successive seasons, the plants in them will eventually die and the micro-wetland and its ecological function will be lost.

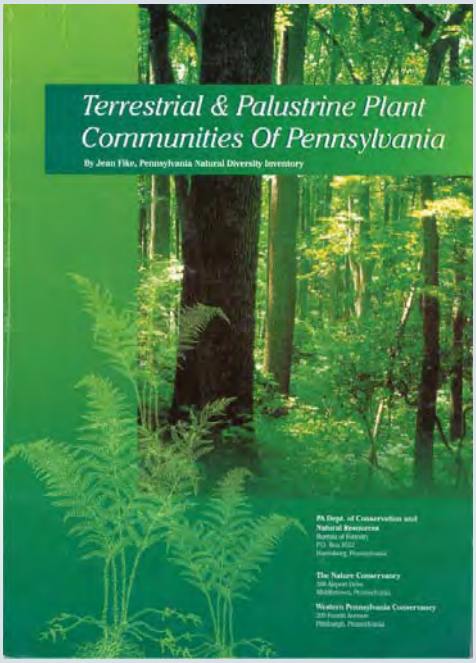


Photo source: Andrew Strassman

A remnant tidal marsh outside of Tinicum Marsh along the Delaware River shoreline with blooming annual wild-rice, pickerelweed, and salt-marsh water-hemp. Annual wild rice and salt-marsh water-hemp are species of concern.

Classification of Natural Plant Communities in Pennsylvania

Terrestrial & Palustrine Plant Communities of Pennsylvania (Fike 1999) is the most current community classification system for Pennsylvania's palustrine and terrestrial plant communities. This report was developed by the Pennsylvania Natural Heritage Program to update and refine Smith's 1991 report *Classification of Natural Communities in Pennsylvania (draft)*, the first effort dedicated specifically to the classification of natural communities in the state. Work is ongoing to improve the current classification system and therefore, future editions may define new community types or alter currently defined types. Aquatic communities (lakes, streams, and rivers), communities where vegetation is absent or not a definitive characteristic (caves, scree slopes), and communities resulting from extensive human disturbance (old agricultural fields, manmade wetlands, etc.), are not addressed in this classification. Until more extensive work can be completed to define these types of communities and incorporate them into a single statewide framework, the County Natural Heritage Inventory reports will provisionally refer to features of ecological interest that fall outside the Fike 1999 system using categories described in Smith 1991. More information on community classification in Pennsylvania is available at http://www.naturalheritage.state.pa.us/



Landscape-scale Conservation

A number of studies have looked at the effects of roads and other linear features on the landscape. Ecological impacts of these fragmenting features include: 1) direct mortality of wildlife from vehicles; 2) disruption of wildlife dispersal; 3) habitat fragmentation and loss; 4) imposition of edge effects; 5) spread of exotic invasive species; and 6) alteration of the chemical environment.

Forest Fragmentation

Prior to European settlement, forest covered more than 90 percent of Pennsylvania (Goodrich et al., 2003). Today, 62 percent of the state is forested, comprising an area of over 17 million acres (Figure 5a; Goodrich et al., 2003; Myers et al., 2000). Figure 5b shows the division of these forests by major fragmenting features such as interstate highways and major rivers; however, much of this forest exists as relatively small islands isolated by surrounding linear features such as roads, utility rights-of-way, all-terrain vehicle trails, snowmobile trails, railroads, and patches of non-forested lands. Figure 5c shows forested areas greater than 25 acres that remain after fragmentation by interstates and highways, state and local roads, public forest roads, utility rights-of-way, and active railroads. These forest blocks represent potential contiguous habitat for animals sensitive to all scales of fragmenting features, such as amphibians and interior forest birds. The forest blocks of Delaware County are presented in Figure 6.

Roads

Roads, wide trails, and grass corridors can also function as barriers restricting the movements of invertebrates and amphibians. Populations of microhabitat-specific species, like land snails and salamanders that generally require moist habitats, may be isolated by inhospitable, dry corridors (Williams, 1995; Blaustein et al., 1994). Roads can be a significant source of mortality for a variety of animals. Amphibians may be especially vulnerable to road-kill because their life histories often involve inconspicuous individuals migrating between wetland and upland habitats. One study conducted in southeastern Pennsylvania documented over 100 road-killed salamanders and frogs on a single one-mile stretch of road during one rainy night during the spring breeding season (Goodrich et al., 2003).

Large and mid-sized mammals are particularly susceptible to vehicle collisions on secondary roads, while birds and small mammals are most vulnerable on wider, high-speed highways (Forman and Alexander, 1998). In Upper St. Clair Township, Pennsylvania, over a recent four year period, white-tailed deer mortality due to road-kills was approximately four times higher than mortality due to hunting (Upper St. Clair Township Department of Deer Management, 2005). Bobcat (*Lynx rufus*) road-kills reported in Pennsylvania between 1985 and 2000 totaled 637 (Goodrich et al., 2003) when there was no legal bobcat trapping before 2000.

Animals may also alter their behavior in the presence of a road. One study found that small forest mammals (such as the eastern chipmunk, the eastern gray squirrel, and the deer mouse) were reluctant to venture onto road surfaces where the distance between forest margins exceeded 65.6 feet (Oxley et al., 1974). The same study concluded that a four lane, divided highway might be as effective a barrier to the dispersal of small forest mammals as a body of freshwater twice as wide. A study conducted in North Carolina found that black bears shift their home ranges away from areas with high road densities (Brody and Pelton, 1989). Traffic noise has been shown to interfere with songbird vocal communication, which affects their territorial behavior and their mating success (Seiler, 2001). Some forest butterflies, such as the West Virginia white (*Pieris virginiensis*), will not cross non-forested habitats; its current rarity may be a function of habitat fragmentation and isolation (Williams, 1995). Consequences of the isolation of populations include reduced genetic diversity and reduced breeding success, which may ultimately result in local extinctions (Seiler, 2001).

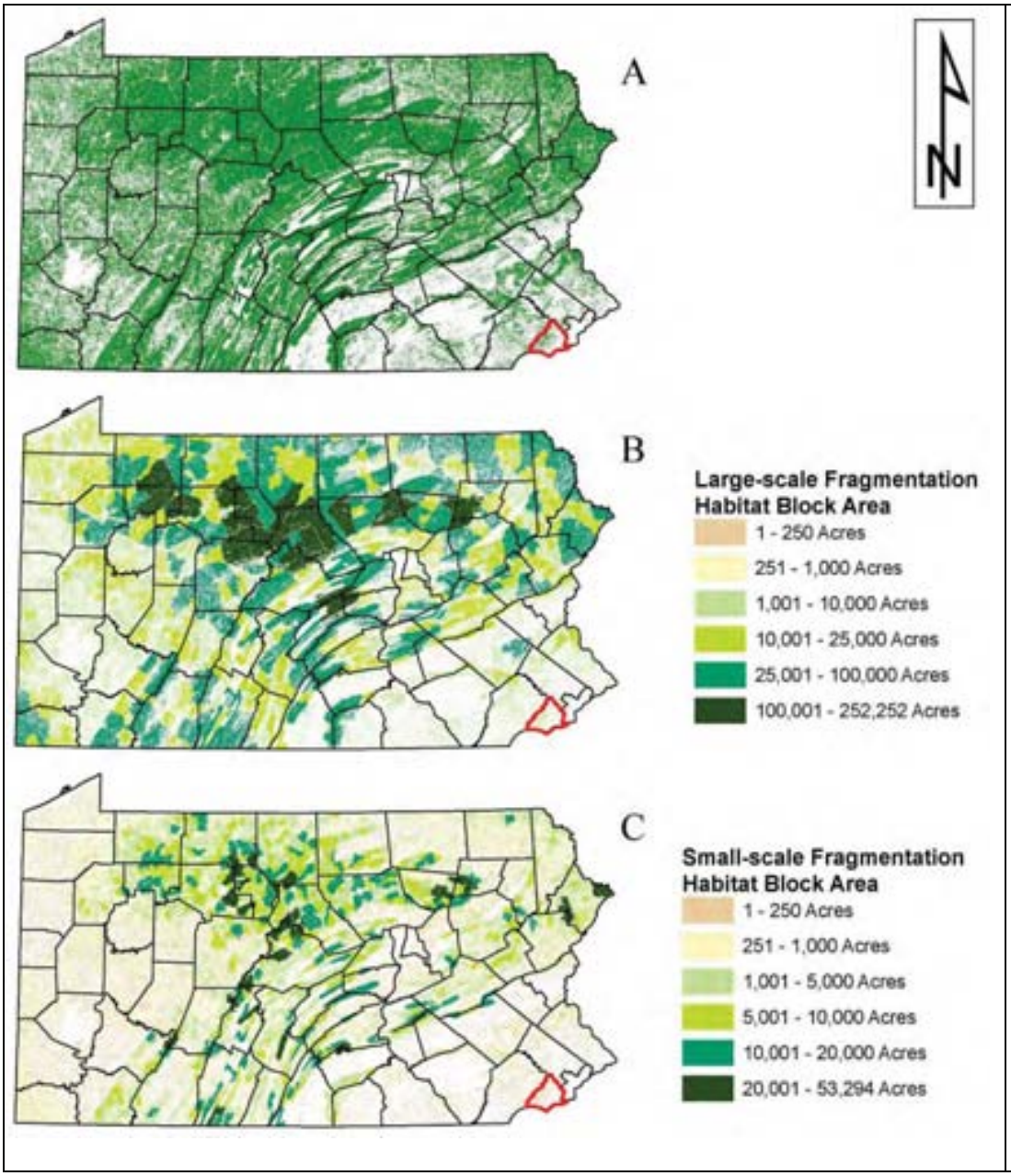


Figure 5. Forest and wetland areas of Pennsylvania shown at varying scales of fragmentation due to human-created linear landscape features (Delaware County outlined). **A.** Forest and wetland areas in Pennsylvania derived from the National Land Cover Data Set for Pennsylvania (USGS 2003). **B.** Forest and wetland areas greater than one acre, fragmented by interstate, US, and state highways. Roads of this magnitude function as a barrier to all animals. These habitat blocks represent potential contiguous habitat for animals relatively insensitive to smaller-scale fragmenting features, such as black bear and white-tailed deer. **C.** Forest and wetland areas greater than one acre, fragmented by interstate, US, and state highways, state and local roads, public forest roads, and active railroads. These habitat blocks represent potential contiguous habitat for animals sensitive to all scales of fragmenting features, such as forest interior birds and amphibians.

Fragmentation of contiguous forested landscapes into smaller, isolated tracts has an effect on plant and animal distribution and community composition. When a large piece of forest tract is fragmented, or split into pieces, the resulting forest islands may lack some of the habitats that existed in the original tract, or may be smaller than the minimum area required by a given species (Lynch and Whigham, 1984). For example, the Louisiana waterthrush (*Seiurus motacilla*) is rarely found in small woodlots because they require upland forest streams within their territory and most small woodlots lack this necessary component (Robbins, 1980; Robinson, et al., 1995). Area-sensitive species such as the northern goshawk (*Accipiter gentilis*), barred owl (Strix varia), bobcat, and timber rattlesnake (*Crotalus horridus*) require interior forest areas in excess of 6,000 acres to accommodate breeding and foraging territories (Ciszek, 2002; Mazur and James, 2000; Squires and Reynolds, 1997).

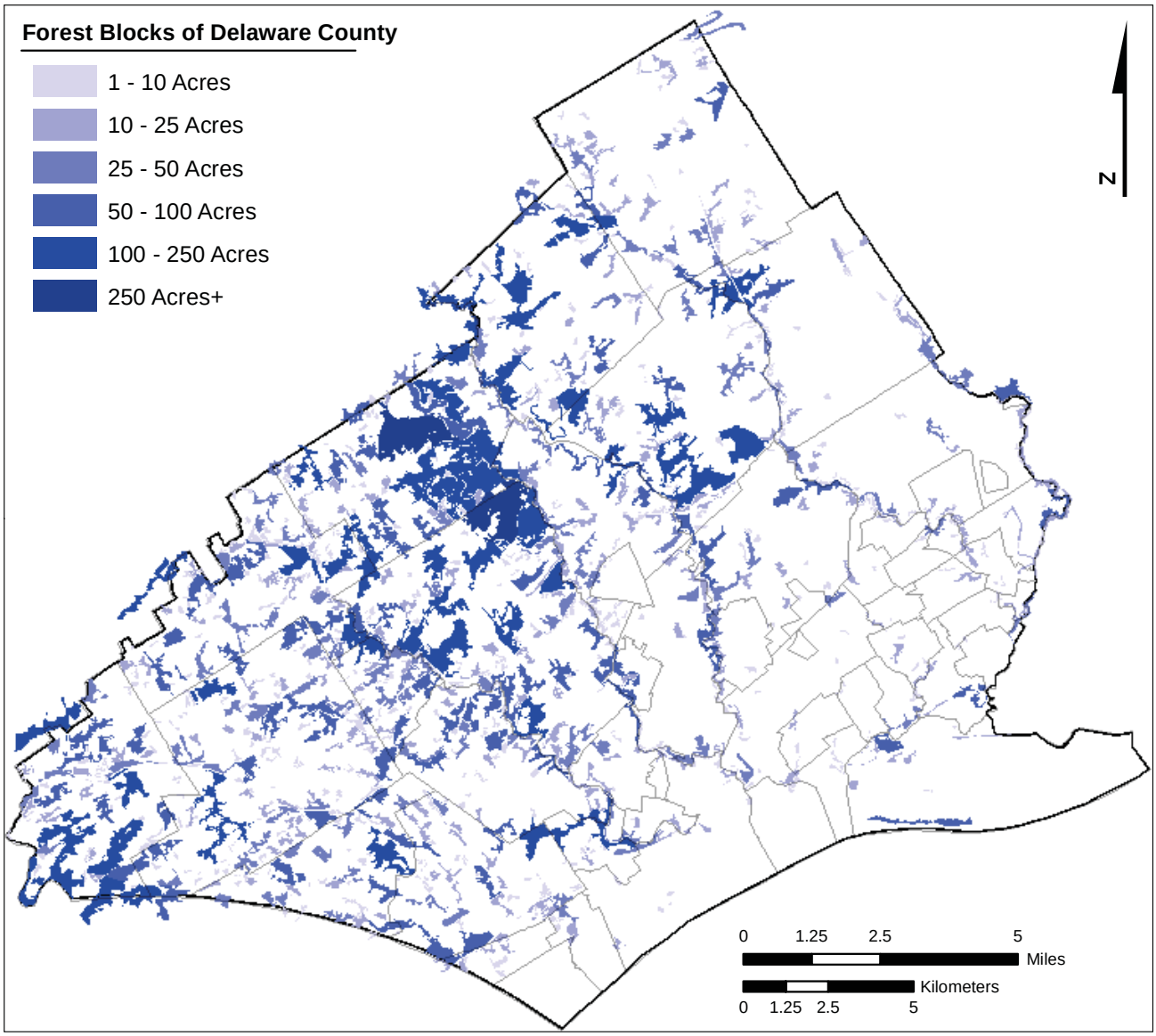


Figure 6: The forest blocks of Delaware County greater than 1 acre in area.

Edge forest is composed of a zone of altered microclimate and contrasting community structure distinct from the interior or core forest (Matlack, 1993). Along with a reduction in total forested area, forest fragmentation creates a suite of edge effects which can extend 1,000 feet into the remaining fragment (Forman and Deblinger, 2000). Edge effects include increased light intensity, reduced depth of the leaf-letter layer, altered plant and insect abundance, reduced numbers of macroinvertebrates, and fewer species of macroinvertebrates (Haskell, 2000; Watkins et al., 2003; Yahner, 2000). The macroinvertebrates in the leaf litter are significant for the pivotal role they play in energy and nutrient cycling; these macroinvertebrates also provide food source for salamanders and ground-feeding birds (Voshell, 2002). Additionally, a number of studies have shown that the nesting success of forest-interior songbirds is lower near forest edges than in the interior, due to increased densities of nest predators and brooding parasites.

Not only do roads fragment forests, but roads can also act as corridors for dispersal of invasive plants and toxic chemicals, and pollute nearby aquatic systems (Forman and Alexander, 1998; Trombulak and Frissell, 2000; Watkins et al., 2003; Williams, 1995). Vehicles can transport exotic plant seeds into previously un-infested areas, while road construction and maintenance operations provide sites for seed germination and seedling establishment (Schmidt, 1989; Trombulak and Frissell, 2000). Road traffic and maintenance of

rights-of-way also contribute to the introduction of at least six different kinds of chemicals to the environment: heavy metals, salt, organic pollutants, ozone, nutrients, and herbicides (Forman and Alexander, 1998; Trombulak and Frissell, 2000). Heavy metals such as lead, aluminum, and iron contaminate soils, plants, invertebrates, and vertebrates up to 656 feet from roads (Trombulak and Frissell, 2000). Deicing salts alter the soil's chemical composition (including the pH), which affects plant growth (Forman and Alexander, 1998; Trombulak and Frissell, 2000). Airborne sodium chloride from snowplowing may cause leaf injury to trees up to almost 400 feet from a road (Forman and Alexander, 1998). Organic pollutants such as dioxins and polychlorinated biphenyls (PCBs) are present in higher concentrations along roads, and hydrocarbons may accumulate in aquatic ecosystems near roads. Storm runoff from roads, particularly where roads abut or cross water bodies, results in the transport of nutrients and sediments into aquatic ecosystems. Drifting or misused herbicides applied to roadsides and utility rights-of-ways to control woody plant growth may damage forest edge and interior plant species or directly kill rare plants (Williams, 1995).

Humans function as ecosystem engineers, altering the landscape around us to suit our needs. Some species benefit from human-induced changes, such as birds that inhabitant the early successional and edge habitats created by utility corridors, or disturbance-adapted plants that colonize roadsides; however, as is more often the case, species with specific habitat requirements suffer declines when faced with human encroachment. Given the pervasiveness of human influence throughout the northeastern United States, the ecological importance of large areas of relatively pristine habitat cannot be overestimated. Not only are they potential habitat for a number of sensitive species, but they are also important for the maintenance of vital ecosystem processes and services such as nutrient cycling, pollination, predator-prey interactions and natural disturbances regimes. Additionally, large forested areas also serve to filter and regulate the flows of streams within watersheds, and store large quantities of carbon as biomass.

Using Forest Patches in Land Use Planning

Where is the best place, ecologically, to situate any given land use, such as a new housing development, road, shopping center, farm, or nature reserve? Although the answer to this question probably depends largely on place specific variables such as slope or distance to existing development, landscape ecology can offer a useful answer, which can then be adapted to the planning and design questions at hand. Four "indispensable patterns" of natural land cover must be maintained in order to protect native species and natural processes:

Large natural patches – Large patches are the only way to protect interior species and species with large home ranges. Large patches also allow natural disturbances, such as wind throws of trees, to not affect all of the land at once, thus, allowing several successional stages to be represented at any given time.

Vegetated riparian corridors – Naturally vegetated corridors are essential for protecting many aquatic species, including fish, mussels, and amphibians.

Connectivity between large patches – The landscape must provide functional connectivity for species of conservation interest—that is, linkages that these species can use for movement through their home range, migration, and dispersal into new sites. Functionality will most likely be served by wide continuous corridors, but stepping stones of suitable habitat may allow movement across less suitable habitat types.

Remnant natural areas in human-dominated landscapes – Within agricultural and urban landscapes, three types of natural remnants should be protected (in descending priority):

- Areas of high conservation value, such as rare species habitat;
- Landscape types that provide essential ecosystem services (e.g. wetlands that provide water infiltration);
- Remnants of the former natural land cover that provide edge species habitat and human access to nature.

These principles are considered indispensable because it is beyond our ability to replace the functions that they provide. Used together, these patterns form the basis of the coarse-filter/fine-filter approach to conservation.

Disturbance in Delaware County

Overview

Disturbances, whether natural or man-made, have played a key role in shaping many of the County's natural communities and their associated species. The frequency and scale of these disturbances is formative in the appearance of natural communities today.

Natural Disturbances

Natural disturbances, such as fire and flooding, can actually benefit certain natural communities and species. Periodic fires are needed to maintain grassland openings, allow new growth of the characteristic species, and keep out other successional species. Floodplain forests benefit from the periodic scouring and deposition of sediments as streams overtop their banks. At the same time, streamside wetland communities retain excess water, thus reducing the scale of downstream flooding.

Another natural disturbance (exacerbated by human mismanagement), over-browsing by deer, can have detrimental effects on natural communities and species (Rhoads and Klein 1993; Latham et al. 2005). Excessive deer browse can remove the understory of some forests and halt regeneration of new growth of the canopy and understory by preferential feeding. Deer feeding preferences can have a direct effect on rare plants and severely decrease essential habitat for other animal species. Over-browsing can result in a lack of forest regeneration, a reduction in the diversity and density of forest understory, a decrease in songbird diversity and direct loss of rare plants (Yahner 1995). Current deer density in Ridley Creek State Park is estimated from 81-139 deer per mi^2 (Rhoads and Block, 2008), density of 8 to 10 deer per mi^2 will be needed to restore native vegetation. Private landowners can be encouraged to control deer populations by allowing hunting on their lands.

Historically, beavers occupied the streams in Delaware County. Disturbances caused by beaver can be both beneficial and detrimental to wetland habitats within the state. On one hand, thinning the canopy and flooding by beavers eventually creates open wetland meadows upon which many unique species rely. On the other hand, damming by beavers alters habitats to a degree that renders the sites no longer suitable for some species. For example, peatlands support an array of rare plants and animals, but flooding by beaver can degrade these communities until they no longer support the uniquely adapted species. Beaver activity in the long term is critical to the cyclic pattern of wetland disturbance, but in the short term, beaver activity can threaten the integrity of now rare wetland habitats and jeopardize many of the unique species that inhabit these natural communities. This creates difficulty in assessing how beavers should be managed. The long-term benefit of habitat creation must be weighed against the potential short-term threat to the existing plants and animals. In certain situations, beaver removal is preferred and implementation of management practices with regard to beaver must be considered on a case-by-case basis. In Delaware County it may be necessary to consider how the absence of beavers is affecting wetland succession across the landscape.

Human Disturbances

Human and natural disturbances create different habitats in different scenarios, but human disturbances often leave the most lasting effect on the environment. Many human disturbances can be beneficial to a specific suite of species that require an early successional habitat. However, what is beneficial to one species is often detrimental to many other species. Many once common species have become rare because they are unable to adapt to disturbance of their small, specialized part of the environment. Consequently, many species have declined due to human alteration of the landscape. Human disturbances are semi-permanent parts of landscape, but decisions about the type, timing, location, and extent of future disturbances are important to the natural ecological diversity that remains.

From a historical perspective, human disturbance to the natural communities of the County has been occurring for hundreds, if not thousands, of years. Because of Pennsylvania's central location in the original colonies and the abundant natural resources present, the state was a hub of human settlement and subsequently served as a "keystone" in the developing economies of the emerging country. Housing the first European settlement in the state, Delaware County may have one of the most human modified landscapes in the state. Additionally, because the County has been inhabited for such an extended period it has been extensively colonized by non-native species.

In many cases, human disturbances have directly affected natural communities and animal and plant species of the area. In Delaware County, development has created biological "islands" where small natural areas are surrounded by development. These islands contain isolated populations of plant and animal species where gene flow between populations is inhibited. This loss of gene flow reduces the health of the population as individuals within an isolated group become more and more related.

Additionally, the many wetlands of the County were intentionally drained or flooded, resulting in the loss of biodiversity at a given site. In fact, in less than 25 years Pennsylvania lost 50% of its natural wetlands through draining and filling. Though increased efforts have been made to protect our remaining wetlands, these often rely on wetland mitigation, where artificial wetlands are created to replace those that are destroyed. From a biological standpoint, mitigated wetlands are of a poorer quality than natural wetlands and do not provide the diversity of species and functioning food webs that natural wetlands can provide (Ashworth et al. 2006; Balcombe et al. 2005; Fennessy et al. 2008; Hartzell et al. 2007; Snell-rood and Cristol 2003; Stanczak and Keiper 2004). It is important to protect existing wetlands first, even if they are degraded and resort to mitigation only as a last resort.

Dams

Pennsylvania has thousands of dams on its rivers, streams, and creeks. Some of these dams currently serve important purposes, but many of these dams no longer serve their intended uses and have fallen into a state of disrepair. Delaware County, being an area of original settlement in the Commonwealth, still has numerous dams. These unnecessary structures can be a liability to their owners, as many run-of-the-river dams* create dangerous hydraulic conditions at their base, making them a threat to river users in the area. Due to this public safety threat, owners of existing run-of-the-river dams and permittees for the construction of new run-of-the-river dams are required to mark the areas above and below the dam to warn river users of the dangerous conditions around the dam structure. This requirement went into effect on January 1, 1999 through an amendment to the Fish and Boat Code known as Act 91 of 1998 (P.L. 702, No. 91). Failure to comply with the responsibilities of Act 91 can lead to a civil penalty between $500 and $5,000 annually for each calendar year of noncompliance.

*At normal flow levels, run-of-the-river dams permit all flow entering the impoundment to pass over the spillway within the banks of the river—see Act 91 of 1998 (P.L. 702, No. 91)

Dam Safety

Due to the public safety threat, owners of existing run-of-the river dams and permittees for the construction of new run-of-the-river dams are required to mark the areas above and below the dam to warn river users of the dangerous conditions around the structure. This requirement went into effect on January 1st, 1999 through an amendment to the Fish and Boat Code known as Act 91 of 1998 (P.L. 702, No. 91). Failure to comply with the responsibilities of Act 91 can lead to a civil penalty between $500 and $5,000 annually for each calendar year of noncompliance.

Pennsylvania currently leads the nation in dam removal and its commitment to dam safety. Numerous agencies, nonprofit organizations, and engineering firms have experience with dam removal in Pennsylvania. For more information on dam safety, dam owner requirements, and dam removal, please contact the DEP Division of Dam Safety, at: http://www.depweb.state.pa.us/waterwaysesng/cwp/view.asp?a=1274&q=533592&waterwaysengNav=|

Besides acting as liabilities and maintenance headaches, dams cause numerous environmental impacts including reduced water quality, thermal pollution, disrupted sediment transport processes that increase sedimentation in impounded areas and increase streambed and streambank erosion in downstream areas, altered flow regimes, and habitat destruction and fragmentation. By removing the unused, unnecessary dams from waterways, natural free-flowing dynamics which support diverse ecosystems, reduce localized flooding and erosion, improve water quality, and restore habitat and access to upstream habitat for aquatic organisms can be reestablished. To address the impacts to resources under their management, the Pennsylvania Fish and Boat Commission has authority (PEnnsylvania Code Chapter 57, Section 22) to request that dam owners install fish passage structures on dams to benefit migratory or resident fish species.



photo source: Andrew Strassman, PNHP

Millbourne Dam, a run-of-the-river dam, across Cobbs Creek between Philadelphia and Delaware County.

Pennsylvania currently leads the nation in dam removal. Numerous agencies, non-profit organizations, and engineering firms have experience with dam removal in Pennsylvania. For more information on dam safety, dam owner requirements, and dam removal, please contact the Department of Environmental Protection Division of Dam Safety, at 717-787-8568 or at http://www.dep.state.pa.us/dep/deputate/watermgt/we/damprogram/main.htm.



photo source: PNHP

Extensive ATV damage on Middletown Township open space and accompanying trash. Numerous streams and wetlands, and an extensive area of interior forest have been permanently impacted.

Off-Road and All-Terrain Vehicles

During our surveys we noted extensive areas of severe damage caused by the use of off-road and all-terrain vehicles (ORV or ATV). Many of the sites where we found extensive ATV damage were specifically posted as no motor vehicle areas, but this is clearly not being enforced.

These vehicles are capable of doing irreparable damage to natural systems by completely denuding vegetation form areas. This leads to a significant increase in erosion and makes disturbed areas much more susceptible to invasion by invasive species especially when ATVs are moved from one location to another without proper cleaning.

Invasive Species

The introduction of non-native species into Pennsylvania began with the initial European settlement in the 17th century (Thompson 2002) and continues today. Plants and animals have been deliberately introduced for a variety of purposes including food sources, erosion control, landscaping, and game for hunting and fishing. Other species have been accidentally introduced as 'stowaways' through increases in global trade and transportation. These introductions have had drastic effects on Pennsylvania's biodiversity over time. For example, over 37% of the plant species now found in the Commonwealth did not occur here during the first period of European settlement (Thompson 2002).

Invasive Plants

Invasive plants reproduce rapidly, spread quickly over the landscape, and have few, if any, natural controls such as herbivores and diseases to keep them in check (Table 4). Invasive plants share a number of characteristics that allow them to spread rapidly and make them difficult to remove or control:

1) Spreading aggressively by runners or rhizomes;
2) Producing large numbers of seeds that survive to germinate;
3) Dispersing seeds away from the parent plant through various means such as wind, water, wildlife, and people.



photo source: PNHP

Mile-a-minute (*Polygonum perfoliatum*) and a tangle of other invasive plants compete for resources with native species.

Invasive plants are capable of displacing native plants from natural communities, especially those with rare, vulnerable, or limited populations. This initial impact is worsened by the tendency for native wildlife to prefer native species over invasive species for food. In some cases, a switch to the invasive plant food supply may affect the physiology of the prey species. For example, many invasive shrubs, such as nonnative bush honeysuckles (*Lonicera* spp.), provide fruits that native birds find attractive, yet these fruits do not provide the nutrition and high-fat content the birds need in their diets (Swearingen et al. 2002).

Aggressive invasive plants can also transform a diverse small-scale ecosystem, such as a wetland or meadow, into a monoculture of a single species, drastically reducing the overall plant richness of an area and limiting its ecological value. The decrease in plant biodiversity can, in turn, impact the mammals, birds, and insects in an area, as the invasive plants do not provide the same food and cover value as the natural native plant species did (Swearingen et al., 2002).

Control methods for these invasive species can range from hand pulling to mechanical methods (e.g., mowing) to herbicides. A variety of tools have been developed for control of several of these species (e.g., the WeedWrench and the Honeysuckle Popper). Control with herbicide should only be performed by individuals with proper training and licensing by the Pennsylvania Department of Agriculture. When working in sensitive habitats such as wetlands, a "wetland-safe" herbicide should be used to avoid indirect effects on other organisms. It should be noted that several popular herbicides have severe adverse affects on amphibians and reptiles and should not be used in or around wetlands under any circumstances. Also, different invasive species present on a site may require a different technique or suite of techniques for effective control. Generally speaking, control efforts should be concentrated before these species disperse their seed for the year. Specific control methods for many invasive species can be found at: http://www.invasive.org/eastern/. Other invasive plants that pose emerging threats to native flora and fauna have been observed in the County. For example, zebra grass or Chinese silvergrass (*Miscanthus sinensis*), a widely planted ornamental grass, has been observed extensively spreading along roadsides into natural areas in the County.



photo source: PNHP

Plants introduced for the landscape trade often escape their intended setting to the point of becoming invasive species that threaten native ecosystems.

Table 4.
Abridged list of significant invasive plant species found or with colonization potential in Delaware County.

Species	Description and Threat
Bamboo (*Pseudosasa* spp.), Japanese plumegrass (*Miscanthus sinensis*), Common reed (*Phragmites australis*)	These large grasses spread through runners and wind-blown seeds. They are highly invasive and quickly form large monocultures that offer little habitat to native species.
European alder (*Alnus glutinosa*) Japanese angelica-tree (*Aralia elata)* Japanese barberry (*Berberis thunbergii*) Paper mulberry (*Broussonetia papyrifera*) Butterfly bush (*Buddleja* sp.) Burning bush (*Euonymus alatus*) Privet (*Ligustrum* spp.) White mulberry (*Morus alba*) Mock-orange (*Philadelphus* sp.) Bradford pear (*Pyrus calleryana*) Jetbead (*Rhodotypos scandens*) Wineberry (*Rubus phoenicolasius*) Japanese Spiraea (*Spiraea japonica*) Sapphire-berry (*Symplocos paniculata)*	Many of these commonly used landscape shrubs have escaped from cultivation to form dense thickets that displace native woody and herbaceous plants.
Garlic mustard (*Alliaria petiolata*) Crown vetch (*Coronilla varia)* Japanese stiltgrass (*Microstegium vimineum*) Lesser Celandine (*Ranunculus ficaria*)	These increasingly common invasive herbs are spreading through natural areas throughout the region. Garlic mustard is known to disrupt mycorrhizal relationships that trees depend on for growth and pachysandra forms large mats of vegetation that can prevent forest regeneration.
Purple loosestrife (*Lythrum salicaria*) Japanese and giant knotweed (*Polygonum cuspidatum* and *P. sachalinense*)	These fast-growing exotics displace natural vegetation, greatly alter natural ecosystems, and degrade riparian systems throughout the state. Once established in a wetland these species are difficult to eradicate and will displace native species.
Five-leaved Akebia (*Akebia quinata)* Porcelain berry (*Ampelopsis brevipedunculata*) Oriental bittersweet (*Celastrus orbiculatus*) Wintercreeper (*Euonymus fortunei*) English ivy (*Hedera helix*) Japanese hops (*Humulus japonicus*) Japanese honeysuckle (*Lonicera japonica*) Pachysandra (*Pachysandra terminalis*) Periwinkle (*Vinca minor*) Exotic wisterias (*Wisteria sinensis & W. floribunda*)	These perennial vines cover and out-compete native vegetation as well as girdle trees by twining up them. They are noted for devastating unmanaged tree and shrub planting by smothering the plants and often form an impenetrable barrier along forest and stream edges. Additionally, Japanese hops and English ivy are noted for causing skin rashes.
Mile-a-minute (*Polygonum perfoliatum*)	An annual vine that invades open and disturbed areas and scrambles over native vegetation, smothering them.
Autumn olive (*Elaeagnus umbellata*) Non-native bush honeysuckles (*Lonicera tatarica, L. morrowii,* *L. maackii*, and *L. xylosteum*), Multiflora rose (*Rosa multiflora*)	Found in a variety of environments from wetlands to uplands. These compete with native plants for moisture, nutrients, and pollinators. Fruits do not provide high-energy food for migrating birds.
Non-native viburnums (*Viburnum plicatum, V. sieboldii, V. dilatatum*)	Shrubs or small trees that supplant native viburnum species. Commonly used in landscaping, the berries of viburnums attract birds allowing quick and widespread invasion.
Norway maple (*Acer platanoides*) Sycamore maple *(Acer pseudoplatanus)* Tree-of-heaven (*Ailanthus altissima*) Princess tree (*Paulownia tomentosa*) Amur corktree (*Phellodendron amurense)* Bird cherry (*Prunus avium)* Siberian elm *(Ulmus pumila)*	These fast growing introduced trees are still sold as ornamental trees. They have spread throughout Pennsylvania invading many rich upland woodlands and are commonly found along roadsides.

Invasive Animal Species

In addition to invasive plants, Pennsylvania is now home to several exotic species of animals including mammals, birds, fish, and reptiles along with a suite of invertebrates, fungi, and bacteria (Table 4). These species can directly threaten populations of native animals through direct competition or predation. Other invasive exotic animals can alter habitats and ecosystems by changing plant cover or diversity. Some of these invasive animals, such as the Norway rat (*Rattus norvegicus*), are all too common pests of our homes and developed areas.

Chestnut blight (*Cryphonectria parasitica*), a fungus, was probably introduced to North America from infected nursery stock from China in the 1890s. First detected in New York City in 1904, it has all but wiped out the American chestnut (*Castanea dentata*) from Maine to Alabama to the Mississippi River. American

Table 5.
Abridged list of significant invasive animal species found or with colonization potential in Delaware County.

Species	Description and Threat
Asian clam (*Corbicula fluminea*)	Found in extremely high densities along major tributaries and rivers, this species is directly competing with native mussels for food and habitat.
Red-eared slider (*Trachemys scripta*)	This species of turtle, native much further south in the United States, competes directly with native turtles for basking and nesting sites.
Common carp (*Cyprinus carpio*)	Introduced as a food fish, this species is now found anywhere with warm, slow-moving water. As a bottom feeder it greatly increases turbidity and mobilizes large amounts of sediment.
European starling (*Sturnus vulgaris*)	Competing directly with native cavity-nesting birds, this species also cause severe crop damage.
Grass carp (*Ctenopharyngodon idella*)	A voracious herbivore, this species was introduced to control weeds in eutrophied lakes. However, it now causes significant damage to native wetland vegetation that is important for reducing nutrients in water-bodies.
Gypsy moth (*Lymantria dispar*)	Feeding preferentially on oak trees (*Quercus* spp.) and their relatives, this species will eat almost any plant when forced and can cause severe environmental and economic damage.
Hemlock woolly adelgid (*Adelges tsugae*)	Often called simply HWA, this species is causing severe damage to eastern hemlock (*Tsuga canadensis*) killing up to 90% of infected trees, thus greatly modifying ecosystems.
House cat (*Felis silvestris*)	House cats, both domestic and feral, can individually kill several small animals each day. Summed among the great number of house cats out-of-doors this adds up to *billions* of small amphibians, reptiles, birds, and mammals each year in the United States.
House mouse (*Mus musculus*)	Ubiquitous throughout the world, this species carries many diseases, competes directly with many native species, and can cause significant damage to crops and structures.
House sparrow (*Passer domesticus*)	Generally found any place humans are, this species can cause crop damage, but mainly competes with small, native cavity nesting birds.
Multicolored Asian ladybird beetle (*Harmonia axyridis*)	Preying on native insects and invading houses each winter, this species was likely introduced in an attempt to control non-native aphids.
Mute swan (*Cygnus olor*)	While considered pretty by some, this European invader causes significant damage to wetland vegetation that it "grubs" out during feeding. Additionally, it is fiercely competitive and will exclude all other native waterfowl from its nesting territory to the point of killing intruders.
Norway rat (*Rattus norvegicus*)	Generally a pest of human infrastructure, the Norway rat is also found around rivers and other water systems. Known as a carrier for many diseases, this species is a threat anywhere it occurs.
Rock dove / European pigeon (*Columba livia*)	Generally found around human structures, this species can cause crop damage, is a known carrier for several serious human diseases, and causes a general mess where it nests and roosts.
Rusty crayfish (*Orconectes rusticus*)	Found in many of our streams, this recent invader is displacing native crayfish, reducing fish populations by feeding on young fish, and generally disrupting aquatic systems.
Flathead catfish (*Pylodictis olivaris*)	Native to the Mississippi watershed, this species was introduced to the Delaware River watershed for sport fishing. An efficient and voracious predator, flathead catfish are known to reach over 100 lbs allowing them to prey upon almost any native species of fish.
Snakehead (*Channa* spp.)	Prized as a food species in Asia, this species was recently introduced to the East Coast and has quickly taken root. It is currently found in several ponds in the Philadelphia area.
Zebra mussel (*Dreissena polymorpha*)	Introduced from dumped ballast water, this species must be watched for given its disastrous effects on ecosystems and economies.

chestnut once comprised one-fourth to one-half of eastern U.S. forests, and was prized as a food for humans, livestock, and wildlife and for its beautiful and durable wood. Today, only stump sprouts from killed trees remain and the canopy composition has been filled by the chestnut's associate species of oaks and hickories.



photo source: Connecticut Agricultural Experiment Station Archive

Hemlock woolly adelgid infestation along a hemlock branch.

Another introduced tree-killing species is the hemlock woolly adelgid (*Adelges tsugae*). This is a small aphid-like insect that feeds on the leaves of eastern hemlock trees (*Tsuga canadensis*). Infestations of the woolly adelgid appear as whitish fluffy clumps of feeding adults and eggs along the underside of the branch tips of the hemlock. Hemlock decline and mortality typically occurs within four to ten years of initial infestation. The adelgid can cause up to 90% mortality in eastern hemlocks, which are important for shading trout streams, and provide habitat for about 90 species of birds and mammals, some exclusively. Several control options are currently being tested, but these have met with very limited success. It is currently distributed from Maine to Georgia and can be found in most of the counties in Pennsylvania (DCNR 2007d).

The gypsy moth (*Lymantria dispar*) has caused extensive defoliation of forests in the northeast. This European moth was intentionally introduced to the U.S. in 1869 as part of a failed commercial silk production venture. Its main impact is that it defoliates trees, concentrating on oak species, but opportunistically eating almost any type of plant. This defoliation can result in a reduction in the growth rate and eventual death of afflicted trees.

The European starling (*Sturnus vulgaris*) is an exotic bird species established to North America in the late 1890s and it has since spread throughout the US. In addition to competing with native bird species for food and space, large flocks of this species destroy fields of crops. The house sparrow (*Passer domesticus*) was introduced to several places in the United States in the late 1800's and has since become ubiquitous with human settlement. In addition to causing crop damage, house sparrows will kill native adult cavity nesting birds and their young and smash unattended eggs. The house sparrow is partially responsible for a decline of eastern bluebirds (*Sialia sialis*) in the United States.



photo source: M. C. Barnhart http://unionid.missouristate.edu/

Fatmucket (*Lampsilis siliquoidea*) covered in zebra mussels (*Dreissena polymorpha*)

Several invasive animal species are spreading throughout the streams, rivers, and lakes of Pennsylvania, but in many cases the impact of these species remains unknown. The zebra mussel (*Dreissena polymorpha*) was accidentally introduced to the Great Lakes in the 1980's and has been spreading in Pennsylvania's waters. This mussel poses a great threat to industry, recreation, and native fish and mussel species and should be controlled wherever it occurs. Another non-native bivalve, the Asian clam (*Corbicula fluminea*), has spread throughout most of Pennsylvania's waterways including the Schuylkill, Delaware, and their tributaries. Of greatest concern to biodiversity is the capacity of the clam to alter the ecology of aquatic systems, making it less hospitable to the native assemblage of freshwater mussels, fish,

invertebrates, and plants. Another aquatic species found in the County, the rusty crayfish (*Orconectes rusticus*), has been transplanted from its native range in the Midwestern United States to many of Pennsylvania's watersheds in the form of live fishing bait even though it is prohibited from transport by the state. Potentially, rusty crayfish can reproduce in large numbers and reduce lake and stream vegetation, depriving native fish and their prey of cover and food. Their size and aggressive nature keep many fish species from feeding on them. Rusty crayfish may also reduce native crayfish, freshwater mussels, and reptile and amphibian populations by out-competing them for food and habitat or by preying directly on young individuals.

An additional threat in urban areas is large flocks of resident Canada goose (*Branta canadensis*). These flocks have lost the incentive to migrate due to human modification to the environment that have suppressed the number of predators, create open water year round, and provide a constant supply of food. These large flocks can do significant damage to native vegetation (both aquatic and terrestrial) and contribute to nutrient loading of lake, rivers, and lawns. Large resident populations of waterfowl may also become repositories for pathogens, which they continually reintroduce into the environment.

Overall Invasive Recommendations

The prevalence of invasive species within Delaware County presents a significant hurdle to the reestablishment of native plants and animals. Additionally, new invasive species continue to be introduced, further degrading natural habitat and displacing native species. This continuous disturbance from invasive species mandates their active management for any native vegetation restoration plan to be successful.

The County has many areas managed for native vegetation, but these sites are threatened by invasive species. Successful control of invasive species is a time-, labor-, and resource-intensive process, but it is also necessary for native areas to survive. Prevention or control during the early stages of an infestation is the best strategy. In areas where invasive plants are well established, multiple control strategies and follow-up treatments may be necessary. After the infestation has been eliminated, regular "maintenance" of the site to prevent a new infestation may also be needed. Specific treatment depends on the target species' biological characteristics and population size. Invasive plants can be controlled using biological, mechanical, or chemical methods.

The following are presented as ways to deal with invasive species in the region:

- Natural Heritage sites in this report can serve as useful high conservation value "focus areas" for the control of invasive species.
- Many education resources exist regarding invasive exotic species. Regional groups such as the Mid-Atlantic Exotic Pest Plant Council (http://www.ma-eppc.org/) can help with funding opportunities and educational outreach on invasive species.
- Weed warrior programs can be used to educate the public on the identity and consequences of invasive species and involve them in the removal of invasive species. Urban Weed Warrior programs have been initiated in large cities around the world as partnerships between private non-profit organization, city governments, and the people.
- Pennsylvania has a Noxious Weed law that prevents the propagation, sale, or transport of several weed species within the Commonwealth (http://www.agriculture.state.pa.us/agriculture/lib/agriculture/plantindustryfiles/NoxiousWeedLawSummary.pdf). Most of the 13 species that are currently listed are agricultural weeds that rarely threaten natural areas; however several are invasive in non-agricultural settings. The Pennsylvania Fish and Boat Commission maintains a list of aquatic nuisance species that are prohibited from possession, sale, barter, or distribution within the Commonwealth (http://www.fish.state.pa.us/ais.htm). This list includes the zebra mussel and the rusty crayfish among others. See table 6 for the complete list of prohibited species.

After intensive removal of invasive species, restoration of natural habitats through replanting with native species is often needed. Nurseries, landscape architects, and horticultural professionals can assist with native plant restoration. Complete eradication of invasive non-native plants from a site may not be completely achieved, but it is possible to reduce infestations within native plant communities to a level which can be routinely maintained. Control of invasive plants is critical to the long-term protection of Pennsylvania's natural areas and rare species. An excellent resource for information on Pennsylvania's native horticulture friendly plants can be found at: http://www.dcnr.state.pa.us/forestry/wildplant/native.aspx.

Additional references on invasive plant species and using native plant species in plantings include two Pennsylvania Department of Conservation and Natural Resources publications:





http://www.dcnr.state.pa.us/forestry/wildplant/invasive.aspx
http://www.dcnr.state.pa.us/forestry/wildplant/native.aspx

Table 6. Noxious Species List for Pennsylvania. Possession, propagation, transport, barter, and/or sale of these species is prohibited in Pennsylvania.

Common Name	Scientific Name
	Plants
Bull or spear thistle	*Cirsium vulgare*
Canadian thistle	*Cirsium arvense*
Giant hogweed	*Heracleum mantegazzianum*
Goatsrue	*Galega officinalis*
Jimsonweed	*Datura stramonium*
Johnson grass	*Sorghum halepense*
Kudzu-vine	*Pueraria lobata*
Marijuana	*Cannabis sativa*
Mile-a-minute	*Polygonum perfoliatum*
Multiflora rose	*Rosa multiflora*
Musk or nodding thistle	*Carduus nutans*
Purple loosestrife	*Lythrum salicaria*
Shattercane	*Sorghum bicolor*
	Fish
Bighead carp	*Hypophtalmichtys nobilis*
Black carp	*Mylopharyngodon piceus*
European rudd	*Scardinius erythrophthalmus*
Round goby	*Neogobius melanostomus*
Ruffe	*Gymnocephalus cernuus*
Silver carp	*Hypophtalmichtys molitrix*
Snakehead	*Channa* spp.
Tubenose goby	*Proterothinus marmoratus*
	Invertebrates
Quagga mussel	*Dreissena bugensis*
Rusty crayfish	*Orconectes rusticus*
Zebra mussel	*Dreissena polymorpha*

A Review Of The Animals Of Delaware County

Although this Natural Heritage Inventory focuses on the rare, threatened, and endangered species and the habitats that compose the biodiversity found within Delaware County, this region is home to a great number of more common species. The following section provides an overview of these species and makes general conservation recommendations for these taxa.

Mammals of Delaware County

Delaware County contains large populations of white-tailed deer (*Odocoileus virginianus*) where moderately small woodlands and forests abut the remaining agricultural lands and suburban development. Unlike much of Pennsylvania, deer hunting in Delaware County is not a common activity as land access to hunters is often limited. Vast areas of the County are closed to hunting due to development pressure and urban sprawl.



Charlie Eichelberger (PNHP)

White-tailed deer thrive in Delaware County. Development limits hunting opportunities and the overpopulation of deer places a heavy strain on the patches of remaining habitat in the County.



Charlie Eichelberger (PNHP)

A dramatic browse line and homogenous understory due to an over-abundant deer population.

This overpopulation of deer, along with limited access to deer hunting in certain areas, has led to increased conflicts between deer and the residents of Delaware County and has negatively impacted many native species, both plant and animal. Deer will browse all typical forested habitats until food resources are low and then turn to agricultural crops as well as ornamental plantings such as those found around housing developments. As they become more reliant on non-typical food resources, populations continue to grow unchecked by traditional game management techniques. A multitude of scientific studies have shown that deer populations in the state remain elevated in this portion of the state, and the annual allocation of antlerless deer tags in the Wildlife Management Units within Delaware County (WMU 5C, 5D), are unfortunately rarely fully utilized. With the light hunting pressures in Delaware County, the deer over population remains a challenge to the conservation of biodiversity.

Many other mammal species occurring throughout Delaware County are able to survive in a wide range of habitat types and are well represented throughout the County. These species are termed “generalists” and include the northern short-tailed shrew (*Blarina brevicauda*), gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), white-footed mouse (*Peromyscus leucopus*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*), and the ubiquitous chipmunk (*Tamias striatus*). All of these species occur throughout the many and diverse habitats within Delaware County, and the rest of Pennsylvania, and are in no jeopardy of disappearing from the landscape.

Other species have more restricted habitat needs and are termed “habitat specialists”. They may be restricted to grassland habitats, the forest interior, upper elevation ridgelines, wetlands and streams, or caves and mines. Examples of these species include the meadow vole (*Microtus pennsylvanicus*) which relies on grasslands and

meadows, bats which hibernate in caves and mines, and muskrats (*Ondatra zibethicus*) and beaver (*Castor canadensis*) both of which are specialized to live in wetlands and streams.


John White

River otter (*Lontra canadensis*)

Wetlands and streams play a major role in providing habitat for mammals as well as serving as corridors for dispersal throughout the County. One of the first environs investigated by biologists are marshes and streams, as these habitats are often sites where mammalian diversity is highest. It is not uncommon to find multiple species of shrews, rodents, and weasels along these habitats. Some of the weasels, including the ermine (*Mustela erminea*), mink (*M. vison*), and long-tailed weasel (*M. frenata*), can be found in a variety of habitats, but are frequently associated with these wetlands and waterways where prey items are abundant. Another species typically associated with wetlands is the star-nosed mole (*Condylura cristata*) which is adept at diving for aquatic invertebrate prey items. The largest member of Pennsylvania's extant weasels, the river otter (*Lontra canadensis*), was previously trapped to near extirpation but has been reintroduced to several regions of Pennsylvania and has recently been photographed using the fish ladder at the Fairmount Dam on the Schuylkill River confirming their presence in waterways adjacent to Delaware County. Another species that could possibly occur along the marshes and wetlands of Delaware County is the marsh rice rat (*Oryzomys palustris*). The marsh rice rat is a native of North America and differs from non-native Norway rat, being smaller and with softer, more colorful fur and a mouse-like face. Due to the extensive wetland degradation along the Delaware River, this species, if it ever existed in Pennsylvania, is now likely extirpated.


Dennis W. Donohue

Ground hog (*Marmota monax*)

Open land in the form of meadows and reverting grasslands can be found primarily in the western portion of Delaware County. Species of mammals known to occur within open lands include the eastern cottontail rabbit (*Sylvilagus floridanus*), woodchuck (*Marmota monax*), and meadow jumping mouse (*Zapus hudsonius*). Also found in this habitat, the southern bog lemming (*Synaptomys cooperi*), may exist in very low densities, unlike many other small rodents whose populations are consistently large. The eastern mole (*Scalopus aquaticus*) can be found in well drained soils throughout habitats harboring a wealth of subterranean invertebrates, including earthworms. These mammals offer invaluable benefits to humans, by turning over soils, and keeping some invertebrate pest species in check. Another inhabitant of these well drained areas is the woodland vole (*Microtus pinetorum*), a common species whose stronghold is in the southeastern portion of the state. One species that formerly occurred within the fields and meadows of Delaware County is the least shrew (*Cryptotis parva*), a small mammal species that is currently listed as "state endangered". Once common throughout much of Pennsylvania, only a handful of sites are known to harbor this insectivore. Historically the species was widespread throughout much of the state, occurring in early successional fields and meadows that were kept open by rotational cropping practices or intensive forestry practices. Today it is only known from Adams and York Counties.

The remaining forested tracts of Delaware County, while relatively small, are also important habitat for the regions mammals. The gray fox (*Urocyon cinereoargenteus*) is primarily a denizen of forests, though it may also be found foraging in more open habitats. This native fox is known to be an adept tree climber, and feeds on rabbits and other small mammals. Also living in forested habitats is the southern red-backed vole (*Myodes gapperi*). This species serves as an important food source for many other mammals, as well as birds of prey. The masked shrew (*Sorex cinereus*) and Maryland shrew (*Sorex fontinalis*) are found in a number of different habitats,

but tend to prefer cool, moist forests and woodlands. These shrews can also be found close to waterways where insect populations, the major food source for these species, are healthy.

Favoring conifer patches, the red squirrel (*Tamiasciurus hudsonicus*) is much smaller than the more common widespread gray squirrel. Though much smaller than it's larger gray cousin, the red squirrel is highly territorial, and it's loud staccato "cherr" is used to fend off potential predators. The native fox squirrel (*Sciurus niger*) prefers floodplain forests, and possibly occurs in Delaware County. Little is known about the distribution of the fox squirrels in the southeastern portion of the state, however the range of the federally endangered subspecies of the fox squirrel, the Delmarva fox squirrel (*Sciurus niger cinereus*), once was noted from this portion of the state. An attempt at reintroduction of the Delmarva fox squirrel along the Delaware and Chester County line has thought to have been unsuccessful. The nocturnal southern flying squirrel (*Glaucomys volans*) is also known from Delaware County, living in mixed forests with adequate tree cavities, in which they nest.

Bats are common but declining residents of Delaware County, most often encountered during the summer months along the streams and open bodies of water. The little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), northern myotis (*M. septentrionalis*), and eastern pipestrelle (*Perimyotis subflavus*) are all year round residents of Pennsylvania. These bats spend the active season foraging along waterways and rearing young in forested areas with dead woody timber, or in some cases in man made structures like garages, barns, and sheds and during the winter hibernate in caves and mines. The state threatened eastern small-footed bat (*Myotis leibii*) may occur in Delaware County, and raises its young among rocky outcrops and boulder fields where crevices provide ample cover to avoid predators. All of Pennsylvania's year round resident bats are being affected by a deadly fungus which attacks them while in hibernation. Known as white-nose syndrome (WNS), the fungus takes advantage of the periods of inactivity during hibernation where it overwhelms the exposed portions of the bats skin, causing them to rouse and eventually use up their fat reserves. While most of Delaware County's bats disappear into caves and mines to hibernate during the winter, several species such as the hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), and silver-haired bat (*Lasionycteris noctivagans*) do not over-winter in the state at all and migrate further south to states like the Carolinas and Florida and are thought to spend their winter months in hibernation under deep patches of leaf and forest floor litter.



Charlie Eichelberger (PNHP)

In 2009, White-Nose-Syndrome (WNS), which was first found in New York State in 2006, showed up in several locations in Pennsylvania. Causing mass mortality within infected sites, WNS has the potential to wipe out cave bats in Pennsylvania. The spread has been rapid, and so far, there is little hope that the spread of the disease can or will be controlled. Bats play a key role in forest ecology, and the loss of this suite of unique animals will undoubtedly cause pest insect populations to rise dramatically. Bat conservation should be considered a top priority over the coming years, with the hope that at least some of Pennsylvania's cave bats will survive. For more information, visit www.batcon.org

Unfortunately, several invasive mammal species are widespread throughout Delaware County. Frequently encountered in urban and suburban areas, the Norway rat (*Rattus norvegicus*) and house mouse (*Mus musculus*), both old world species, have become well established. These two introduced species are the true pests of the County, being nuisance to residents, causing much damage to farmer's crops, competing with native species, and altering natural food webs.

With Delaware County's early conversion from pre-colonial virgin forests to a primarily agrarian landscape, the mammalian fauna of the County was likely one of the earliest in the state to be altered by European colonization. While this change increased the populations of species adapted to more open environments, a corresponding loss of those species considered incompatible with human land use occurred. Lost from the County's mammalian fauna were the bison, elk, martin, fisher, mountain lion, and gray wolf. Though these species would never be able

to be reintroduced to the County for many reasons, some mammals formerly abundant in Delaware County may someday benefit from reintroduction programs, including the least shrew and Delmarva fox squirrel.



photo source: Wikimedia Commons

Raccoons (*Procyon lotor*) and skunks (*Mephitis mephitis*) have adapted easily to human-modified environments.

Monitoring of existing populations of the mammal species of the County could provide a better picture of the conservation needs of the County's mammals. Of utmost importance to the diversity of Delaware County's mammals, is the maintenance of acreage of fallow fields (instead of row crops), avoidance of fragmentation of the remaining forested patches, and protection of existing riparian corridors and wetlands. The potential restoration of previously destroyed wetlands is needed to secure those mammal species that live in these declining environs. Though humans can provide this type of habitat restoration, the long term effects that beavers may play in modifying wetland systems may naturally allow for this restoration over time. These restored habitats would serve a multitude of mammal species, as well as many other species of plants and animals, both common and rare, in the County.

Delaware County is diverse in terms of the habitats available to the mammal fauna of Pennsylvania. While the enormous forested blocks common in the north-central part of the state are absent from Delaware County, the remaining riparian corridors still provide relatively good habitat for many species of mammals and serve as avenues of dispersal. Development of land, splitting of habitats by un-crossable barriers such as major highways, drainage of wetland areas and environmental degradation have all served to confine many mammal species to localized populations that become limited in their ability to survive any major change in food resources, availability of habitat, or increased predation. These populations may be doomed to what is termed as "localized extinction". If enough of these populations disappear from the landscape, these species' existence in Pennsylvania may be in jeopardy. Continued vigilance as well as enlightened management will ensure that this list will not be shortened and may grow in the future providing opportunities to all Pennsylvanians to enjoy the state's mammalian wildlife.



Kansas Department of Parks and recreation

American beaver (*Castor canadensis*)

Important Mammal Areas

One Important Mammal Area (IMA) has been designated in Delaware County. The John Heinz National Wildlife Refuge is listed as an area important to the conservation and protection of the states mammal populations under the IMA program developed by the Pennsylvania Biological Survey. The area is noted as supporting northern river otter use on occasion and being the last potential location for the marsh rice rat in the Commonwealth.

Conservation

Conservation of this IMA should be focused on improving the water quality of the area. Continued control of non-native invasive species on the refuge will be needed to maintain the habitat, along with restoration of native vegetation in the managed areas. Management of the local deer herd, non-migratory Canada goose, and carp populations will be needed to maintain and restore the vegetation in the respective habitats.

Birds of Delaware County

Pennsylvania is an important state for breeding, migrating, and wintering birds (Brauning 1992). Delaware County, with its proximity to Tinicum Marsh, the Delaware Bay, and the Delaware River, presents a wide range of habitats for birds. The habitat types include the remnant tidal marsh of Tinicum, upland woods and grasslands, riparian corridors and expansive riverine areas, and the urban environment. Several of these important habitats are being negatively affected by land use choices both within and beyond the county line. The protection and responsible management of these ecosystems is necessary for the maintenance of healthy bird populations.



photo source: Joe Kosack/PGC Photo

Peregrine Falcon (*Falco peregrinus*)

Additionally, because of County's proximity to many important migratory areas, it serves as a major resting stop for migratory birds traveling along the Atlantic Flyway. It is not uncommon for several hundred different species of birds to pass through the Delaware County area over the course of the year.

Urban Species

The urban landscape that covers much of the County area offers habitat for many common bird species. These are species that can not only find habitat for feeding, nesting, and hiding in an urban setting, but can also adapt to the pressures of continued close encounters with humans. In densely populated areas the species that are able to adapt to these conditions are limited. In more suburban areas or neighborhoods with greater tree cover this list can rapidly increase as more habitat niches become available.

The urban environment has even become as a refuge for rare species in some instances. The Peregrine Falcon (*Falco peregrinus*) nearly went extinct due to the effects of DDT and other organochlorine pesticides. These chemicals cause the bird eggshells to become so thin that the nesting parent would crack the eggs at the slightest bump and kill the chick inside. This eggshell thinning affected many species and nearly drove some to extinction and extirpated others from much of their range. However, the Peregrine Falcon, historically nesting on steep rock cliffs, readily took to nesting on top of tall buildings in urban areas. This allowed resource conservation specialists easy access (via the elevator!) to the nests, where they collected the eggs, carefully hatched them in a controlled environment, and then returned the chicks to the parents without the parents ever knowing. Today the affects of DDT have subsided enough that Peregrine Falcons are now able to raise their chicks without human assistance and may be seen chasing the Pigeons along the Delaware River shoreline on any average summer day.

Forest Species and Edge Habitat

Large contiguous tracts of forests, necessary for forest interior species, are declining in most regions. This is true in Delaware County where even the large forested blocks within Ridley Creek State Park are bisected by roads, paths, and trails. Fragmentation and smaller interior area negatively affects the nesting success of forest interior bird species (Whitcomb et al. 1981). Increased forest edges exposes nesting birds to greater dangers such as brood parasitism and nest predation (Robinson 1994). For example, interior birds nesting near edges are more often parasitized by Brown-headed Cowbirds (*Molothrus ater*), which lay their eggs in other bird nests where they are raised at the resident bird's expense.

However, several bird species are specially adapted to the forest edge and "old field" habitat types and are found within the County. Good examples of this habitat type can be found scattered throughout the County. This successional habitat is generally short lived and acts as suitable habitat for these species for only 10 to 30 years. After that, the vegetation age and structure becomes too forest-like and these species move away. Additionally, this habitat type is very susceptible to invasion by non-native plant species that decrease the value for nesting birds. Maintaining this habitat type through periodic management and control of invasive plant species can help preserve these species within the County.

Grassland Birds

Grasslands and open fields create a unique habitat for a variety of bird species. Historically, grasslands were not a dominant part of the northeastern United States landscape, but were present and extensive in some areas. Delaware County would have had extensive grassland-like areas within the tidal marshes found in the area. Although more grassland has been created in this historically forested state, a large number of grassland birds appear to be declining throughout the eastern US as documented in the American Breeding Bird Survey (Sauer et al. 2008). Most grassland birds, including common species, show a decline of around 40 to 60% (Sauer et al. 2008). Their decline has resulted from increasingly intensive agricultural practices, habitat fragmentation, increased pesticide and herbicide application, natural fire suppression, and human development of the landscape.

Marsh, Wetland, and Riparian Dependent Birds

Wetlands and riparian zones are an imperiled habitat across the commonwealth and the nation (Myers et al. 2000). From 1956-1979, 38% of Pennsylvania's wetlands with emergent vegetation were drained, filled, or succumbed to succession (Tiner 1990). Of the 1,900 species of breeding birds in North America, 138 require wetlands to survive.

Wetlands are transitional lands between terrestrial and aquatic systems and have high species diversity and exceptional environmental value. Saturation by water determines the soil development, which in turn influences the type of plants and animals using that habitat. Wetlands range in size from very small vernal pools to massive complexes; the associated plants and animals are just as varied. Common wetland birds include waterfowl, shorebirds, herons, rails, bitterns, swallows, and sparrows to name a few. Many wetland-dependent birds are of special concern to the Pennsylvania Natural Heritage Program (PNHP) because of habitat loss across their range. Many of these birds are also secretive, cryptic, and hard to flush, making marshes difficult areas to survey. These species are also very habitat specific and unknown from other habitats.

Wetlands and riparian zones also provide breeding and foraging habitat for various raptors and wading birds. Raptors, such as the Osprey and Bald Eagle, prefer nesting on top of tall trees with a good view of the surrounding land. Wading birds, such as herons and egrets, prefer clumps of dead trees surrounded by water for their rookeries. Trees around wetlands often provide the nesting habitat these species require with all of these species often found around rivers and wetlands at the same time. Species, such as the Double-crested Cormorant (*Phalacrocorax auritus*), are very common along the Delaware River shoreline and are regularly seen on the buoys in the river.

Conservation and management programs for marsh birds are critical to sustaining healthy populations of breeding birds as well as general ecosystem viability. Immediate needs include the preservation of emergent wetlands that provide nesting, feeding, and wintering habitats. Primary management needs include the protection of wetlands from draining and filling, pollution, siltation, and invasion by exotic plant species.

Delaware County abuts the largest tidal marsh remaining in Pennsylvania. Tinicum Marsh, residing within the John Heinz National Wildlife Refuge, contains around 200 acres of remnant tidal wetland. Originally covering between 10 and 20 square miles (6,400-12,800 acres), this wetland has been severely modified by



photo source: Andrew Strassman, PNHP

Great Black-backed Gull (*Larus marinus*)

human activity through diking, dredging, and filling. Despite these activities the wetland still supports populations of several Pennsylvania rare, threatened, and endangered species. In addition, Tinicum Marsh is a feeding and nesting location for many wetland and upland species and a migratory stopover point for hundreds of thousands of birds each spring and fall.

Open-water Dependent Birds

Several species generally found over the open waters of the Delaware Bay and Atlantic Ocean wander to the shoreline of the Delaware River on a regular basis. These species, sometimes termed pelagic species, generally do not nest in the area, but are in search of areas to feed, rest, and mature before they return to their nesting grounds or the open ocean. Species like the Great Black-backed Gull (*Larus marinus*) are uncommon residents of the area, while species like the Iceland Gull (*Larus glaucoides*) appear rarely, but regularly, during the deep of winter. Others, like Leach's Storm-petrel (*Oceanodroma leucorhoa*), visit the area on occasion as they travel up and down the coast in search of food.

The needs of all of these species are similar. They need safe places to roost either on shore or on open water and quality water to feed in. Pollution in the form of chemicals (oil, industrial effluent, agricultural runoff, etc.) garbage (plastic bags, tires, foam cups, golf balls, etc.), sewage, and noise and light pollution all have a direct negative effect on these species. These environmental degradations reduce the benefit birds receive from staying along the river in this area and forces them to other location.

Migratory Birds in Delaware County

Delaware County is located within the Atlantic Flyway, which stretches from the shores of Greenland south along the Atlantic seaboard of North America to the tip of Florida. This flyway opens the area up to Arctic species in the winter, tropical species in the summer, and a wide range of boreal, temperate, and coastal species during migration. Additionally, the city's location within the landscape helps to funnel birds through the area; spring migrants follow the shoreline of Delaware Bay to the city while fall migrants follow the river-course of the Delaware back south. This density and diversity of migratory birds makes Delaware County a preeminent city for birding. It also increases the importance of maintaining adequate habitat within the city to give migratory birds the opportunity to rest and "refuel".

Because migratory birds have not adapted as quickly as humans have modified the landscape around the County, it is not uncommon to see migratory birds from a diverse suite of ecosystems gathered in the available natural habitat within the area. Ridley Creek State Park and John Heinz NWR are well known as regional birding hotspots, but it is not uncommon to see a diverse group of migratory birds in small neighborhood parks or even along tree-lined streets.

This concentration of birds makes the protection and preservation of a matrix of natural areas within the County vital for migratory birds. Areas such as Darlington Tract regularly host large aggregations of birds during migration. These natural areas, as higher quality habitat, attract birds away from otherwise sub-standard or dangerous areas. In the absence of this habitat these individuals would be forced to use whatever habitat is available, whether it is suitable, such as a neighborhood park, or disastrous, such as a roadway.

Important Bird Areas in Delaware County

In an effort to conserve the Commonwealth's avifauna, the Pennsylvania chapter of the National Audubon Society, along with the Pennsylvania Ornithological Technical Committee of the Pennsylvania Biological Survey, has identified 85 areas within the state that it considers to be a part of a global network of places recognized for their outstanding value to bird conservation. Termed Important Bird Areas, or IBAs, two of these areas occur within Delaware County. The County's IBAs highlight what is considered to be critical bird habitat for both common and rare birds. More information about the IBA Program can be found at Audubon PA's website (http://pa.audubon.org/).

The County's IBAs are the John Heinz NWR at Tinicum and Mud Island IBA, and the Upper Ridley–Crum Creek IBA (Fig. 5). The IBAs extend beyond the County's border; therefore, features described below pertain to the entire IBA and are not necessarily confined to the County.

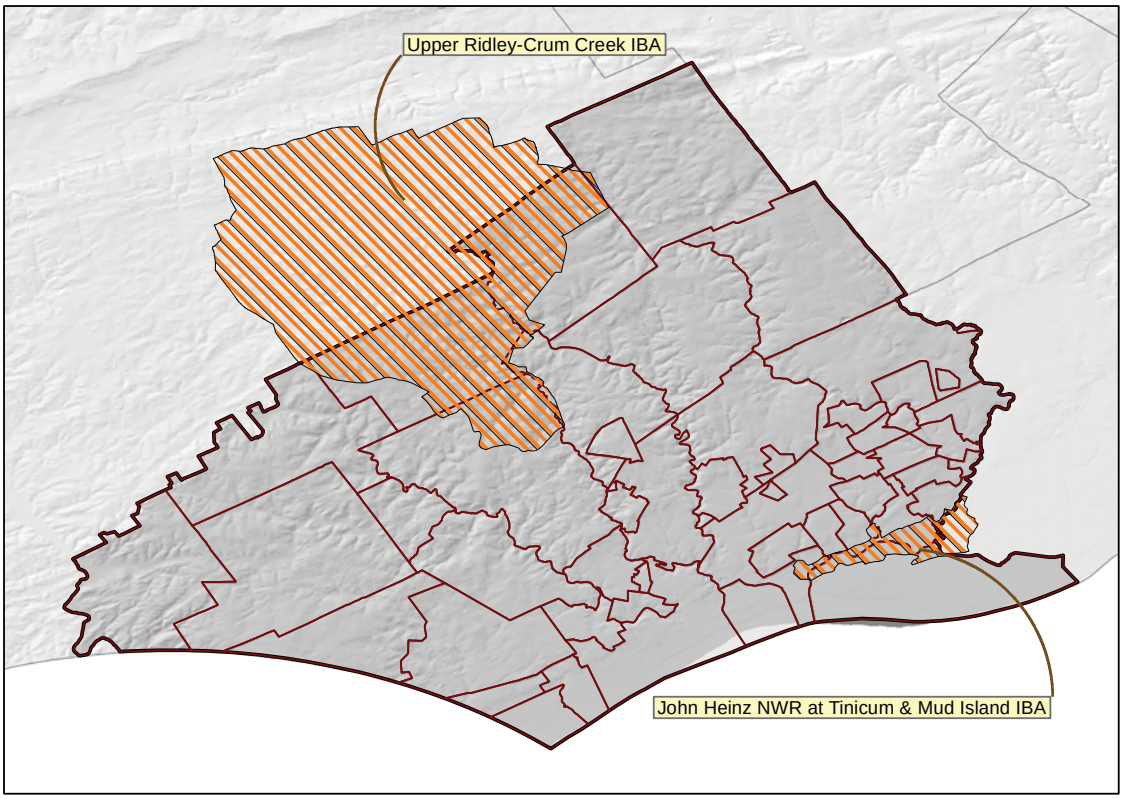


Figure 5. Important Bird Areas of Delaware County

<u>John Heinz NWR at Tinicum and Mud Island IBA</u>
This IBA is composed of the John Heinz NWR (Tinicum Marsh), Little Tinicum Island, and the connecting waters and surrounding land. This area is a critically important wildlife oasis in urbanized southeastern Pennsylvania. Its neighbors include the Philadelphia International Airport, several major thoroughfares, and extensive urban development and infrastructure.

This IBA is a critical migratory stopover for birds using the Atlantic Flyway in spring and fall. It also supports breeding for many state threatened and endangered species during the summer, as well as many neotropical migrants that are of increasing conservation concern.

Tinicum Marsh is the largest freshwater tidal marsh remaining in the Commonwealth, and it is only a vestige of the marsh that once covered the site. This small remnant now comprises approximately 80% of the state's coastal wetland habitat.

This area satisfies the following IBA criteria:

- Hosts thousands of migratory waterfowl and tens of thousands of migratory shorebirds during the spring and fall migration.
- Supports breeding populations of several state species of concern including American and Least Bittern, various rails, and Marsh Wrens.
- Provides foraging habitat for several Pennsylvania species of concern including Bald Eagle, Osprey, Peregrine Falcon, Great Blue Heron, and Great Egret.

Conservation

Conservation of this IBA should be focused on mitigating the water quality of inflow from Darby Creek and contamination from the Lower Darby Creek Superfund Site. Continued control of non-native invasive species on the refuge will be needed to maintain the habitat, along with restoration of native vegetation in the managed areas. Management of the local deer herd, non-migratory Canada Goose, and carp populations will be needed to maintain and restore the vegetation in the respective habitats.

Upper Ridley-Crum Creek IBA

This IBA is composed of the combined area of Ridley Creek State Park, the Tyler Arboretum, and several other public and privately owned lands in Delaware and Chester Counties (29,000 acres).

This area satisfies the following IBA criteria:

- Hosts over 195 species of birds known to breed or migrate through the IBA.
- Hosts breeding populations of bird species rare in southeastern PA.
- Maintains forest thicket habitat, which is decreasing in the region.

Conservation

This site maintains some of the last forested area within Delaware County, but it is being impacted by deer browse. This browse is reducing or eliminating the ground-cover required by numerous species of forest bird. Control of the deer and predators of ground nesting birds may be needed to protect these species.

Bird Regulations and Protection

The Pennsylvania Game Commission has the ownership, control, and jurisdiction of the birds within the commonwealth. Rules and Regulations on the taking of wildlife can be found through consultation with the PGC.

Many bird species are also protected through international treaties and federal and state laws such as the Migratory Bird Treaty Act and the Endangered Species Act (US Fish and Wildlife Service 2007).

Pennsylvania's Breeding Bird Atlas

The 2nd Pennsylvania Breeding Bird Atlas is the most extensive survey of the state's nesting birds ever attempted. More information about the breeding bird atlas can be found at http://www.carnegiemnh.org/atlas/

Reptiles and Amphibians of Delaware County

Pennsylvania's mixed landscapes provide diverse habitats for many species of reptiles and amphibians, a group collectively known as the "herpetofauna". The ranges of most Pennsylvania reptiles and amphibians are restricted to certain regions of the state, a testament to the varied topography and physiographic provinces of the Commonwealth. Today, Pennsylvania is home to 76 native herptile species, including those found in the glaciated regions of the Canadian Shield, many of the southern species from the lower regions of the Appalachians, several associated with western prairies, and a few connected with coastal habitats.



Charlie Eichelberger (PNHP)

Green Frog (*Lithobates clamitans*)

Delaware County is split between the Piedmont and Coastal Plain physiographic provinces. Pennsylvania's Coastal Plain is found in the eastern portion of Delaware County, and follows a band just a few miles deep, along the lower Delaware River. This portion of the state is one of the most highly developed, and correspondingly, the remaining areas of undeveloped Coastal Plain are a both unique and rare. The amount of habitat destruction in the eastern portion of Delaware County has dramatically decreased the overall diversity of reptile and amphibian species, and several inhabiting the Coastal Plain are considered species of concern. A number of herptiles are listed by the Pennsylvania Fish & Boat Commission as threatened or endangered, not only because there is little habitat left for them in Pennsylvania, but also because of the continued development pressure on these unique remaining habitats.

Despite the large-scale change from an agrarian landscape to a primarily suburban landscape, some sizable tracts of habitat remain in Delaware County, particularly in the public park systems. The Brandywine, Ridley, Darby, Crum, Cobbs, and Chester Creeks follow the most natural drainages in the County, and consequently house much of the herpetological diversity. These areas, while small when compared to other portions of the state, provide the most contiguous habitat for Delaware County's herptiles.

Delaware County is home to a number of common, generalist species, such as the eastern garter snake (*Thamnophis sirtalis*), the bull and green frogs (*Lithobates catesbeianus, L. clamitans*), the red-spotted newt (*Notophthalmus viridescens*), and the painted and snapping turtles (*Chrysemys picta, Chelydra serpentina*). These species occur in many different habitats, exist throughout the entire state, and are the most commonly encountered reptiles and amphibians in the Commonwealth. Along with these common species, Delaware County includes several less common species of herptiles. Many of these species have restricted ranges or are considered specialists, meaning their life histories have more specific habitat requirements.

Salamanders

The terrestrial woodland salamanders depend on canopied forests with adequate amounts of leaf litter. These salamanders are voracious predators of the forest floor. Their role in limiting the numbers of leaf decomposing invertebrates has been shown to be significant in maintaining a rich layer of organic matter on the forest floor, often an indicator of forest health. The red-backed and slimy salamanders (*Plethodon cinereus, P. glutinosis*) are the most common woodland species in Delaware County's forests.

The numerous waterways and streams of Delaware County provide habitat for the brook salamanders, including the northern dusky salamander (*Desmognathus fuscus*), the northern two-lined and long-tailed salamanders (*Eurycea bislineata, E. longicauda*). The northern red salamander (*Pseudotriton ruber*) is an infrequent, but persistent resident along the high quality drainages of the County. All of the streamside

salamanders require high water quality. Amphibians as a whole are particularly sensitive to pollution. Consequently, pollutants can be detrimental to the amphibians inhabiting affected streams.

Temporary wetlands are critical to a group of amphibians that rely on the wet/dry annual cycle that eliminates the possibility of fish populations being established. Temporary wetlands serve as critical breeding habitat for the spotted and marbled salamanders (*Ambystoma maculatum, A. opacum*). Suitable shallow, temporary wetlands used by these species for breeding are rare in the County, and therefore Delaware County may only support smaller isolated populations of these species. Also found breeding along these temporary wetlands, as well as along cool flowing streams, is the four-toed salamander (*Hemidactylium scutatum*). This species lays its eggs in vertical mats of Sphagnum moss overhanging cool water. As the eggs hatch, the larvae wriggle down into the water where they stay until metamorphosing into adults.

Frogs and Toads

The wood frog (*L. sylvaticus*), like the Ambystomatid salamanders discussed earlier, is considered a vernal pool obligate species, however wood frogs are one of the more "liberal" vernal pool species and can also be found breeding in shallow marshes and ditches. The American toad (*Anaxyrus americanus*), spring peeper (*Pseudacris crucifer*), and grey tree frog (*Hyla versicolor*), are regular visitors to many different types of wetlands where they breed and forage. Shallow wetlands, or shallow margins to deeper wetlands with emergent vegetation are important for these species for cover, food, and for development of eggs and young.



Charlie Eichelberger (PNHP)

Southern Leopard Frog (*Lithobates sphenocephala*)

The Fowler's toad (*A. fowleri*) is generally less common than the related American toad, and prefers the sandier soils frequently found in the Coastal Plain. The pickerel frog (*L. palustris*) requires heavily vegetated streams and creeks and is found along Delaware County's waterways.

The New Jersey chorus frog (*Pseudacris kalmi*) can be found in herbaceous marshes, riparian backwaters, and ephemeral wetlands where there is plenty of cover among the grasses and sedges. This species has declined precipitously in the past few decades because of habitat loss and is accordingly listed as an endangered species in Pennsylvania. The southern leopard frog (*L. sphenocephala*) can be found breeding in shallow open pools. Known for its characteristic call, sounding like muffled laughing, this species is listed as endangered in Pennsylvania. Though they are certainly rare, little is known about the status of the populations of these species in the state, and dedicated searches should be conducted to establish where the species and habitat for the species still exist.

Turtles

The spotted turtle (*Clemmys guttata*) is a small semi-aquatic turtle that can inhabit a range of wetlands, from vernal pools, to wet meadows, marshes, and slow moving streams. Spotted turtles are becoming increasingly rare in the state because of habitat loss, predation, and illegal collection. The semi-aquatic wood turtle (*Glyptemys insculpta*) relies on wooded creeks and rivers, and while it can be locally common in areas, the species is becoming increasingly rare across its range. The stinkpot turtle (*Sternotherus odoratus*) inhabits most moderate-to-large wetlands, though it is infrequently encountered because of its secretive nature. Found along the Delaware River, the map turtle (*Graptemys geographica*) is a riverine species, usually inhabiting moving water systems in Pennsylvania. The eastern box turtle (*Terrapene carolina*) is an easily recognized species still found in pockets of woodlands in Delaware County. While this species is still considered common, with a lifespan that may reach beyond a century, many biologists believe that box turtle populations have been in a steady decline due to road mortality and predation on nests and juveniles. Turtle nests are laid in suitable substrates with sun exposure, frequently along waterways. These sites are used by many nesting

females and are easily targeted by overpopulations of raccoons, skunks, and opossums, which can thrive in urban and suburban areas. There is growing concern for many of Pennsylvania's turtles, because numerous populations are nearly void of juvenile turtles, indicating that there is little successful reproduction occurring.


Charlie Eichelberger (PNHP)

Bog Turtle (*Glyptemys muhlenbergii*)

Two of Pennsylvania's rarest turtles are found in Delaware County. The bog turtle (*Glyptemys muhlenbergii*), is a federally threatened species and is listed as state endangered. This species has suffered severe declines due to habitat destruction, habitat fragmentation, illegal collection, and predation. The distinctive orange spots on either side of the neck are the most obvious identifying character. Bog turtles are habitat specialists, requiring open herbaceous wetlands with spring fed water and mucky soils. The red-bellied turtle (*Pseudemys rubriventris*) is listed as a Pennsylvania threatened species. The very restricted range of this species is confined to the southeastern counties of Pennsylvania. One of the concerns for this species is the introduction of the invasive sliders (*Trachemys scripta*). These turtles are native to the southeastern US, and are now widely distributed outside of its native range, a result of pet owners releasing their turtles (a practice that is illegal in the state). There is concern that the sliders may be displacing the red-bellied turtle. Red-bellied turtles are also known to travel considerable distances from their aquatic habitats in order to lay their eggs. As these females move across land in search of suitable nesting habitats, they face an onslaught of threats, including predation and road mortality.

The eastern mud turtle (*Kinosternon subrubrum*) has historically been known from Delaware County. A very secretive turtle, the mud turtle may still exist in small pockets of habitat in the County, and dedicated search efforts should be conducted to find out if this species still exists in the County. The eastern spiny softshell (*Apalone spinifera*) is native to the Ohio River drainage, however, a population was established in New Jersey decades ago and has been spreading steadily ever since. More recently, spiny softshells have been showing up in the Delaware River drainage, and if the species has not yet been seen in Delaware County yet, it will likely show up soon.

Lizards and Snakes

The ranges of the northern fence lizard (*Sceloporus undulatus*) and the five-lined skink (*Plestiodon faciatus*) enter Delaware County. These species occur in relatively small, isolated populations in dry habitats with an abundance of cover objects and basking areas and are particularly susceptible to localized extinction because of their populations' small sizes and isolation from other lizard populations.

The eastern ribbon snake (*Thamnophis sauritus*), a slender species of garter snake, depends on the sedge and grass covered edges of wetlands and is thought to be declining due to wetland destruction. The northern black racer (*Coluber constrictor*) and the black rat snake (*Pantherophis alleghaniensis*) are two of the larger snakes in the Commonwealth and can still be found within the borders of Delaware County. These large predators feast on small mammals including mice and rats. The brilliantly patterned eastern milk snake (*Lampropeltis triagulatum*) can be found in a variety of habitats and though it is common, this species is rather secretive and is rarely seen. A more frequently observed snake, northern water snake (*Nerodia sipedon*) is a widespread resident of Delaware County. This species hunts along open waterways, searching for amphibians and small fish. At times overlapping habitats with the northern watersnake is the queen snake (*Regina septemvittata*). This snake is smaller than the northern watersnake, with an unpatterned olive-brown back, and a belly that is yellowish tan which is striped with four black bands that run the length of the snake. This species is specialized to feed on crayfish, and is thought to be declining in the state because of water pollution.



Charlie Eichelberger (PNHP)

Northern Brown Snake (*Storeria dekayi*)

The northern brown snake (*Storeria dekayi*) and the ringneck snake (*Diadophus punctatus*) are small and secretive snakes, and are common residents of Delaware County where they are found beneath rocks and decaying wood and bark. Unlike most snake species which do not tolerate urban environments well, the brown snake can actually thrive in vacant lots in urban settings. Worm snakes (*Carphophis amoenus*) and smooth earth snakes (*Virginia valeriae*) are exclusively fossorial, meaning they spend their lives underground. Little is known about these species in the state, and although both of their ranges overlap Delaware County, they have not been recorded from the County yet. More survey work needs to be conducted to update the status of worm snakes and to determine if the smooth earth snake still exists in Pennsylvania.

Historically known from Delaware County is the northern copperhead (*Agkistrodon contortrix*), the only venomous snake species known to have inhabited the County. This species was persecuted due to its venomous nature and although they may deliver a serious bite if threatened, the danger they pose has been drastically over-exaggerated. Copperheads may no longer exist in Delaware County.

Although relatively little habitat exists within Delaware County, it remains a significant spot in the state for the Commonwealth's reptiles and amphibians due to its unique geographical location. The forested tracts, though small, and numerous waterways and wetlands provide critical habitat for reptiles and amphibians, both common and rare. Of utmost importance to the conservation of the County's herpetofauna is the protection of the remaining forests, streams, marshes, and wet meadows. Several species should be considered a priority for conservation in Delaware County, including the New Jersey chorus frog, southern leopard frog, red-bellied turtle, bog turtle, and mud turtle.

Pennsylvania Fish and Boat Commission Regulations

In Pennsylvania, the Fish and Boat Commission has jurisdiction over the reptiles and amphibians. Recently, regulations concerning the herptiles were reviewed and there have been considerable changes with how this group is managed. The regulations now include a list of "no-take" species that are thought to be declining. More information on the amphibian and reptile regulations can be found on the Fish and Boat Commission's website at http://www.fish.state.pa.us/regs_nongame.htm.

Pennsylvania Herpetological Atlas

The Pennsylvania Herpetological Atlas, begun in 1997, serves to fill some of the gaps in our knowledge of herptile distributions in the state. The atlas is a volunteer based project and citizens are encouraged to submit records for species of conservation concern to the atlas. Submissions may be made online at http://webspace.ship.edu/tjmare/herp.htm

Fish of Delaware County

Fish are just one of the diverse and interesting groups of animals found in streams, rivers, reservoirs, and lakes. Anglers appreciate sport fishes such as brook trout and smallmouth bass, but there are over 150 fish in the Commonwealth, many of which eat, reproduce, and occupy their habitats in unique and fascinating ways.

Fish eat a wide variety of items in rivers and streams. Most fish are predatory and eat other stream animals including invertebrates and other fish. Some fish will eat mollusks, crayfish, salamanders, frogs or other animals that live in or near streams. Other fish eat only plant material, like the algae that grows on the rocks on the stream bottom. The diet of predatory fish changes throughout their life; as young larval fish, many species will eat algae, plankton and other microorganisms. They will eat larger prey items as they become bigger, generally going from algae to invertebrates, and eventually to fish and other vertebrates.

Fish mating is called spawning, and many species migrate upstream to do so. As such, smaller streams can be important habitat for fishes – both for the act of spawning and the development of young fish. Many species of stream fish create nests for spawning and egg development. River chubs (*Nocomis micropogon*) assemble piles of gravel up to 24 inches wide, while brook trout (*Salvelinus fontinalis*) make nests called redds, which are trough-like depressions in the stream bottom. The orientation of the redd creates currents that supply the eggs with extra oxygen while they develop. Channel catfish (*Ictalurus punctatus*) lay their eggs in undercut banks, sunken logs, or even abandoned muskrat holes. Sunfish, such as bluegills (*Lepomis macrochirus*) and redbreast sunfish (*Lepomis auritus*), create depressions in sand and gravel on the stream bottom. The adult fish guard the developing eggs from predators and later defend the young larvae until they are able to fend for themselves.

Habitat provides food resources and shelter for fish. Bottom dwelling fish prefer to cling to the rocks and logs that line the stream beds. Sculpins (*Cottus* spp.), adapted to the life on the stream bottom, rest their fins on the substrate and eat insects that cling to the rocks. Other fish prefer to swim the open waters or among vegetation at the shores of rivers and lakes.

Table 7. Fish communities of Delaware County determined through the PNHP Aquatic Community Classification.

Fish Community	Indicator Species
Atlantic Coldwater Community 1	Slimy sculpin (*Cottus cognatus*), stocked brown trout (*Salmo trutta*), fathead minnow (*Pimephales promelas*), pearl dace (*Margariscus margarita*)
Atlantic Coolwater Community 2	Blacknose dace (*Rhinichthys atratulus*), white sucker (*Catostomus commersoni*), golden shiner (*Notemigonus crysoleucas*)
Lower Delaware River Community	White perch (*Morone americana*), channel catfish (*Ictalurus punctatus*), blueback herring (*Alosa aestivalis*), eastern silvery minnow (*Hybognathus regius*), white catfish (*Ameiurus catus*), striped bass (*Morone saxatilis*), gizzard shad (*Dorosoma cepedianum*), American shad (*Alosa sapidissima*), banded killifish (*Fundulus diaphanus*)
River and Impoundment Community	Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Black Crappie (*Pomoxis nigromaculatus*), Goldfish (*Carassius auratus*)
Warm Water Community	Sunfish (*Lepomis spp.*), rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), common shiner (*Luxilus cornutus*), satinfin shiner (*Cyprinella analostana*), spotfin shiner (*Cyprinella spiloptera*), spottail shiner (*Notropis hudsonius*), swallowtail shiner (*Notropis procne*), shield darter (*Percina peltata*), tessellated darter (*Etheostoma olmstedi*), American eel (*Anguilla rostrata*), bluntnose minnow (*Pimephales notatus*), common carp (*Cyprinus carpio*)

The Aquatic Community Classification has identified several fish communities (Table 7). Fact sheets detailing these communities can be found in Appendix V.

The fish found in Pennsylvania's flowing waters have distinct habitat preferences; the two most important factors of habitat are stream size and water temperature. The typical habitats of streams and rivers are stratified as:

- Headwater streams are the smallest streams, and water temperatures are often cold (<70°F). The water is fast-moving, well-oxygenated, and usually slightly acidic. These streams often hold "Coldwater Communities," and hold species such as brook trout and mottled sculpin.
- Mid-reach streams are slightly warmer (65-75°F) and have a mixture of stream habitat types, such as pools, riffles (fast-flowing, turbulent waters) and runs (moderately flowing, but calm waters). These streams usually have "Coolwater Communities," with smallmouth bass, creek chubs, and a variety of shiner, sucker, and dace species.
- The Lower Reaches of streams often have warmer waters (>75°F) and slower flows. Pools and runs become more prominent than riffles. These streams usually have "Warmwater Communities," with largemouth bass, bluegill sunfish, and different species of darters.
- Large rivers, such as the Delaware, Susquehanna, Allegheny, and Ohio Rivers, usually have warmer, slower waters. When there are dams, the habitat can be similar to lake conditions. Since large rivers usually flow through well-populated areas, they often receive many pollutants and have multiple threats to water quality. Rivers may have "Large River Communities" with fish species like channel catfish, sauger, freshwater drum, and river redhorse.

Migratory Species

Many fish species migrate to spawn. American eels (*Anguilla rostrata*) are catadromous fish, which live in the freshwaters of coastal watersheds, but swim to the Sargasso Sea in the Atlantic Ocean to reproduce. Other fish like American shad (*Alosa sapidissima*), are anadromous, which live most of their lives in salt water, but swim upstream in freshwater environments to find nursery waters for their next generation. Upstream habitats are important for spawning and the development of young fish. One of the largest remaining migrations of anadromous fish along the east coast of the United States passes almost unnoticed along the Delaware River every year. Every spring, generally from April to June, tens of thousands of shad, herring, and alewife, all members of the Culpeidae family, migrate from the Atlantic Ocean up the Delaware River to spawning grounds in the vast network of headwater tributaries.

Since humans first settled in the Delaware Basin, this migration has signaled the return of spring food and represents an important cultural event. During this migration, the shores were lined with fishermen working to bring in nets that were bursting with shad. In the late 1800's, the peak of the shad take, estimates of the catch along the Delaware River reach four million fish, weighing a total of 16 million pounds. By the early 1900's the catch was declining quickly because of the decline in reproduction from damming headwater spawning grounds and severe pollution; 1916 saw the last one-million pound catch. Shortly thereafter, the fishery collapsed catastrophically and has not yet recovered. Though today's migration is just a reflection of the vast number of fish that once moved up the Delaware River each spring, it is showing signs of a slow recovery.



photo source: Lib. of Congress.

Shad fishing around 1905

One species of migratory fish often forgotten, but of both ecological and economic importance, is the American eel (*Anguilla rostrata*). This species, found on both sides of the Atlantic Ocean, is one of only two catadromous species known in North America; the other, *Agonostomus monticola*, is believed to also be catadromous (Orr 2008). American eels begin life as eggs laid in the vast Sargasso Sea, elvers (young eels) embark on a long migration back towards the freshwater estuaries of the coast. This process, potentially lasting years, is completed

by only a small fraction of the elvers. Once the elvers have made it to the freshwater mouths of the North American coast most remain in the brackish waters of the lower estuaries, but some move much further inland. Because they have the unique ability to crawl up and over stream barriers, such as waterfalls and dams, eels can move upstream into even the smallest, most isolated tributaries. The eels reach maturity after 3 to 40 years (depending on sex and habitat quality) at a length of 3 to 5 feet. At this point the large "silver eels" begin the process of migration back to the Sargasso Sea where they will breed and die.

Unfortunately, every year numerous adult eels are killed at hydroelectric dams during their seaward migration; the adult are too large to pass through the turbines without fatal injury. This mortality, combined with habitat loss and fishing pressure, has greatly reduced the population of the American eel. In 2007 the US Fish and Wildlife Service considered granting the species a federally endangered status. However, it concluded that the listing is not warranted at this time, despite current declines in the population.

Historically, American eels were considered a significant part of the fishery along the Delaware River and its tributaries. Eel weirs, v-shaped rock structures used to channel eels into collecting baskets, were once a common sight throughout the area. However, over the past century the eel fishery has also collapsed, potentially due to parasite introduced by fish-farming operations. Today, the American eel is relatively common in the Delaware River basin and appears to have a stronghold in the watershed compared to other coastal river watersheds in the region. The Delaware River and its tributaries may be supporting a large proportion of the global population of eels.

Access to spawning habitats is inhibited by dams along the migratory paths of fish, despite fish ladders on some large dams. Populations of the once common American shad declined greatly from historic levels after dams were constructed on the Susquehanna River. The Delaware River holds a unique distinction of being one of North America's great rivers without a dam on the main channel, allowing for the continued passage of fish and a free-flowing river ecosystem. In past years, however, the fisheries in and around population centers were degraded by human mismanagement. Channelization and damming of headwater streams, modification to the original river channels through dredging and filling, increased sediment loads and alteration to flow rates and patterns, and the removal of tidal marsh habitat have combined to put the future of this resource in jeopardy.



photo source: PNHP

Juvenile American eel (*Anguilla rostrata*) found along the Delaware River shoreline.

Efforts to reduce the level of pollution in the Delaware River Drainage have reopened this migratory pathway and an intensive stocking program is working to restore the population to a self-sustaining and growing level. Work still needs to be done on restoring access to headwater spawning habitat through the removal of dams or the installation of fish ladders where removal is not an option. Additionally, continued restoration of riparian forests and wetlands in the watershed is critical to the continued improvement of water quality.

In recent years an effort has been made to redress these impacts on rivers and restore the native and migratory fish communities. The installation of sewage treatment plants and prohibition of dumping of waste into rivers, creation of fish "ladders" around dams, and the restoration of riparian and marshland habitat have moderated water pollution and reopened migratory passages.

Conservation Recommendations

Preservation of water quality is important to our native aquatic organisms, particularly those sensitive to changes in water quality, such as brook trout and some of the darters. Sensitive fish are readily lost from streams when water quality begins to decline. Additionally, many invertebrates, which serve as the food base to stream fish, are especially sensitive to changes in water quality. The headwaters and mid-reach streams often provide important spawning habitat, even if some of the fishes live further downstream most of the time.

Preservation of water quality in rivers and streams starts in the headwaters and mid-reach streams. Well-vegetated riparian zones provide the leaves and woody debris that sustain the headwater food chain and lead to properly functioning stream ecosystems in the lower reaches. The riparian zone is also important to provide shading, keeping water temperatures cool. The most important function of the riparian buffer is to filter out sediments and other compounds that flow from the land into streams.

Water quality issues are complex for large rivers because there are many sources of pollution. Degradation due to runoff from agriculture and impervious surfaces is compounded by point-source pollution (such as effluent from sewer treatment plants and industrial discharges). Riparian buffers assist in controlling non-point source pollution in larger streams and rivers. Improving water quality from influxes of sewage, storm-water, and legacy mining effluent and industrial pollution, particularly in large rivers, are challenges for water resource managers.

The most widespread causes of water quality and aquatic habitat declines in Pennsylvania are suspended sediments in the water column, and the settling of sediments on the stream bottoms. Erodible sediments are transported into streams or are rapidly eroded from stream banks. Soils can erode from improperly managed agriculture, timber harvest, and other earth disturbances. Suspended sediments cloud the waters to levels that are intolerable to some organisms. The excess sediment fills in the spaces between gravel and rocks, smothering habitat for the invertebrates on which fish feed, for spawning and for nesting habitats. In addition, sediments can carry large amounts of nutrients that over-stimulate plant growth and bacteria causing alterations in the food web and eutrophication. Erosion can be controlled by establishing or maintaining buffers of native vegetation and adequate width along all streams.

Another human-caused alteration to fish populations includes the stocking of non-native fish such as brown trout, rainbow trout, and the hatchery-released subspecies of muskellunge. Fishes such as these are introduced for their appeal as sport fishes, and their capability to thrive in new environments. Unfortunately, their success may be at the expense of native fishes. Stocked species are often more aggressive than native species and can out-compete the natives for food and habitat. This leads to losses in biodiversity as the native fishes are displaced or die because they cannot co-exist with the introduced species.

For more information on Pennsylvania's fish species, see: http://www.fish.state.pa.us/pafish/fishhtms/chapindx.htm

Fish Regulations and Protection

The Pennsylvania Fish and Boat Commission (PFBC) has the control and jurisdiction of the fish within the Commonwealth. Rules and regulations on the taking of wildlife can be found through consultation with the PFBC.

Insects of Delaware County

Butterflies and Moths

Butterflies and moths are grouped together in the scientific order called Lepidoptera. Lepidoptera comes from the Greek words 'lepido,' which means scale, and 'ptera,' which means wing. A butterfly or moth has two forewings and two hindwings. When inspected closely with a hand lens, each wing will reveal thousands of neatly arranged scales of different colors, which form patterns on the wings. Lepidoptera are also characterized by a coiled, tubular mouthpart called the proboscis, which is used to drink nectar. Finally, Lepidoptera are a group of insects that undergo complete metamorphosis in a life cycle that includes eggs, caterpillars, pupae, and adults.



photo source: PNHP

Zabulon skipper (*Poanes zabulon*)

Life history and habitats

The Lepidoptera cycle of life starts with an egg laid on a specific plant. The egg hatches and a tiny caterpillar (larva) emerges. The caterpillar feeds and grows larger, and will shed its skin several times to allow for growth. After the caterpillar has grown through several molts, typically 4 to 6, it is ready to pupate. The pupa emerges when a fully-grown caterpillar sheds its skin and exposes a protective shell. Inside this shell the transformation from caterpillar to adult takes place. After a period of time that varies from species to species, the adult emerges with a plump abdomen and withered wings and immediately begins pumping fluids from the abdomen into the wing veins until they are fully expanded. Then the fluids are withdrawn from the wing veins, the wings harden, and the moth or butterfly takes off on its maiden flight.

Butterflies and moths are closely related insects, and they share many features. They have similar life histories and utilize a similar suite of habitats. Butterfly adults have thread-like antennae with a small rounded club at the end. Moths can have plumose (feather-like) or thread-like antennae, but they will not have a small club at the end. Some moths have very plump and fuzzy bodies, while butterflies tend to have sleeker and smoother bodies. Moths typically land and spread their wings open flat, while butterflies will often land and close their wings together over their back, or at 45-degree angles (the skippers). Moths are mostly active at night and butterflies fly during the day, but there are also many day-flying moths. Butterfly pupae have a smooth exterior called a chrysalis, while moth pupae form a cocoon, which is typically wrapped in silky fibers.

Many Lepidoptera depend not only on a specific habitat, but also a specific plant within that habitat. The larvae of many species will often use only a single host plant. The Monarch (*Danaus plexippus*) uses only milkweed (*Asclepias* spp.) or closely related plants. The Spicebush Swallowtail caterpillar (*Papilio troilus*) prefers to feed on spicebush (*Lindera benzoin*). The same type of relationship exists with many moths.

Species diversity in Pennsylvania

In North America north of the Mexican border, there are an estimated 13,000 butterfly and moth species (Wagner 2005). Pennsylvania's varied habitats support a large range of butterflies. Altogether, the state has about 156 species of butterflies and the closely related skippers, and probably a minimum of 1,200 species of moths (Wright 2007; PNHP 2006). However, no state agency is directly responsible for managing Lepidoptera, and scientists suspect that the populations of many species are declining.

Dragonflies and Damselflies

Damselflies and dragonflies are grouped together in the scientific order called Odonata (or informally, the odonates). Odonata comes from the Greek word 'odon,' which means 'tooth'. Both adult and larval (immature) odonates possess mouthparts armed with serrated, tooth-like edges and grasping hooks that help them catch and eat their prey.

Life history and habitat

Adult odonates lay their eggs (oviposit) in or near water. There are two common methods of oviposition. Some species lay their eggs inside the stems or leaves of living or dead plant material. Other species lay their eggs in the water, singly or in a mass. Odonate eggs develop at different rates depending on the species, but in general development quickens as temperature increases (Brooks 2003). In temperate regions like Pennsylvania, eggs develop over a period of several weeks to several months.

As larvae, odonates are found in a wide variety of aquatic habitats such as seeps, seasonal pools, streams, rivers, ponds, lakes, and other wetlands. Within each habitat, larvae seek out favorable microhabitats with the right combination of water flow, vegetation, substrate texture, etc. They feed on the other insect larvae that share their aquatic habitat, such as mosquitoes, midges, gnats, and other flies. During larval development, odonates undergo 5 to 15 molts (Westfall and May 1996) over a period of a few months for some species and up to several years for others. The number of molts depends upon the species and also on environmental conditions.

When a larva is fully developed, it undergoes metamorphosis inside its larval skin. Then it crawls out of the water for its final molt. This movement of the larva out of the aquatic habitat to shed its larval skin is called emergence. Once properly positioned, the larval skin is shed one last time and a winged adult emerges. Odonates emerge from the water, transforming from camouflaged stalkers into jeweled fighter planes. Adult odonates continue to feed on the community of insects with whom they shared an underwater life. They also add to their diet additional insects they encounter for the first time as adults, such as butterflies.



photo source: Andrew Strassman, PNHP

Ebony jewelwing (*Calopteryx maculata*)

Adult odonates are closely associated with the larval habitat during mating and subsequent oviposition, during which the eggs are laid in suitable habitat. However, it is important to recognize the additional habitat requirements of the adults. For example, some species have specific perching preferences, and will not use a habitat that lacks proper perches, even when suitable larval habitat is present (Westfall and May 1996). Feeding areas are also very important for odonates. After the process of metamorphosis and emergence, a fresh adult has very little energy in reserve and must begin feeding as soon as possible. Young adult females in particular avoid breeding areas for a period of time while they build up mass, mostly in the growth of their ovaries. Males and females can frequently be found feeding far away from breeding habitat, along roadsides, in wooded glades, in open meadows, and in other upland and aquatic habitats. Some males and females disperse long distances from their natal aquatic habitat to find new breeding areas, an important process that strengthens populations by diversifying the gene pool.

Species in Pennsylvania

In North America, there are an estimated 350 species of dragonflies (Needham et al. 2000) and 161 species of damselflies (Westfall and May 1996). In Pennsylvania, 121 species of dragonflies and 55 species of damselflies are currently known (PNHP 2006).

Tiger Beetles

Beetles make up the order Coleoptera, which is the largest order in the animal kingdom with 350,000 named species. We know very little about the distribution of most beetles in Pennsylvania, but the tiger beetle family is an exception. These colorful, active, relatively large beetles have attracted the attention of amateur naturalists, thus they are frequently collected. Consequently, we have a good understanding of their historical range, abundance, and habitat requirements. Although little survey work for tiger beetles has been conducted in Delaware County, approximately 20 species occur in Pennsylvania (Pearson et al. 2006).

Tiger beetles come in a variety of colors, including brilliant green, orange, brown, grayish black, and often have white spots on the wing covers. They are approximately one-half inch (10 to 21 mm) long. Tiger beetles are predators, generally eating smaller insects such as flies and ants. They move swiftly over the ground, and, unlike most other beetles, take flight without a split second's hesitation when approached. Because they hunt by running, they are usually restricted to areas with exposed substrate such as soil, sand, or small rocks, without dense vegetation. Different species have highly specific preferences for habitat, and these exposed habitats are usually created by disturbance. Some species use habitat created by human disturbance, such as quarries or the compacted soil along foot trails, but many other species live along streams and rivers in habitats created by natural disturbance. These riverine habitats, including vertical clay banks, cobble scours, and sand bars, are created and maintained by the fast-flowing water of natural flooding regimes.

Protection of tiger beetles revolves around the maintenance of natural flooding regimes and streamside riparian vegetation in watersheds where these species occur. Reduction of these floods by building dams allows vegetation to grow on previously scoured areas, and prevents the formation of new sandbars. Keeping vegetated buffers along streams prevents erosion that can clog streams with silt and reduce the availability of sand and cobble habitat. Exotic invasive plants such as Japanese stiltgrass (*Microstegium vimineum*) can quickly colonize bare sand sites and thus prevent tiger beetles from using them.

The presence of a diverse assemblage of tiger beetle species along a waterway is an indicator of a healthy stream, that is, a stream with a natural disturbance regime that creates a diversity of bare soil features.



Betsy Leppo (PNHP)

One of the more common species of tiger beetles in Pennsylvania is the six-spotted tiger beetle (*Cicindela sexguttata*). The tiger-like mouth parts and their aggressive predatory nature are the reason for the menacing moniker.

Conservation Recommendations for Insects

The specific habitat requirements of many insects are not well known. Protecting habitats where species of special concern currently occur is a first step towards ensuring their long-term survival. Alteration or destruction of habitat is the greatest threat to populations of Odonata and Lepidoptera and other insects.

There are a few important pieces of information needed when developing conservation and management plans for Odonata and Lepidoptera that are unique to these taxa:

1) Research and define the specific habitat requirements of each life stage of the species of concern.

Most research on the habitats of Odonata and Lepidoptera has focused on the larval habitat and food plants. This makes sense because of the more sedentary nature of the larvae compared to the adults and the subsequently tighter association of larvae to habitat. The adults are also associated with the larval habitat during mating and oviposition when the eggs must be placed in suitable habitat. However, it is important not to lose sight of the additional habitat requirements of the adults such as perching/puddling and upland feeding areas.

2) Acknowledge and maintain the balance that is necessary between predators and their prey.

Larval and adult odonates feed on the other insects that share their environment, such as mosquitoes, midges, gnats, and other flies. Odonates help control insect species that are considered pests. However, when housing developments encroach upon wetland habitats, municipalities and homeowners often take pest control into their own hands. The pesticides used to control mosquitoes and other nuisance insects have many negative effects on non-target species. Direct mortality of all insect species occurs when broad-based killing agents are used. More specific killing agents are available that only harm black flies or mosquitoes, but indirectly these pesticides still affect predators such as fish and insects, which experience a decrease in food availability when their formerly abundant prey items are eliminated. Additionally, the application of pesticides can increase pest populations in the long run by disrupting the intricate natural food webs in these wetland systems. Pesticides may eliminate odonates, which are slower to rebound from die offs, causing a population explosion of the pest species in subsequent years.

Indirect effects of pest control can also severely reduce populations of butterflies and moths. These species are vulnerable to changes in the distribution and abundance of the food plants. Applications of herbicides or vegetation removal (e.g., mowing) while the eggs or larvae are on the plants can cause declines in Lepidoptera and interrupt stages of the life cycle of these animals. In an effort to slow the spread of gypsy moth and to protect timber resources, various insecticides including lead arsenate, DDT, and carbaryl (Sevin), have been sprayed over the years. Presently, the biological insecticide *Bacillus thuringiensis* (*Bt*) and the insect growth regulator diflubenzuron (Dimilin) are considered more environmentally safe than other sprays and are the primary means of gypsy moth control. However, both chemicals affect species of insects beyond the target gypsy moth. The *Bt* variety used against gypsy moth (*Bt kurstaki*) is toxic primarily to caterpillars, or larvae of Lepidoptera. Species with 1st and 2nd instars at the time of spraying and that feed on foliage are most at risk. Butterflies seem to be particularly susceptible to *Bt*, though there have not been studies to evaluate the effect on all butterflies. In order to protect rare or small populations of non-target organisms, the size of the spray blocks and the timing of spraying for gypsy moths can be adjusted on a site-by-site basis.

3) Protect the species and habitats within a healthy, functioning ecosystem.

Landscape-scale conservation of wetland, meadow, and forested habitats and the supporting upland habitat is needed for long term survival of healthy odonate and lepidoptera populations.

"Orphan Taxa" of Delaware County

While the largest and most obvious organisms in our environment are relatively easy to evaluate, many groups of organisms have received little attention, frequently due to their small size or cryptic habits. Known as "orphan taxa", because of the current lack of official protection status, these groups include most insects, snails, spiders, mushrooms, mosses, fungi, and lichens. Though not as widely studied as the mega fauna and flora, the role of these understudied organisms within the environment is enormous. Early efforts to conserve large, quality habitats that support significant diversity of these organisms can help avoid the necessity of protecting individual species in the future. The following account of the biology and ecology of land snails was prepared for this report as an introduction to a group of organisms that are often overlooked and undervalued for the significant roles they play in the environment.

Land Snails of Pennsylvania *prepared by Timothy A. Pearce, Carnegie Museum of Natural History*
Pennsylvania's oft overlooked land snails and slugs play an important role in food webs where they function as scavengers and prey items for other species. By grazing on vegetation and scavenging decomposing material, snails and slugs convert plant and waste matter into concentrated energy sources available to higher predators, serving as a critical food source for small mammals, reptiles, amphibians, insects, and birds. In fact, the shells of snails are extremely important to female birds as a source of calcium during the egg laying season (Graveland et al. 1994).

In Pennsylvania, shell diameters of adult land snails range from 1 to 25 mm (1/25 to 1-1/8 inch). We are more likely to notice the larger snails, particularly during moist weather when the mollusks are most active, but the Commonwealth is also home to many of the less conspicuous micro-snails of which half of the species are 1 to 3 mm (1/25 to 1/8 inch) as adults. Despite their diminutive size, even these micro-snails play critical roles in Pennsylvania's food webs.



Eight species of native snails placed on a penny for scale

Land snails occur in nearly every terrestrial habitat, including relatively pristine forests, disturbed woods, meadows, agricultural areas, residential yards and gardens, and even traffic islands and waste areas. Habitat requirements of individual land snail species are poorly known, however we do know that snails need moisture and that they tend to be more abundant and diverse in limestone areas where calcium is abundant. Some species of land snails occur more in forests, while others are open area species. Microhabitats are likely to be important, but specific needs of individual species are mostly unknown at this time.

Land snail populations are declining across North America with habitat destruction and change being the primary threat (Lydeard et al. 2004). Because land snails are strongly influenced by moisture, changes in hydrology can alter snail populations. Activities such as wall mining, damming, road building and vegetation changes are just a few of those noted in causing land snail declines. Invasive plants can alter microhabitats, and exotic animals such as Norway rats and terrestrial flatworms directly prey on our native land snails. Invasive snails and slugs can compete with, and sometimes outcompete, native land snail species (Rollo 1983a, b). Other threats to land snails include acid precipitation, which can interfere with their ability to acquire calcium for their shells, and global climate change which will alter temperatures and moisture patterns. The quintessentially slow moving snails might be unable to cope with these shifting habitats.

The Pennsylvania Land Snail Atlas Project, an effort begun in 2005 to map the distribution of Pennsylvania's land snails, has already documented several new state records and scores of new county records. The project continues to fill gaps in our knowledge of land snail distributions and status. Pennsylvanian residents may submit specimens to the project by sending land snails along with locality information about where they were collected to: Tim Pearce, Carnegie Museum of Natural History, 4400 Forbes Ave., Pittsburgh, PA 15217; PearceT@CarnegieMNH.org; (412) 622-1916.

METHODS

Sixty-four County Natural Heritage Inventories have been completed in Pennsylvania to date. The methods used in the Delaware County Natural Heritage Inventory followed established Pennsylvania Natural Heritage Program procedures, which are based on those used by Reese et al. (1988), and Davis et al. (1990). Natural Heritage Inventories proceed in three stages: 1) site selection based on existing data, map and aerial photo interpretation, recommendations from local experts and aerial reconnaissance; 2) ground surveys; and 3) data analysis and mapping.

PNHP DATA SYSTEM

The Pennsylvania Natural Heritage Program (PNHP) was established in 1982 as a joint venture between the Pennsylvania Department of Environmental Resources, The Nature Conservancy (TNC), and the Western Pennsylvania Conservancy (WPC). Today this partnership continues under the leadership of WPC, the Pennsylvania Department of Conservation and Natural Resources (DCNR), the Pennsylvania Game Commission (PGC), and the Pennsylvania Fish and Boat Commission (PFBC).

Each year expert biologists representing various taxonomic groups of the Pennsylvania Biological Survey (PABS) meet to discuss and prioritize the most important species for the protection of biodiversity in Pennsylvania. There are various Biological Technical Committees for each of these groups: Bryophytes and Lichens, Vascular Plants, Fungi, Invertebrates (with subcommittees of aquatic, terrestrial, arachnid, and mollusk), Fishes, Herptiles, Birds, and Mammals. These meetings consist of a review and ranking of species of concern within the state, in terms of the rarity and quality of the species or habitats of concern, potential threats, and protection needs. The results of these meetings provide a baseline for evaluating the statewide significance of the species recognized in the Natural Heritage Inventory.

The database maintained by the PNHP has become Pennsylvania's chief storehouse of information on outstanding natural habitat types (natural communities) and plant and animal species of concern. Several other noteworthy natural features are also stored in the database, including the Department of Environmental Protection (DEP)-designated Exceptional Value Streams (Shertzer 1992) and outstanding geologic features (based on recommendations from Geyer and Bolles 1979 and 1987).

The database includes known existing and historic data on occurrences of species and communities of concern, gathered from publications, herbarium and museum specimens, and the knowledge of expert botanists, zoologists, ecologists, and naturalists. From this foundation, PNHP has focused its efforts on, and conducts systematic inventories for, the best occurrences of the priority species and natural communities.

In order to conduct an inventory of significant flora, fauna, and natural communities in Delaware county, scientists from the PNHP first consult the database of rare plants, animals, and communities. They then use a systematic inventory approach to identify the areas of highest natural integrity in the County. The natural community and species of concern data are the basis for judging the existing biological values of sites within the County. Protecting the sites with the best occurrences of the County's natural communities, and viable populations of plant and animal species of concern can help to ensure that a full range of biological diversity is preserved within the County for the future.

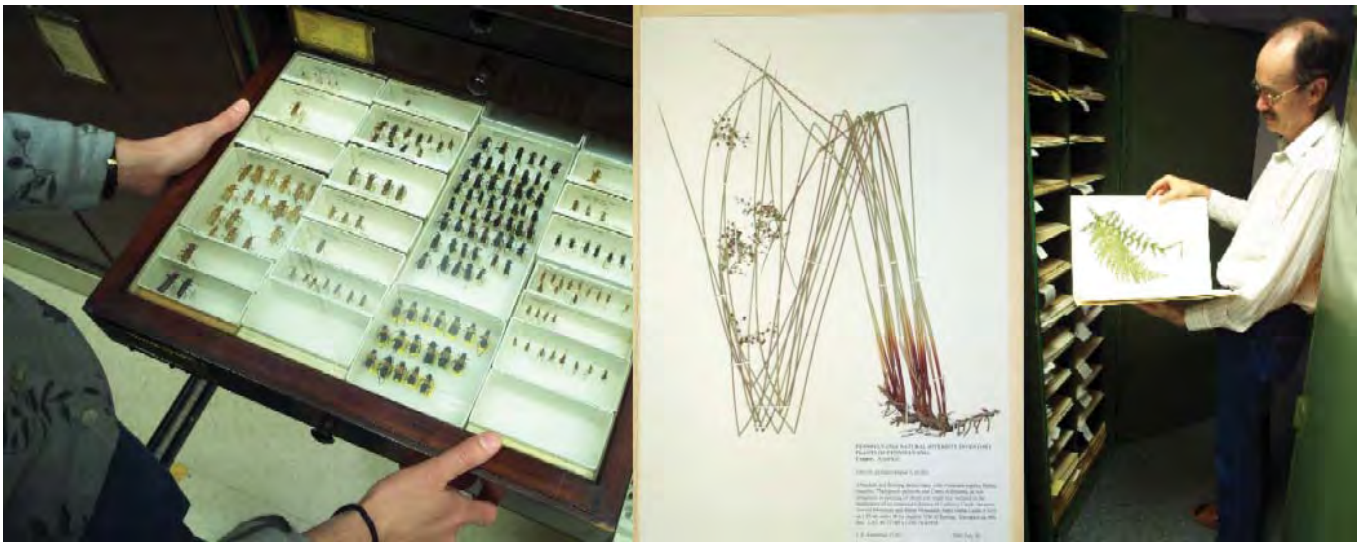


photo source: PNHP

The database is a collection of data on occurrences of species and communities of special concern, drawing from herbarium and museum specimens, publications, and the knowledge of expert botanists, zoologists, ecologists, and naturalists.

Information Gathering

Inventory site selection is guided by information from a variety of sources. A review of the Pennsylvania Natural Heritage Program database determined what locations were previously known for species of concern and important natural communities in Delaware County. Local citizens knowledgeable about the flora and fauna of Delaware County were contacted for site suggestions. Individuals from academic institutions and state and federal agencies that steward natural resources (e.g. Pennsylvania Game Commission, Pennsylvania Bureau of Forestry, Academy of Natural Science, Morris Arboretum) were also contacted to obtain information about lands or resources they manage. General information from other sources such as National Wetland Inventory data, soil maps, geologic maps, earlier field studies, and published materials on the natural history of the area helped to provide a better understanding of the area's natural environment. This information was used to schedule sites for field surveys.

Map and Air Photo Interpretation

PNHP ecologists familiarized themselves with the air photo characteristics of high quality natural communities already documented. This information, along with references on physiography, geology, and soils, was used to interpret photos and designate probable vegetation types and potential locations for exemplary communities and rare species. In many instances, vegetation was classified at an ecosystem level, and it was therefore critical that an ecologist or person with similar training interpret the maps and aerial photos.

The natural area potential of all parcels of land was assessed using aerial photographs. Topographic maps used during field surveys were marked to indicate locations and types of potential natural areas based on characteristics observed on the photos. For example, an uneven canopy with tall canopy trees could indicate an older forest; a forest opening, combined with information from geology and soils maps, could indicate a seepage swamp community with potential for several rare plant and animal species. Baseline information on sites appearing to have good quality communities or potential for rare species was compiled to help prioritize fieldwork.

An additional level of analysis was conducted to assess the restoration potential of open space throughout the County. As air photos were examined the general cover type was noted along with the total area covered. These two characteristics were used to give each mapped parcel of undeveloped land a quality rank and help prioritize survey efforts.

After an initial round of photo interpretation, field surveys were conducted to evaluate the potential natural areas. Locations with minimally disturbed natural communities or with known species of concern were outlined on maps. The photo signatures (characteristic patterns, texture, tone of vegetation, and other features on the photos) of these sites were then used as a guide for continued photo interpretation and future field surveys. Photo signatures with poor quality sites led to the elimination of further fieldwork on other sites with similar signatures.

FIELD WORK

Areas identified as inventory sites were scheduled for ground surveys. Experienced PNHP biologists and contractors conducted numerous field surveys throughout the County during 2009 and 2010. After obtaining permission from landowners, sites were examined to evaluate the condition and quality of the habitat and to classify the communities present. The flora, fauna, level of disturbance, approximate age of forest community and local threats were among the most important data recorded for each site. Field survey forms were completed for each site. Using location data collected using Global Positioning Systems (GPS), boundaries for each site were determined using USGS 1:24,000 topographic maps and PAMAP aerial photography. In cases where landowner permission for site visits could not be obtained or enough existing information was available from other sources, sites were not ground surveyed.



photo source: Andrew Strassman, PNHP

Experienced PNHP staff conducts botanical surveys and habitat assessments for species of concern, here along the tidal Delaware River shoreline. All sites are evaluated for their natural condition. Associated disturbances and threats are noted and recommendations are made to minimize negative impacts.

DATA ANALYSIS AND MAPPING

Data on species of concern and natural communities obtained during the field work for this inventory were combined with existing data and summarized. Plant and animal nomenclature follows that adopted by the Pennsylvania Biological Survey. Natural community descriptions primarily follow Fike (1999). To organize the natural features data and set conservation priorities, each natural community or species of concern (element) is ranked using factors of rarity and threat on a state-wide (state element ranking) and range-wide (global element ranking) basis (see Appendix III). Each location of a species of concern is ranked according to naturalness, its potential for future survival or recovery, its extent or population size, and any threats to it. An explanation of the five element occurrence quality ranks is given in Appendix III. The element-ranking and element occurrence-ranking systems help PNHP biologists to simultaneously gauge the singular importance of each occurrence of, for example, a freshwater intertidal marsh community or puttyroot orchid occurrence in Delaware County, as well as the statewide or world-wide importance of these natural features. Obviously, sites with a greater number of highly ranked elements merit more immediate attention than sites with a smaller number of lower ranked elements.

All sites with species of concern and/or natural communities were selected for inclusion in Natural Heritage Areas. Spatial data on the elements of concern was compiled in a Geographic Information System (GIS; ESRI ArcMap 10). Boundaries defining species of concern habitat for each Natural Heritage Area are typically delineated using PNHP conservation planning polygon specifications for the elements of concern.. These specifications are based on scientific literature and professional judgment for individual species or habitat assemblages and may incorporate physical factors (e.g., slope, aspect, hydrology); ecological factors (e.g. species composition, disturbance regime); or input provided by jurisdictional government agencies. Boundaries tend to vary in size and extent depending on the physical characteristics of a given site and the ecological requirements of its unique natural elements. For instance, two wetlands of exactly the same size occurring in the same region may require very different areas to support their functions if one receives mostly ground water and the other receives mostly surface water. The Natural Heritage Areas were then assigned a significance rank based on their importance to the biological diversity and ecological integrity of Delaware County (table 1). These ranks can be used to help prioritize future conservation efforts. A list of plant and animal species of concern currently known to occur in Delaware County is provided in Appendix I.

SITE MAPPING AND RANKING

Boundaries defining each site were delineated based upon PNHP observation of continuity of habitat, existing greenspace, and similar ecology. Included within some of these sites are recommendations based on scientific literature and professional judgment for individual species or habitat assemblages and may incorporate physical factors (e.g., slope, aspect, hydrology), ecological factors (e.g., species composition, disturbance regime), and input provided by jurisdictional government agencies.

Sites were then assigned a significance rank to help prioritize conservation efforts. For the significance rank the PNHP considers several criteria when ranking Natural Heritage Areas to ensure that all sites, regardless of ecological differences, are evaluated systematically. Each criterion is considered independently and then all are examined collectively. First, the commonness/rareness of all the species of concern at a site, defined by the global and state ranks (G & S ranks Appendix III), is considered in the site ranking process. Those sites which include rarer species with higher ranks (i.e. G1 or S1) are given precedence over sites with more common, lower ranked species (i.e. G5 or S5). Next, the number of different species of concern occurring at a site is also considered in the ranking process. Sites with multiple species of concern are considered to be higher conservation priorities than sites with fewer tracked species. The ecological characteristics of the species at each site are also considered in the ranking process. For example, species that have highly specialized habitat requirements and are not known to readily disperse during periods of disturbance are under greater ecological pressure than species that have more general habitat requirements and have a greater capacity for dispersion. Finally, the site ranking process examines the landscape context of each site. For example, a site that is entirely isolated due to fragmentation, with little chance of restoration of connectedness, is a lower conservation priority than a site that remains connected to other suitable patches of habitat. Site connectedness is critical because the potential for connected populations to remain viable is far greater than small isolated populations.

Table 8. County Natural Heritage Inventory significance ranks.

Significance Rank	Description
exceptional significance	Sites that are of exceptional importance for the biological diversity and ecological integrity of the County or region. Sites in this category contain one or more occurrences of state or national species of concern or a rare natural community type that are of a good size and extent and are in relatively undisturbed condition. Sites of exceptional significance merit quick, strong, and complete protection.
high significance	Sites that are of high importance for the biological diversity and ecological integrity of the County or region. These sites contain species of concern or natural communities that are highly ranked and because of their size or extent, and/or relatively undisturbed setting, rate as areas with high potential for protecting ecological resources in the County. Sites of high significance merit strong protection within the context of their quality and degree of disturbance.
notable significance	Sites that are important for the biological diversity and ecological integrity of the County or region. Sites in this category contain occurrences of species of concern or natural communities that are either of lower NatureServe rank (G and S rank) or smaller size and extent than exceptional or high ranked areas, or are compromised in quality by activity or disturbance. Sites of notable significance merit protection within the context of their quality and degree of disturbance.
local significance	Sites that have great potential for protecting biodiversity in the County but are not, as yet, known to contain species of concern or state significant natural communities. Often recognized because of their size, undisturbed character, or proximity to areas of known significance, these sites are in need of further survey and investigation. In some cases, these sites could be revealed as high or exceptional sites.

GREENSPACE ANALYSIS

In an effort to determine how greenspace is arranged within the County and to assess its relative importance across Delaware County a GIS-based analysis was conducted. This analysis involved the creation of several GIS mapping layers followed by their classification and scoring, overlaying all of the information on the County, and finally producing an overarching score based upon this information. This final scored layer was used to create a map of the County, estimating the most important areas in the County based upon the underlying biology and physiography.

The GIS map layers created for this process include: a natural community classification created from PAMAP aerial photography; a steep-slope layer based on the County 5-foot topographic contour lines; forest and interior forest layers based on the landscape analysis; a layer rating stream quality based on PNHP Aquatic Community Classification (ACC) Project; and a layer rating the quality and importance of the tracked species in Delaware County based on PNHP data. Several additional layers of preexisting information were incorporated: abandoned rail lines and existing hiking trails based on Delaware County layers; and the FEMA 100- and 500-year floodplains. These layers were clipped at the county border for consistency.

The clipped layers were then given the simplest score possible to reflect the relative contribution each attribute made to greenspace; most scores ranged for 0 to 3. A more complex scoring formula was applied to tracked species and communities to reflect the quality and rarity of each occurrence across the landscape; for a fuller explanation of the ranks applied and formulas used see Appendix IV.

The clipped and scored layers were then unioned over the Delaware County outline to produce a single map layer that depicts the score for each of the combined layers. These aspects are: abandoned rail ways, trails, FEMA floodplain, forest and interior forest blocks, natural community type and quality, steep slopes, green versus gray infrastructure, ACC quality, and tracked species. This resulted in every individual polygon within the County having a score for each of the above layers. A final value was derived from these overlain layers to depict the overarching numeric score for each unique combination of biological and physiographic conditions across the County.

In addition to those areas containing species of concern, the analysis of the combined landscape features helped to determine the most evident habitat destinations as well as the most likely potential linkages. These habitat linkages are necessary to help keep natural habitats from becoming isolated islands in a sea of human modified landscape.

AQUATIC COMMUNITY CLASSIFICATION

Results of the Aquatic Community Classification for Delaware County can be found on page 90 and in Appendix VI.

Note: the following project description is adapted from Classifying Lotic Systems for Conservation: Project Methods and Results of the Pennsylvania Aquatic Community Classification Project (2007a) and User's manual and data guide to the Pennsylvania Aquatic Community Classification (2007b).

How were aquatic communities defined?

A statewide project of the Pennsylvania Natural Heritage Program, the Pennsylvania Aquatic Classification Project, collected aquatic datasets from state and federal agencies, interstate basin commissions, and universities, analyzed information with standard statistical methods, and identified community types and habitat associations. Flowing water habitats, such as rivers and streams, and their community types are described. Aquatic community types of non-flowing waters like lakes, wetlands, and ponds, have not been identified to date. Aquatic communities were identified within watersheds. The most common community type per watershed was chosen to represent typical watershed organisms and habitats. Although other community types may exist in a particular watershed, the major community type is described. The term watershed describes an area of land that drains down slope to the lowest point. Watersheds can be large or small. All of the land in the state is part of a watershed. Every stream, tributary, or river has an associated watershed, and small watersheds join to become larger watersheds. In the PNHP Aquatic Community Classification relatively small watersheds (hydrologic unit code 12 – huc12) are described by their community types. (For more information on huc12: http://water.usgs.gov/GIS/huc.html). Separate communities were identified for fish, macroinvertebrates, and mussels. Aquatic communities for each type of organism can be used to describe the aquatic resources, habitat types, and stream quality. Table 9 shows the aquatic communities that were identified within Delaware County. Fact sheets describing these communities follow.

Table 9: Aquatic community classifications by watershed in Delaware County.

Small Watershed Name	Macroinvertebrate Communities	Fish Communities	Mussel Communities
Chester Creek	Urban Stream	Coolwater 1; Coolwater 2; Warmwater; River and Impoundment	No communities described
Cobbs Creek	No communities described	No communities described	No communities described
Crum Creek	Sluggish Headwater Stream; Common Large Stream	No communities described	No communities described
Darby Creek	Limestone Agricultural Stream	Warmwater	No communities described
Delaware River		Lower Delaware River	No communities described
Namaan Creek	No communities described	No communities described	No communities described
Ridley Creek	Urban Stream	Coolwater 2; Warmwater	Eastern Elliptio
West Branch Chester Creek	Limestone Agricultural Stream; Sluggish Headwater Stream	Warmwater	No communities described

How are communities described?

Commonly occurring animals in the community type are listed. While not every organism described in a community will occur in every community location, organisms listed by community types give a general account of what organisms to expect in a community habitat. Environmental and water quality habitats typically associated with the community type are also described.

1) **Community habita**t – The environment of the stream where the community occurs is described by watershed and stream characteristics. Size of the stream and watershed, gradient (slope), and elevation are a few habitat characteristics that may be important to the community type. Local conditions are also mentioned.
2) **Stream quality rating** – Community locations are ranked as low, medium, or high quality based on known habitat, water quality, and sensitivity of organisms to pollution.
3) **Threats and disturbances** – Pollution sources or other threats that may alter the natural state of the community are discussed, where known.
4) **Conservation recommendations** – Recommendations for the County natural resource managers and land planners to consider in protection and management of the watersheds and communities are described.

What do fish, macroinvertebrates, and mussels tell me about streams and watersheds?

All three types of organisms hold unique places in Pennsylvania's streams and rivers. Macroinvertebrates include aquatic insects, worms, and crustaceans, like crayfish and scuds, which occupy the lower levels of food webs in aquatic systems. The presence of certain macroinvertebrates reflects food availability, water quality, and habitats, and gives an overall picture of stream health.

Fish prey upon macroinvertebrates and other stream organisms. Food resources and spawning habitats can be specific for fish. They, too, are influenced by the stream quality and entire environment of the watershed.

As filter-feeders, which siphon water to extract particles of food, mussels also require relatively clean water to thrive. They are particularly sensitive to industrial discharge, acid mine drainage, and urban runoff pollution. Mussels require habitats where they can burrow into the stream bottom and typically occur in larger streams and in rivers that contain sufficient food particles

Many factors influence the occurrence of aquatic communities, including natural variations in stream habitats. Fast-flowing, cold streams flowing from ridges provide a different environment than slower and warmer rivers meandering through valleys. Geology also varies across Pennsylvania and flowing water may have a unique chemical composition based on the rock that it contacts.

Over any natural habitat, variations are caused by human alterations to aquatic environments. Many changes within a watershed can be detected within its streams and rivers. If implemented improperly, timber harvest, agriculture, urban development, roads, are among some alterations that may cause changes in water quality and stream habitats from non-point source pollution. A number of pollutants enter aquatic systems from point sources to flowing waters, such as discharges from sewage treatment plants, mines, and industrial sources.

What is the relationship between Pennsylvania Aquatic Fish Community Classes and stream designations?

Pennsylvania protects aquatic life as a "designated use" of waters in the Commonwealth under the federal Clean Water Act. Enforced by Pennsylvania DEP is the regulation that four types of aquatic life should be propagated and maintained based on their designation in Pennsylvania (Pennsylvania Code 93.3; http://www.pacode.com/secure/data/025/chapter93/chap93toc.html, accessed 10/14/2009):

> **Cold Water Fishes (CWF):** Fishes and associated aquatic flora and fauna preferring colder waters (included in the cold water fishes are trout species).

Warm Water Fishes (WWF): Fishes and associated aquatic flora and fauna preferring warmer waters.

Trout Stocked Fishes (TSF): Stocked trout species (maintained from Feb 15 to July 31) and warm-water flora and fauna.

Migratory Fishes (MF): Fishes (those having anadromous, catadromous, or similar life histories) which must migrate through flowing waters to their breeding habitats.

Additionally, some water bodies receive additional special protections as "Exception Value" or "High Quality" waters because they are especially valued for aquatic life, water quality, and/or recreation. Meeting relatively high water quality and other standards qualify the water bodies for additional protections from degradation beyond the aquatic life uses (Pennsylvania Code 93.4b, http://www.pacode.com/secure/data/025/chapter93/chap93toc.html, accessed 10/14/2009).

The purpose and meanings differ between the classes defined in Pennsylvania aquatic life use/special protection designations and aquatic fish assemblages from the Pennsylvania Aquatic Community Classification. In both cases it is meant to relatively define the organisms and aquatic habitats along a gradient of water temperatures (and associated stream size). The Pennsylvania stream designations broadly encompass habitats occupied by several ACC fish assemblages (Table 10) and are used in water quality regulation.

Table 10: Pennsylvania aquatic life uses and special protection water designations and their occurrence with fish assemblages.

Increasing watershed area	Fish Communities	Exceptional Value (EV)	High Quality (HQ)	Cold Water Fishes (CWF)	Warm Water Fishes (WWF)	Trout Stocked (TSF)	Migratory Fishes (MF)
	Coldwater	X	X	X			
	Coolwater		X	X	X	X	X
	Warmwater			X	X	X	X
	Large River				X		X

STREAM REACH QUALITY ASSESSMENT

Results of the Delaware County stream reach quality assessment can be found on page 92. Stream reaches in Delaware County were extracted from the Aquatic Community Classification dataset and separated into two size classes based on watershed sizes: Small (1 to 10 mi^2) and Medium to Large (>11mi^2). The Small stream size class designates tributaries to the major streams in the County. The Medium to Large class includes the tributaries to the Delaware River, such as Brandywine Creek, Chester Creek, Crum Creek, Darby Creek, and Ridley Creek. The two separate size classes are used in analyses such as this so that comparisons can be made within similar systems; for example, headwater streams often face different threats than large rivers, data from these two types of systems generally are not comparable.

Eight GIS-derived Landcover Variables were used to select the classes of conservation status in all Delaware County Streams, excluding the mainstem Delaware River:

A. Percent Riparian Agriculture
B. Percent Riparian Urbanization
C. Percent Riparian Undeveloped (combined forested area, wetlands, etc.)
D. Percent Total Upstream Agriculture
E. Percent Total Upstream Urbanization
F. Percent Total Upstream Undeveloped
G. Number of Upstream Road Crossings
H. Number of Upstream Point Sources

These data were compiled then statistically normalized for each size class of stream, which allows all data to be combined without outlying data point disproportionately influencing the results. Arcsine-square root transformations were done for the "percent" data types, as this method is standard for transforming data representing proportions. The road-stream crossings and point source data were normalized using log(x+1) transformations. The data were then calculated as follows, using the letters listed above for notation here:

- Stream Score = ((C + F)*3) - (A + B + D + E + G + H)

The Percent "undeveloped" data were multiplied by 3 to ensure they counted equally to the data measuring disturbance. The Stream Scores were then sorted highest to lowest (best to worst quality) and the associated quartiles were assigned to each stream reach from the 3 different size classes. The quartiles represent four categories of potential conservation status:

- First Quartile: Highest Conservation Priority (best potential quality)
- Second Quartile: Secondary Conservation Priority (second-best potential quality)
- Third Quartile: Secondary Restoration Priority (second-worst potential quality)
- Fourth Quartile: Highest Restoration Priority (worst potential quality)

RESULTS

Delaware County has long ago lost most of its natural habitats by conversion to other uses. Extensive woods and vegetated stream corridors serve as dispersal corridors to the diverse list of wildlife occurring in the County. Continued management as well as responsible land use and development will ensure that this list will not be shortened and may grow in the future.

To conserve the native biological diversity of Delaware County, we recommend the use of a two-tiered approach to selecting areas for their contribution to conservation. The fine-filter/coarse-filter approach focuses attention on both the immediate habitat of the at-risk species, as well as the larger landscape scale processes that help to keep common species common.

- The **fine-filter approach** targets protection of uncommon species that generally occur in specialized and discrete habitats. Focusing conservation efforts on these smaller habitats will help defend these species from local, or in some cases, global extinction. This fine-filter approach has been the focus of our field studies to find locations of these unique species and their habitats, and to draw attention to the potential for their inadvertent destruction. These at-risk species and their habitats are described in the section describing natural Heritage Areas.

- The **coarse-filter approach** suggests that whole suites of species as well as general ecological and environmental processes can be offered protection by focusing conservation efforts on large expanses of quality habitats of all types. We address the coarse filter approach by highlighting the largest unfragmented forest and natural habitats as well as riparian corridors.

Besides these highest priority landscapes, all of the habitats of the County will benefit from conservation of large forested blocks and forested riparian corridors. The fine filter approach is characterized in the report by highlighting the species of concern core habitats and supporting landscapes. Also found in this report is a coarse filter approach to conservation, with large forested blocks and all riparian corridors highlighted for that area. Through a combined effort of these two approaches, we can help to assure that uncommon species avoid local or global extinction, and that common species remain common in Delaware County.

AQUATIC COMMUNITY CLASSIFICATION RESULTS

Table 11. Fish and macroinvertebrate communities identified by the most commonly occurring community in each watershed (Also called 12-digit hydrologic unit) for each animal type in Delaware County. These community types were determined using the methodology described on page 85. Please refer to the individual fact sheets regarding these aquatic community types for more information (Appendix VI).

12-Digit Hydrologic Unit Code	Hydrologic Unit Name	Fish Community Name	Macroinvertebrate Community Name	Mussel Community Name
020402031005	Schuylkill River-Stony Creek	Atlantic River and Impoundment Community	Sluggish Headwater Stream Community	N/A
020402020402	Darby Creek	Atlantic Warm-water Community 2	Limestone / Agricultural Stream Community	N/A
020402020502	West Branch Chester Creek	Atlantic Warm-water Community 2	Limestone / Agricultural Stream Community	N/A
020402031003	Pickering Creek	Atlantic Warm-water Community 2	N/A	N/A
020402020603	Ridley Creek	Atlantic Cool-water community 2	Urban Stream Community	N/A
020402031004	Valley Creek	Atlantic Cool-water community 2	Limestone / Agricultural Stream Community	N/A
020402020503	Chester Creek	Atlantic River and Impoundment Community	Urban Stream Community	N/A
020402050401	Brandywine Creek	Atlantic Warm-water Community 2	High Quality Small Stream Community	N/A
020402020605	Delaware River	Atlantic Lower Delaware River Community	N/A	N/A
020402020305	Mantua Creek	Atlantic Lower Delaware River Community	N/A	N/A
020402031007	Schuylkill River-Wissahickon Creek	Atlantic River and Impoundment Community	Limestone / Agricultural Stream Community	N/A
020402020602	Crum Creek	N/A	Common Large Stream Community	N/A
020402020401	Cobbs Creek	N/A	Limestone / Agricultural Stream Community	N/A
020402020501	East Branch Chester Creek	N/A	Limestone / Agricultural Stream Community	N/A

020402050601	Namaans Creek	N/A	Common Small Stream Community	N/A
020402050402	Brandywine Creek	N/A	N/A	N/A

References

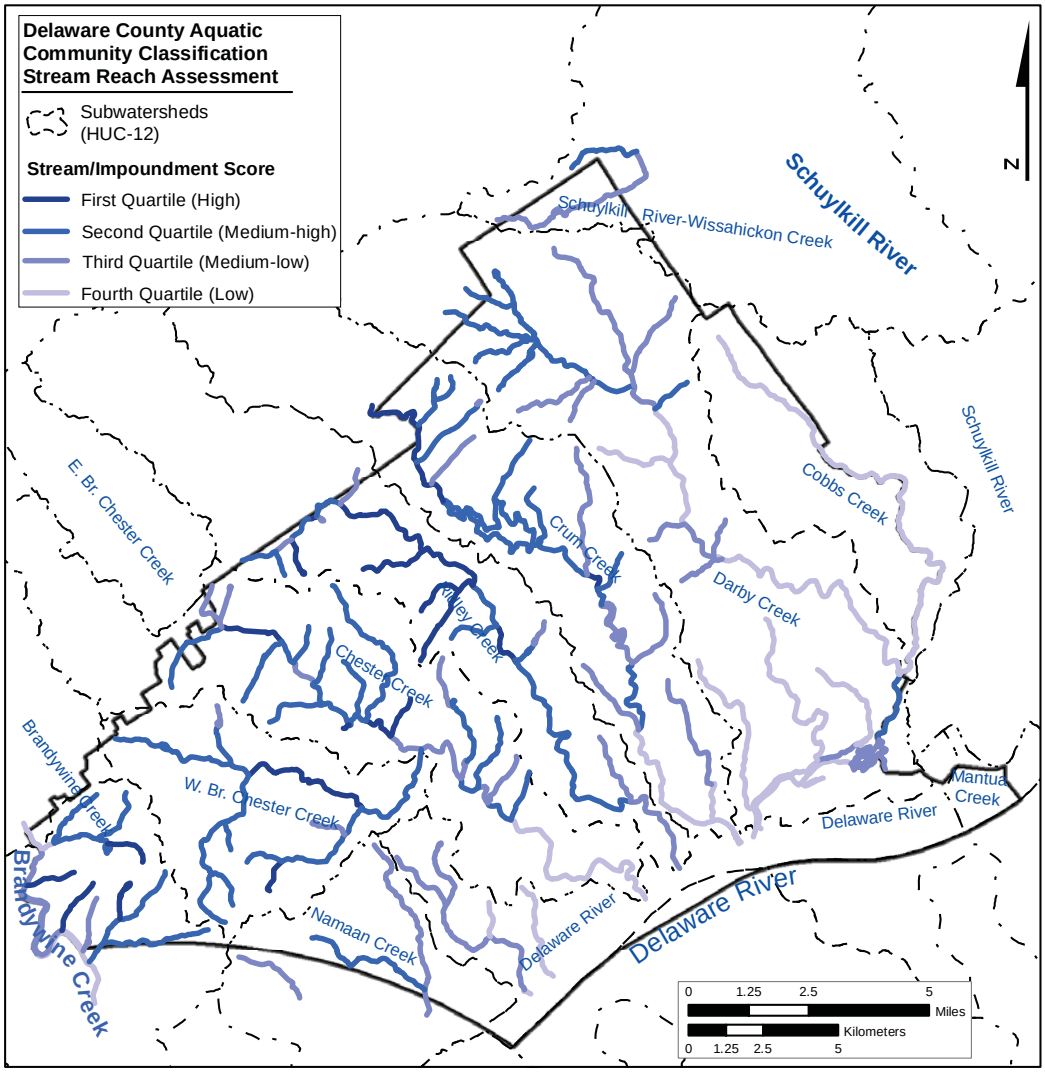
- Walsh, M., J. Deeds and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy.

Stream Reach Quality Assessment

The results of the stream reach assessment represent the relative riparian buffer quality, which directly affects water quality of the adjacent streams and was derived using the methodology described on page 88. Water and habitat quality is referred to as "potential" because these categories are based on GIS-derived data. The variables used in the analyses are indicators of quality rather than a measure of in-stream quality.

Streams that rank in the first quartile (high) in this assessment will have relatively good riparian buffer quality for the County and should be targets of conservation. Streams that rank in the second quartile (medium-high) can be brought up in quality by targeted actions to improve the riparian buffer quality. Streams ranked in the third quartile (medium-low) are in danger of becoming severely degraded without remedial action. Those stream reaches that rank in the fourth quartile (low) have much degraded riparian buffers and are in need of restoration activities. These categories should guide planning efforts and aid in the decision-making process, but should not be substituted for on-site stream assessments.

The results of this analysis are rather intuitive: those areas with more forest cover will have a higher quality ranking and conversely, those areas with the least forest cover will have the lowest quality ranking. Therefore, the streams in the relatively undeveloped portions of the County have the highest quality rank, while the most urbanized areas have the lowest quality rank. Most stream reaches are of higher quality than the stream reach directly downstream from it. The stream reach quality of headwater portions of most streams is generally higher quality than the portion that empties into the Delaware River.



GREENSPACE ANALYSIS

In order to better assess the location, quality, and connectedness of greenspace in Delaware County a greenspace analysis was undertaken. Combining information from numerous sources a map was created depicting the relative importance of greenspace across the landscape. All non-developed space within the County was considered in this analysis.

Combining ranked ecological variables can help reveal patterns and trends in the landscape. Several mapping elements went into determining and defining the ecological context that provides the framework for a network of natural habitats within Delaware County. The primary elements include: (see Appendix IV for full list and weighting variables)

- Species of Concern Habitat
- Forested Habitats
- Interior Forests
- Natural Communities
- Wetlands
- Riparian Corridors
- Floodplains (100 & 500-year)
- Steep Slopes (>15% & >25%)
- Trails & Abandoned Railways

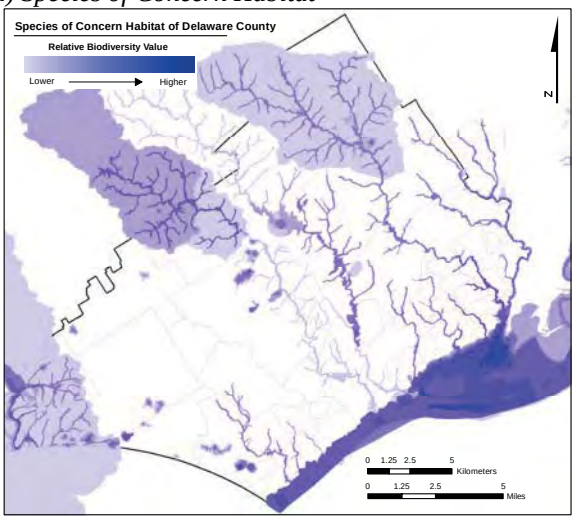
Within Delaware County greenspace with high ecological value generally corresponds to larger blocks of forest or wetlands along riparian corridors. Because of the intentional weighting of the landscape analysis many of the areas with highest ecological value also maintain habitat for species of concern.

These high ecological value areas should be looked at as long-term greenspace conservation and enhancement locations. These sites provide areas of relatively unbroken natural habitat of various levels of quality and offer habitat to both common and rare species. They also offer extensive outdoor recreational opportunities where access is permitted.

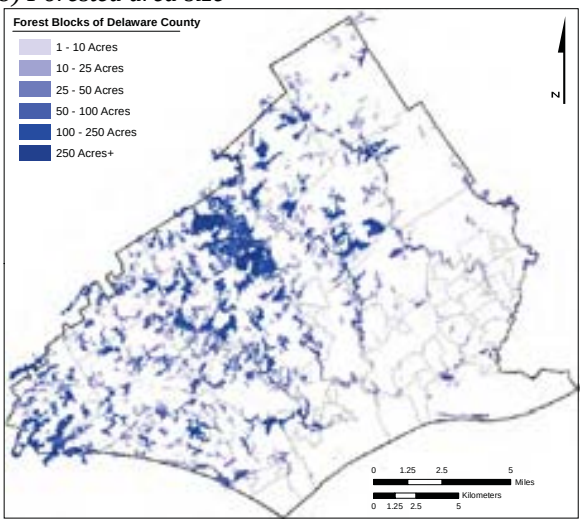
Relatively narrow corridors of greenspace occur throughout the County. Most follow riparian areas along streams or are narrow bands of smaller woodlots that form stepping stones of habitat within a largely human modified landscape. These corridors have an essential role in the landscape. They connect together the larger pieces of the County's green infrastructure to form a network of suitable habitats to alow the movement f plants and animals within and outside of the County. Using existing greenspace, every large landscape area was shown to have a potential green corridor connecting it within the matrix of greenspace in the County. However, not every corridor leads to a large area of natural habitat and some are greenspace "dead ends" that end in urban development. Corridors are composed of all types of land ownership from individual backyards to protected public property. They should be looked at as suggested connections between the large intact habitats of the County in need of further detailed investigation to determine 1) their ownership and level of protection from conversion to a more intensive land use and 2) their level of greenspace quality and what can be done to improve the function of the greenspace as a corridor for safe plant and animal dispersal.

The relative value of any piece of greenspace is based only partially on the ecological value assigned to it; community support and involvement also needs to be considered. For this analysis the social aspect of greenspace preservation was not accounted for. The overall goal of this greenspace analysis is to show the relative trends in the biological value of greenspace across the County and to help guide greenspace preservation actions.

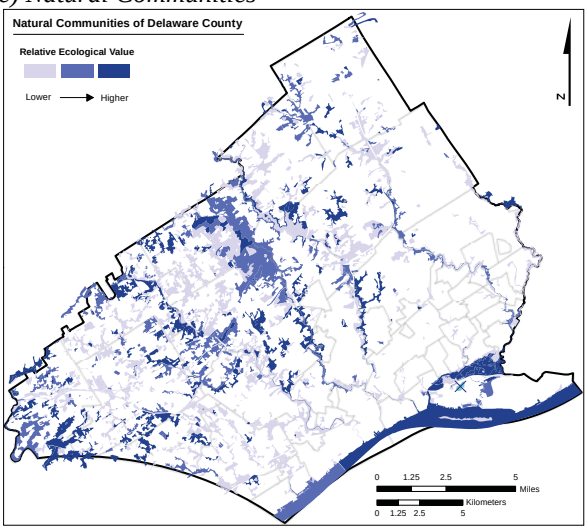
a) Species of Concern Habitat



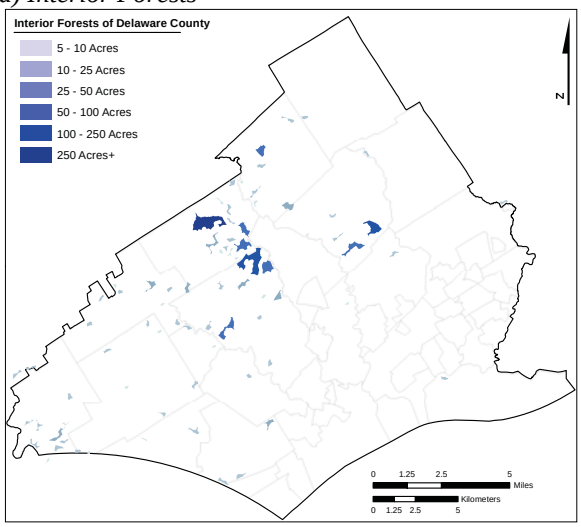
b) Forested area size



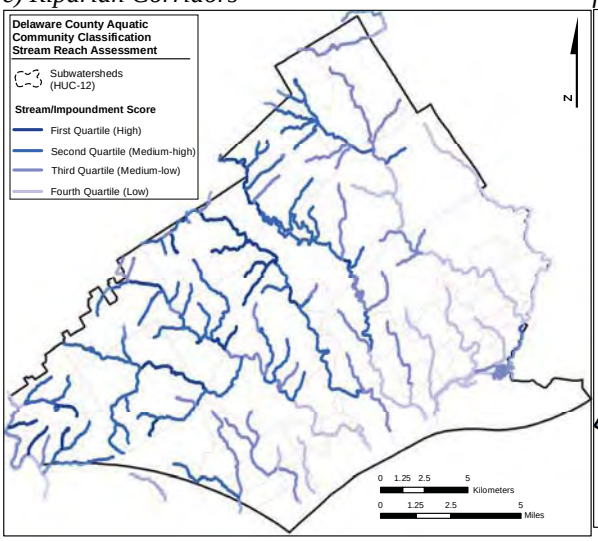
c) Natural Communities



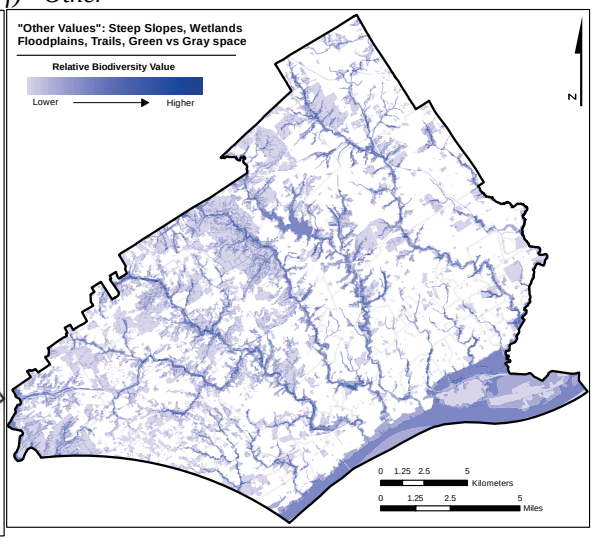
d) Interior Forests



e) Riparian Corridors



f) "Other"



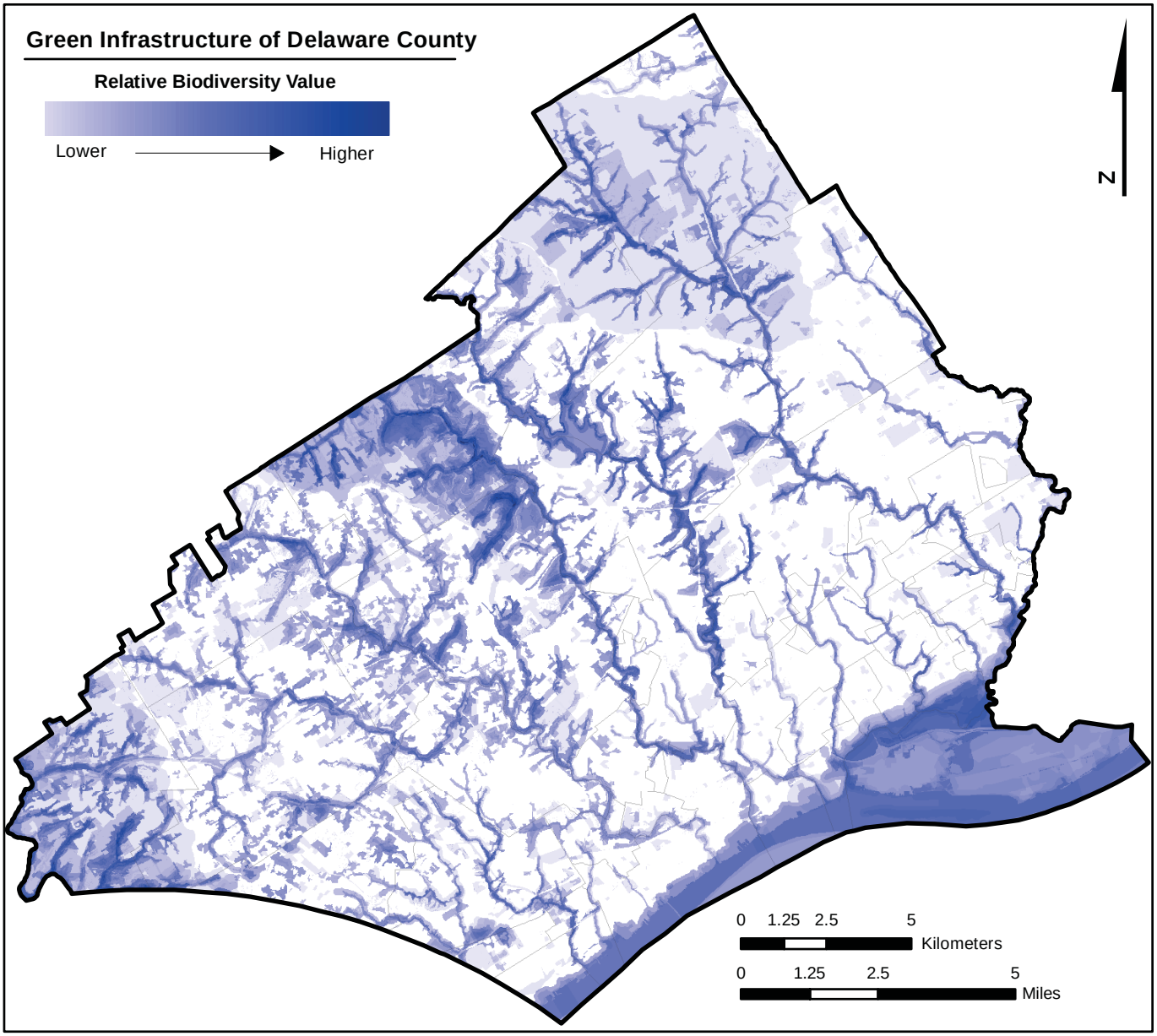


Figure 9: Relative ecological value of greenspace in Delaware County.

NATURAL HERITAGE AREAS

The Natural Heritage Areas identified for this project are depicted in the County-wide site index map on page 2. Detailed maps and descriptions of each of Delaware County's Natural Heritage Areas follow in alphabetical order. For each site, a summary table, map, and full report are provided.

Plant and animal species nomenclature follows that adopted by the Pennsylvania Biological Survey. Natural community descriptions follow Fike (1999).

Summary Table Conventions

- A categorical designation of a site's relative significance is listed after the site name. Table 2 (page 7) summarizes sites by significance category. Definitions of the significance categories are outlined below.
- Listed under each site name are any species of concern and state-significant natural communities that have been documented within the area.
  - Some species perceived to be highly vulnerable to intentional disturbance are referred to as "Sensitive species of concern" rather than by their species name as required by the jurisdictional agency overseeing its protection.
  - The Pennsylvania Natural Diversity Inventory (PNDI) ranks, and current legal status (detailed in Appendix III), are listed for each community and species.

The text that follows each table discusses the natural qualities of the site and includes descriptions, potential threats, and recommendations for protection.

County Natural Heritage Inventory significance ranks.

Significance Rank	Description
exceptional significance	Sites that are of exceptional importance for the biological diversity and ecological integrity of the County or region. Sites in this category contain one or more occurrences of state or national species of concern or a rare natural community type that are of a good size and extent and are in relatively undisturbed condition. Sites of exceptional significance merit quick, strong, and complete protection.
high significance	Sites that are of high importance for the biological diversity and ecological integrity of the County or region. These sites contain species of concern or natural communities that are highly ranked and because of their size or extent, and/or relatively undisturbed setting, rate as areas with high potential for protecting ecological resources in the County. Sites of high significance merit strong protection within the context of their quality and degree of disturbance.
notable significance	Sites that are important for the biological diversity and ecological integrity of the County or region. Sites in this category contain occurrences of species of concern or natural communities that are either of lower NatureServe rank (G and S rank) or smaller size and extent than exceptional or high ranked areas, or are compromised in quality by activity or disturbance. Sites of notable significance merit protection within the context of their quality and degree of disturbance.
local significance	Sites that have great potential for protecting biodiversity in the County but are not, as yet, known to contain species of concern or state significant natural communities. Often recognized because of their size, undisturbed character, or proximity to areas of known significance, these sites are in need of further survey and investigation. In some cases, these sites could be revealed as high or exceptional sites.

NATURAL HERITAGE AREAS OF DELAWARE COUNTY



Chester Creek near Cheyney

Airport Tidal Wetlands

Delaware County, PA

Natural Heritage Inventory



N

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.25 0.5 1 1.5 Kilometers

0 0.25 0.5 1 1.5 Miles

PNHP

Airport Tidal Wetlands – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Northern Harrier (*Circus cyaneus*)	B	G5	S3B,S4N	N (CA)	1991	E
Marsh Wren (*Cistothorus palustris*)	B	G5	S2S3B	N (CR)	2004	E
Least Bittern (*Ixobrychus exilis*)	B	G5	S1B	PE (PE)	1991	E
Virginia Rail (*Rallus limicola*)	B	G5	S3B	N (N)	1991	E
Big bluet (*Enallagma durum*)	O	G5	S3	N (N)	2007	E
Waterhemp ragweed (*Amaranthus cannabinus*)	P	G5	S3	PR (PR)	2009	C
Three-awned grass (*Aristida dichotoma var. curtissii*)	P	G5T5	S1S2	TU (PE)	2005	E
Swamp beggar-ticks (*Bidens bidentoides*)	P	G3G4	S1	PT (PE)	2004	E
Beggar-ticks (*Bidens laevis*)	P	G5	S1	N (PE)	2005	E
Velvety panic-grass (*Dichanthelium scoparium*)	P	G5	S1	PE (PE)	2004	E
Wrights spike rush (*Eleocharis obtusa* var. *peasei*)	P	G5	S1	PE (PE)	2005	E
Little-spike spike-rush (*Eleocharis parvula*)	P	G5	S1	PE (PE)	2005	E
Roundleaf thoroughwort (*Eupatorium rotundifolium*)	P	G5	S3	TU (TU)	2005	E
Bugleweed (*Lycopus rubellus*)	P	G5	S1	PE (PE)	2005	E
Multiflowered mud-plantain (*Heteranthera multiflora*)	P	G4	S1	PE (PE)	2009	AB
Shrubby camphor-weed (*Pluchea odorata*)	P	G5	S1	TU (PE)	2004	E
Long-lobed arrow-head (*Sagittaria calycina* var. *spongiosa*)	P	G5T4	S1	PE (PE)	2009	AB
Subulate arrowhead (*Sagittaria subulata*)	P	G4	S3	PR (PR)	2009	BC
Purple sandgrass (*Triplasis purpurea*)	P	G4G5	S1	PE (PE)	2004	E
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	2009	D
Sensitive species of concern[3]	---	---	---	---	1991	E
Sensitive species of concern[3]	---	---	---	---	1991	E
Sensitive species of concern[3]	---	---	---	---	2001	B
Sensitive species of concern[3]	---	---	---	---	2009	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: The shoreline of the Delaware River adjacent to the Philadelphia Airport and the scattered wetlands and grassy openings within and surrounding the airport.

- Municipalities:
  - Tinicum Township (Delaware County)
  - Philadelphia County
- USGS Quadrangles:
  - Bridgeport Quadrangle
  - Philadelphia Quadrangle
  - Woodbury Quadrangle
- Watersheds:
  - Darby Creek
  - Delaware River
  - Mantua Creek
  - Schuylkill River
- 1992 Delaware County Natural Areas Inventory reference:
  - "SA502, SP575, SP587, SA584" (Bridgeport Quadrangle)
  - "SP501, SA505, SA511, SA512, SA513" (Woodbury Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The Philadelphia International Airport was constructed in the late 1930s on what at the time was almost certainly considered "waste ground". The airport occupies land that was formerly a significant tidal estuary and remains within an important migratory bird corridor. This unfortunate conflict of priorities has resulted in the near complete destruction of the former tidal estuary. This large low lying area adjacent to the Delaware River was part of a vast tidal marsh system at the mouth of the Schuylkill and Darby Creeks that had been drained, ditched, diked, walled and filled over several generations to expand the area of developable land. The airport grounds and the surrounding river shoreline remain biologically important in this degraded context because they maintain aspects of the original tidal marsh that composed the area. The tidally-influenced wetlands that dot the shoreline as well as wetland and grassland habitats surrounding and within the airport runways support numerous species of concern. The Delaware River marsh system hosts a suite of species which in Pennsylvania are found only along the tidal Delaware River. These species, while common in other healthy freshwater tidal ecosystems, are limited to the marsh and a few nearby locations because they are the limit of tidal influence within the Commonwealth.

Species of Concern Considerations:

- The Marsh Wren, Least Bittern and Virginia rail are bird species of concern documented within this area that primarily use the marshy wetlands scattered around and within the airport runways. A stable wetland hydrology and buffer from suburban/urban run-off are important features to maintain the habitat for these species. Draining, diking, damming, and other hydrologic disruptions to existing wetland habitat should be prohibited. Since two of these species have not been documented at this location in the past 20 years, additional surveys are recommended to determine if the species are still nesting within this area.
- The Northern Harrier is a large raptor that typically nests on the ground in grassy habitats including those found adjacent to the airport complex. Since this species has not been documented at this location in the past 20 years, additional surveys are recommended to determine if the species is still nesting within this area.
- The numerous plant species of concern found along the river shoreline can be grouped according to their occurrence in the non-tidal areas, freshwater intertidal marsh or freshwater intertidal mudflat zones.
  - Non-tidal areas are not typically subject to tidal influence but can include wetlands that occur due to poor drainage and a high water table. Plant species of concern found in this zone include three-awned grass, velvety panic-grass, roundleaf thoroughwort and purple sandgrass.

- Intertidal freshwater marsh occurs at the upper edge of tidal inundation at high tide. Waterhemp ragweed, swamp beggar-ticks, beggar-ticks, bugleweed, shrubby camphor-weed, and Indian wild rice are plant species of concern that occur in this zone.
- Intertidal freshwater mudflat is submerged during high tide and only exposed during low tide. Most plants are relatively short and often form clumps. Plant species of concern within this zone include Wrights spike rush, little-spike spike-rush, multiflowered mud-plantain, long-lobed arrow-head and subulate arrowhead.

- The marsh supports several additional sensitive species of concern that are not named at the request of the jurisdictional agency overseeing their protection. These species depend on the continued cleanup and restoration of the marsh to survive. Additionally, they also require control of predators (such as skunks, opossums, and raccoons) around their breeding areas to increase the survival chances of their young.

Forest Cover / Natural Communities: The mostly walled or rubble armored river shoreline at this location is highly modified and only a narrow band of remnant tidal marsh vegetation occurs along its banks. A few areas within the tidal zone have emergent aquatic vegetation dominated by spatterdock (*Nuphar lutea*), pickerelweed (*Pontederia cordata*), arrowheads (*Sagittaria graminea, S. rigida*), arrow arum (*Peltandra virginica*) and scattered patches of waterweed (*Elodea nuttallii*). Adjacent areas of shallow water are dominated by tape-grass (*Vallisneria americana*). Along the river shoreline, native species of plants and animals compete with introduced species for the limited space and resources available for their use.

Ownership:

- Almost the entire area is owned by the Philadelphia Airport Authority. An area at the southwestern end of the runway is maintained as non-recreational open space by Tinicum Township. The reduced number of landowners can be helpful towards implementation of consistent conservation action of this piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the area between the I-95 freeway and the Delaware River has been greatly modified from the extensive system of tidal marshes that used to dominate the shoreline. The tidally influenced shoreline of the Delaware River historically hosted expansive freshwater tidal marshes, especially at the mouths of the tributary creeks. Over the past several centuries and especially this past one, the marshes have been diked, ditched, drained, filled and converted to dry areas of commerce and residence and in this area the airport runways and associated infrastructure. This modification to the landscape has drastically altered the topology and ecology of the area, removing large swaths of tidal marsh and estuary habitat while severely altering the local hydrology. Most of this area is still within the floodplain of the river and is likely to be subject to future flooding from increasingly unpredictable weather patterns and an anticipated rise in sea level.
  - Rail lines and roadways were built parallel to, and through the former marshes.
  - Industrial plants and shipping wharfs were built on the banks of the river.
- Current:
  - Airport expansion is a primary threat within this site. While this land is mostly composed of wetlands and floodplain, airport expansion plans have rarely been altered by these conditions.
  - The bulkheads along the river shoreline inhibit natural tidal flow. This tidal flow supports the creation and maintenance of tidal wetlands along this stretch of river.
  - The impact of wave action from passing boat traffic is significant and acts to constantly scour the river shoreline.
  - In 2004 the oil tanker Athos I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River.

- Stormwater runoff from the highly developed surrounding communities flows into the watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species – In many of the remaining marsh habitats, non-native narrow-leaf cattail (*Typha angustifolia*) and common reed (*Phragmites australis*) dominate to the exclusion of almost all other species. The disturbed strip of shoreline vegetation is frequently dominated by invasive non-native trees such as tree-of-heaven, princess tree, Norway maple, Siberian elm, white poplar and white mulberry. Invasive shrubs and vines frequently dominate the understory including Japanese honeysuckle, porcelain berry, Asiatic bittersweet, multiflora rose, bush honeysuckles, common privet, barberry, paper mulberry and autumn olive to name a few.

Conservation Actions:

- Highlight wetland areas and other areas supporting species of concern as necessary components of airport upgrade and expansion plans. The scattered habitat remnants should be protected from future abuses and afforded the opportunity to expand. Once open space is lost to development it is effectively unrecoverable. Additionally, restoring existing degraded habitat is far cheaper and easier than recreating habitat on a formerly developed site.
- Remove invasive species of plants. This would allow native species the opportunity to expand their populations and suppress future invasions of non-native species. The river floodplain is particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species can have a significant impact on the available habitat for the species of concern.
  - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
  - Focus non-chemical control efforts on selected areas surrounding species of concern.
  - Control of invasive species in the area will require extensive and continual effort.
- Increase the extent of land open to tidal flow and the rate at which the tide is exchanged.
- Excavate fill from former tidal areas in an effort to restore tidal marsh to increase the available habitat for the rare tidal wetland species supported in this area.
- Reduce the impact of the wakes from passing ships. This may entail establishing a shoal that can absorb the wake impact, and/or reducing the speed at which boats may travel through the river.
- Collect trash brought in by storm and tide events. Trash collection at the source is the most efficient manner of preventing its eventual deposition on the island. Storm events in the surrounding urban and suburban communities wash trash into tributaries to the Delaware River where it can accumulate along the banks of the river. Trash collection events should be looked at as excellent opportunities to involve the community in the care of the riverfront.
- With most of the island near, at, or below sea level, even a small increase in the mean water level stands to significantly impact the marsh and the species that depend upon it. Monitoring the effect of climate-change induced sea level rises on the marsh system will be important in directing the conservation of the marsh. Assessing how sea level changes are progressing and how they are affecting the tidal marsh habitat can help direct conservation efforts.



Tidal wetland dominated by spatterdock (*Nuphar lutea*) along the Delaware River.



The abandoned wooden pilings, piers and ramps within the river help to diminish the impact of wave action from passing ships on the river shoreline and may help to encourage the formation of tidal mudflats along this portion of the river.

Photo Source: Andrew Strassman, (PNHP)

Beaver Valley Woods

Delaware County, PA

Natural Heritage Inventory



N

Painters Crossroads

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.25 0.5 1 Kilometers

0 0.25 0.5 1 Miles

PNHP

Beaver Valley Woods – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Velvety panic-grass (*Dichanthelium scoparium*)	P	G5	S1	PE (PE)	2010	C
Soapwort gentian (*Gentiana saponaria*)	P	G5	S1S2	TU (PE)	2010	C
Grass-leaved rush (*Juncus biflorus*)	P	G5	S2	TU (PT)	1995	B
Downy lobelia (*Lobelia puberula*)	P	G5	S1	PE (PE)	2010	C
Tawny ironweed (*Vernonia glauca*)	P	G5	S1	PE (PE)	2010	C
Sensitive species of concern[3]	---	---	---	---	2010	C
Sensitive species of concern[3]	---	---	---	---	2010	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This large area includes adjoining habitats along Beaver Creek and its tributaries roughly bounded on the east by Route 202, on the south by the Delaware State Line, and on the west and north by Ridge Road.

- Municipalities:
  - Chadds Ford Township
  - Concord Township
  - New Castle County, State of Delaware
- USGS Quadrangles:
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP525" (Wilmington North Quadrangle)
  - "Quarry Woods" (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - "SP535, SP536, SP537, SP539, SP540 - Beaver Valley Road Pipeline Site"- (West Chester Quadrangle)

Description: A mosaic of upland forest, forested wetlands, open wetlands, spring seeps, successional old fields and pipeline rights-of-way are set within an agricultural and residential context. Forested habitats include several significant patches of interior forest, which is forested habitat at least 100 meters away from any canopy fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds. This area combines two sites from the original 1992 CNHI report "SP525" and "Quarry Woods" and the subsequent 1998 update: "Beaver Valley Road Pipeline Site" into this enlarged area that hosts a wide variety of habitats and scattered populations of several species of concern.

Species of Concern Considerations:

- Five plant species of concern, velvety panic-grass, soapwort gentian, grass-leaved rush, downy lobelia and tawny ironweed are plants that typically grow in damp to seasonally wet clearings, abandoned fields, woods borders, thickets, marshes, and disturbed ground. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for these species to thrive. Vegetation maintenance along agricultural field edges and the pipeline at this location helps to reduce competition from woody and aggressive species and keep the habitat in a state of early succession. Habitat loss, deer browse and the indiscriminate spraying of herbicides are threats to these species in some locations.
- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.
- An additional sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this forested area. Its preferred habitat is moist deciduous forests requires specific plant communities within a matrix of open canopied habitats. Restoration of the marshy habitats historically associated with the Beaver Creek floodplain will help to provide expanded habitat opportunities for this species of concern.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red oak – mixed hardwood forest
  - Tuliptree – beech-maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Silver maple floodplain forest

- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality. Though the forest was likely selectively cut for fuel wood and timber several times since colonial times, much of the existing forest has apparently been standing for well over 100 years. Some of the trees were in the past likely considered less desirable for lumber and fuel or were less accessible due to steep slopes and were left in place. While this tract of forest can't be considered virgin timber, some individual trees in the area may be 200-300 years old or older. Although there is invasion of exotic plant species into the woods the overall quality of the woods is remarkably natural and aesthetically pleasing.
- The forest canopy is dominated by a mix of large tuliptrees (*Liriodendron tulipifera*), American beeches (*Fagus grandifolia*) and mixed oaks (*Quercus alba, Q. rubra, Q. palustris, Q. montana*). The shrub layer is dominated by invasive species in much of the area, though some areas have a relatively good representation of native shrub species. In other areas, the shrub layer is missing altogether, giving the forest an open, park-like look. This openness is likely due to excessive deer pressure on the reproductive success of understory vegetation including tree seedlings. The herbaceous layer is variable within the diversity of habitat types present.

Ownership:

- This large area is owned by two primary owners, but also includes several secondary property owners. The reduced number of landowners of this large piece of the green infrastructure of Delaware County can be tremendously helpful towards implementation of consistent conservation action across this significant piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has likely been standing for over 100 years.
  - The gas pipeline right-of-way was cut east to west through the lower portion of the area. Though this was a disturbance to the integrity of the forested habitats, it established a narrow strip of vegetation that was maintained as early successional habitat up to the present day.
- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with scattered forested areas surrounded by open pastures and agricultural fields.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - Norway maple *(Acer platanoides)*
    - garlic-mustard *(Alliaria petiolata)*
    - Japanese barberry (*Berberis thunbergii*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - autumn olive (*Elaeagnus umbellata*)
    - wintercreeper (*Euonymus fortunei)*
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*
    - Japanese stiltgrass *(Microstegium vimineum)*
    - mile-a-minute weed *(Persicaria perfoliata)*
    - common reed *(Phragmites australis)*
    - multiflora rose *(Rosa multiflora)*
    - wineberry (*Rubus phoenicolasius*)
    - linden viburnum (*Viburnum dilatatum*)
  - Control options for invasive plants range from mechanical to chemical. However, indiscriminate use of herbicides as rights-of-way defoliants is not acceptable. A smarter, more selective use of chemical controls is required in these areas that contain both invasive species and species of concern.
  - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free portions of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid

denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

- The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over-browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
  - Prevent the conversion of the surrounding agricultural lands to residential or industrial development.
  - Conserve and expand the forested riparian buffers of Beaver Creek and its tributaries. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Beaver Creek, as indicated by its name, was likely heavily influenced by beaver activity in the historical past. Habitat modification by beavers could help to improve the integrity of this Natural Heritage Area, by reestablishing the matrix of open and canopied wetland complexes. Beaver numbers are on the rise in Pennsylvania, and it is very possible that they could be documented here in the future. If beavers expand into this system, they should be left to modify and restore some of the open habitats that previously existed at this site.
- Within the Core Habitat:
  - The Core Habitat for this location was drawn to exclude the most unnatural portions of the adjacent habitat, which are primarily active agricultural fields and residential areas.
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Beaver Creek, its tributaries, springs and wetlands. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - Forested and open wetlands each require special consideration to maintain their unique attributes. Existing wet meadows should not be modified (i.e. dammed, planted in trees or farmed), as this will deprive the open wetlands adapted species of suitable habitat. Light grazing with pastoral animals can be an effective tool to maintain these soggy meadows in their preferred condition. Once the open habitat within the historic floodplain has been restored, light grazing, often considered compatible with high financial yield organic meat and dairy production, could be an effective tool to maintaining the habitat for all wet meadow species.

- As existing farm ponds deteriorate and are in need of maintenance, the removal of such ponds should be explored, in order to recreate the natural hydrologic flows of the landscape.
- Because several of the species of concern noted from this site rely upon open canopied habitats, programs that support establishment of riparian buffers with trees, such as CREP, should be avoided in areas along the pipeline rights-of-way. In addition, removal of woody shrubs appears to be necessary to restore habitat for several of the open habitat adapted plant species as formerly open fallow fields have become dominated by the invasive woody shrub autumn olive (*Elaeagnus umbellata*). Autumn olive should be cut, stump treated with herbicide to avoid resprouting and the area mowed every other year in early spring to help maintain the early successional conditions favorable for these plant species of concern.
- The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
- Remove invasive species of plants (see below).
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.

- Potential Restoration Activities:
  - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
    - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
    - Riparian Buffers:
      - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
      - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
      - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
  - Remove invasive species of plants. Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Control options for invasive plants range from mechanical to chemical. However, indiscriminate use of herbicides as rights-of-way defoliants is not acceptable. A smarter, more selective use of chemical controls is required in these areas that contain both invasive species and species of concern.
  - High priority for invasive species control at this site should be targeted towards removing woody shrubs, especially autumn olive, from the successional old fields adjacent to the pipeline rights-of-way.
  - Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory

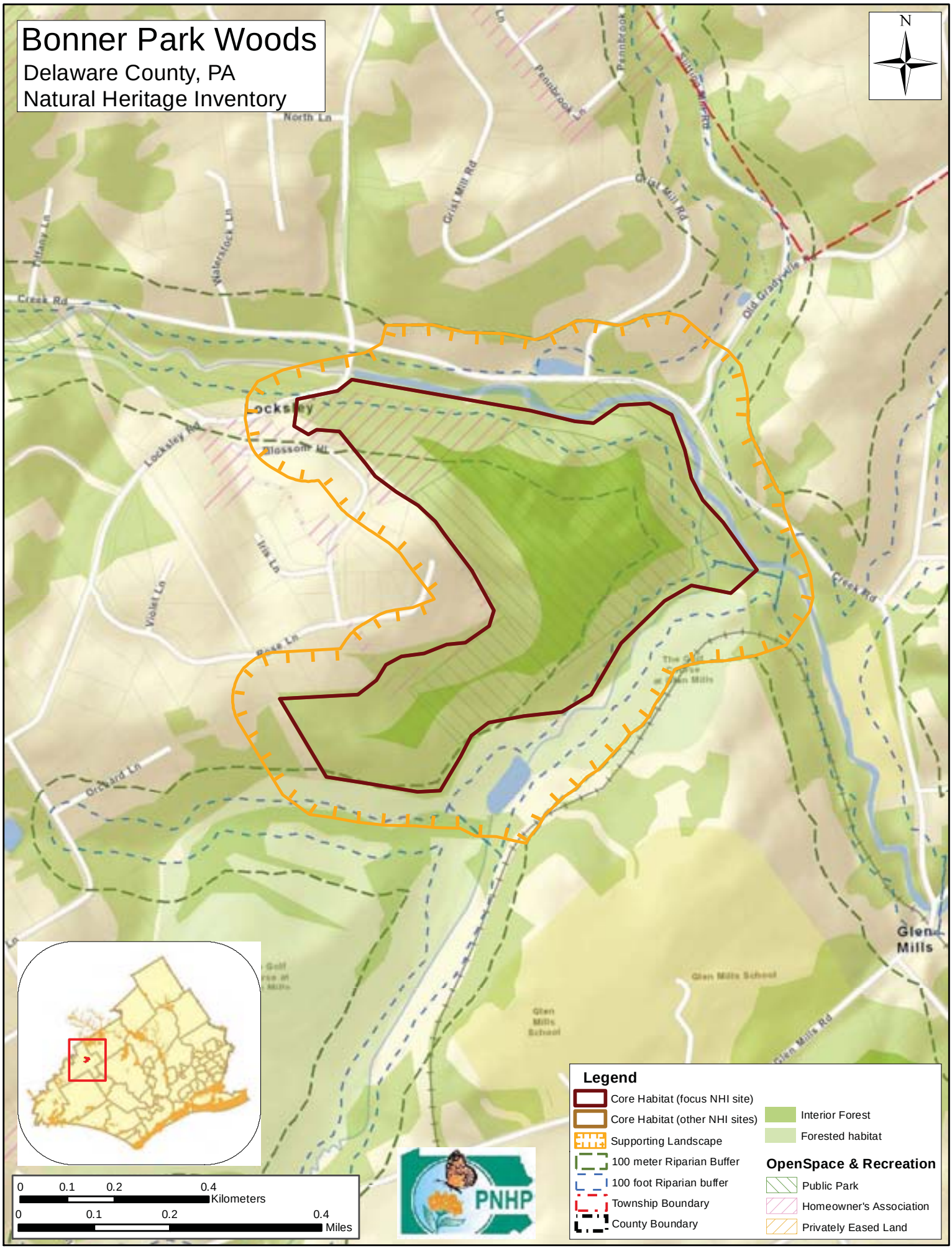
vegetation. Control of invasive species in the area will require extensive and continual effort.

- Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.



Photo Source: Rocky Gleason (PNHP)

Large, older trees contribute to the canopy of the forested habitats in Beaver Valley.


Bonner Park Woods
Delaware County, PA
Natural Heritage Inventory
N
North Ln
Grist Mill Rd
Old Gradyville Rd
Creek Rd
Locksley Rd
Blossom Hl
Iris Ln
Violet Ln
Rose Ln
Orchard Ln
Glen Mills
Glen Mills School
Glen Mills Rd
0 0.1 0.2 0.4 Kilometers
0 0.1 0.2 0.4 Miles
PNHP
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land

Bonner Park Woods – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	2009	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Forested habitat on the south side of Chester Creek is bounded on the north and east by Creek Road, and on the south by the Glen Mills School golf course.

- Municipalities:
  - Thornbury Township
- USGS Quadrangles:
  - Media Quadrangle
  - West Chester Quadrangle
- Watersheds:
  - Chester Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Forested hillside and riparian habitat along Chester Creek contains some patches of relatively mature trees and roughly 30 acres of interior forest, which is forested habitat at least 100 meters away from any fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds. Some portions of the forest are in the long process of recovering from past clearing for agricultural and mining activity.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this mature forested area. Its preferred habitat is moist deciduous forests. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation of the forested habitat. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - modified successional forest*

Ownership:

- Much of this patch of forest is owned and maintained by Thornbury Township as a public park. The remainder is part of Glen Mills School and a homeowners association.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show portions of this forest in a relatively intact condition, surrounded by active agricultural fields and a former quarry. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has likely been standing for over 100 years. Some portions of the existing forest in Bonner Park were in active agricultural production at the time of the 1937 aerial photos, but have been allowed to revert to woody vegetation since that time.
- Current:
  - The large farms have mostly been converted to smaller residential and commercial lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure.
  - Increased residential development and expansion of school facilities and golf course have diminished the available natural habitat at this location.
  - Stormwater runoff from the highly developed upstream communities flows into the Chester Creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.

Conservation Actions:

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
- Within the Core Habitat:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. The creek floodplain and edge habitats associated with residences and reverting agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.

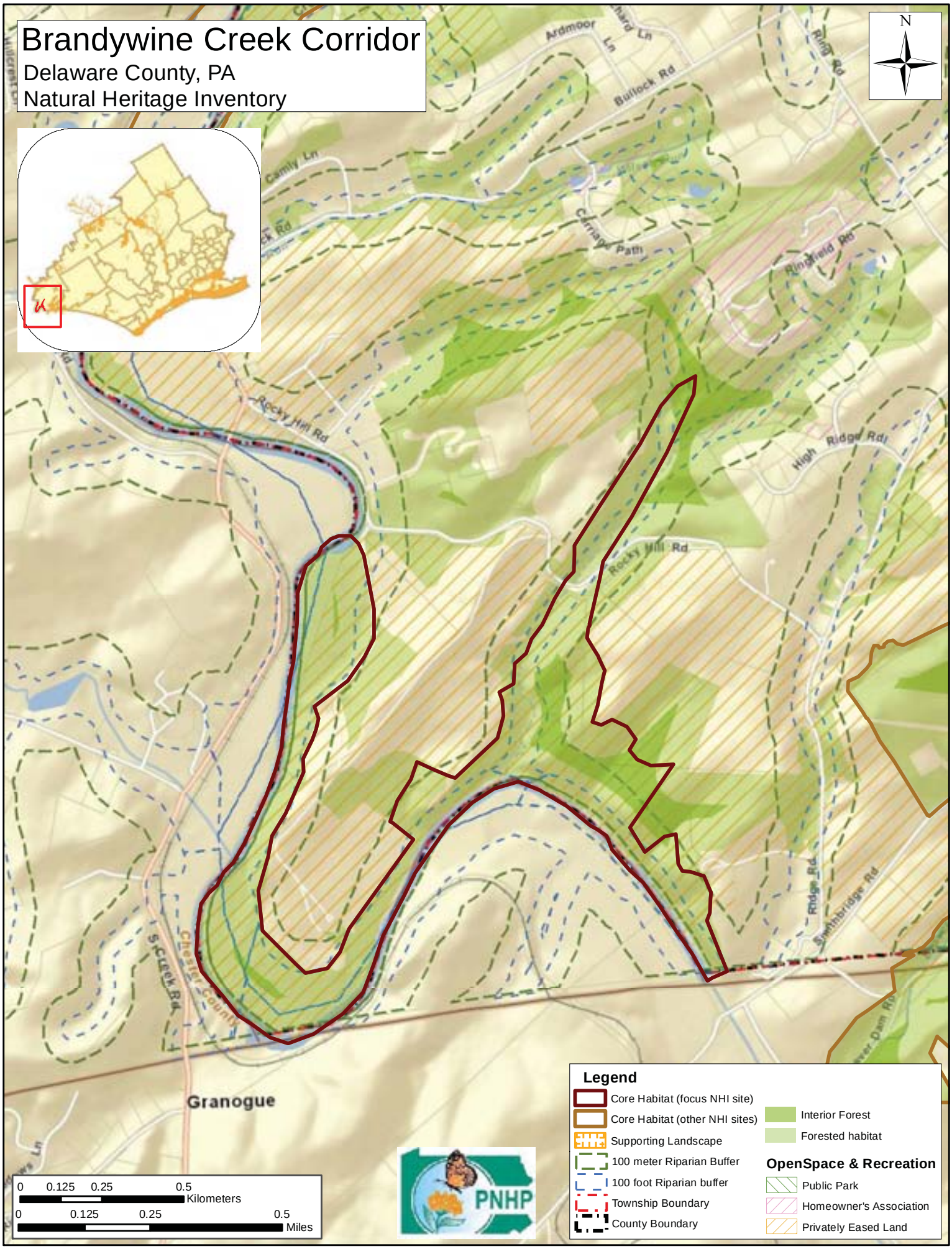
- Target pioneer populations of invasive plants for immediate and continued removal, particularly. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
- Continual invasive species monitoring and control will be necessary.
- Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.

- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.



photo source: Andrew Strassman, PNHP

The red oak – mixed hardwood forest at Bonner Park has a relatively intact herbaceous layer of native plants including many spring wildflowers.


Brandywine Creek Corridor
Delaware County, PA
Natural Heritage Inventory
N
Ardmoor Ln
Bullock Rd
Camly Ln
Carriage Path
Ringfield Rd
Rocky Hill Rd
High Ridge Rd
Rocky Hill Rd
Ridge Rd
Smithbridge Rd
S Creek Rd
Chester County
Granogue
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Brandywine Creek Corridor – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Puttyroot (*Aplectrum hyemale*)	P	G5	S3	PR (PR)	2002	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area is roughly bounded by the Brandywine Creek on the west, Ridge Road to the east, and the Pennsylvania / Delaware state line to the south.

- Municipalities:
  - Chadds Ford Township
- USGS Quadrangles:
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP513" (Wilmington North Quadrangle)
  - "Brandywine Creek Corridor" (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This area was drawn to highlight the wide floodplain, forested slopes and riparian buffer along the eastern shore of the Brandywine Creek. Directly adjacent to the forested habitats are active agricultural fields and pastures. Forested habitats include several significant patches of interior forest, which is forested habitat at least 100 meters away from any fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds.

Species of Concern Considerations:

- Puttyroot is a wildflower in the orchid family that grows in several locations within this Natural Heritage Area in humus-rich soil under a canopy of mature tuliptree, beech and oak. The known populations of puttyroot are threatened by habitat loss, invasive species and excessive browsing by deer. Maintain the unbroken forest canopy and remove invasive species of plants to help secure these plant populations.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Silver maple floodplain forest
- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality. Though the forest was likely

selectively cut for fuel wood and timber several times since colonial times, much of the existing forest has apparently been standing for well over 100 years. Some of the trees were in the past likely considered less desirable for lumber and fuel or were less accessible due to steep slopes and were left in place.

- There are some very large trees within the floodplain and especially along the creek bank including silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), pin oak (*Quercus palustris*) & basswood (*Tilia americana*). The understory of the floodplain is dominated by the native species box elder (*Acer negundo*) and spice bush (*Lindera benzoin*), but also by the invasive shrub species amur honeysuckle (*Lonicera maackii*), privet (*Ligustrum* sp.), and invasive vines Asiatic bittersweet (*Celastrus orbiculatus*) and Japanese honeysuckle. Although the herb layer is dull and weedy in mid-summer, it is brilliant in spring with assorted spring ephemerals including Virginia bluebell (*Mertensia virginica*). Scattered temporary ponds supporting arrow arum (*Peltandra virginica*) serve as breeding grounds for reptiles and amphibians.
- The upland forest canopy is dominated by a mix of large tuliptrees (*Liriodendron tulipifera*), American beeches (*Fagus grandifolia*), hickories (*Carya ovata, C. cordiformis*) and mixed oaks (*Quercus alba, Q. rubra, Q. palustris, Q. montana*). The shrub layer is dominated by invasive species in much of the area, though some areas have a relatively good representation of native shrub species. In other areas, the shrub layer is missing altogether, giving the forest an open, park-like look. This openness is likely due to excessive deer pressure on the reproductive success of understory vegetation including tree seedlings. The herbaceous layer is variable within the diversity of habitat types present.

Ownership:

- This large area is owned by a few private landowners. The reduced number of landowners can be helpful towards implementation of consistent conservation action across this significant piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has likely been standing for over 100 years.
  - Aerial photos from 1937 show most of the wide floodplain in this area cleared for active agricultural uses, either as row crops or pasture, with only a narrow band of trees along the creek bank. Steep slopes along the creek and its tributaries have good forest cover at the time of these photos.
- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with scattered forested areas surrounded by open pastures and agricultural fields. The exception is that the formerly cleared and farmed wide floodplain has since reverted to early successional forest cover dominated by silver maple and box elder.
  - Stormwater runoff from the highly developed upstream communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by floodplain habitats and reverting agricultural fields creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - goutweed (*Aegopodium podagraria*)

- garlic-mustard *(Alliaria petiolata)*
- porcelain berry (*Ampelopsis brevipedunculata*)
- Asiatic bittersweet (*Celastrus orbiculatus*)
- wintercreeper (*Euonymus fortunei)*
- Dame's rocket (*Hesperia matronalis*)
- Privet (*Ligustrum* sp.)
- Japanese honeysuckle *(Lonicera japonica)*
- amur honeysuckle *(Lonicera maackii)*
- Japanese stiltgrass *(Microstegium vimineum)*
- mile-a-minute weed *(Persicaria perfoliata)*
- common reed *(Phragmites australis)*
- lesser celandine (*Ranunculus ficaria*)
- multiflora rose *(Rosa multiflora)*
- wineberry (*Rubus phoenicolasius*)

- The relatively low diversity of understory herbs and shrubs noted in parts of this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the affect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

<u>Conservation Actions:</u>

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
  - Conserve and expand the forested riparian buffers of Brandywine Creek and its tributaries. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Remove dams to allow the free flow of water between the headwaters of the Brandywine Creek and its confluence with the Delaware River. Removal of dams will help allow unrestricted fish passage throughout the watershed.
- Within the Core Habitat:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Brandywine Creek, its tributaries, springs and wetlands. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures

such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.

- Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
  - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
    - Riparian Buffers:
    - An ideal vegetated stream buffers should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
    - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
    - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
- Remove invasive species of plants. Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate of removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.



Photo: Andrew Strassman (PNHP)

The distinctive white-veined leaves of puttyroot (*Aplectrum hyemal*e) are most easily observed during late winter or early spring, before other vegetation has had an opportunity to leaf out. The flower blooms in mid summer long after the leaf has withered away.



Photo Source: Andrew Strassman (PNHP)

Portions of the cobble-bottomed creek support good populations of the eastern elliptio (*Elliptio complanata*). This freshwater mussel requires specific fish hosts during the earliest stage of its life cycle. Unrestricted movement of fish up and down the creek helps to ensure a wide distribution of the species within the watershed.




Brandywine Summit
Delaware County, PA
Natural Heritage Inventory
N
Painters Crossroads
Christy Dr
Hickory Ln
Painters CRSG
Dickinson Dr
Hillman Dr
Painters Xing
Summit Dr
Longview Rd
Woodland Dr
N Glen Dr
Pheasant Ln
Spring Hill Rd
Glen Eagle Square
Hilloch Ln
Ring Rd
Tally Ho Dr
Raven Dr
Chevers Dr
Ringfield Rd
Ridge Rd
High Ridge Rd
Kelley Dr
Wilderness Way
Foothill Path
202
Robins Way
Molly Ln
Ruby Rd
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Brandywine Summit – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	1990	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Wooded riparian corridor along a tributary to Harvey Run is roughly bounded by Ridge Road on the south, Heyburn Road on the west, Route 1 on the north and Evergreen Place on the east.

- Municipalities:
  - Chadds Ford Township
- USGS Quadrangles:
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP524"- (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: A small patch of relatively mature second or third-growth forest occurs in a small valley hosting the headwaters of a tributary to Harvey Run. The upper part of the valley where the stream is most deeply incised is in very good shape and should be maintained in an undisturbed condition. Moving further downstream and onto the surrounding uplands, the woods becomes younger and very weedy. Although these areas are less desirable, they are still important to maintain in a wooded condition to act as buffer for the central mature section. In addition to the species of concern present, the forest is significant for its maturity, lack of exotic species, representation of the native forest, educational and recreational value, and wildlife habitat. This habitat has not been ground surveyed since the original CNHI report, so this description is based on observations from that period. There has been a significant reduction in the overall size of the wooded area since the original surveys, through the residential development of part of the forest. Negative changes to the understory from deer pressure and invasive species of plants are also likely to have occurred.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this mature forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

    - Terrestrial (upland) communities:
        - Dry oak – mixed hardwood forest
        - Tuliptree – beech – maple forest
        - modified successional forest*
- A tall closed canopy (90-to 100-feet) of American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), and northern red oak (*Quercus rubra*) shades the understory in which the shrub layer is dominated by maple-leaved viburnum (*Viburnum acerifolium*), witch hazel (*Hamamelis virginiana*), and arrowwood (*Viburnum dentatum*). Mayapple (*Podophyllum peltatum*), Christmas fern (*Polystichum acrostichoides*), jack-in-the-pulpit (*Arisaema triphyllum*), and additional species comprise the herb layer. Skunk cabbage (*Symplocarpus foetidus*), violets (*Viola* spp.), and jewelweed (*Impatiens* sp.) grow in scattered seeps emanating from the valley walls.

Ownership:

- The forested habitat is owned by numerous landowners, each of which may have a different view on the future use or role of their portion of the ravine. A significant patch is owned by a Homeowners Association. An additional large part of the habitat is owned by Saint Cornelius Catholic Church. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
    - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show two small mature forest patches on either side of the tributary to Harveys Run surrounded by active agricultural fields. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has been standing for over 100 years. Most of this area was in active agricultural production interspersed with small woodlots in 1937 and some of the cleared land has been allowed to revert to woody vegetation since that time, while other portions were planted in conifer tree farms.
- Current :
    - The large farms have mostly been converted to smaller residential lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure.
    - A housing development was constructed on the eastern portion of the woodlot, an area that had been planted in conifer trees. This loss of buffer to the main portion of the forest diminishes the long term viability of this habitat.
    - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
    - The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd.
    - Dumping of garden refuse or construction debris into the ravine or at the forest edge can spread invasive species of plants and diminish the overall quality of the habitat.
    - Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced resulting in aging forest that is not actively regenerating with native species.
- Exotic Species:
    - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. A list of invasive species

was not noted at the time of the previous survey, but there are widespread invasive plants in the county that are likely present in the habitat.

Conservation Actions:

- Overall:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for this habitat should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for the populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species.
  - Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Coordinate a management plan among the primary and adjacent landowners to achieve a consensus approach to the conservation of the forested habitat.
  - Conserve and expand the forested riparian buffers of these tributaries to Harvey Run. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Within the Core Habitat:
  - The upper part of the valley where the tributary to Harvey Run is most deeply incised is in very good shape and should be maintained in an undisturbed condition. Work with the numerous adjacent landowners to preserve the remnant wooded ravine in its current intact condition. Limit residential encroachment on the forested ravine and degradation of the habitat by garden refuse dumping.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Potential Restoration Activities:
  - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
  - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
    - Riparian Buffers:
      - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.

    - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
    - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
- Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields and residential lawns are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline right-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.

Brinton Lake Wetland

Delaware County, PA

Natural Heritage Inventory



N

Thornton

0 0.125 0.25 0.5 Kilometers

0 0.125 0.25 0.5 Miles

PNHP

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

Brinton Lake Wetland – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Grass-leaved rush (*Juncus biflorus*)	P	G5	S2	TU (PT)	2006	CD
Stiff cowbane (*Oxypolis rigidior*)	P	G5	S2	TU (PT)	2006	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area is bounded on the west by Route 202, on the north by Dilworthtown Road and on the east by Brinton Lake Road.

- Municipalities:
  - Thornbury Township
- USGS Quadrangles:
  - West Chester Quadrangle
- Watersheds:
  - West Branch Chester Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Brinton Lake Wetland"
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The headwater recharge area for the West Branch Chester Creek and the artificially impounded Brinton Lake area was a combination of active farm fields, seepy wet woods and wet meadows as recently as 1999, but has since been developed for residential uses. There are some remaining seepy forested areas and wet meadows, but the habitat has been severely fragmented by the building activity and its associated infrastructure. The remaining habitat continues to support two plant species of concern in a degraded context.

Species of Concern Considerations:

- Grass-leaved rush is a globally secure (G5), state imperiled (S2) plant that occurs in association with the seepy wet woods and wet meadows within the housing development open space. It grows in damp, sunny places, such as grasslands, meadows, clearings, old fields, thickets, and utility rights-of-way, and seems to have an affinity for diabase substrates. The viability of populations of grass-leaved rush often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Management activities within the housing development open space can help maintain these conditions.
- Stiff cowbane is a globally secure (G5), state imperiled (S2) plant that prefers to grow in marshes, swamps, damp or wet meadows, and along streams. The viability of populations of stiff cowbane often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Excessive deer browse may be a threat in some locations.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing.

Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - modified successional forest*
- Most of the small woodlots that occur in this area are regenerating from past agricultural activity and are considered modified successional forest. These regenerating woodlots are typically tangled with invasive and aggressive plants adapted to more open conditions. Given enough time and selective management, these woodlots can recover to forest types more typical of mature conditions, but will likely continue to be adversely affected by edge effects due to their small size.

Ownership:

- Most of the remaining natural habitat in this area is maintained as open space by the Cherry Farm Homeowners Association and the New Brinton Lake Club. Several large parcels remain in agricultural production. Additional small parcels with appropriate habitat are privately owned. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place.
  - Aerial photographs from 1939 show this area as a highly cultivated landscape with narrow bands of riparian vegetation through fields of active row crops, hayfields, pastures and fallow fields adjacent to isolated forest patches of various sizes.
  - By 1963 the area was showing the beginnings of increased subdivision on the periphery of this area, primarily by conversion of farmland to residential development, but the area still had much land dedicated to agriculture and forest. The Wilmington Pike (Route 22/322) was constructed along the western edge of this area.
- Current:
  - Development has steadily increased in the past decade. The large farms have mostly been converted to smaller residential lots and expansive suburban developments and associated retail business, fragmenting the landscape with additional buildings, roads and infrastructure, though several farms remain intact in the area.
  - Much of the primary habitat indicated as hosting species of concern in the original CNHI report has been converted to a residential development, leaving fragments of the former habitat surrounded by houses, lawns, roads and infrastructure. These habitat fragments can continue to support these populations of species of concern.
  - Stormwater runoff from the highly developed surrounding communities flows into the West Branch Chester Creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat.
- Exotic Species:
  - The exotic species composition and threat of this location is unknown, though narrow corridors in unnatural surroundings are frequently dominated by invasive species of plants.

Conservation Actions:

- Overall:
  - Since much of the known habitat for the species of concern has been converted to residential housing, management of the remaining open space will be critical to the continued viability of these populations.
  - Conserve the existing agricultural lands as actively supporting the species of concern in field edges and fallow ground.

- Conserve and expand the vegetated riparian buffers of the headwater streams of the West Branch Chester Creek system. Establish at least a 100 foot buffer of forest, woody or fallow field vegetation along each stream tributary to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.

- Within the Core Habitat:
  - Maintain wet meadow openings in their current condition. Both of the plant species of concern at this location prefer early successional habitats that can be found at the edges of woodlands, fields and roadways. Occasional mowing (every other year) along forest edges can help provide the habitat necessary for these species to persist at this location.
  - Conduct periodic surveys of the habitat for the grass-leaved rush and stiff cowbane and indicate the areas to maintenance crews to keep them from being inadvertently destroyed.
  - The use of herbicides should be avoided near wet swales or forest edges.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. Populations of rare plants within this area may need to be fenced to protect them from deer browsing.
- Potential Restoration Activities:
  - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.

Chadds Ford Old Fields

Delaware County, PA

Natural Heritage Inventory



N

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.125 0.25 0.5 Kilometers

0 0.125 0.25 0.5 Miles

PNHP

Chadds Ford Old Fields – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Elliott's beardgrass (*Andropogon gyrans*)	P	G5	S3	N (PR)	2008	B

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Floodplain and fallow field habitat occurs along the southern bank of Harvey Run just south of Route 1.

- Municipalities:
  - Chadds Ford Township
- USGS Quadrangles:
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The floodplain of Harvey Run and fallow portions of adjacent agricultural fields provide suitable habitat for a plant species of concern.

Species of Concern Considerations:

- Elliot's beardgrass is a globally secure (G5), state rare (S3) plant that occurs in several locations within this area, most notably where the cultivated fields have been left fallow for a few seasons. This species typically grows in dry to damp grasslands, clearings, open slopes, and successional old fields. Given this species' preference for open habitats, active management such as periodic mowing, fire, or invasive species removal is often required to maintain the proper successional stage at sites where it grows. Some populations have threats from the indiscriminate spraying of herbicide

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red maple terrestrial forest
  - Red oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
  - modified successional woodland*
- Most of this area is an active agricultural field. The east and west ends of the area have been allowed to remain fallow for a few seasons and have succeeded to tall grasses, forbs and shrubs. Modified successional forest and woodland cover some of the adjacent area. These were formerly agricultural fields that have been left fallow for several decades. Over the course of years, the fields revert to woodland or forest, but of a much lower quality than areas that had not previously been farmed.

These successional woodlands are often dominated by invasive species of plants that tangle the woody vegetation into an impenetrable thicket. Careful selective logging and vegetation management can help speed up the succession process.

Ownership:

- Most of this area is owned by the Brandywine Conservancy, whose core mission is the protection of open space and natural habitats.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural uses over the past several centuries, leaving little of the original vegetation in place.
  - Aerial photographs from 1939 show that this area was in agricultural production at that time, a mixture of row crops and pasture, which extended to the banks on both sides of Harvey Run.
- Current:
  - The northern side of Harvey Run is currently reverting to forest, while the southern side of the run is in active agricultural production, perhaps as hay, that provides little buffer to the creek from runoff. Pollution of the creek by agricultural and development runoff has an easy point of entry along this field.
  - Harvey Run as it nears Brandywine Creek is deeply channelized, likely the result of flash flooding from increased runoff from impervious surfaces like roads, parking lots and building roofs. Stormwater runoff from the surrounding communities flows into the creek system with little opportunity to be filtered, a potentially significant non-point source of pollution.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields creates conditions favorable for many introduced species of plants though none were noted during surveys of the area.

Conservation Actions:

- Overall:
  - Maintain the early successional habitat preferred by the plant species of concern that occurs in this area.
  - Conserve and expand the forested riparian buffers of Harvey Run. Portions of Harvey Run lack vegetated riparian buffers and are nearly or fully unprotected from suburban and agricultural runoff. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Within the Core Habitat:
  - Most of the species of concern core habitat occurs within the early successional fallow fields adjacent to the powerline rights-of-way.
  - Mowing of the area should be limited to every other year or less frequently to allow the plant species of concern to grow, set fruit and establish before the next mowing cycle. Complete elimination of mowing may have a detrimental effect on the species of concern habitat by allowing woody vegetation to dominate the site, closing the canopy for the species of concern. Chemical vegetation management should not be broadcast applied, but spot treatments to target invasive species may be necessary to achieve control of these aggressive plants.
  - Expand the forested riparian buffer along Harvey Run. Most of the southern shore of the creek at this location is narrowly vegetated and should be expanded to 100 meters from the creek's edge. This action will slightly diminish the available potential habitat for Elliott's beardgrass, but is warranted to provide additional water quality protection for this tributary to the

Brandywine Creek. The current hayfield use of the land adjacent to the creek currently provides little opportunity for expansion of the population of Elliott's beardgrass.

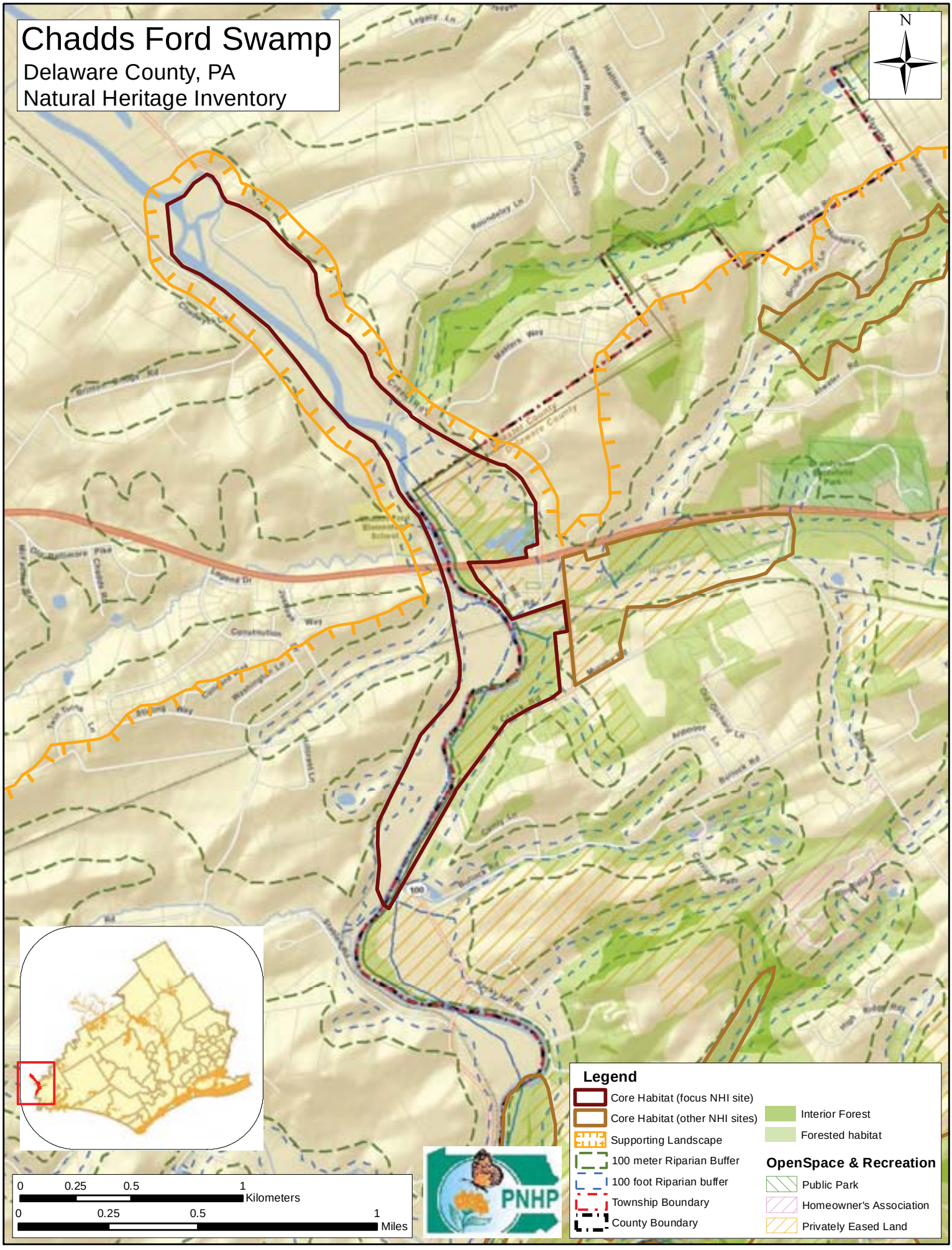
- The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.

- Potential Restoration Activities:
  - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
    - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
    - Riparian Buffers:
      - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
      - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
      - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
  - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline right-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species are a significant feature of the powerline right-of-way. However, indiscriminate use of herbicides as rights-of-way defoliants is not acceptable. A smarter, more selective use of chemical controls is required in these areas that contain both invasive species and species of concern.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.

Chadds Ford Swamp

Delaware County, PA

Natural Heritage Inventory



Chadds Ford Swamp – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Cattail sedge (*Carex typhina*)	P	G5	S2	PE (PT)	2009	D
Waterpod (*Ellisia nyctelea*)	P	G5	S2	PT (PT)	2001	C
Yadkin River panic-grass (*Dichanthelium yadkinense*)	P	G4Q	S1	TU (PE)	2002	C
Toothcup (*Rotala ramosior*)	P	G5	S3	PR (PR)	2002	BC
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	1999	CD
Sensitive species of concern[3]	---	---	---	---	1987	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Marshy floodplain habitat occurs along the Brandywine Creek both north and south of where Route 1 crosses the creek at Chadds Ford.

- Municipalities:
  - Chadds Ford Township, (Delaware County)
  - Birmingham Township, (Chester County)
  - Pennsbury Township, (Chester County)
- USGS Quadrangles:
  - West Chester Quadrangle
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SA508" – (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The wide floodplain and wetlands adjacent to the Brandywine Creek provide the appropriate habitat for the species of concern documented at this location. The scouring action of periodic flooding removes and replaces soil seasonally and replenishes wetlands and oxbows associated with the creek's wide floodplain at Chadds Ford. The natural disturbance of fluctuating seasonal water levels helps to create conditions favorable to annual plants that can go from seed to maturity in one growing season. Wetlands provide essential habitat for a high diversity of more common wetland plants and animals. This habitat also provides an important migratory stopping place for waterfowl and other birds that use the Brandywine Creek as a migratory pathway.

Species of Concern Considerations:

- Three plant species of concern documented at this location are annual plants: the globally secure (G5), state imperiled (S2) waterpod; the globally secure (G5), state imperiled (S2) Indian wild rice; and the

globally secure (G5), state rare (S3) toothcup. They reach maturity from seed in a single season. These plants are adapted to the seasonal flooding disturbance and shallow water conditions that occur in wide floodplain habitats along the Brandywine Creek and do well in habitats otherwise favoring 'weedy' species of plants. Populations of these species can be enhanced by maintaining the natural seasonal fluctuations in the water level of the stream and the natural conditions of its shoreline.

- Cattail sedge is a perennial grass-like plant that occurs in seasonal wetlands and along periodically flooding streams and is well suited to the seasonal flooding associated with this portion of the Brandywine Creek.
- Yadkin River panic-grass is a globally secure (G4Q), state critically imperiled (S1) perennial grass that typically grows in dry to moist woodlands. Habitat loss and invasive species are threats in some locations. Additional field surveys are needed to determine the distribution and habitat requirements of this species.
- This area also contains habitat for a sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection. This species requires abundant food source and breeding areas. This can be achieved by preserving and improving the water quality of the Brandywine Creek and by protecting and expanding the natural vegetation buffer along the creek.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
  - modified successional woodland*
- Palustrine (wetland) communities:
  - Silver maple floodplain forest
  - Sycamore (river birch) – box elder floodplain forest

- The floodplain on both sides of the creek is dominated by a silver maple floodplain forest, seasonal and permanent wetlands and wet meadows. Much of the species of concern core habitat occurs in floodplain habitat that is subject to predictable flooding as to be considered part of the creek. Most of this habitat remains in a relatively natural condition, or is in the process of converting back from previous agricultural uses.

Ownership:

- Almost the entire floodplain habitat within this area is owned by the Brandywine Conservancy, whose core mission is the protection of open space and natural habitats.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural uses over the past several centuries, leaving little of the original vegetation in place.
  - Aerial photographs from 1939 show that the wetland north of Route 1 has persisted relatively undisturbed since that time. Most of the remainder of the floodplain of the creek, however, was in agricultural production at that time, likely as pasture, which extended to the banks of the creek.
- Current:
  - The floodplain and adjacent habitat along the Brandywine Creek is in relatively good condition and is reverting back from former agricultural uses. A few buildings, roadways, bridges and powerline rights-of-way interrupt the otherwise unbroken floodplain habitat.
  - Harvey Run as it nears Brandywine Creek is deeply channelized, likely the result of flash flooding from increased runoff from impervious surfaces like roads, parking lots and

building roofs. Stormwater runoff from the surrounding communities flows into the creek system with little opportunity to be filtered, a potentially significant non-point source of pollution.

- Exotic Species:
  - The natural disturbance of seasonal flooding creates ideal conditions for many introduced species of plants. Consequently, the creek shoreline and floodplain is prone to colonization by a large number of invasive species. Invasive species that were recorded during past surveys include:
    - tree-of-heaven (*Ailanthus altissima*)
    - garlic mustard (*Alliaria petiolata*)
    - porcelain-berry (*Ampelopsis brevipedunculata*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - Japanese hops (*Humulus japonicus*)
    - common privet (*Ligustrum vulgare, Ligustrum obtusifolium*)
    - Japanese honeysuckle (*Lonicera japonica*)
    - bush honeysuckles (*Lonicera morrowii, Lonicera maackii*)
    - purple loosestrife (*Lythrum salicaria*)
    - Japanese stiltgrass (Microstegium vimineum)
    - multiflora rose (*Rosa multiflora*)
    - common reed (*Phragmites australis*)

Conservation Actions:

- Overall:
  - Coordinate the protection of this landscape between Delaware and Chester Counties.
  - Protect and expand the natural vegetation along the shore of the creek floodplain and adjacent upland.
  - Conserve and expand the forested riparian buffers of tributaries to the Brandywine Creek. Brinton Run, a tributary to this section of the Brandywine Creek, is well buffered with forest cover and should be emulated for other riparian areas within the county. Portions of Harvey Run lack vegetated riparian buffers and are nearly or fully unprotected from suburban and agricultural runoff.
  - High water quality and appropriate substrate are both critical aspects to sustaining suitable habitat in this section of the river. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Within the Core Habitat:
  - Most of the species of concern core habitat occurs within the creek floodplain and adjacent wetlands. Maintain the natural hydrology of the creek system by avoiding building dams, or draining wet areas.
  - Mowing of the area should be minimized or eliminated with special emphasis on protecting and expanding wet meadow areas with native vegetation and restoration and protection of the natural condition of the shoreline.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
- Within the Supporting Landscape:
  - The supporting landscape includes a buffer around the tributaries leading to this stretch of the Brandywine Creek. Activities and land use patters in these areas can have a significant impact on the water quality of the creek and the habitats of the species of concern.

- All of the conservation actions for the core habitat also apply to the supporting landscape.
- The long term goal for the area should be to restore mature floodplain forests and the associated upland buffer forests along the Brandywine and its tributaries. Expand the native vegetation along the riparian corridor to include land within 300 meters of the river's banks. Reforestation efforts should be designed to mimic the adjacent natural community type by planting a similar composition of native trees and shrubs of varying age classes. Reforestation is a labor intensive effort that requires long term monitoring and maintenance to avoid infestation by invasive species of plants. Expansion of native vegetation along the creeks and streams will also provide greater connectivity between and among the adjacent natural habitats, providing a corridor for animal and plant movement within this portion of the county.
- The immediate watershed draining into the creek includes some forested, developed and agricultural areas. Pollutants from roads, development and agricultural fields, failures from septic systems within the watershed, lawn care fertilizers and other sources can accumulate in the creek. Detention basins and rain gardens should be incorporated into suburban infrastructure to allow stormwater to be slowed and filtered before entering the creek or its tributaries.
- Preserve and improve the integrity of the large unfragmented forest blocks within the area. These large forested areas provide a significant filter for runoff entering the aquatic habitats from these slopes. Avoid development activities that would fragment this habitat or create more edge areas which encourage the introduction of invasive plants or edge-adapted species.
- Educate homeowners about the effects of the overuse of fertilizers, pesticides, and herbicides on groundwater. Promote groundwater quality awareness when conducting education and outreach programs, and provide educational information about potential threats to the water supply.

- Potential Restoration Activities:
    - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
        - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
        - Riparian Buffers:
            - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
            - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
            - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
    - Remove invasive species of plants. The creek floodplain is naturally susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the floodplain can have a significant impact on the available habitat for the species of concern, which can occupy much the same habitat as purple loosestrife and Japanese knotweed. Control of invasive species along the floodplain will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species are a significant feature of the powerline rights-of-way. However, indiscriminate use of herbicides as rights-of-way defoliants is not acceptable. A

smarter, more selective use of chemical controls is required in these areas that contain both invasive species and species of concern.

- Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
- Continual invasive species monitoring and control will be necessary.



Photo Source: Andrew Strassman (PNHP)

A portion of the wetland habitat at Chadds Ford Swamp

Clayton Park, Shavertown Woods

Delaware County, PA Natural Heritage Inventory



N

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.125 0.25 0.5 Kilometers

0 0.125 0.25 0.5 Miles

PNHP

Clayton Park, Shavertown Woods – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Slender three-awn (*Aristida longespica var. longespica*)	P	G5T5?	S3S4	N (Watch)	2010	E
Screw-stem (*Bartonia paniculata*)	P	G5	S3	N (PR)	2010	C
Nuttalls' tick-trefoil (*Desmodium nuttallii*)	P	G5	S2	TU (PT)	1995	F
Vervain thoroughwort (*Eupatorium pilosum*)	P	G5	S4	(SP)	2010	E
Grass-leaved goldenrod (*Euthamia tenuifolia*)	P	G5	S1	PT (PT)	1991	F
Spring ladies'-tresses (Spiranthes vernalis)	P	G5	S1	PE (PE)	1995	D
Netted chainfern (*Woodwardia areolata*)	P	G5	S2	N (PT)	2010	BC
Sensitive species of concern[3]	---	---	---	---	2008	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area includes parts of Clayton Park and the powerline and pipeline right-of-ways and Green Creek that pass through the park. The site is roughly bounded by Featherbed Lane on the north, Route 322 on the east, Garnet Mine Road on the south, and Kirk road on the west.

- Municipalities:
  - Bethel Township
  - Concord Township
- USGS Quadrangles:
  - Marcus Hook Quadrangle
  - Wilmington North Quadrangle
- Watersheds:
  - West Branch Chester Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP513" (Marcus Hook Quadrangle)
  - "Shavertown Woods" (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - "Clayton Park" (Marcus Hook Quadrangle)
  - "Shavertown Woods" (Wilmington North Quadrangle)

Description: This area is a mosaic of upland forest, forested wetlands, open wetlands, spring seeps, successional old fields and pipeline right-of-way set within a residential context. The forested area is bounded by roads and bisected by both a powerline right-of-way and a pipeline right of way. The slope has scattered diabase boulders. Several springs originate in the woods and Green Creek meanders through the forest. Vegetation maintenance of the powerline right-of-way has kept the linear corridor in an early successional stage of development, which is the preferred habitat of several of the plant species of concern at this location. Forested habitats include a 12 acre patch of interior forest, which is forested habitat at least

100 meters away from any fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds. This area combines two sites from the original 1992 CNHI report "SP513" and "Shavertown Woods" and the subsequent 1998 update: "Clayton Park" and "Shavertown Woods" into this enlarged area that hosts a wide variety of habitats and scattered populations of several species of concern.

Species of Concern Considerations:

- Five of the plant species of concern, slender three-awn, Nuttalls' tick-trefoil, vervain thoroughwort, grass-leaved goldenrod, and spring ladies'-tresses are plants that typically grow in damp to seasonally wet clearings, abandoned fields, woods borders, thickets, and disturbed ground. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for these species to thrive. Vegetation maintenance along agricultural field edges and the pipeline at this location helps to reduce competition from woody and aggressive species and keep the habitat in a state of early succession. Habitat loss, deer browse and the indiscriminate spraying of herbicides are threats to these species in some locations.
- Two of the plant species of concern, screwstem and netted chainfern, typically occur in swamps, seepages, wet woods, boggy wetlands and along the margins of streamlets. At this location, they inhabit some of the seeps within the forested area. The viability of populations of these species and their habitat may be enhanced by establishing buffers around wetlands, controlling invasive plant species, and protecting the natural hydrology surrounding wetlands.
- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red maple terrestrial forest
  - Red oak – mixed hardwood forest
  - Tuliptree – beech-maple forest
  - modified successional forest*

- The canopy consists of relatively large trees, mostly of tuliptree (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), and white ash (*Fraxinus americana*), but with at least 20 additional species mixed in. The shrub zone varies from dense spice bush (*Lindera benzoin*) to dense exotic species including multiflora rose (*Rosa multiflora*) and Asiatic bittersweet (*Celastrus orbiculatus*) to more of an open woods with scattered shrubs. The herbaceous species are most numerous and diverse in areas near diabase boulders or where small rivulets flow downslope. These rivulets are lined with skunk cabbage (*Symplocarpus foetidus*). The forest appears to get more weedy as one goes upslope. Some parts of the lower slope have very few exotics suggesting that perhaps some exotic plant removal has occurred, while other parts of the lower slope have plenty of exotics.
- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality. Though the forest was likely selectively cut for fuel wood and timber several times since colonial times, much of the existing forest has apparently been standing for well over 100 years. Some of the trees were in the past likely considered less desirable for lumber and fuel or were less accessible due to steep slopes and were left in place. While this tract of forest can't be considered virgin timber, some individual trees in the area

are likely 100-200 years old. Although there is invasion of exotic plant species into the woods the overall quality of the woods is remarkably natural and aesthetically pleasing.

Ownership:

- Roughly half of this area is owned by the county and the township as public parks and open space. The remainder is owned by numerous landowners, some with larger parcels than others. Fragmentation of ownership can make coordinated conservation actions more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show that most of the currently forested area was forested in 1937 within a landscape dominated by active agriculture. Though the forest was likely selectively cut for fuel wood and timber several times since colonial times, much of the existing forest has been standing for over 100 years and individual trees could be much older.
  - The electric powerline rights-of-way was cut east to west through the upper portion of the wooded area by 1971. Though this was a disturbance to the integrity of the forested habitats, but helped to maintain the habitat preferred by several of the plant species of concern; it established a narrow strip of vegetation that was maintained as early successional habitat up to the present day.
- Current:
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - tree-of-heaven (*Ailanthus altissima*)
    - garlic-mustard *(Alliaria petiolata)*
    - Japanese angelica tree (Aralia elata)
    - Japanese barberry (*Berberis thunbergii*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - winged euonymous (*Euonymus alatus*)
    - winter creeper (*Euonymus fortunei*)
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*
    - sweet cherry *(Prunus avium)*
    - Japanese stiltgrass *(Microstegium vimineum)*
    - multiflora rose *(Rosa multiflora)*
    - wineberry (*Rubus phoenicolasius*)
    - linden viburnum (*Viburnum dilatatum*)
  - Control options for invasive plants range from mechanical to chemical. However, indiscriminate use of herbicides as rights-of-way defoliants is not acceptable. A smarter, more selective use of chemical controls is required in these areas that contain both invasive species and species of concern.

- Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
- High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free portions of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

- The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

<u>Conservation Actions</u>:

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
  - Maintain early successional habitats where they currently exist by periodically removing woody vegetation and invasive plant species.
  - Conserve and expand the forested riparian buffers of Beaver Creek and its tributaries. Conserve at least a 100 meter (328 feet) buffer of woody vegetation where it exists along the creek and establish at least a 100 foot buffer where it is lacking to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Within the Core Habitat:
  - Because several of the species of concern noted from this site rely upon open canopied habitats, removal of woody shrubs will be necessary to maintain habitat for several of the open habitat adapted plant species. Mowing of the powerline and pipeline every other year in early spring can help maintain the early successional conditions favorable for these plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and their habitat.
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Avoid altering the hydrology of Green Creek, its tributaries, springs and wetlands.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures

such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
    - Remove invasive species of plants.
    - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory..
- Potential Restoration Activities:
    - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
        - Riparian Buffers:
            - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
            - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
            - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.



Photo Source: PNHP

Diabase boulders are scattered beneath a maturing forest canopy along the floodplain of Green Creek.


Cobbs Creek
Delaware County, PA
Natural Heritage Inventory
N
Penn Wynne
Penfield
Kirklyn
Highland Park
Beverly Hills
Bywood
Stonehurst
Millbourn
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.25 0.5 1 Kilometers
0 0.25 0.5 1 Miles
PNHP

Cobbs Creek – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Elephant's Foot (*Elephantopus carolinianus*)	P	G5	S3	PE (PR)	2002	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area includes disjunct habitats along both sides of the Cobbs Creek floodplain and adjacent riparian area.

- Municipalities:
  - Haverford Township
  - Philadelphia County
- USGS Quadrangles:
  - Lansdowne Quadrangle
- Watersheds:
  - Cobbs Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP558" (Lansdowne Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Scattered floodplain and riparian habitats occur along both sides of Cobbs Creek, the border between Delaware County and Philadelphia County.

Species of Concern Considerations:

- Elephant's foot occurs in several locations along the floodplain and adjacent upland habitat within this area. Its preferred habitat is woodlands, openings and clearings, frequently in somewhat disturbed conditions. The plant population will probably continue to survive as long as light conditions do not change radically through either opening up or complete closing of the canopy. Since the species tends to occupy disturbed habitats, active management may be required to maintain the proper successional conditions for the species to thrive.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red oak – mixed hardwood forest
  - modified successional forest*
- Most of the forest patches are in the long process of reverting from clearing for past agricultural uses, while other patches exhibit a much more undisturbed quality.

Ownership:

- Part of this area is owned and managed as Cobbs Creek Park by the Fairmont Park System.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show small scattered forested woodlots, open fields and golf courses within a landscape dominated by residential development.
- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with scattered forested floodplain areas surrounded by urban and suburban development.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by an active floodplain, reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.

Conservation Actions:

- Overall:
  - Coordinate the protection of this landscape between Delaware and Philadelphia Counties.
  - The long term goal for the area should be to preserve and restore mature floodplain forests and the associated upland buffer forests along Cobbs Creek and its tributaries.
- Within the Core Habitat:
  - Most of the species of concern core habitat occurs within the creek floodplain and adjacent riparian zone. Maintain the natural hydrology of the creek system by avoiding building dams, or draining wet areas. Expand the native vegetation along the riparian corridor to include land within 100 meters of the creek's banks. Forested and open wet habitats each require special consideration to maintain their unique attributes. Existing wet meadows should not be modified (i.e. drained, or planted in trees), as this will deprive the open wetlands adapted species of suitable habitat. Restoration efforts should be designed to mimic the adjacent natural community type by planting a similar composition of native trees and shrubs of varying age classes. Restoration is a labor intensive effort that requires long term monitoring and maintenance to avoid infestation by invasive species of plants. Expansion of native vegetation along the creeks and streams will also provide greater connectivity between and among the adjacent natural habitats, providing a corridor for animal and plant movement within this portion of the county.
  - Mowing of the creek shoreline should be minimized or eliminated with special emphasis on protecting and expanding wet meadow areas with native vegetation and restoration and protection of the natural condition of the shoreline.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.

    - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.

Crum Creek Floodplain and Reservoir

Delaware County, PA Natural Heritage Inventory



0 0.375 0.75 1.5 Kilometers

0 0.375 0.75 1.5 Miles

PNHP

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

Crum Creek Floodplain and Reservoir – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Netted chainfern (*Woodwardia areolata*)	P	G5	S2	N (PT)	1998	E
Sensitive species of concern[3]	---	---	---	---	2008	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area includes the floodplain of Crum Creek from the dam breast of the Crum Reservoir upstream to the outflow of the Springton Reservoir dam and Trout Run from its headwaters to its confluence with Crum Creek.

- Municipalities:
  - Marple Township
  - Nether Providence Township
  - Springfield Township
  - Upper Providence Township
- USGS Quadrangles:
  - Lansdowne Quadrangle
  - Media Quadrangle
- Watersheds:
  - Crum Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SA604" (Lansdowne Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - "SA520- Lower Crum Reservoir"- (Lansdowne Quadrangle)

Description: A mosaic of upland forest, forested wetlands, open wetlands, spring seeps, successional old fields and an open water reservoir are set within a residential context along the floodplain of Crum Creek. Much of the 100 foot riparian buffer on either side of Crum Creek from the dam breast of the Crum Reservoir upstream to the outflow of Springton Reservoir is forested, while outside of that boundary, suburban residences and infrastructure crowd the creek floodplain. Occasional small wetlands occur along the creek floodplain where it widens and the water slows.

Species of Concern Considerations:

- Netted chainfern is a plant that typically inhabits swamps, seepages, wet woods, boggy wetlands and along margins of streamlets. The viability of populations of netted chainfern and its habitat may be enhanced by establishing buffers around wetlands, controlling invasive species and protecting the natural hydrology surrounding wetlands. A survey in late fall 2009 did not relocate this population, but it may still occur along portions of the creek's floodplain and adjacent wetlands. A resurvey earlier in the season may be more likely to detect this population.
- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, requires specific plant communities within a matrix of open canopied habitats. Restoration of the marshy habitats historically associated with the Crum Creek floodplain will help to provide expanded habitat opportunities for this species of concern.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Sycamore – (river birch) – box elder floodplain forest

Ownership:

- The linear riparian corridor of these creeks and tributaries has a very fragmented ownership, with many small parcels abutting the creeks. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show small scattered forested woodlots within a landscape dominated by active agriculture.
  - The Crum Creek Reservoir had been constructed by the time of the 1937 air photos, disrupting the natural hydrology of the waterway.
- Current:
  - Rapid development has occurred on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.
    - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.
  - The relatively low volume and diversity of understory herbs and shrubs in forested habitats may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have

been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

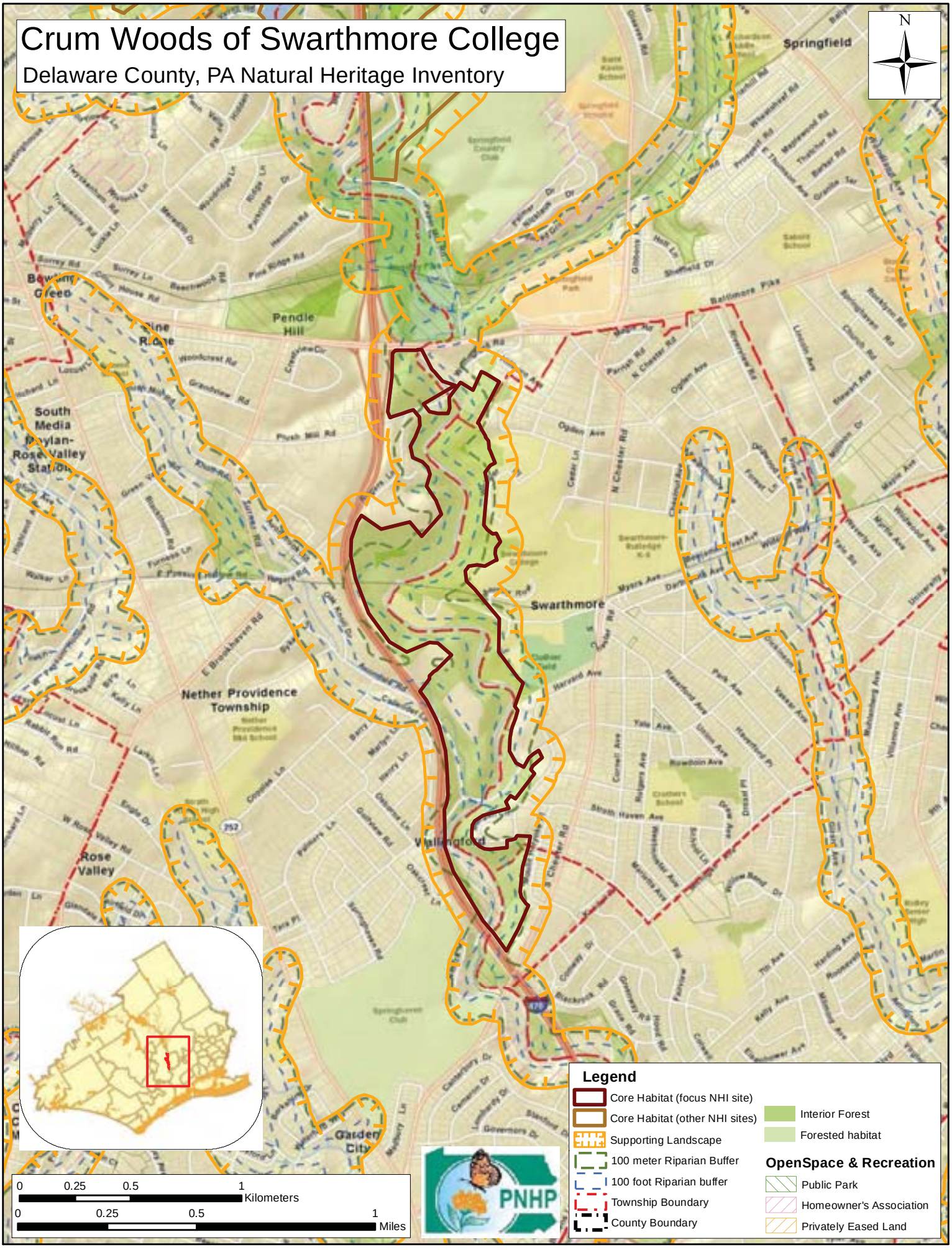
Conservation Actions:

- Overall:
  - Conserve and expand the forested riparian buffers of Crum Creek and its tributaries. Establish at least a 100 foot buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Habitat modification by beavers could help to improve the integrity of this Natural Heritage Area, by reestablishing the matrix of open and canopied wetland complexes. If beavers expand into this system, a few should be allowed to modify and restore some of the open habitats that previously existed at this site. Beaver numbers are on the rise in Pennsylvania, and it is very possible that they could be documented here in the near future.
- Within the Core Habitat:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Crum Creek, its tributaries, springs and wetlands. This may require that road crossing improvements involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - Forested and open wetlands each require special consideration to maintain their unique attributes. Existing wet meadows should not be modified (i.e. dammed, planted in trees or farmed), as this will deprive the open wetlands adapted species of suitable habitat. Light grazing with pastoral animals can be an effective tool to maintain these soggy meadows in their preferred condition. Once the open habitat within the historic floodplain has been restored, light grazing, often considered compatible with high financial yield organic meat and dairy production, could be an effective tool to maintaining the habitat for all wet meadow species.
  - As existing farm ponds deteriorate and are in need of maintenance, the removal of such ponds should be explored, in order to recreate the natural hydrologic flows of the landscape.
  - Because the species of concern noted from this site relies in part on open canopied habitats, programs that support establishment of riparian buffers with trees, such as CREP, should be avoided in areas close to open wetlands. Instead, these programs may be better suited beyond the historic floodplain of the drainages delineated within in this Natural Heritage Area.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.

- Potential Restoration Activities:
    - Streams through forested areas should be considered high priority for conservation in the habitat. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
        - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
        - Riparian Buffers:
            - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
            - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
            - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.

Crum Woods of Swarthmore College

Delaware County, PA Natural Heritage Inventory



Crum Woods of Swarthmore College – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Southern red oak (*Quercus falcata*)	P	G5	S1	PE (PE)	1999	C
Sensitive species of concern[3]	--	--	--	--	2008	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Wooded riparian corridor along Crum Creek bounded on the west by Route 476 (Blue Route), on the north by Baltimore Pike, on the east by the Swarthmore College campus, and on the south by Route 320.

- Municipalities:
  - Nether Providence Township
  - Springfield Township
  - Swarthmore Borough
- USGS Quadrangles:
  - Lansdowne Quadrangle
- Watersheds:
  - Crum Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Swarthmore College Woods"- (Lansdowne Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Well-known locally as the Crum Woods, the expanse of forest along Crum Creek adjacent to Swarthmore College is a significant connection in the green infrastructure of Delaware County. This mature second-growth forested area helps to provide a nearly continuous habitat connection between Chester County to the north and the Delaware River to the south. Within the larger forested area are smaller patches of forest that are of higher quality due to the relative lack of past disturbances and the natural integrity of the native species composition. The woods function to protect the water quality of Crum Creek and to provide habitat for wildlife and a refuge for native plants. Because of its physical and institutional connection to Swarthmore College, the Crum Woods also fulfill a unique educational and scientific research function.

Species of Concern Considerations:

- Southern red oak is a globally secure (G5), state critically imperiled (S1) tree that occurs scattered over several acres within this mature forested area. Its preferred habitat is dry to moist woods, thickets, serpentine barrens, and on slopes. Ranging from New York south to Texas and Florida, in Pennsylvania the range for this species is limited to a few southeastern counties. Known populations of this species are threatened by habitat loss, habitat degradation by invasive species of plants, and in some locations, over-browsing by deer. These high quality forests may be altered by habitat fragmentation, which can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations of southern red oak and encourage new population growth. Establishing undisturbed buffers around fragmented forested habitat and invasive species removal will help to maintain viable populations of this species.

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, uses both aquatic and upland habitats along Crum Creek in this vicinity for various functions during its life cycle. This species requires an abundant food source in the creek and suitable breeding areas in the upland forest. This can be achieved by protecting and expanding the natural vegetation buffer along the creek, the adjacent slopes, and its tributaries.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*). A very detailed delineation of the natural community types present here is available in a management plan developed for the area (Latham et al. 2003).

  - Terrestrial (upland) communities:
    - Dry oak – heath forest
    - Dry oak – mixed hardwood forest
    - Hemlock (white pine) – red oak – mixed hardwood forest
    - Red oak – mixed hardwood forest
    - Tuliptree – beech – maple forest
    - modified successional forest*
  - Palustrine (wetland) communities:
    - Sycamore – (river birch) – boxelder floodplain forest
    - Red maple – mixed shrub palustrine woodland
    - Black willow scrub/shrub wetland
    - Mixed forb marsh
- Most of the floodplain of Crum Creek, adjacent slopes along the gorge, and small tributary valleys next to Swarthmore College are cloaked in forest. Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality. Though the forest was likely selectively cut for fuel wood and timber several times since colonial times, much of the existing forest has apparently been standing for well over 100 years. Some of the trees were in the past likely considered less desirable for lumber and fuel or were less accessible due to steep slopes and were left in place. While this tract of forest can't be considered virgin timber, some individual trees in the area, in particular several northern red oaks approaching 4 feet in diameter and 100 feet tall, may be 200-300 years old or older. Although there is invasion of exotic plant species into the woods and quite a number of trails crisscrossing the steep eastern slope, the overall quality of the woods is remarkably natural and aesthetically pleasing.
- The native canopy species characterizing the forested habitat are northern red, black and white oaks (*Quercus rubra, Q. velutina* and *Q. alba*), eastern hemlock (*Tsuga canadensis*), American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), mockernut hickory (*Carya tomentosa*) and red maple (*Acer rubrum*).
- Characteristic sub-canopy trees and shrubs documented include American hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*), spicebush (*Lindera benzoin*), bladdernut (*Staphylea trifoliata*), mountain-laurel (*Kalmia latifolia*), pawpaw (*Asimina triloba*), maple-leaf viburnum (*Viburnum acerifolium*), and witch-hazel (*Hamamelis virginiana*).
- The floodplain of Crum Creek is rather weedy with some Japanese knotweed (*Polygonum cuspidatum*) present, although the principal landowner is engaged in an aggressive program to control the species.

Ownership:

- Almost all of the area within this site is owned by Swarthmore College and managed by its horticultural and land-management division, the Scott Arboretum. Single ownership of a large piece of the green infrastructure of Delaware County can be tremendously helpful towards implementation of consistent conservation actions across this significant piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the region had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. The woods on the east side of the creek have been protected since 1884 when they were acquired by Swarthmore College. The college added most of the woods on the west side of the creek more recently, but the level of maturity of the forest stands on both sides is similar. Aerial photographs from 1937 show this forested Crum Creek gorge in a relatively intact condition, surrounded by active agricultural fields and scattered residences.
  - The surrounding habitat was converted first to agricultural then to residential and commercial uses. The forested area has been continually fragmented and reduced in size and contiguity over the years by additional buildings and infrastructure.
  - A rail line was constructed in 1854 perpendicular to Crum Creek through the forest patch, dividing it into two smaller pieces.
- Current:
  - The Blue Route, completed in 1991, was constructed parallel to Crum Creek. Through diligent negotiations by Swarthmore College and local municipalities, the original alignment was changed to spare most of the forested habitat from destruction, though the interchange with Baltimore Pike has substantially fragmented the former connectivity of the landscape.
  - A large municipal composting facility occupies an area formerly cleared for agriculture. This facility is in very close proximity to one of the higher quality forest patches that contains a population of southern red oak. Dumping of landscaping and construction debris along the edges of the forest can spread invasive species of plants and degrade the integrity of high quality patches of forest.
  - Sewer lines from the adjacent region connect to a trunk line that parallels Crum Creek.
  - A narrow pipeline access path parallels Crum Creek through this area. Vegetation maintenance of the rights-of-way eliminates all but the lowest growing non-woody species. The tree canopy is continuous across the airspace above the right-of-way.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Portions of the immediate floodplain are maintained as large patches of lawn, eliminating essential floodplain habitat and reducing the filtering capacity of the riparian corridor. In the small areas where the floodplain is unforested on Swarthmore College land, the Scott Arboretum has recently installed a riparian buffer of native floodplain trees planted in tubes to resist deer browsing and antler rubbing.
  - A tributary of Crum Creek flowing down the steep eastern valley wall near the center of the college campus has been severely eroded by high storm flows.
  - An insect pest on hemlock trees, the hemlock woolly adelgid, which was accidentally introduced from Asia, has impacted numerous hemlock trees in the ravine. Additional information on this insect pest can be obtained from the Pennsylvania Bureau of Forestry web site at <http://www.dcnr.state.pa.us/forestry/woollyadelgid/index.aspx>. If this insect pest succeeds in decimating the hemlock population at this location, it could have a severe affect on the microclimate of the ravine, potentially leading to a drier and warmer environment.
  - The relatively low volume and diversity of native understory herbs and shrubs and the recent failure of native tree seedling survival in this forest can be attributed to an oversized deer herd.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. The proximity of this

forest patch to an arboretum subjects this habitat to a potential onslaught of species of unknown invasive tendencies. Since around 2000, the Scott Arboretum has been closely monitoring for the expansion of landscape ornamentals occurring outside of their intended area, removing species from its collection that are known to be invasive, and conducting piecemeal removal of woody invasive species in some sections of the woods, mainly east of Crum Creek. It is important to continue these efforts. Informing other neighboring property owners of the benefits of invasive species removal could result in additional improvement. For a full list of invasive species at this location, please refer to Latham et al 2003. Some of the primary invasive species occurring in this location include:

- Norway maple *(Acer platanoides)*
- goutweed *(Aegopodium podagraria)*
- garlic-mustard *(Alliaria petiolata)*
- angelica-tree *(Aralia elata)*
- oriental bittersweet *(Celastrus orbiculatus)*
- burning-bush (*Euonymus alatus)*
- Japanese knotweed *(Fallopia japonica)*
- English ivy *(Hedera helix)*
- Japanese hops *(Humulus japonicus)*
- border privet *(Ligustrum obtusifolium)*
- Japanese honeysuckle *(Lonicera japonica)*
- amur honeysuckle *(Lonicera maackii)*
- Japanese stiltgrass *(Microstegium vimineum)*
- mile-a-minute weed *(Persicaria perfoliata)*
- common reed *(Phragmites australis)*
- lesser celandine *(Ranunculus ficaria)*
- multiflora rose *(Rosa multiflora)*

- Control options for invasive plants range from mechanical to chemical (see individual fact sheets). High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

- Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. They avidly consume seedlings of virtually all native tree species and generally avoid eating invasive plants. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

A very detailed and comprehensive management plan for this area has been developed by The Natural Lands Trust and Continental Conservation (Latham et al, 2003). Implementation of the recommendations set forth in this management plan will help ensure the conservation and improvement of this significant natural resource.

- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for this habitat should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for the populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species. Prevent fragmentation and incursions into the forested landscape.
- Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Conserve and expand the forested riparian buffers of Crum Creek. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Care needs to be taken not to attempt to reforest portions of the floodplain that should remain open wetland habitats. Reduce the non-pervious surfaces in the surrounding area. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Find a new location for the existing municipal composting facility and restore the area to native habitat appropriate for the region. Discontinue the practice of dumping landscaping and construction debris at the forest edge. Recycle or compost all applicable material, and find other disposal options for those materials that cannot be recycled or composted.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape. Swarthmore College currently has a deer herd reduction program in place to help control this pressure on the integrity of the natural community.
- Minimize the existing haphazard network of trials by closing unnecessary or redundant trails.
- The ravine habitat can be strongly affected as a result of nearby land use decisions. Conservation efforts should focus on protecting and improving the quality of the surface water. Reduce the amount of impervious surfaces in the Crum Creek watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the creek, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.
- Residents who live adjacent to the Crum Woods should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants

in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.
    - Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.
- Potential Restoration Activities:
    - Former agricultural fields that have been allowed to revert to woody vegetation may require selective management to speed the succession process. Remove weedy woody species and favor native climax community species. Use the higher quality adjacent forests in similar topographic and geologic settings as natural community reference examples and mimic the forest composition. Use local native seed sources and root stock whenever possible in restoration efforts.
    - Areas currently maintained as lawn, particularly in the active floodplain of Crum Creek, should be restored to native floodplain forest or open meadow habitats appropriate for the region.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields and residential neighborhoods are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal, particularly English ivy, Norway maple, tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, Japanese knotweed, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.

Darby Creek Mouth Mudflat

Delaware County, PA

Natural Heritage Inventory



0 0.25 0.5 1 Kilometers

0 0.25 0.5 1 Miles

PNHP

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

Darby Creek Mouth Mudflat – *Exceptional significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Waterhemp ragweed (*Amaranthus cannabinus*)	P	G5	S3	PR (PR)	2009	C
Eastern baccharis (*Baccharis halimifolia*)	P	G5	S3	PR (PR)	2007	D
Swamp beggar-ticks (*Bidens bidentoides*)	P	G3G4	S1	PT (PE)	2009	D
Beggar-ticks (*Bidens laevis*)	P	G5	S1	N (PE)	2009	BC
Wrights spike rush (*Eleocharis obtusa* var. *peasei*)	P	G5	S1	PE (PE)	1994	B
Little-spike spike-rush (*Eleocharis parvula*)	P	G5	S1	PE (PE)	1994	B
Multiflowered mud-plantain (*Heteranthera multiflora*)	P	G4	S1	PE (PE)	1994	B
Bugleweed (*Lycopus rubellus*)	P	G5	S1	PE (PE)	2009	D
Shrubby camphor-weed (*Pluchea odorata*)	P	G5	S1	TU (PE)	2009	E
Long-lobed arrow-head (*Sagittaria calycina* var. *spongiosa*)	P	G5	S1	PE (PE)	2009	AB
Subulate arrowhead (*Sagittaria subulata*)	P	G4	S3	PR (PR)	2001	BC
River bulrush (*Schoenoplectus fluviatilis*)	P	G5	S3	PR (PR)	2001	A
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	2009	D
Sensitive species of concern[3]	---	---	---	---	2000	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: The tidally influenced area at the confluence of Darby Creek and the Delaware River south of Interstate 95.

- Municipalities:
  - Ridley Township
  - Tinicum Township
- USGS Quadrangles:
  - Bridgeport Quadrangle
- Watersheds:
  - Darby Creek
  - Delaware River
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP587", "SP534" (Bridgeport Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - "SP603, SP605, SP606, SP607, SP608, SP609, SP610" – Darby Creek Mouth Mudflat"- (Bridgeport Quadrangle)

Description: This site consists of remnant tidal mudflats and riverbank in a highly modified portion of the Delaware River shoreline where Darby Creek meets the Delaware River opposite Little Tinicum Island. The mostly walled or rubble armored shoreline is dominated by a series of yacht clubs and small-boat marinas, but also includes some relatively undeveloped shoreline. Some of the piers do not appear to have been used in the recent past and are giving way to early successional vegetation. Along the river shoreline, native species of plants and animals compete with introduced species for the limited space and resources available for their use. Tidal mudflats are beginning to form in shallow areas at the base of the shoreline retaining walls and between marinas. The vegetation consists of tidal marsh dominated by spatterdock and bulrushes, and adjacent areas of shallow water dominated by tape-grass (*Vallisneria americana*). The species composition is similar to that found across the channel on the mudflat and tidal marsh on the north side of Little Tinicum Island.

Species of Concern Considerations:
The numerous plant species of concern found on the tidally influenced river shoreline can be grouped according their occurrence in relation to the high and low tide line.

- Intertidal freshwater marsh occurs at the upper edge of tidal inundation. Waterhemp ragweed, eastern baccharis, swamp beggar-ticks, beggar-ticks, bugleweed, shrubby camphor-weed, river bulrush, and Indian wild rice occur in this zone.
- Intertidal freshwater mudflat is submerged during high tide and only exposed during low tide. Most plants are relatively short and often form clumps, and includes the plant species of concern little-spike spike-rush, Wrights spike rush, multiflowered mud-plantain, subulate arrowhead, and long-lobed arrow-head grow with leafy emergent vegetation such as spatterdock (*Nuphar lutea*), pickerelweed (*Pontederia cordata*), arrowheads (*Sagittaria graminea, S. rigida*), arrow arum (*Peltandra virginica*) and scattered patches of waterweed (*Elodea nuttallii*).
- The tidal marsh also supports a sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing their protection. This species depends on the continued cleanup and restoration of the marsh and aquatic habitat to survive.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Palustrine (wetland) communities:
  - Intertidal freshwater mudflat*
  - Intertidal freshwater marsh*

Ownership:

- A small part of the shoreline is publicly owned as Governor Printz State Park, while the remainder is held in several relatively large private parcels. A large undeveloped portion right at the mouth of Darby Creek is owned by the Delaware County Industrial Development Authority. The reduced number of landowners can be helpful towards implementation of consistent conservation action of this piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the area between the I-95 freeway and the Delaware River has been greatly modified from the extensive system of tidal marshes that used to dominate the shoreline. The tidally influenced shoreline of the Delaware River historically hosted expansive freshwater tidal marshes, especially at the mouths of the tributary creeks. Over the past several centuries and especially this past one, the marshes have been diked, ditched, drained, filled and converted to dry areas of commerce and residence. Most of this area is still within the floodplain of the

river and is likely to be subject to future flooding from increasingly unpredictable weather patterns and an anticipated rise in sea level.
    - Rail lines and roadways were built parallel to, and through the former marshes.
    - Industrial plants and a coal-fired electric generating plant were built on the banks of the river.
- Current:
    - Much of the area remains as it was at the time of the 1937 aerial photos, with a series of small marinas lining the river shore, though upland development has filled most of the formerly sparsely developed area. Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
    - In 2004 the oil tanker Athos-I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River.
    - The impact of wave action from passing boat traffic along this section of the river is buffered by Little Tinicum Island, which is likely the reason for its popularity as a small boat marina.
    - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
    - Exotic Species – This disturbed strip of vegetation is frequently dominated by invasive non-native trees such as tree-of-heaven, princess tree, Norway maple, Siberian elm, white poplar and white mulberry. Invasive shrubs and vines frequently dominate the understory including Japanese honeysuckle, porcelain berry, Asiatic bittersweet, multiflora rose, bush honeysuckles, common privet, barberry, paper mulberry and autumn olive to name a few.

<u>Conservation Actions</u>:

- Future long range goals for this section of the river should be to simultaneously enhance the native ecology of the riverfront as well as provide public access and park space opportunities. Since much of the Delaware River shoreline in Delaware County is currently transitioning from past industrial and shipping activity, the county is presented with an excellent opportunity to recreate a continuous greenway corridor along this stretch of the river. This linear area currently lends itself well to the reestablishment of a ribbon of native vegetation that will help provide habitat for native plants and animals while filtering and trapping runoff from the urban and suburban areas before it enters the river. In addition, the linear corridor can function as a portion of a public greenway along the length of the Delaware riverfront. Such a public amenity would greatly improve the quality of life for all residents and visitors to the area.
- Future developments should be set back from the river shoreline to accommodate a 100-meter wide vegetated riparian buffer between the river's edge and development activity.
- The shoreline habitat can be improved by removing portions of the armored bulkheads and reconnecting the river to a portion of its natural floodplain.
- Restore and protect the natural hydrology of the river and it tributaries. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
- The undeveloped habitat on the north side of the mouth of the Darby Creek is owned by the Delaware County Industrial Development Authority. This parcel is currently well suited to ecological restoration activities. This parcel was undeveloped in 1937 air photos except for a few small-boat launch areas. Restoration activities could restore both tidal marsh and coastal plain upland forest habitats to this area.
- Replant the riparian area in native trees and shrubs to enhance its ecological value.
- Remove invasive species of plants. Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards

removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.



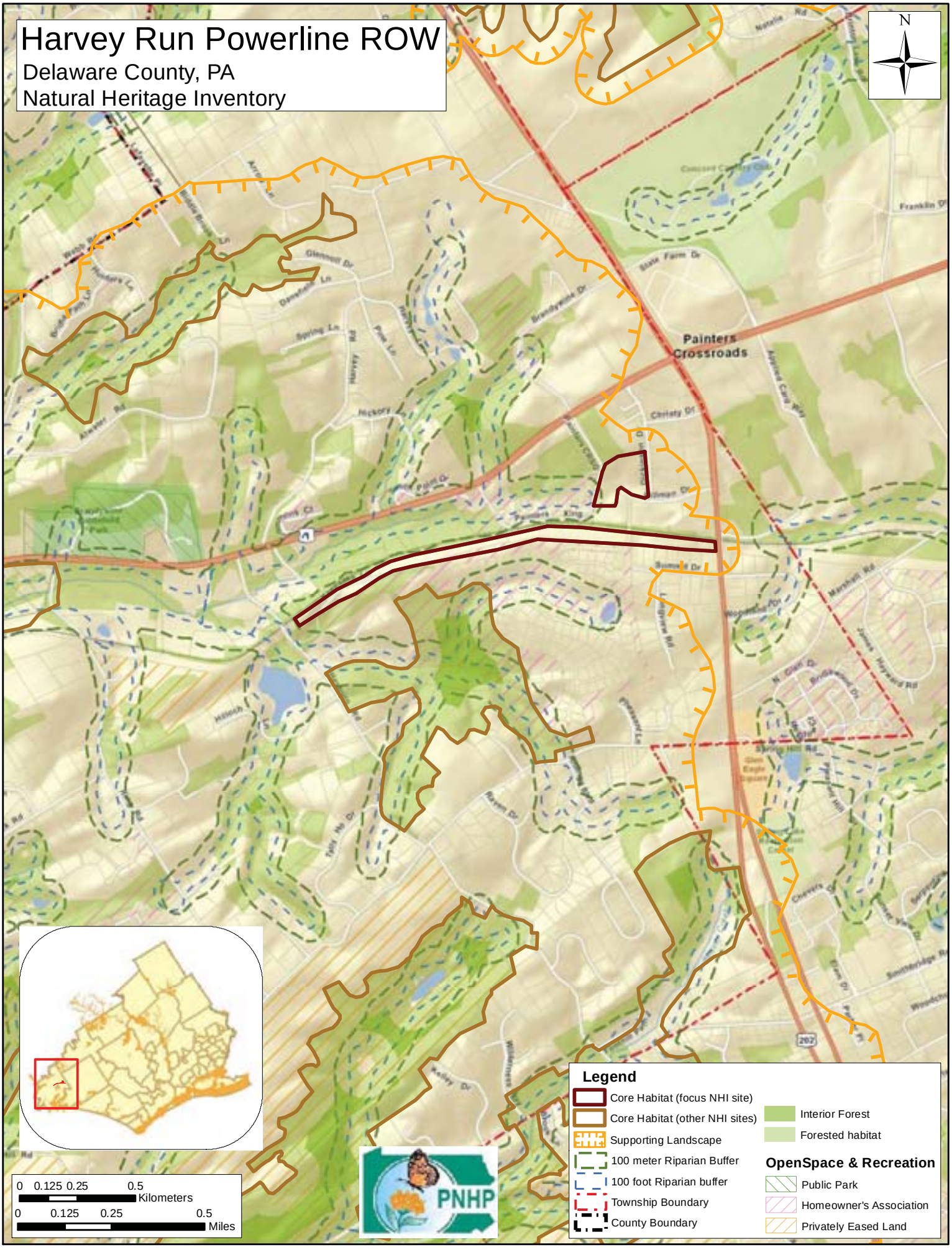
Photo Source: Rocky Gleason (PNHP)

Tidal mudflat vegetation is beginning to colonize the shallow waters at the base of retaining walls and between developed marinas in this section of the river shoreline.

Harvey Run Powerline ROW

Delaware County, PA

Natural Heritage Inventory



Harvey Run Powerline ROW – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Elliott's beardgrass (*Andropogon gyrans*)	P	G5	S3	N (PR)	2000	B
Velvety panic-grass (*Dichanthelium scoparium*)	P	G5	S1	PE (PE)	2001	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area is primarily concentrated on the utility rights-of-way south of Route 1 between Route 202 on the east and Heyburn Road on the west.

- Municipalities:
  - Chadds Ford Township
- USGS Quadrangles:
  - West Chester
  - Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
  - West Branch Chester Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Successional old fields and utility rights-of-way are set within a residential and commercial context. Utility line maintenance helps to preserve the early successional habitat preferred by the two plant species of concern.

Species of Concern Considerations:

- Velvety panic-grass and Elliot's beardgrass are plants that typically grow in damp to seasonally wet clearings, abandoned fields, woods borders, thickets, marshes, and disturbed ground. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for these species to thrive. Vegetation maintenance along agricultural field edges and the pipeline at this location helps to reduce competition from woody and aggressive species and keep the habitat in a state of early succession. Habitat loss, deer browse and the indiscriminate spraying of herbicides are threats to these species in some locations.

Forest Cover / Natural Communities: The habitat outlined in this Natural Heritage Area is limited to the open, early successional habitat of the utility corridor and an adjacent old field. These habitats are typically dominated by introduced species of plants, but also support many native early successional species.

Ownership:

- This narrow corridor is owned by a utility company and several private property owners.

Habitat Disturbances:

- This habitat is the result of disturbance, the clearing of forests for agriculture and its subsequent periodic mowing to maintain the open aspect of the utility rights-of-way.
- Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.

Conservation Actions:

- Most of the species of concern core habitat occurs within the early successional fallow fields of the utility right-of-way.
- Mowing of the area should be limited to every other year or less frequently to allow the plant species of concern to grow, set fruit and establish before the next mowing cycle. Complete elimination of mowing may have a detrimental effect on the species of concern habitat by allowing woody vegetation to dominate the site, closing the canopy for the species of concern. Chemical vegetation management should not be broadcast applied, but spot treatments to target invasive species may be necessary to achieve control of these aggressive plants.
- Remove invasive species of plants. Edge habitats associated with utility corridors and residential development are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.


Haverford State Hospital Borrow Field
Delaware County, PA Natural Heritage Inventory
N
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Haverford State Hospital Borrow Field – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Elliott's beardgrass (*Andropogon gyrans*)	P	G5	S3	N (PR)	2010	B
White thoroughwort (*Eupatorium album*)	P	G5	S1	PX (PE)	2010	AB
Little ladies'-tresses (*Spiranthes tuberosa*)	P	G5	S1	TU (PE)	1999	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This early successional habitat is bounded on the west by the Blue Route (Route 476), on the north and east by Darby Road and on the south by the former Haverford State Hospital Buildings.

- Municipalities:
  - Haverford Township
- USGS Quadrangles:
  - Lansdowne Quadrangle
  - Norristown Quadrangle
- Watersheds:
  - Darby Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This area is dominated by an early successional woodland and forest with occasional grassy openings, the remnants of former agricultural fields and pastures. The understory is dominated by non-native and invasive shrub and herbaceous species.

Species of Concern Considerations:

- All three plant species of concern known to occur at this site, Elliott's beardgrass, white thoroughwort and little ladies'-tresses prefer to grow in open habitats with little competition from woody vegetation. White thoroughwort has a wide range across eastern North America where it grows in openings, clearings, rights-of-way, thickets, and open woods, and had been documented historically in the southeastern counties of Pennsylvania. This plant was considered to no longer occur in the state until a recent survey by the Morris Arboretum located this population. This newly documented population is the only currently known location for this species in the state. Active management, such as periodic mowing or prescribed fire and invasive species removal, will be needed to maintain the proper successional stage and ecological conditions for these species to thrive. Excessive deer browse is also a concern for these populations.

Forest Cover / Natural Communities:

- The forest patches are in the long process of reverting from past agricultural uses.
- The young forest canopy is dominated by red maple (*Acer rubrum*) and mixed oaks (*Quercus alba, Q. rubra, Q. montana*). The shrub layer is dominated by invasive species in much of the area, though

some areas have a relatively good representation of native shrub species. In other areas, the shrub layer is missing altogether, giving the woodlot an open, park-like look. This openness is likely due to excessive deer pressure on the reproductive success of understory vegetation including tree seedlings.

Ownership:

- The former Haverford State Hospital grounds was acquired by Haverford Township in 2002 to be used as passive recreation open space.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture.
  - The Blue Route (Route 476) was constructed through a portion of the habitat.
- Current:
  - Much of the formerly open fallow field habitat that was evident in 1937 air photos is reverting to forest. These early successional forests, though beneficial to many common species, eliminate the open habitat conditions favorable for the plant species of concern that occur at this location.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the adjacent creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species:
    - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
      - tree-of-heaven *(Ailanthus altissima)*
      - garlic-mustard *(Alliaria petiolata)*
      - Asiatic bittersweet (*Celastrus orbiculatus*)
      - Japanese honeysuckle *(Lonicera japonica)*
      - Japanese stiltgrass *(Microstegium vimineum)*
      - mile-a-minute weed *(Persicaria perfoliata)*
      - multiflora rose *(Rosa multiflora)*
    - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.
  - The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced.

Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Maintain and expand early successional habitats by periodically removing woody vegetation and invasive plant species. Because the species of concern known from this site rely on open canopied habitats, removal of woody shrubs and trees will to be necessary to maintain habitat for these open habitat adapted plant species. Periodic mowing of the open meadow every other year, or even less frequently, in early spring can help maintain the early successional conditions favorable for these plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and its habitat.
- Remove invasive species of plants. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. Edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Because the species of concern noted from this site rely on open canopied habitats, programs that support establishment of riparian buffers with trees, such as CREP, should be avoided in the upland meadow area.
- The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the adjacent creeks and their floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creeks.


Ithan - Darby Creek Wetlands
Delaware County, PA
Natural Heritage Inventory
N
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.25 0.5 1 Kilometers
0 0.25 0.5 1 Miles
PNHP

Ithan - Darby Creek Wetlands – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	2008	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area roughly corresponds to the lower portions of the riparian corridors of Ithan Creek and Meadowbrook Creek where they join Darby Creek on both sides of Route 476 (the Blue Route).

- Municipalities:
  - Haverford Township
  - Marple Township
  - Radnor Township
- USGS Quadrangles:
  - Lansdowne Quadrangle
  - Norristown Quadrangle
- Watersheds:
  - Darby Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Darby Creek Valley Park" (Lansdowne Quadrangle)
  - "Ithan Creek Wetland" (Norristown Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The riparian corridor of Ithan Creek and Meadowbrook Creek meet Darby Creek from opposite sides of Route 476. The floodplain and riparian zones of the creeks occasionally flatten and widen to allow small, marshy wetlands to form. The riparian zones are tightly bounded by residential development and other infrastructure. The proximity of the wetlands to local schools and colleges makes them a convenient outdoor classroom.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, uses both aquatic and upland habitats along the creeks and tributaries in this vicinity for various functions during its life cycle. This species requires an abundant food source in the creek and suitable breeding areas in the upland forest. This can be achieved by protecting and expanding the natural vegetation buffer along the creek, the adjacent slopes, and its tributaries.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:

        - Tuliptree – beech – maple forest
        - modified successional forest*
    - Palustrine (wetland) communities:
        - Sycamore – (river birch) – box elder floodplain forest
- Most of the forested portions of the floodplain are in the long process of reverting back from past clearing. Part of the floodplain at the confluence of Ithan Creek and Darby Creek is dominated by silver maples (*Acer saccharinum*), black willow (*Salix nigra*), red maple (*Acer rubrum*) and box elder (*Acer negundo*).
- In the wetlands, scattered black willow (*Salix nigra*) and silver maple (*Acer saccharinum*) are the dominant tree species. Scattered patches of silky dogwood (*Cornus amomum*) and wild rose (*Rosa multiflora*) are surrounded by a continuous cover of assorted wetland herbs, grasses, sedges, and rushes. Monkeyflower (*Mimulus ringens*), ironweed (*Vernonia noveboracensis*), joe-pye weed (*Eupatorium fistulosum*), and mountain mint (*Pycnanthemum* sp.) add hues of purple to the wetland in mid-summer. Stands of common cattail (*Typha latifolia*) are intermixed with areas dominated by species of sedge (*Carex lurida*), rush (*Juncus effusus*), bulrush (*Scirpus cyperinus*), and spike-rush (*Eleocharis* spp.). Purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*) are weedy species abundant in the wetland.

Ownership:

- The linear riparian corridor of these creeks and tributaries has a very fragmented ownership, with many small parcels abutting the creeks. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
    - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture and the small, clustered town of Broomall.
    - A rail line was constructed northwest to southeast and followed Darby Creek in this section, likely altering the natural drainage patterns of the area with the railroad embankment. This rail line is now inactive.
    - Route 476 was constructed north to south through this area, following a portion of the Ithan Creek floodplain modifying the natural hydrology and drainage of the area.
- Current:
    - The large farms have mostly been converted to smaller residential lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure.
    - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed. Development patterns tightly restrict the available floodplain and riparian habitat for the creeks and tributaries.
    - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.

- Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - Norway maple *(Acer platanoides)*
    - tree-of-heaven (*Ailanthus altissima*)
    - garlic-mustard *(Alliaria petiolata)*
    - Japanese barberry (*Berberis thunbergii*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*
    - Japanese stiltgrass *(Microstegium vimineum)*
    - mile-a-minute weed *(Persicaria perfoliata)*
    - common reed *(Phragmites australis)*
    - multiflora rose *(Rosa multiflora)*
    - wineberry (*Rubus phoenicolasius*)
    - linden viburnum (*Viburnum dilatatum*)
  - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.
- The relatively low volume and diversity of understory herbs and shrubs in forested habitats may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

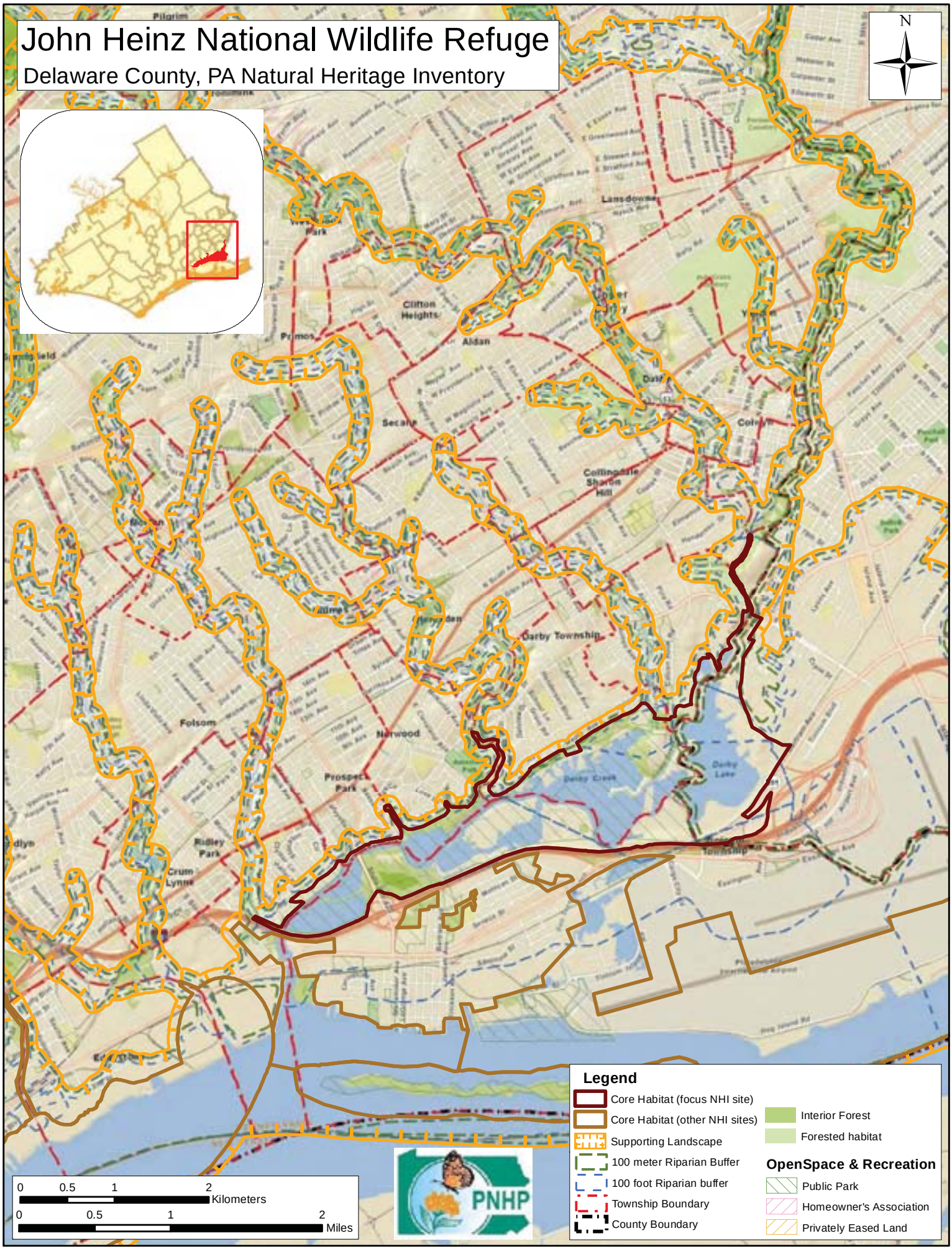
<u>Conservation Actions</u>:

- Overall:
  - Conserve and expand the forested riparian buffers of Darby Creek and its tributaries. Establish at least a 100 foot buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Habitat modification by beavers could help to improve the integrity of this Natural Heritage Area, by reestablishing the matrix of open and canopied wetland complexes. If beavers expand into this system, they should be left to modify and restore some of the open habitats that previously existed at this site. Beaver numbers are on the rise in

Pennsylvania, and it is very possible that they could be documented here in the near future.

- Within the Core Habitat:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Darby Creek, its tributaries, springs and wetlands. This may require that road crossing improvements involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - Forested and open wetlands each require special consideration to maintain their unique attributes. Existing wet meadows should not be modified (i.e. dammed, planted in trees or farmed), as this will deprive the open wetlands adapted species of suitable habitat. Light grazing with pastoral animals can be an effective tool to maintain these soggy meadows in their preferred condition. Once the open habitat within the historic floodplain has been restored, light grazing, often considered compatible with high financial yield organic meat and dairy production, could be an effective tool to maintaining the habitat for all wet meadow species.
  - As existing farm ponds deteriorate and are in need of maintenance, the removal of such ponds should be explored, in order to recreate the natural hydrologic flows of the landscape.
  - Because the species of concern noted from this site relies in part on open canopied habitats, programs that support establishment of riparian buffers with trees, such as CREP, should be avoided in areas close to open wetlands. Instead, these programs may be better suited beyond the historic floodplain of the drainages delineated within in this Natural Heritage Area.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Potential Restoration Activities:
    - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
      - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
      - Riparian Buffers:
        - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.

    - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
    - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
- Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.


John Heinz National Wildlife Refuge
Delaware County, PA Natural Heritage Inventory
N
Clifton Heights
Aldan
Secane
Collingdale
Sharon Hill
Darby Township
Folsom
Norwood
Prospect Park
Ridley Park
Crum Lynne
Lansdowne
Primos
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.5 1 2 Kilometers
0 0.5 1 2 Miles
PNHP

John Heinz National Wildlife Refuge – *Exceptional significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Freshwater intertidal marsh Natural Community	C	G3G4	S1	N	2010	B
Great Egret (*Ardea* (*Casmerodius*) *albus*)	B	G5	S1B	PE (PE)	1984	E
American Bittern (*Botaurus lentiginosus*)	B	G4	S1B	PE (PE)	1989	E
Marsh Wren (*Cistothorus palustris*)	B	G5	S2S3B	N (CR)	2004	E
Least Bittern (*Ixobrychus exilis*)	B	G5	S1B	PE (PE)	1991	A
Virginia Rail (*Rallus limicola*)	B	G5	S3B	N	1991	E
Waterhemp ragweed (*Amaranthus cannabinus*)	P	G5	S3	PR (PR)	2009	C
Velvety panic-grass (*Dichanthelium scoparium*)	P	G5	S1	PE (PE)	2008	BC
Walter's barnyard-grass (*Echinochloa walteri*)	P	G5	S1	PE (PE)	1986	BC
A eupatorium (*Eupatorium rotundifolium*)	P	G5	S3	TU (TU)	1986	B
Shrubby camphor-weed (*Pluchea odorata*)	P	G5	S1	TU (PE)	2008	B
River bulrush (*Schoenoplectus fluviatilis*)	P	G5	S3	PR (PR)	2001	A
Wild senna (*Senna marilandica*)	P	G5	S3	TU (PR)	2007	BC
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	1991	BC
Sensitive species of concern[3]	---	---	---	---	2009	E
Sensitive species of concern[3]	---	---	---	---	1991	E
Sensitive species of concern[3]	---	---	---	---	1991	E
Sensitive species of concern[3]	---	---	---	---	1991	E
Sensitive species of concern[3]	---	---	---	---	1998	E
Sensitive species of concern[3]	---	---	---	---	2001	E
Sensitive species of concern[3]	---	---	---	---	2000	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area is roughly bounded by the extent of the John Heinz National Wildlife Refuge above Interstate 95.

- Municipalities:
  - Colwyn Borough (Delaware County)
  - Darby Township (Delaware County)
  - Folcroft Borough (Delaware County)
  - Norwood Borough (Delaware County)
  - Prospect Park Borough (Delaware County)
  - Ridley Township (Delaware County)
  - Sharon Hill Borough (Delaware County)
  - Tinicum Township (Delaware County)
  - Eastwick Borough (Philadelphia County)
- USGS Quadrangles:
  - Bridgeport Quadrangle
  - Lansdowne Quadrangle
- Watersheds:
  - Darby Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "John Heinz National Wildlife Refuge" (Lansdowne Quadrangle)
  - "SP538" (Bridgeport Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Tinicum Marsh, part of the John Heinz National Wildlife Refuge (NWR), is what remains of the vast freshwater tidal wetland that covered the southern portion of Philadelphia and Delaware Counties at the time of colonization. This marsh covered between 10 and 20 square miles (6,400-12,800 acres) and supported an untold diversity and density of plants and animals. This large marsh was just part of an extensive marsh system that extended up the Delaware River from the Delaware Bay to well past Philadelphia. Today the Refuge is undergoing active restoration to manage invasive species, remove fill, restore wetland species, mitigate the effects of past chemical and oil spills, and increase the availability of the space for public use.

The Tinicum Marsh system, both within the John Heinz NWR and on Little Tinicum Island, hosts a suite of species which in Pennsylvania are found only along the tidal Delaware River. These species, while common in healthy freshwater tidal ecosystems, are limited to the marsh and a few nearby locations in Pennsylvania because they are the limit of tidal influence within the Commonwealth. This marsh also provides a critical spring and fall migratory bird stopover along the Atlantic flyway.

Species of Concern Considerations: These species fall into three general groups: plants; birds, and herptiles.

- The wetland-dependent plants of concern are found in different portions of the marsh depending on their specific habitat needs. Some, such as subulate arrowhead (*Sagittaria subulata*) and multi-flowered mud-plantain (*Heteranthera multiflora*), depend on regular exposure and inundation by the tide of the mudflats they live on. A few species specialize on the permanently water-saturated shoreline habitat, such as Smith's bulrush (*Schoenoplectus*

smithii) and Walter's barnyard-grass (*Echinochloa walteri*). Others, like annual wild rice (*Zizania aquatica*), are marsh obligate species that have managed to maintain a foothold in the Refuge.

- Among the bird species of concern are three general groups. The first is the group that feeds along the interface between water and vegetation like Great Egret (*Ardea* (*Casmerodius*) *albus*). The second group, composed primarily of rails such as the Virginia Rail (*Rallus limicola*), utilize the flooded vegetation for foraging and nesting. A third group prefers the more grassland-like structure of the marsh. Among these species is the Marsh Wren (*Cistothorus palustris*).
- The marsh supports several additional sensitive species of concern that are not named at the request of the jurisdictional agency overseeing their protection. These species depend on the continued cleanup and restoration of the marsh to survive. Additionally, they also require control of predators (such as skunks, opossums, and raccoons) around their breeding areas to increase the survival chances of their young.
- All of these species of concern depend in one way or another on the natural communities that occur on the Refuge. Two of these natural communities are of conservation concern due to their limited distribution in Pennsylvania. Freshwater intertidal marsh and freshwater intertidal mudflat, are only found in a very limited area of the Commonwealth along the Delaware River. This area is also highly urbanized, making the remaining areas of these communities even rarer and more important to preserve and maintain.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - modified successional forest*
- Palustrine (wetland) communities:
  - Freshwater intertidal marsh*
- Most of the forest patches are in the long process of reverting from past disturbances.

Ownership:

- This large area is managed as the John Heinz National Wildlife Refuge. The consolidated ownership of this large piece of the green infrastructure of Delaware County can be tremendously helpful towards implementation of consistent conservation action across this significant piece of the landscape.

Habitat Disturbances:

- Historic:
  - The marsh was left relatively undisturbed until the early 1800's when the city began to construct ditches and levees throughout the marsh on the east bank of the Schuylkill River. In the mid-1800's the city grid system of roads extended over the area, with Broad Street extending south to League Island (then still an island) and by 1886 the area was covered with farms, factories, rail lines, and shipyards. By the 1926 sesquicentennial celebration in Philadelphia, League Island and the entire marsh east of the Schuylkill River were gone.
  - The marsh on the west bank of the Schuylkill River survived for a much longer period of time. Though extensively diked and levied during the 1800's, it remained tidally influenced and marsh-like over much of the area. Major degradation of the area started with the construction of a massive shipyard on Hog Island during World

War I. Abandoned during the Great Depression, the island was bought by the city of Philadelphia from the federal government and expanded the original Philadelphia Municipal Airport, which reopened in 1940. Closed during World War II, the airport reopened in 1945 for the beginning of the jet age and quickly expanded over the marsh.

- Over the years the Refuge has weathered many insults from leaking landfills, oil spills, pipeline breaks, and invasive species, and yet it still survives and supports a diverse range of rare and important species.
- The small remaining pieces of tidal marsh below the confluence of Darby and Cobbs Creeks were severely threatened in 1969 with the planned expansion of Interstate 95 directly through the marsh and the expansion of a landfill into the marsh. Through the coordinated efforts of a large number of people this area was designated by the US Congress as the Tinicum National Environment Center in 1972. This forced the redirection of I-95 and the closure and capping of the landfill. In 1991 the center was rededicated in memory of Pennsylvania Senator John Heinz who had worked very hard to see that the marsh was protected.
- With major expansion projects at the airport every decade continuing to the present, much of the wetland in this area is underneath the over 4-square mile airport.

o Current:

- An expansion of Interstate 95 was constructed along the southern edge of the marsh.
- The continued expansion of the Philadelphia International Airport has decreased the available marsh habitat, decreased air quality and increased noise pollution in this Important Bird Area.
- Two oil spills have affected the marsh in recent history. In the winter of 2000 a pipeline that travels under the eastern end of the Refuge ruptured, spilling 192,000 gallons of oil into the area. In 2004 the oil tanker Athos I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River.
- A significant change in the flooding regime has occurred as a result of the diking and impounding of portions of the marsh. These areas no long maintain the same pattern of tidal exchange they once did, and as a result cannot support tidal marsh species. In a similar manner, the massive increase in impermeable surface around the Refuge has resulted in a significant increase in stormwater runoff and a noticeable decrease in base flow from Darby Creek and other groundwater sources. Both of these hydrologic changes have negatively impacted the health of the marsh.
- A significant source of historic disturbance to the marsh was the draining and filling of large sections of habitat. Most of these areas are unrecoverable, but some have to be actively dealt with. One, the 45-acre Folcroft Landfill, potentially contains toxic substances and is monitored for leakage.
- Rapid development outside of and on the periphery of the core habitat area has fragmented the landscape with additional buildings, roads and infrastructure and increased the amount of impervious surface and edge habitat in the immediate watershed. Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species:

- A primary disturbance is the significant areas of non-native invasive plants, particularly common reed and purple loosestrife, that dominate vast areas of the marsh and do not provide the same type and quality of habitat as the native species they displace. Some of the primary invasive species occurring in this location include:
    - Norway maple (*Acer platanoides*)
    - tree-of-heaven (*Ailanthus altissima*)
    - porcelain berry (*Ampelopsis brevipedunculata*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - Japanese hops (*Humulus japonicus*)
    - privet (*Ligustrum* sp.)
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*
    - purple loosestrife (*Lythrum salicaria*)
    - Japanese stiltgrass *(Microstegium vimineum)*
    - white mulberry *(Morus alba)*
    - mile-a-minute weed *(Persicaria perfoliata)*
    - common reed (*Phragmites australis*)
    - multiflora rose *(Rosa multiflora)*
    - narrowleaf cat-tail *(Typha angustifolia)*
- Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

Conservation Actions:

- Conservation and restoration goals at Tinicum Marsh should be approached as either short-term or long-term in scope. Short-term goals are achievable on the current Refuge with a limited to moderate commitment of resources, while long-term goals are potential projects within and outside the Refuge that will increase the health of the marsh system and its sustainability, but will require a much greater commitment of resources.
- In the short-term, ongoing efforts to systematically remove invasive species from the Refuge and replace them with native tidal marsh species should be continued and expanded. To facilitate this process an on-site grow-out station for native plants should be investigated.
- Ongoing efforts to collect trash brought in by the tide and by storm events within the Darby and Cobbs Creeks watershed should be continued and expanded as possible. Trash collection events should be looked at as excellent opportunities to involve the community in the care of the Refuge.
- The continued promotion of the John Heinz National Wildlife Refuge as an environmental education center is also vital. Not only is it important for the Refuge to maintain its place as a critical aspect in local curriculum, but promoting and pervading the understanding that Tinicum Marsh is a vital link in the national chain of natural areas will strengthen its place in the community.

- Over the long-term, more ambitious and resource demanding goals should be examined. Primary among these is the reestablishment of tidal marsh within as much of the Refuge as is feasible. This restoration process will mandate the removal of large areas of fill and the extensive reworking of the hydrology of the sites along with the replanting of native tidal species and the management of non-native invasive species. Additionally, adjoining pieces of property should be examined for purchase or easement with the intent to increase the natural buffer around the Refuge.
- Over the long-term, the storm surges from Darby Creek will need to be addressed. These flows result from poorly managed stormwater in the highly developed watershed and antiquated sewage management infrastructure. To address these issues will require systemic changes across the watershed that address how development is permitted and how stormwater is managed.
- Monitoring the effect of climate-change induced sea level rises on the marsh system will be important in directing the conservation of the marsh. With most of the Refuge near, at, or below sea level, even a small increase in the mean water level stands to adversely affect the marsh and the species that depend upon it. Assessing how sea level changes are progressing and how they are affecting the marsh will help direct conservation efforts.
- Conserve and expand the forested riparian buffers of the tributaries leading to the marsh. Establish at least a 100 foot buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Potential Restoration Activities:
    - Streams through forested areas in the watershed should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
        - Riparian Buffers:
            - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
            - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
            - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
    - Remove invasive species of plants. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal, particularly common reed, purple loosestrife and narrowleaf cattail. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.

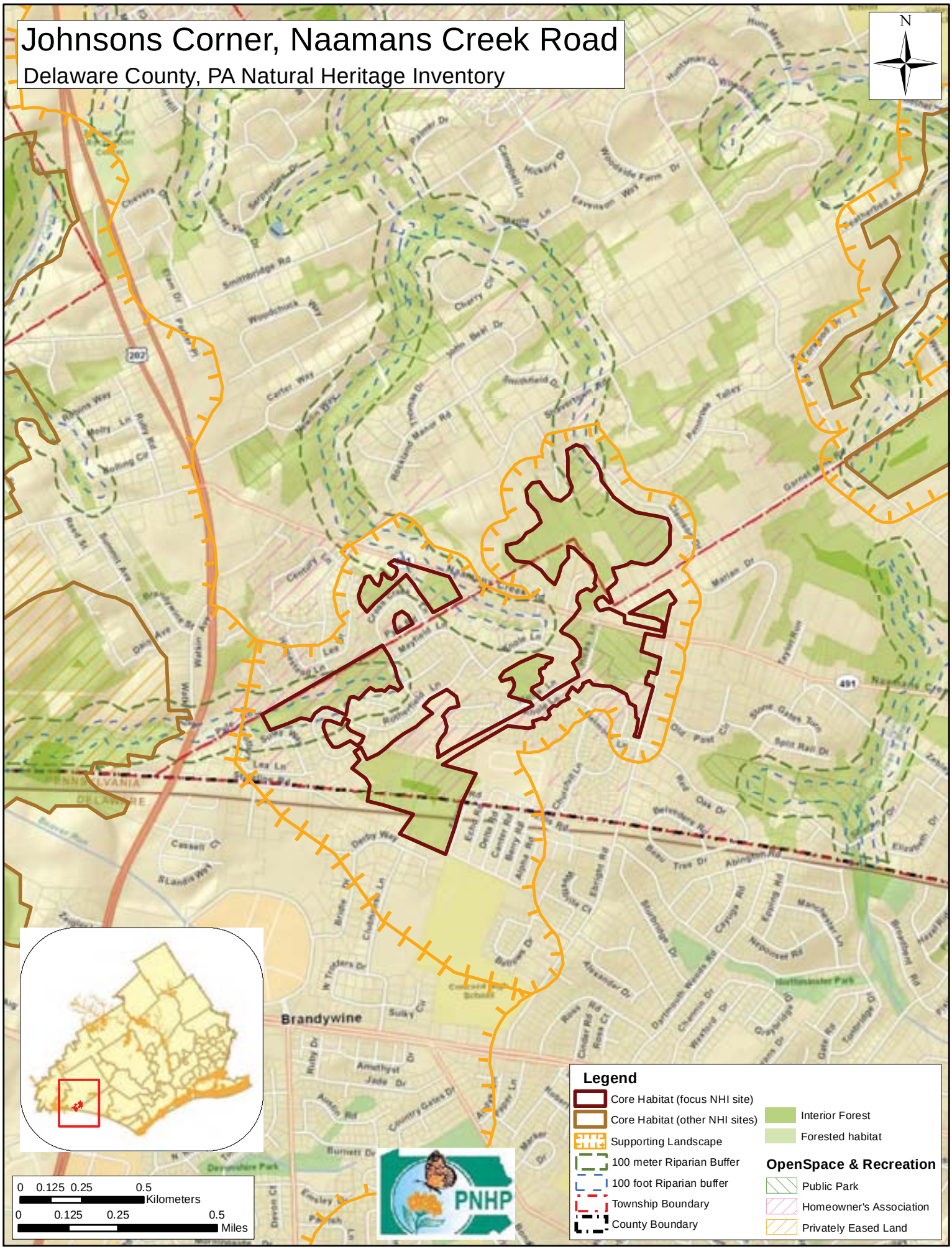


Photo: Andrew Strassman (PNHP)

A stand of wild rice (*Zizania aquatica*) among other tidal marsh species and a backdrop of the invasive plant common reed (*Phragmites australis*).

Johnsons Corner, Naamans Creek Road

Delaware County, PA Natural Heritage Inventory



Johnsons Corner, Naamans Creek Road – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Oblong-leaf serviceberry (*Amelanchier canadensis*)	P	G5	S1	N (PE)	1998	CD
Colic-root (*Aletris farinosa*)	P	G5	S1	TU (PE)	2010	C
Round-leaved thoroughwort (*Eupatorium rotundifolium*)	P	G5	S3	TU (TU)	1989	X
Soapwort gentian (*Gentiana saponaria*)	P	G5	S1S2	TU (PE)	1995	BC
Grass-leaved rush (*Juncus biflorus*)	P	G5	S2	TU (PT)	2010	E
Forked rush (*Juncus dichotomus*)	P	G5	S1	PE (PE)	1989	X
Narrowleaf bushclover (*Lespedeza angustifolia*)	P	G5	S1	PE (PE)	1989	X
Swamp dog-hobble (*Leucothoe racemosa*)	P	G5	S2S3	TU (PT)	2010	C
Downy lobelia (*Lobelia puberula*)	P	G5	S1	PE (PE)	2010	C
Southern bog clubmoss (*Lycopodiella appressa*)	P	G5	S2	PT (PT)	1990	X
Stiff cowbane (*Oxypolis rigidior*)	P	G5	S2	TU (PT)	1995	BC
Many-flowered panic-grass (*Panicum polyanthes*)	P	G5	S4	N (SP)	2009	BC
Cross-leaved milkwort (*Polygala cruciata*)	P	G5	S1	PE (PE)	1995	C
Swamp chestnut oak (*Quercus michauxii*)	P	G5	S1	N (PE)	2009	C
Willow oak (*Quercus phellos*)	P	G5	S2	PE (PE)	2009	D
Spring ladies'-tresses (*Spiranthes vernalis*)	P	G5	S1	PE (PE)	1990	D
Sensitive species of concern	---	---	---	---	1991	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This fragmented habitat is loosely bounded on the west by Route 202, on the north by Shavertown Road, on the east by Ebright Road, and on the south by the Maryland state line. This area is at the drainage divide of three watersheds and hosts the headwaters of two tributaries of the West Branch Chester Creek and one tributary of Beaver Creek.

- Municipalities:
  - Bethel Township
  - Concord Township
- USGS Quadrangles:

- Wilmington North Quadrangle
- Watersheds:
  - Brandywine Creek
  - Naamans Creek
  - West Branch Chester Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Johnsons Corner Quarry Woods"- (Wilmington North Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - "Naamans Creek Road Site" – (Wilmington North Quadrangle)

Description: Considered one of the top sites of statewide significance for the protection of biological diversity in the original 1992 Delaware CNHI and the 1998 update, this area has been severely impacted by accelerated development in the past 20 years. This site was part of a larger mosaic of habitats of coastal plain affinity including forest, wetlands, fallow and active fields, and a former sand and gravel quarry (coastal plain deposits) that left a wet, sandy irregular surface. This area is underlain by bedrock and soils that have a high water table and the flat topography limits drainage. Seasonal ponding of water is typical for the area. This wetness has provided suitable habitat for numerous coastal plain affinity species, many of which continue to persist in scattered patches of suitable habitat. This area was one of very few in the state to support species associated with the Atlantic coastal plain in an intact habitat. Of special note was the presence of a cranberry wetland, a very unusual habitat for this region of the state. Much of the area has since been converted to residential development leaving scattered remnants of habitat that in many cases still manage to support species of concern. Several of the species of concern noted on past surveys have failed to be relocated in recent surveys due to the destruction of their former habitat and may be extirpated from this site.

Species of Concern Considerations:

- Nine of the plant species of concern, colic-root, soapwort gentian, grass-leaved rush, downy lobelia, stiff cowbane, many-flowered panic-grass, cross-leaved milkwort and spring ladies'-tresses are plants that typically grow in open canopy conditions such as damp to seasonally wet clearings, woods borders, thickets, abandoned fields, and disturbed ground. Active management, such as bi-yearly mowing or prescribed fire, may be necessary to create the proper successional stage and ecological conditions for these species to thrive. Vegetation maintenance along road edges, open fields and the pipeline at this location can help to reduce competition from woody and aggressive species and keep the habitat in a state of early succession. Habitat loss, natural succession deer browse and the indiscriminate spraying of herbicides are threats to these species in some locations.
- Oblong-leaf serviceberry and swamp dog-hobble are understory shrubs or small trees that typically occur in swamps and wet thickets. Much of the formerly suitable habitat in this area has been modified for residential development, but the species continue to persist within wet roadside ditches, swales, moist stream banks and swamp forests in this area. Preserve and restore the natural hydrology of the habitat and protect the species from excessive deer browse.
- Two tree species of concern, swamp chestnut oak and willow oak occur in the seasonally wet forested habitats and bottomlands in this area. Closely associated with the Atlantic coastal plain habitat, naturally occurring populations of these species are typically restricted to the extreme southeastern counties in Pennsylvania. Swamp chestnut oak is a recent addition to the known flora of Pennsylvania, having only been documented as occurring in the state in the past five years. Currently, there are only two known populations of this species in the state. Known populations of both of these tree species are threatened by habitat loss, disruptions to the site hydrology, habitat degradation by invasive species of plants, and in some locations, over-browsing by deer. Forests may be negatively altered by habitat fragmentation, which can have a drying effect on the habitat and promote invasive species growth. Establish protective buffers around fragmented habitat and remove invasive species to help maintain populations of these tree species of concern and encourage new population growth. Fencing of seedlings and saplings may be necessary to protect future generation of these trees from deer herbivory.
- Four of the plant species of concern documented within this habitat during the initial inventory, round-leaved thoroughwort, forked rush, narrowleaf bushclover and southern bog clubmoss, have not been relocated during subsequent surveys. The habitat was essentially destroyed by development and the

- populations are presumed extirpated, though more thorough searching may uncover remnant populations of these species in the degraded habitat that remains.
- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.



Photo source: Andrew Strassman (PNHP)

A massive swamp chestnut oak and its progeny in Jack King Memorial Park is one of only two populations of this tree species currently known to occur in Pennsylvania.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red maple terrestrial forest
  - Red oak – mixed hardwood forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Black willow scrub/shrub wetland
  - Mixed forb marsh

- The habitat has been severely fragmented. Patches of forest are frequently seasonally wet dominated by mixed oaks and other hardwoods, with a strong representation by sweet-gum (*Liquidambar styraciflua*) in the canopy and understory. Some trees in these woodlots are of impressive girth and height, suggesting a relatively mature habitat. Vestigial patches of early succession habitat are maintained as powerline/pipeline rights-of-way, roadsides, lawns, and open space fields. Most of the remaining non-forested wetland habitat is the result of earthmoving and habitat modification.
- The native canopy species characterizing the forested habitat are northern red, pin and white oaks (*Quercus rubra, Q. palustris* and *Q. alba*), sweet-gum, (*Liquidambar styraciflua*), American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), shagbark hickory (*Carya ovata*), black-gum (*Nyssa sylvatica*) and red maple (*Acer rubrum*).
- Besides numerous invasive shrub species the characteristic native sub-canopy trees and shrubs include spicebush (*Lindera benzoin*), winterberry (*Ilex verticillata*), American hazelnut (*Corylus americana*), American hornbeam (*Carpinus caroliniana*), flowering dogwood (*Cornus florida*) and several native viburnums (*Viburnum acerifoli*um, *V. dentatum & V. prunifolium*).

Ownership:

- Much of the habitat has been subdivided into suburban lots, though a fair part of the habitat is owned by Bethel Township and maintained as Jack King Memorial Park. Additional portions of the habitat are

owned by various homeowner associations and maintained as open space. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the region had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photos from 1937 show that much of the forested area in the core habitat that remains today was forested then, reflecting a relatively high degree of habitat maturity. Most of the surrounding area in 1937 was in active agricultural production, with some portions of the forested habitat in the early stages of recovering from past clearing.
  - A gravel quarry operated in the vicinity of the some significant plant populations, perhaps helping to create favorable conditions for these species.
- Current:
  - Development has steadily increased in the past decade. The large farms have mostly been converted to smaller residential lots and expansive suburban developments and associated retail business and infrastructure, fragmenting the landscape with additional buildings, roads and infrastructure.
  - Much of the primary habitat indicated as hosting species of concern in the original CNHI report has been converted to a residential development, leaving fragments of the former habitat surrounded by houses, lawns, roads and infrastructure. In some cases these habitat fragments can continue to support these populations of species of concern, while other habitats are considered destroyed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Portions of the immediate floodplain are maintained as large patches of lawn, eliminating essential floodplain habitat and reducing the filtering capacity of the riparian corridor.
  - The relatively low volume and diversity of native understory herbs and shrubs in this forest may be attributable to an oversized deer herd.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Informing other neighboring property owners of the benefits of invasive species removal could result in additional improvement. Some of the primary invasive species occurring in this location include:
    - Norway maple *(Acer platanoides)*
    - garlic-mustard *(Alliaria petiolata)*
    - oriental bittersweet *(Celastrus orbiculatus)*
    - border privet *(Ligustrum obtusifolium)*
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*
    - Japanese stiltgrass *(Microstegium vimineum)*
    - mile-a-minute weed *(Persicaria perfoliata)*
    - common reed *(Phragmites australis)*
    - multiflora rose *(Rosa multiflora)*
  - Control options for invasive plants range from mechanical to chemical (see individual fact sheets). High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in

coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

- Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. They avidly consume seedlings of virtually all native tree species and generally avoid eating invasive plants. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Because several of the species of concern noted from this site rely upon open canopied habitats, removal of woody shrubs and invasive species in early successional habitats such as open fields, pipeline/powerline rights-of-way, and roadsides will to be necessary to maintain habitat for several of the open habitat adapted plant species. Mowing of these habitats every other year in early spring can help maintain the early successional conditions favorable for these plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and their habitat.
- Preserve and expand permanent and seasonal wetlands. The natural hydrology should be maintained and restored. Wet habitats should be thoroughly surveyed for remnant populations of species of concern and other coastal plain affinity species. Remove invasive species to allow native species to expand their populations. Establish vegetated buffers around wet and moist habitats to help protect the water quality entering the system.
- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for forested habitats should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for several populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species. Prevent fragmentation and incursions into the forested landscape.
- Avoid logging in this area except as it relates to invasive species removal and stand improvement. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape.
- Conserve and expand the forested riparian buffers of all streams and wetlands. Conserve at least a 100 meter (328 feet) buffer of woody vegetation where it exists along the waterways and establish at least a 100 foot buffer where it is lacking to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- The significant habitats of the area can be strongly affected as a result of nearby land use decisions. Reduce the amount of impervious surfaces in the watershed to diminish the impact of

flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the waterways, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.

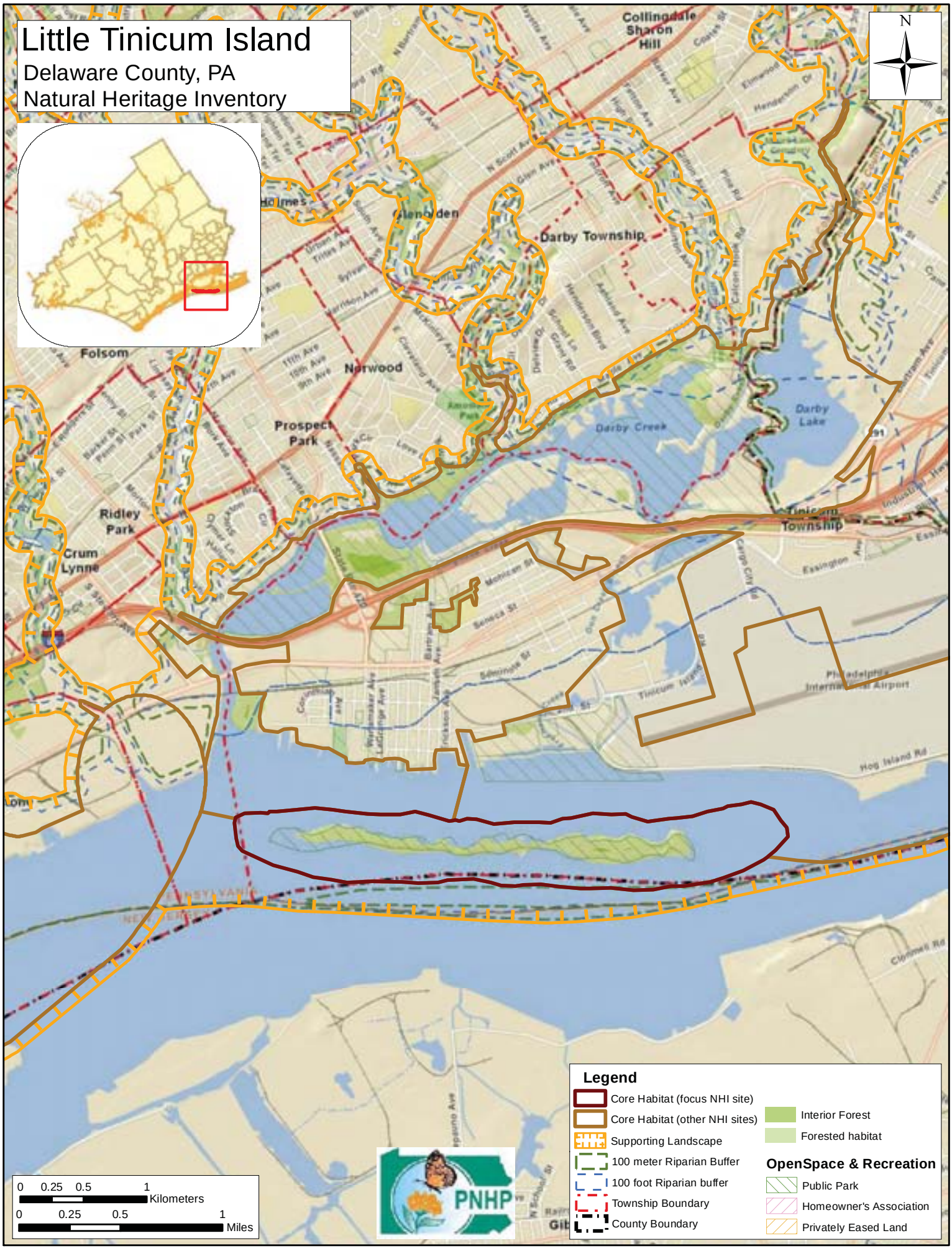
- Residents who live adjacent to this area should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - In many cases, their house and yard may occupy formerly highly significant habitats for species of concern. In some cases, species of concern may still persist on their property. Homeowners should consider improving habitat conditions within their property for these species of concern. Permanently or seasonally wet areas of their property are likely areas that can support these species. Reduce the area of mowed lawn and cultivated gardens in favor of existing native plants suitable to the coastal plain habitat. Permanent and seasonal wetland habitats should be protected and expanded to reclaim a portion of the habitat lost to recent development.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.
    - Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.
- Potential Restoration Activities:
    - Former agricultural fields that have been allowed to revert to woody vegetation may require selective management to speed the succession process. Remove weedy woody species and favor native climax community species. Use the higher quality adjacent forests in similar topographic and geologic settings as natural community reference examples and mimic the forest composition. Use local native seed sources and root stock whenever possible in restoration efforts.
    - Areas currently maintained as lawn, particularly in the active floodplain of the streams in the area, should be restored to native floodplain forest or open meadow habitats appropriate for the region.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields and residential neighborhoods are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.

- Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
- Continual invasive species monitoring and control will be necessary.



Photo Source: (PNHP)

Open wet meadows, like this one adjacent to Jack King Memorial Park, would benefit from early spring mowing every other year to help keep the habitat in an early successional stage preferred by several plant species of concern found here.


Little Tinicum Island
Delaware County, PA
Natural Heritage Inventory
N
Collingdale
Sharon Hill
Darby Township
Folsom
Norwood
Prospect Park
Ridley Park
Crum Lynne
Darby Creek
Darby Lake
Tinicum Township
Hog Island Rd
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.25 0.5 1 Kilometers
0 0.25 0.5 1 Miles
PNHP

Little Tinicum Island – *Exceptional significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Freshwater intertidal marsh Natural Community	C	G3G4	S1	N	1991	B
Waterhemp ragweed (*Amaranthus cannabinus*)	P	G5	S3	PR (PR)	2009	C
Beggar-ticks (*Bidens laevis*)	P	G5	S1	N (PE)	2009	BC
Engelmann's flatsedge (*Cyperus engelmannii*)	P	G4	S2	PR (DL)	1991	D
Wrights spike rush (*Eleocharis obtusa* var. *peasei*)	P	G5	S1	PE (PE)	2009	B
Walter's barnyard-grass (*Echinochloa walteri*)	P	G5	S1	PE (PE)	1991	E
Little-spike spike-rush (*Eleocharis parvula*)	P	G5	S1	PE (PE)	1994	B
Multiflowered mud-plantain (*Heteranthera multiflora*)	P	G4	S1	PE (PE)	2009	AB
Bugleweed (*Lycopus rubellus*)	P	G5	S1	PE (PE)	2009	D
Shrubby camphor-weed (*Pluchea odorata*)	P	G5	S1	TU (PE)	2009	D
Willow oak (*Quercus phellos*)	P	G5	S2	PE (PE)	2009	BC
Long-lobed arrowhead (*Sagittaria calycina* var. *spongiosa*)	P	G5T4	S1	PE (PE)	2009	AB
Subulate arrowhead (*Sagittaria subulata*)	P	G4	S3	PR (PR)	2009	BC
River bulrush (*Schoenoplectus fluviatilis*)	P	G5	S3	PR (PR)	2001	E
Smith's bulrush (*Schoenoplectus smithii*)	P	G5	S1	PE (PE)	1991	E
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	2009	D
Sensitive species of concern[3]	---	---	---	---	2001	E
Sensitive species of concern[3]	---	---	---	---	2009	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Tinicum Island is in the Delaware River between the Philadelphia airport and the mouth of Darby Creek.

- Municipalities:
  - Tinicum Township
- USGS Quadrangles:
  - Bridgeport Quadrangle
- Watersheds:
  - Darby Creek-Mantua Creek
  - Delaware River
- 1992 Delaware County Natural Areas Inventory reference:
  - "Little Tinicum Island" (Bridgeport Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The two-mile long island in the Delaware River is owned and managed by the Pennsylvania Bureau of Forestry as part of the William Penn State Forest. This island is all that remains of an extensive chain of low, sandy, marsh-surrounded islands that extended downriver from League Island and included Mud Island (the location of Fort Mifflin), Little Mud, Redbank, Woodberry, and Reed Islands in the Delaware River; Province, Carpenters, Boon's, and Big Tinicum Islands along the shore; Little Tinicum Island and Chester Island at the downstream end of the chain. Geologically, these islands were transient, continually being built, eroded, and moved by the flow of the river. This process offered a wide variety of habitat for species as new sand and mud flats were exposed while others eroded away. Today, this process of erosion and rebuilding continues, though in a much diminished fashion.

The existing mudflat surrounding the island is exposed at low tide and is considered a good example of a freshwater intertidal mudflat natural community and is an important refuge for numerous plant species of concern. Although the extensive mudflat encircles the island, the flora grows best on the low-energy northern side. The southern shore experiences greater wave action and the wake of shipping channel traffic. The upland portion of the island is in poor shape. Weedy, early successional species are abundant and dredge spoil has been deposited on it. The Tinicum Marsh system, both within the John Heinz NWR and on Little Tinicum Island, hosts a suite of species which in Pennsylvania are found only along the tidal Delaware River. These species, while common in healthy freshwater tidal ecosystems, are limited to the marsh and a few nearby locations because they are the limit of tidal influence within the Commonwealth. This island and the associated tidal mudflat also provide a critical spring and fall migratory bird stopover along the Atlantic flyway.

Species of Concern Considerations: The numerous plant species of concern found on and around the island can be grouped according to occurrence in the upland forest, freshwater intertidal marsh and freshwater intertidal mudflat.

- Willow oak occurs within the disturbed, broken upland forest along with silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), box elder (*Acer negundo*) and a host of weedy, early successional species of plants.
- Intertidal freshwater marsh occurs at the upper edge of tidal inundation, around the periphery of the island at high tide, primarily on the north side of the island. Waterhemp ragweed, Walter's barnyard-grass, Indian wild rice, river bulrush, multiflowered mud-plantain, shrubby camphor-weed, and Engelmann's flatsedge (recently delisted) occur in this zone.
- Intertidal freshwater mudflat is submerged during high tide and only exposed during low tide. Most plants are relatively short and often form clumps, subulate arrowhead, long-lobed arrowhead, little-spike spike-rush, Smith's bulrush, and Wrights spike rush grow with leafy emergent vegetation such as spatterdock (*Nuphar lutea*), pickerelweed (*Pontederia cordata*), arrowheads (*Sagittaria graminea, S. rigida*), arrow arum (*Peltandra virginica*) and scattered patches of waterweed (*Elodea nuttallii*).
- The marsh supports several additional sensitive species of concern that are not named at the request of the jurisdictional agency overseeing their protection. These species depend on the continued cleanup and restoration of the marsh to survive. Additionally, they also require control of predators (such as skunks,

opossums, and raccoons) around their breeding areas to increase the survival chances of their young.
- All of these species of concern depend in one way or another on the natural communities that occur on the Refuge. Two of these natural communities are of conservation concern due to their limited distribution in Pennsylvania. Freshwater intertidal marsh and freshwater intertidal mudflat, are only found in a very limited area of the Commonwealth along the Delaware River. This area is also highly urbanized, making the remaining areas of these communities even rarer and more important to preserve and maintain.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - modified successional woodland*
- Palustrine (wetland) communities:
  - Freshwater intertidal mudflat*
  - Freshwater intertidal marsh*

Ownership:

- This island is owned and managed as a Wild Plant Sanctuary by the Pennsylvania Bureau of Forestry as part of William Penn State Forest. The single ownership of this large piece of the green infrastructure of Delaware County can be tremendously helpful towards implementation of consistent conservation actions.

Habitat Disturbances:

- Historic:
  - Historical air photos from 1937 show that Little Tinicum Island was excavated, probably for fill, and was reduced to around 85 acres at high tide, divided among three separate islands.
  - By 1971 much of the island had been rebuilt by the river and was once again a single island that covered around 155 acres with large areas of sparse vegetation.
- Current:
  - Today Little Tinicum Island covers approximately 130 acres at high tide, but appears to be shrinking. Because of excavation for the shipping channel, patterns of sediment erosion and deposition have changed, with the river preferentially filling in the deep channel rather than the high island.
  - The impact of wave action from passing boat traffic is significant and acts to constantly scour the southern side of the island, which is exposed to the shipping lane. The large wakes of the ocean-going freighters that use the Delaware River channel are often in excess of six-feet tall and have caused significant erosion on the up, and downstream ends of the island, shortening it by over 800 feet since the 1971 photo.
  - In 2004 the oil tanker Athos I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River.
  - Probably the most obvious problem to any visitor to Little Tinicum Island is the trash strewn across it. Some is left by picnickers, but the majority washes up in storms and with the daily tidal inundation. Efforts to control littering are encouraged. Education of island visitors regarding the value of the area to rare plants and animals may help to reduce impacts.
  - Exotic Species: A primary disturbance is the significant areas of non-native invasive plants, particularly common reed that does not provide the same type and quality of habitat as the native species it displaces. Some of the primary invasive species occurring in this location include:
    - Norway maple, (*Acer platanoides*)
    - tree-of-heaven (*Ailanthus altissima*)
    - European alder (*Alnus glutinosa*)
    - porcelain berry (*Ampelopsis brevipedunculata*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)

- Japanese hops (*Humulus japonicus*)
- privet (*Ligustrum* sp.)
- Japanese honeysuckle *(Lonicera japonica)*
- amur honeysuckle *(Lonicera maackii)*
- purple loosestrife (*Lythrum salicaria*)
- Japanese stiltgrass *(Microstegium vimineum)*
- white mulberry *(Morus alba)*
- mile-a-minute weed *(Persicaria perfoliata)*
- common reed (*Phragmites australis*)
- multiflora rose *(Rosa multiflora)*

- Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

Conservation Actions:

- Preserve and restore the natural hydrologic conditions that allow the scour and deposition of island forming material.
- Reduce the impact of the wakes from passing ships and small boats. This may entail establishing a shoal that can absorb the wake impact, and/or reducing the speed at which boats may travel through the river.
- Remove invasive species of plants. The river floodplain and the disturbed island habitat are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
  - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
  - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Continual invasive species monitoring and control will be necessary.
- Ongoing efforts to collect trash brought in by the tide and by storm and tide events should be continued and expanded as possible. Trash collection at the source is the most efficient manner of preventing its eventual deposition on the island. Storm events in the surrounding urban and suburban communities wash trash into tributaries to the Delaware River where it can accumulate along the banks of the river including this island. Trash collection events should be looked at as excellent opportunities to involve the community in the care of the island.
- Monitoring the effect of climate-change induced sea level rises on the marsh system will be important in directing the conservation of the marsh. With most of the island near, at, or below sea level, even a small increase in the mean water level stands to adversely affect the marsh and the species the depend upon it. Assessing how sea level changes are progressing and how they are affecting the island habitat can help direct conservation efforts.



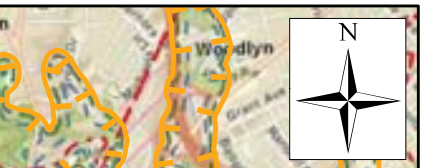
The extensive intertidal mudflat on the north side of Little Tinicum Island (above) is exposed at low tide. The southern side of the island, being exposed to the shipping channel (below), is subject to the erosive effects of the excessive wake action of passing ships.



Photo Source: Andrew Strassman (PNHP)

Marcus Hook to Commodore Barry Bridge

Delaware County, PA Natural Heritage Inventory





Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.375 0.75 1.5 Kilometers

0 0.375 0.75 1.5 Miles

PNHP

Marcus Hook to Commodore Barry Bridge – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Peregrine Falcon (*Falco peregrinus*)	B	G4	S1B,S1N	PE (PE)	2009	E
Osprey (*Pandion haliaetus*)	B	G5	S2B	PT (PT)	2009	E
Waterhemp ragweed (*Amaranthus cannabinus*)	P	G5	S3	PR (PR)	2008	C
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	1994	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This portion of the Delaware River shoreline extends from the Delaware / Pennsylvania state line at Marcus Hook upriver to include the Commodore Barry Bridge and much of the Chester riverfront.

- Municipalities:
  - Chester City
  - Marcus Hook Borough
  - Trainer Borough
- USGS Quadrangles:
  - Bridgeport Quadrangle
  - Marcus Hook Quadrangle
- Watersheds:
  - Delaware River
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - Chester Tidal Flats



Photo Source: Andrew Strassman, (PNHP)

Osprey nest showing two adults and two juveniles on the docking structure at the Marcus Hook refinery.

Description: This highly industrialized portion of the Delaware River shoreline supports remnant freshwater tidal marsh and mudflat habitats in a much degraded context. In some areas, the crumbling, paved footprints of past industrial activity are giving way to expanses of early successional vegetation. Vegetation has begun to colonize the unused piers and unpaved portions of the former industrial sites. Where the shoreline vegetation strip widens, it supports trees, shrubs, vines and herbaceous vegetation between the rubble-armored hardened shoreline and the crumbling pavement of the former industrial sites. Along the periphery of the river, native species of plants and animals compete with introduced species for the limited space and resources available for their use.

The abandoned wooden pilings, piers and ramps within the river help to diminish the impact of wave action from passing ships on the river shoreline and may help to encourage the formation of tidal mudflats along this portion of the river. Many of the formerly active piers have been neglected for long enough that trees, shrubs and herbaceous vegetation have colonized them. Between the vacant piers are areas of shallow water and deep mud that, in some cases already support tidal mudflat vegetation. These small estuaries help support young

fish populations, an essential ecological function of shallow water habitats along the river.

Species of Concern Considerations:

- Being primarily fish eaters, Ospreys utilize aquatic habitats for food gathering and upland habitats or prominent features as nesting areas. Osprey will nest on artificial structures including poles and towers that support electric or phone lines, cell-phone relay towers, buildings, fences, and channel markers. Osprey populations tend to be clustered where shallow waters and nesting support structures are available. The aquatic habitats provided by the river and tributaries as well as nesting structures are both important components of this species' habitat preferences. Since Osprey forage for fish visually, they are sensitive to poor water quality including loss of clarity. A decrease in water quality or clarity can have a direct negative effect on Osprey foraging efficiency and perhaps nesting success.
- Successfully breeding pairs of Peregrine Falcons have been documented at this site over the past several years. Peregrine Falcons require a combination of large open areas for hunting and tall, inaccessible ledges for nesting. Ledges can either be natural cliffs or human-made structures that have similar structural characteristics. Though buildings and bridges are not the traditional habitat for this species, pairs are nesting successfully in these situations around the country. Peregrines range widely to forage for prey, frequently several kilometers. There is high potential for collisions with structures and automobiles in this hunting territory.
- Indian wild rice and waterhemp ragweed are plants that typically grow in tidally influenced shoreline marshes. These plants are adapted to the twice daily flooding disturbance and shallow water conditions that occur in tidally inundated habitats along the Delaware River and do well in habitats otherwise favoring 'weedy' species of plants. Populations of these species can be enhanced by maintaining the natural fluctuations in the river's water level and restoring the natural conditions of its shoreline.

Forest Cover / Natural Communities: The river shoreline at this location is highly industrialized and only a narrow band of remnant vegetation occurs along its banks. A few areas within the tidal zone have emergent aquatic vegetation typical of the habitat.

Ownership:

- This portion of the Delaware River shoreline currently has very little publicly owned land but rather is held in several relatively large privately-owned parcels. The large parcel size can be tremendously helpful towards implementation of consistent conservation actions across this significant piece of the landscape. Conservation action should proceed before ownership fragmentation makes this process more difficult.

Habitat Disturbances:

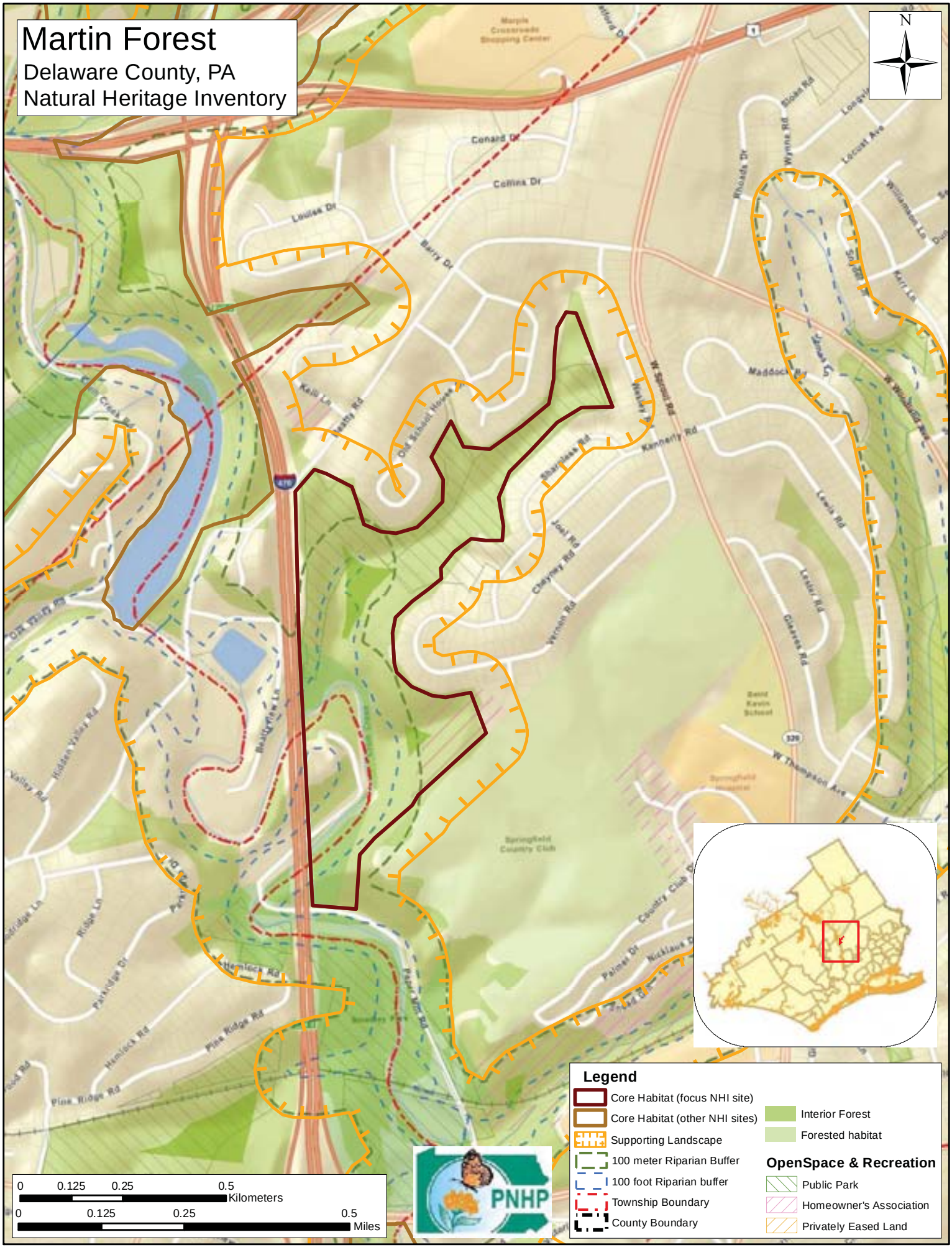
- Historic:
  - Most of the area between the I-95 freeway and the Delaware River has been greatly modified from the extensive system of tidal marshes that used to dominate the shoreline. The tidally influenced shoreline of the Delaware River historically hosted expansive freshwater tidal marshes, especially at the mouths of the tributary creeks. Over the past several centuries and especially this past one, the marshes have been diked, ditched, drained, filled and converted to dry areas of commerce and residence. Most of this area is still within the floodplain of the river and is likely to be subject to future flooding from increasingly unpredictable weather patterns and an anticipated rise in sea level.
  - Formerly, this area was a very active shipping and industrial part of North America. While still an important entryway for sea freight and significant oil refinery, much of the riverfront has seen considerable change in the past few decades. Many areas that had been associated with shipping and industry have been demolished, leaving various large and small patches of vacant ground and their associated piers along the riverfront.
  - Rail lines and roadways were built parallel to, and through the former marshes.
  - Industrial plants and a coal-fired electric generating plant were built on the banks of the river.
- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with a mix of heavy

industrial areas and shipping wharfs with several areas of undeveloped riverfront.

- A new sports stadium and its associated parking area were recently built at the base of the Commodore Barry Bridge on a former industrial site that was in the process of reverting to natural habitat.
- In 2004 the oil tanker Athos I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River
- The impact of wave action from passing boat traffic is significant and acts to constantly scour the river shoreline. The large wakes of the ocean-going freighters that use the Delaware River channel are often in excess of six-feet tall and have caused significant erosion.
- Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
- Stormwater runoff from the highly developed surrounding communities flows into the watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species – This narrow, disturbed strip of vegetation is frequently dominated by invasive non-native trees such as tree-of-heaven, princess tree, Norway maple, Siberian elm, white poplar and white mulberry. Invasive shrubs and vines frequently dominate the understory including Japanese honeysuckle, porcelain berry, Asiatic bittersweet, multiflora rose, bush honeysuckles, common privet, barberry, paper mulberry and autumn olive to name a few.

Conservation Actions:

- Future long range goals for this section of the river should be to simultaneously enhance the native ecology of the riverfront as well as provide public access and park space opportunities. Since much of the Delaware River shoreline in Delaware County is currently transitioning from past industrial and shipping activity, the county is presented with an excellent opportunity to recreate a continuous greenway corridor along this stretch of the river. This linear area currently lends itself well to the reestablishment of a ribbon of native vegetation that will help provide habitat for native plants and animals while filtering and trapping runoff from the urban and suburban areas before it enters the river. In addition, the linear corridor can function as a portion of a public greenway along the length of the Delaware riverfront. Such a public amenity would greatly improve the quality of life for all residents and visitors to the area.
- Future developments should be set back from the river shoreline to accommodate a 100-meter wide vegetated riparian buffer between the river's edge and development activity.
- The shoreline habitat can be improved by removing portions of the armored bulkheads and reconnecting the river to a portion of its natural floodplain and encouraging tidal estuary development.
- Restore and protect the natural hydrology of the river and it tributaries. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
- Replant the riparian area in native trees and shrubs to enhance its ecological value.
- Reduce the impact of the wakes from passing ships and small boats. This may entail establishing a shoal that can absorb the wake impact, and/or reducing the speed at which boats may travel through the river.
- Conserve and expand the forested riparian buffers of Chester Creek, Marcus Hook Creek, Stoney Creek and their tributaries. Establish at least a 100 foot buffer of woody vegetation along the creeks to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the upstream watershed.


Martin Forest
Delaware County, PA
Natural Heritage Inventory
N
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Martin Forest – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Many-flowered panic-grass (*Dichanthelium polyanthes*)	P	GNR	S4	N (SP)	2009	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Wooded riparian corridor along Crum Creek loosely bounded on the west by Route 476 (Blue Route), on the south by Baltimore Pike, on the north by Beatty Road, and on the east by W. Sproul Road.

- Municipalities:
  - Nether Providence Township
  - Springfield Township
- USGS Quadrangles:
  - Lansdowne Quadrangle
- Watersheds:
  - Crum Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: The expanse of forest along Crum Creek between the Blue Route and the Springfield Country Club is a significant connection in the green infrastructure of the Crum Creek watershed in Delaware County. This mature old-growth forested area with dramatic cliffs and rock outcrops provides an essential part of a nearly continuous habitat connection along Crum Creek between Chester County to the north and the Delaware River to the south. The westerly-facing steep slope along Crum Creek and an adjacent area of floodplain on the east side of the creek are considered of very high quality due to the relative lack of past disturbances and the natural integrity of the native species composition. This tract was singled out more than a century ago as a rare remnant of "virgin" forest in southeastern Pennsylvania (Harshberger 1904): "In some places, notably on the Wissahickon creek within the confines of Fairmount Park and in areas on Crum creek, the primeval forest still remains. Mr. J. Howard Lewis, Sr., and his progenitors have preserved inviolate a large tract of timber along Crum creek, while the surrounding country settled by patent in 1681 and 1682 has been cleared of its timber for many years." To assure its continued protection, it was purchased from the Lewis family and donated to Swarthmore College in 1926 by Dr. Edward Martin, an alumnus and member of the college's Board of Managers. The Martin Forest has been leased to Delaware County since 1941 to serve as a nature reserve within Smedley Park. While this tract of forest was in all likelihood selectively cut, it hosts some massive trees that are likely 200-300 years old. The woods function to protect the water quality of Crum Creek and to provide habitat for wildlife and a refuge for native plants and animals. The older growth section of the forest can be used as a reference example for the restoration of habitats in similar ecological settings.

Species of Concern Considerations:

- Many-flowered panic grass typically grows in open woods, woods borders, clearings and openings, and utility rights-of-way that exhibit early successional habitat characteristics. This species takes advantage of recent disturbances such as flood scour or tree fall, but man made disturbances can also mimic these events. At this location the plant species of concern inhabits a weedy opening within the floodplain of

Crum Creek. The species population may move up and down the floodplain, colonizing appropriate habitat as habitat conditions fluctuate. Additional field surveys are needed to determine the distribution and particular habitat requirements of this species.



Photo source: Roger Earl Latham

Very large, old-growth trees are a component of Martin Forest.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*). A very detailed delineation of the natural community types present here is available in a management plan developed for the area (Latham et al. 2003).

- Terrestrial (upland) communities:
  - Hemlock (white pine) – red oak – mixed hardwood forest
  - Red oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Sycamore – (river birch) – boxelder floodplain woodland

- The westerly-facing slopes above Crum Creek are cloaked in mature forest and exhibit a fairly undisturbed and pristine quality. The overall quality of the woods is remarkably natural and aesthetically pleasing. Though the forest was likely selectively cut for fuel wood and timber in colonial times, much of the existing forest has apparently been standing since at least the early 1800s and some

of the trees may be 200-300 years old or older. It is not known why this tract was spared clearcutting but by the late 1800s its owners apparently recognized and valued the novelty of an old-growth forest.

- The native canopy species characterizing the forested habitat are beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), hemlock (*Tsuga canadensis*), northern red, black and white oaks (*Quercus rubra*, *Q. velutina* and *Q. alba*).
- Characteristic shrubs include spicebush (*Lindera benzoin*), mountain-laurel (*Kalmia latifolia*), and witch hazel (*Hamamelis virginiana*).
- The understory, particularly in the floodplain, hosts a lush growth of characteristic spring wildflowers including wild-ginger (*Asarum canadense*), blue cohosh (*Caulophyllum thalictroides*), spring-beauty (*Claytonia virginica*), Dutchman's-breeches (*Dicentra cucullaria*), yellow trout-lily (E*rythronium americanum*), Virginia waterleaf (*Hydrophyllum virginianum*), mayapple (*Podophyllum peltatum*) and round-leaved violet *(Viola rotundifolia)*.

Ownership:

- The 30 acres that comprise the core of the site is owned and managed by Swarthmore College, including the steep slope and adjacent floodplain hosting the old-growth forest stand. Other parts of this habitat are publicly owned and managed as part of Smedley Park (Delaware County) and Jane Lownes Park (Springfield Township). Numerous private property owners line the perimeter of the site.

Habitat Disturbances:

- Historical:
  - Most of the original forest cover of the region had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show this forested ravine in a relatively intact condition, surrounded by active agricultural fields and scattered residences.
  - In 1826 a paper mill and access road were built (Ashmead 1884) on the banks of Crum Creek across from the southern end of the steep slope supporting the old-growth forest. By that time or earlier much of the floodplain west and downstream from the Martin Forest had most likely been cleared. The mill and its successors were in continuous operation until the mid-twentieth century but have since been removed. In the 1990s the mill area was sealed beneath a covering of fresh soil to contain toxic materials associated with the paper mill and later, ball fields and meadows were installed on the site.
  - By 1967 the forest was flanked to the east by a large golf course and a housing development. Runoff from these two sources likely detrimentally affects the water quality of Crum Creek and leads to flooding and erosion.
- Current:
  - Route 476 (the Blue Route), completed in 1999, was built along the western edge of Crum Creek, which removed significant parts of the forest and fragmented the landscape. The extent of the older growth area was reduced by as much as half by this infrastructure improvement.
  - The Springfield Mall was built to the east of the forest. The large expanses of impervious surface can have a significant detrimental impact on the water quality of Crum Creek.
  - Sewer lines from the adjacent region connect to a trunk line that parallels Crum Creek.
  - A narrow pipeline access path parallels Crum Creek through this area. Vegetation maintenance of the rights-of-way eliminates all but the lowest growing non-woody species.
  - An aqueduct right-of-way maintained by contractors of the Philadelphia Suburban Water Company clears the right-of-way of all but the lowest growing non-woody vegetation.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat.

- Portions of the immediate floodplain are maintained as large patches of lawn, eliminating essential floodplain habitat and reducing the filtering capacity of the riparian corridor.
- An insect pest on hemlock trees, the hemlock woolly adelgid, which was accidentally introduced from Asia, has impacted numerous hemlock trees in the ravine. Additional information on this insect pest can be obtained from the Pennsylvania Bureau of Forestry web site at <http://www.dcnr.state.pa.us/forestry/woollyadelgid/index.aspx>. If this insect pest succeeds in decimating the hemlock population at this location, it could have a severe affect on the microclimate of the ravine, potentially leading to a drier and warmer environment.
- An oversized deer population can have a significant detrimental impact of current and future forest composition.
- Vegetation clearing, dumping of garden, landscaping and other refuse into the forest and other encroachments by adjacent landowners is occurring in several locations.

o Exotic Species:

- The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. While much of this forested area has been described as only slightly impacted by invasive species, the proximity of this forest patch to developed areas subjects this habitat to a potential onslaught of invasive species. This area should be closely monitored for the expansion of landscape ornamentals occurring outside of their planted area. For a full list of invasive species at this location, please refer to Latham et al 2003. Some of the more abundant invasive species occurring in this location, mainly on the floodplain and around the forest edges in the uplands, are:
  - garlic-mustard *(Alliaria petiolata)*
  - oriental bittersweet *(Celastrus orbiculatus)*
  - border privet *(Ligustrum obtusifolium)*
  - Japanese honeysuckle *(Lonicera japonica)*
  - Japanese stiltgrass *(Microstegium vimineum)*
  - lesser celandine *(Ranunculus ficaria)*
  - multiflora rose *(Rosa multiflora)*

- Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

o Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increases competition between deer and other wildlife due to reduced food sources. Furthermore, deer prefer higher quality food leaving poorer, less diverse species to mature and dominant the overstory.

Conservation Actions:

A very detailed and comprehensive management plan for this area has been developed by The Natural Lands Trust and Continental Conservation (Latham et al, 2003). Implementation of the recommendations set forth in this management plan will help ensure the conservation and improvement of this significant natural resource.

- Coordinate conservation action among the several large landowners of the forest and adjacent area: Swarthmore College, Delaware County (Smedley Park), Springfield Township (Jane Lownes Park) and Springfield Country Club.

- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for this habitat should be to focus on safeguarding the quality and expanse of the forested landscape. The forested landscape helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for forest dependent species.
- Avoid tree-cutting in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Avoid the incremental chipping away at this landscape. Expansion of active park facilities such as ball fields and parking areas can eliminate essential natural habitat. A small area of natural habitat is much less viable than a larger area.
- Conserve and expand the forested riparian buffers of Crum Creek. Establish at least a 100 meter (328 foot) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Care needs to be taken not to attempt to reforest portions of the floodplain that should remain open wetland habitats. Reduce the non-pervious surfaces in the surrounding area. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Reduce the deer density in the area. The success of a deer management program here depends critically on close cooperation among Swarthmore College, Delaware County, Springfield Township and the Springfield Country Club.
- Conservation efforts should focus on protecting and improving the quality of the surface water. Reduce the amount of impervious surfaces in the Crum Creek watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the creek, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments, active parks and golf courses can have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins, vegetated swales, green roofs, and water gardens should be implemented adjacent to all expanses of impervious surfaces to slow and capture water flow in these suburban landscapes.
- Residents living adjacent to the Martin Forest should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.

- Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.
- Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.

- Potential restoration activities:
  - Former cleared areas that have been allowed to revert to woody vegetation may require selective management to speed the succession process. Remove weedy woody species and favor native climax community species. Use the higher quality adjacent forests in similar topographic and geologic settings as natural community reference examples and mimic the forest composition. Use local native seed sources and root stock whenever possible in restoration efforts.
  - Areas currently maintained as lawn, particularly in the active floodplain of Crum Creek, should be restored to native floodplain or open meadow habitats appropriate for the region.
  - Establish coordination between Swarthmore College, the Delaware County authorities and the Springfield Country Club to reduce the permeability of the forest-golf course edge. For instance, eliminate dumping of organic waste by groundskeepers at the forest edge, remove invasive plants, plant a buffer of native trees and shrubs at the forest edge, and designate an additional buffer zone of "rough" on the golf course where mowing is less frequent and herbicides or pesticides are not used.
  - Remove invasive species of plants. The creek floodplain and edge habitats associated with residential neighborhoods are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly English ivy, Norway maple, tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose, oriental bittersweet and border privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the native species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.


Media Wetlands
Delaware County, PA
Natural Heritage Inventory
N
Upper Providence Township
Black Horse
Springton Lake Middle School
Elwyn Training School
Davis Dr
Colt Rd
Kimberwick Rd
Foxdale Rd
Sycamore Mills Rd
Pinetree Rd
Kelly
Hunt Club Ln
W Rose Tree Rd
Morgan Ln
Wooded Way Dr
Highland Ave
Kirk Ln
N Orange St
Arbor Cir
Ridley Creek Rd
N Heilbron Dr
S Heilbron Dr
Hunting Hills
Blackhorse Ln
Penn Charter Dr
School Ln
Painter St
Brooke St
W Jefferson
Bakar St
Paarl St
W State St
N Lemon St
352
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Media Wetlands – *Local significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
None currently known						

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This forested habitat along Ridley Creek is roughly bounded on the south by Baltimore Pike, on the northwest by Route 1 (Media Bypass) and on the east by Ridley Creek Road.

- Municipalities:
  - Middletown Township
  - Upper Providence Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Media Wetland" (Media Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Ridley Creek is well buffered by the forested habitat on both sides of the creek in this location. The broad floodplain allows the creek to braid slightly in this area forming a complex of forested, scrub/shrub, and graminoid robust emergent wetlands that occupy the site of a former impoundment. Although the documented wetland plant species are ordinary, the wetland and riparian habitats are important for the ecological functions they performs such as filtering stormwater runoff from upland areas and providing habitats for numerous species of plants and animals. Trails along both sides of the creek and throughout Mineral Hill indicate moderate recreational use of the area.

Species of Concern Considerations:

- None currently known, though potential exists. Additional surveys for species of concern should be conducted at this location.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Silver maple floodplain forest
- The forested area includes a patch of interior forest of about 30 acres, which is forested habitat at least 100 meters away from any canopy fragmenting feature such as roads, powerlines, residences or open

fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds.

- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality. Though the forest was likely selectively cut for fuel wood and timber several times since colonial times, parts of the existing forest has apparently been standing for well over 100 years. Although there is invasion of exotic plant species into the woods the overall quality of the woods is remarkably natural and aesthetically pleasing.
- In areas along Ridley Creek of quiet open water, fragrant water lily (*Nymphaea odorata*) and water pennywort (*Hydrocotyle americana*) carpet the surface. An open 30-to 40-foot canopy of white ash (*Fraxinus americana*), box elder (*Acer negundo*), red maple (*Acer rubrum*), and black willow (*Salix nigra*) typifies the forested wetland areas. In scrub/shrub areas, silky dogwood (*Cornus amomum*), buttonbush (*Cephalanthus occidentalis*), alder (*Alnus serrulata*), and rose (*Rosa palustris*, *R. multiflora*) form impenetrable thickets. The diverse herbaceous layer, varying in composition and density as a function of changing light and moisture conditions, contains cattail (*Typha latifolia*), sedges (*Carex lurida*, *C. frankii*, *C. crinita*, *C. lupulina*), rice cutgrass (*Leersia oryzoides*), jewelweed (*Impatiens capensis*), skunk cabbage (*Symplocarpus foetidus*), tearthumbs (*Polygonum arifolium*, *P. sagittatum*), forget-me-not (*Myosotis scorpioides*), and many more species.

Ownership:

- Most of this area is owned by the adjoining municipalities and maintained as public passive recreational open space.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place.
  - A dam was constructed on Ridley Creek, creating an artificial impoundment.
  - Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture and scattered residential development on the outskirts of Media.
  - A power transfer station was built along the southern edge of the habitat.
- Current:
  - Much of the forested habitats within this area remain relatively unchanged since the 1937 aerial photos were taken.
  - Most of the former agricultural lands surrounding this area had been subdivided and developed into smaller residential lots.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - garlic-mustard *(Alliaria petiolata)*
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - Japanese hops (*Humulus japonicus*)
    - privet (*Ligustrum* sp.)
    - Japanese honeysuckle *(Lonicera japonica)*
    - amur honeysuckle *(Lonicera maackii)*

- Purple loosestrife (*Lythrum salicaria*)
- Japanese stiltgrass *(Microstegium vimineum)*
- mile-a-minute weed *(Persicaria perfoliata)*
- common reed *(Phragmites australis)*
- Japanese knotweed (*Fallopia japonica*)
- multiflora rose *(Rosa multiflora)*
- wineberry (*Rubus phoenicolasius*)

- The relatively low diversity of understory herbs and shrubs noted in the upland portion of this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
  - Protect and expand the natural vegetation along the shore of the creek floodplain and adjacent upland.
- Within the Core Habitat:
  - Conserve and expand the forested riparian buffers of Ridley Creek and its tributaries. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Ridley Creek, its tributaries, springs and wetlands. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Potential Restoration Activities:

- Streams through forested areas should be considered high priority for conservation in the habitat. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
  - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
  - Riparian Buffers:
    - An ideal vegetated stream buffers should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
    - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
    - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
- Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
  - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
  - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Continual invasive species monitoring and control will be necessary.



Photo Source: PNHP

Ridley Creek is braided and forms oxbows in the wide floodplain of this portion of the creek.


Mineral Hill
Delaware County, PA
Natural Heritage Inventory
N
Upper Providence Township
Black Horse
Springton Lake Middle School
Elwyn Training School
Kimberwick Rd
Foxdale Rd
Sycamore Mills Rd
Pinetree Rd
Kelly Ln
Hunt Club Ln
W Rose Tree Rd
Ridley Creek Rd
N Heilbron Dr
S Heilbron Dr
Hunting Hills Ln
Blackhorse Ln
Penn Charter Dr
Morgan Ln
Wooded Way Dr
Highland Ave
Kirk Ln
N Orange St
N Lemon St
Pearl St
W State
Baker St
Brooke St
W Jefferson
Painter St
Woodland Ave
S Ridley Creek Rd
Elwyn Rd
Indian Ln
Chipmunk Ln
Brinton Ave
352
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Mineral Hill – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Few flowered nutrush (*Scleria pauciflora*)	P	G5	S2	PT (PT)	2005	D
Small white-snakeroot (*Ageratina aromatica*)	P	G5	S3	N (PR)	2005	CD

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This forested habitat along Ridley Creek is roughly bounded on the south by Route 1 (Baltimore Avenue), on the northwest by Route 1 (Media Bypass) and on the east by Ridley Creek.

- Municipalities:
  - Middletown Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "Mineral Hill Woods" (Media Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Mineral Hill contains a mosaic of younger and older, less disturbed and more disturbed patches of forest. The western portion of Mineral Hill is underlain by Chrome series soils which are derived from serpentine bedrock parent material. The area was a former quarry and the interesting and unusual minerals derived from the quarry were prized by rock collectors and gave the area its name. Small remnant plant populations of serpentine affinity plant species at this location indicate that this area was in the past more open and hosted a serpentine grassland community. Common serpentine associates grow in an area approximately 300 square feet in size. Scattered stems of blackjack oak grow in a tangled mass of greenbrier.

Serpentine habitats occur in isolated patches as the bedrock material, serpentinite, is exposed at the surface of the ground in a scattered fashion much like an archipelago chain of islands. Historically, these areas were relatively small herbaceous openings in the vast unbroken primeval forests of pre-colonial days. The unusual chemistry of serpentine derived soils has restricted the available nutrients to all but those plants evolutionarily adapted to the harsh growing conditions present. The serpentine habitats are often referred to as grasslands, and they do have a strong representation of warm season grasses and grass-like plants, but they also contain a good diversity of other plant species, many uncommon in the state and several unique to serpentine habitats. It may be possible to rehabilitate a larger area of serpentine grassland habitat at this location through the use of cutting, mowing and prescribed burns.

Species of Concern Considerations:

- Few flowered nutrush is typically restricted to serpentine influenced herbaceous openings or within the adjacent thin woodlands. In the past, natural disturbance, such as wild fires or animal grazing, would have helped to keep these areas in an open condition. With the relatively recent suppression of fire, the open areas have gradually closed due to natural succession. Several other serpentine habitat associated species of concern were known historically to this area, but have not been relocated during recent surveys. An active restoration effort to restore the serpentine openings will be necessary to ensure the continued

existence of this habitat and the species they contain.

- Small white-snakeroot grows in various types of well drained openings and open woods, but is especially a characteristic species of the serpentine barrens in the southeastern part of the state. The viability of populations of Small white snakeroot often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Quarrying and habitat loss are threats in some locations.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Silver maple floodplain forest
- Most of this area is dominated by modified successional forest, a vegetation type typical of previously disturbed areas. The forest is in the long process of succession from a previously cleared state to a forested canopy, with early successional species dominating the habitat. Formerly open habitats have since been colonized by trees and shrubs, forming a near continuous canopy over the area.

Ownership:

- The central interior forest portion of this area is a 40.5-acre parcel acquired by the County of Delaware for public passive recreational open space in 2010. Adjacent parcels are owned by municipalities, PECO (electric utility), Aqua PA (water company), and Elwyn, Inc.

Habitat Disturbances:

- Historic:
  - Historically, naturally sparked and intentionally set wildfires likely helped to maintain the open aspect of serpentine grassland habitats. Early accounts record the intentional setting of fire in these habitats by Native Americans to help open the area for greater potential hunting success.
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place.
  - Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture and scattered residential development on the outskirts of Media. The much more expansive open fields of that era offered a much increased area for serpentine habitat adapted species to thrive. Much of the serpentine habitat was cleared by grazing in the past. Past grazing activities likely helped to maintain the open aspect of the barrens habitat.
  - In the absence of natural disturbance events, most of the open serpentine barrens habitats will gradually succeed to more common woody vegetation such as junipers, pines and oaks as the accumulation of organic matter and soil around the bases of successional species allows them to colonize the opening. Over the past several decades, the forest edge has been expanding into the grassland through natural succession to the point where early successional species provide almost complete canopy cover of the area.
- Current:
  - Ironically, the lack of disturbance poses one of the greatest threats to the serpentine grassland habitat at this location. In the absence of natural disturbance events, most of the open serpentine barrens habitats will gradually succeed to more common woody vegetation such as junipers, pines and oaks as the accumulation of organic matter and soil around the bases of successional species allows them to colonize the opening. The existing herbaceous opening has diminished to a critically small area. Further inaction to maintain and expand herbaceous openings will result in the eventual complete loss of the habitat supporting these species of concern.

- Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
- Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species: The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
  - garlic-mustard *(Alliaria petiolata)*
  - Asiatic bittersweet (*Celastrus orbiculatus*)
  - Japanese hops (*Humulus japonicus*)
  - privet (*Ligustrum* sp.)
  - Japanese honeysuckle *(Lonicera japonica)*
  - amur honeysuckle *(Lonicera maackii)*
  - purple loosestrife (*Lythrum salicaria*)
  - Japanese stiltgrass *(Microstegium vimineum)*
  - mile-a-minute weed *(Persicaria perfoliata)*
  - common reed *(Phragmites australis)*
  - Japanese knotweed (*Fallopia japonica*)
  - multiflora rose *(Rosa multiflora)*
  - wineberry (*Rubus phoenicolasius*)
- Colonization of the herbaceous openings and forest by native woody species can have the same effect on the habitat as invasion by introduced species of plants, eliminating the habitat of concern.
- The relatively low diversity of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the affect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

<u>Conservation Actions:</u>

- Overall:
  - Incorporate serpentine habitat restoration and expansion into park management plans. Conservation managers at this location would benefit from reviewing the management plans developed for Tyler Arboretum's Pink Hill Serpentine Barrens (Latham 2008) and the Goat Hill Wild Plant Sanctuary (Furedi 2008).
  - Active stewardship of these habitats is necessary. In the absence of natural fire disturbance, or active vegetation removal, these habitats will succeed into woodlands and forests, replacing the globally rare habitat with a more common type.
  - Habitat restoration activities should strive to swiftly expand the herbaceous openings by removing woody and invasive species in areas with the thinnest canopy cover to increase the habitat potential for the serpentine dependent species occurring at this location.
- Within the Core Habitat:

- Please refer to other Pennsylvania serpentine barrens restoration and management plans for detailed and specific habitat restoration actions that can apply to this site as well.
- Expand herbaceous openings by removing most trees and other woody plants in the area identified as herbaceous opening in the 1937 aerial photos. In the past, naturally occurring fires helped maintain the open aspect characteristic of the serpentine barren habitat. Today, active vegetation management, in the form of mechanical woody plant removal, prescribed burns, or as necessary, spot application of herbicides, helps to remove trees and shrubs that in the past would have been cleared by fire events.
- Remove the excessive buildup of soil that has accumulated as the result of recent succession. Measure soil depths throughout the proposed serpentine expansion area and carefully skim the surface soil to a desirable depth. This action will also help to eliminate tough stands of woody vegetation. Remove the soil to an off site location to avoid the soil pile becoming a source for future invasion of woody and invasive species.
- Control invasive species of plants. Mechanical (hand pulling, cutting and mowing) and chemical (spot herbicide treatment) management techniques may be necessary to protect the habitat from colonization by aggressive species. Broadcast application of herbicides is not suitable for this delicate habitat.
- Reduce the deer density in the area.
- Carefully consider reintroductions of serpentine plant species. Each serpentine habitat has a slightly different species composition, likely due to the slightly different environmental conditions and past land use at each distinct location as well as the size of the available habitat. Any species reintroductions should follow careful surveys of the existing habitat to determine existing species composition. All seed source used to repopulate this habitat should be collected from this or other nearby serpentine habitats in Delaware or Chester County.
- Survey adjacent and nearby areas that occur on serpentine derived soils (Chrome series soils) for their potential as future expansion of the habitat.
- The plants that characterize these habitats are adapted to the dry, nutrient poor soils and periodic fire events. A priority for the security of these globally rare habitats should be to establish protection for the core habitats as well as to provide for the landscape context in which natural process can be maintained. These systems may be best maintained in an agricultural or rural setting. Additional development near this habitat should be strongly discouraged.
- Educate the adjacent landowners on the significance of the globally rare habitat and the need for ongoing management activities.
- Engage other organizations working to actively preserve and manage serpentine habitats in the area. The Friends of the State Line Serpentine Barrens is organized to “encourage community involvement in preserving this globally rare ecosystem” in Pennsylvania and Maryland (http://statelineserpentinebarrens.org/home). Other organizations such as the Natural Lands Trust, The Nature Conservancy of PA, Brandywine Conservancy and Nottingham County Park have also actively participated in various aspects of serpentine habitat conservation.

References:

Furedi, M. A., R. Latham, A. Davis, and G. Podniesinski. 2008. Management Plan for Goat Hill Wild Plant Sanctuary. Pennsylvania Natural Heritage Program, Middletown PA, and Continental Conservation, Rose Valley PA. 58 pp.

Latham, R. E. 2008. Pink Hill Serpentine Barrens Restoration and Management Plan. John J. Tyler Arboretum, Media, Pennsylvania, and Mt. Cuba Center, Greenville, Delaware. 87 pp.



Photo Source: PNHP

Early successional habitats with thin canopy are prime areas for serpentine habitat restoration potential. The herbaceous layer of these areas is currently dominated by the invasive plant Japanese stilt grass.


Naamans Creek near Ogden
Delaware County, PA
Natural Heritage Inventory
N
Village Green-Green Ridge
Boothwyn
Ogden
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Naamans Creek near Ogden – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Autumn bluegrass (*Poa autumnalis*)	P	G5	S1	PE (PE)	2000	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Wooded riparian corridor along Naamans Creek roughly bounded by Naamans Creek Road on the south, Larkin Road on the west, Bethel Road on the north and Mill Road on the east.

- Municipalities:
  - Upper Chichester Township
- USGS Quadrangles:
  - Marcus Hook Quadrangle
- Watersheds:
  - Naamans Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Narrow disturbed riparian corridor along Naamans Creek has been modified and reduced in width and habitat value by recent residential development.

Species of Concern Considerations:

- Autumn bluegrass is a plant species of concern that typically occurs within moist deciduous forests and along seeps and stream banks. Habitat modifications at this location may have negatively impacted this plant population. Additional surveys are recommended to determine the status of this population.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - modified successional forest*

Ownership:

- Most of the habitat outlined in this Natural Heritage Area is maintained as home-owners association open space and as several Township-owned open space parks.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show this riparian area in a relatively intact condition, surrounded by scattered woodlots and active agricultural fields.
- Current:

- Rapid development has occurred outside of and on the periphery of the core habitat area. Though scattered woodlots remain in the area, the former agricultural landscape has mostly been converted to smaller residential lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
- Stormwater runoff from the highly developed surrounding communities flows into the Naamans Creek watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution.

o Exotic Species:

- The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.

Conservation Actions:

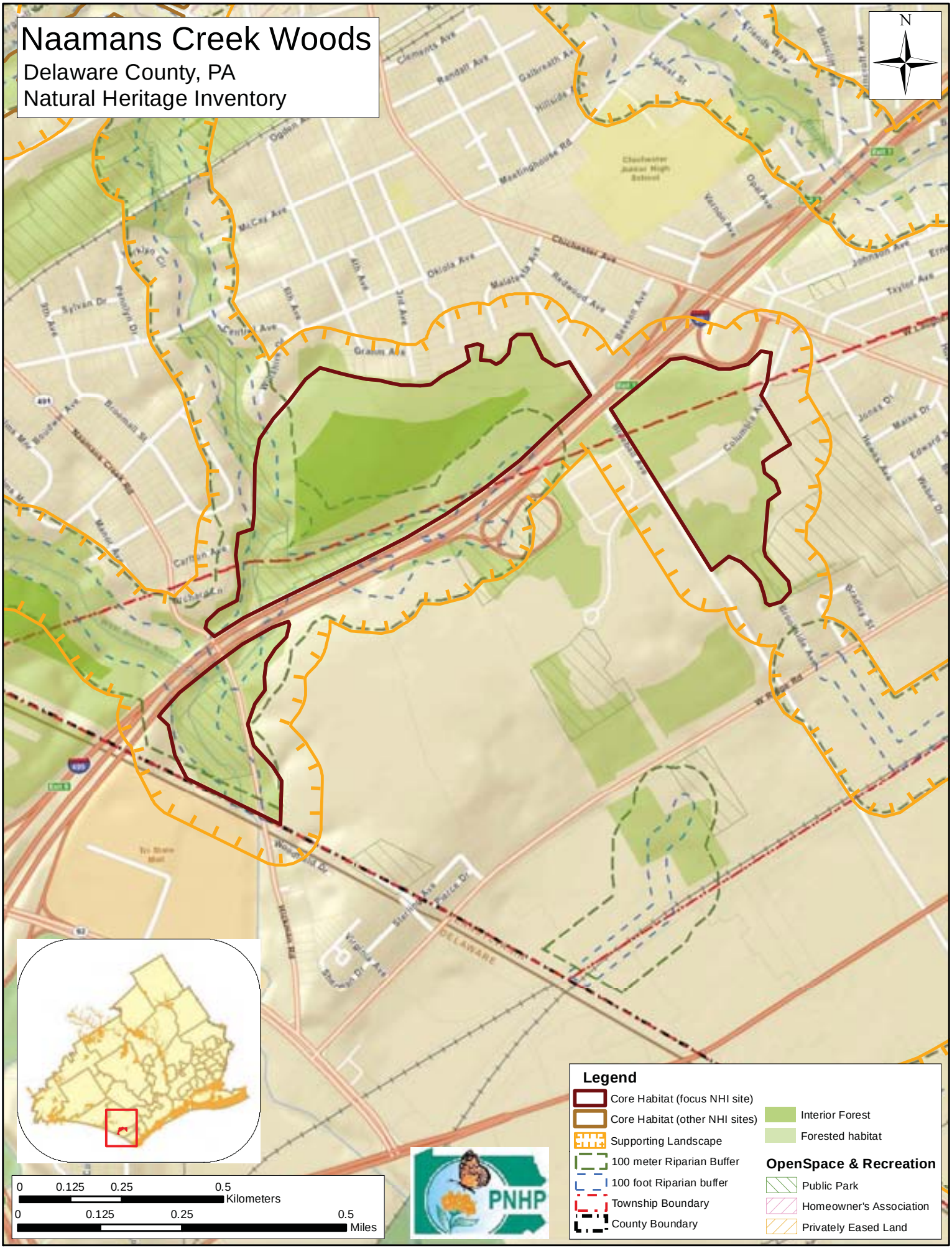
- Conserve and expand the forested riparian buffers of Naamans Creek and its tributaries. Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat. Establish at least a 100 foot buffer of woody vegetation along the creek and its tributaries to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Preserve and improve the water quality of Naamans Creek to help provide a continued and increased food chain. The stormwater runoff from development should be considered a potential source of significant contamination for the reservoir. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. All tributaries within the watershed of this creek can help improve water quality by decreasing unfiltered runoff from non-point sources of pollution. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
- Remove invasive species of plants. The creek floodplain is naturally susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species along the floodplain will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
  - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
  - Continual invasive species monitoring and control will be necessary.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Residents who live adjacent to Naamans Creek should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
  - Municipal sewage systems may need to be upgraded to help improve water quality.
  - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods bordering the creek should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
  - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.

- Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
- Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.

Naamans Creek Woods

Delaware County, PA

Natural Heritage Inventory



Naamans Creek Woods – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Small-flowered false-foxglove (*Agalinis paupercula*)	P	G5	S1	PE (PE)	2007	BC
Eastern baccharis (*Baccharis halimifolia*)	P	G5	S3	PR (PR)	1985	C
Round-leaved thoroughwort (*Eupatorium rotundifolium*)	P	G5	S3	TU (TU)	2007	BC
Grass-leaved goldenrod (*Euthamia tenuifolia*)	P	G5	S1	PT (PT)	2007	C
Soapwort gentian (*Gentiana saponaria*)	P	G5	S1S2	TU (PE)	2007	C
Grass-leaved rush (*Juncus biflorus*)	P	G5	S2	TU (PT)	2000	D
Swamp dog-hobble (*Leucothoe racemosa*)	P	G5	S2S3	TU (PT)	1997	BC
Willow oak (*Quercus phellos*)	P	G5	S2	PE (PE)	2007	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: These small fragmented woodlots and fields straddle Interstate 95 at the Pennsylvania / Delaware state line.

- Municipalities:
  - Lower Chichester Township
  - Upper Chichester Township
- USGS Quadrangles:
  - Marcus Hook Quadrangle
- Watersheds:
  - Naamans Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: A mosaic of small patches of upland forest, forested wetlands, open wetlands, spring seeps, successional old fields and utility rights-of-way are separated by Interstate 95, cemeteries, and residential development. The species composition of the various habitats reflects a coastal plain affinity. Much of the available habitat for species of concern has recently been eliminated due to the construction of a new school.

Species of Concern Considerations:

- Small-flowered false-foxglove, round-leaved thoroughwort, grass-leaved goldenrod, soapwort gentian and grass-leaved rush are plants that typically grow in damp to seasonally wet clearings, abandoned fields, woods borders, thickets, marshes, and disturbed ground. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for these species to thrive. Habitat loss, deer browse and the indiscriminate spraying of herbicides are threats to

these species in some locations.

- Swamp dog-hobble is an understory shrub that typically occurs in swamps and wet thickets. Much of the formerly suitable habitat in this area has been modified for residential development, but the species continues to persist within a shrub swamp in this area. Preserve and restore the natural hydrology of the habitat and protect the species from excessive deer browse.
- Willow oak is a tree species of concern that occasionally occurs in the seasonally wet forested habitats and bottomlands in this area. Closely associated with the Atlantic coastal plain habitat, naturally occurring populations of this species are typically restricted to the extreme southeastern counties in Pennsylvania. Known populations of this tree species are threatened by habitat loss, disruptions to the site hydrology, habitat degradation by invasive species of plants, and in some locations, over-browsing by deer. Forests may be negatively altered by habitat fragmentation, which can have a drying effect on the habitat and promote invasive species growth. Establish protective buffers around fragmented habitat and remove invasive species to help maintain populations of these tree species of concern and encourage new population growth. Fencing of seedlings and saplings may be necessary to protect future generation of these trees from deer herbivory.
- Eastern baccharis is a shrub species of concern that grows in natural coastal wetlands, but also thrives in certain types of drier disturbed ground such as clearings, railroad grades and, as in this occurrence, along major highways. This species appears to be expanding its range in southeastern Pennsylvania along highways and other roads due to the application of road salt, which creates habitat conditions favorable for this species.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red maple terrestrial forest
  - Sweetgum – oak coastal plain forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Red maple – mixed shrub palustrine woodland

Much of the forested habitat is in the long process of reverting back from past clearing for agricultural activities. These early successional habitats are essential habitat for several of the plant species of concern known from this site. The existing fragments of coastal plain forest represent some of the few remaining examples of this habitat type in the state.

Ownership:

- Chichester School District is the owner of one of the larger parcels. Another parcel is owned by Southern Delaware County Authority and maintained as Naamans Creek Road Park. The remaining habitat is held in numerous privately owned parcels of various sizes.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape of mixed active agriculture, suburban development from the city of Chester and industrial "tank farms".
  - Interstate 95 was constructed through this area, severing and diminishing habitats.
- Current:
  - Unfortunately, the recent construction of a new school on the north side of I-95 has eliminated much of the available habitat for the species of concern known from this site. The remaining habitat should be set aside as essential habitat for species of concern and can be compatible with passive recreation.
  - Rapid development has occurred outside of and on the periphery of the core habitat area,

fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.

- Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
- Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. The invasive shrub winged euonymus (*Euonymus alatus*) dominates much of the understory in this area. This shrub is commonly planted as an ornamental, but has spread in natural habitats in southeastern Pennsylvania at an alarming rate in recent years. This species should be removed from both natural and cultivated landscapes to prevent its continued spread in the state.
- The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Recent school construction has severely diminished the available habitat for the species of concern at this location. Measures to preserve and enhance the remaining habitat are essential for the long term survival of these species at this location.
- Because several of the species of concern noted from this site rely upon open canopied habitats, removal of woody shrubs and invasive species in early successional habitats such as open fields, pipeline/powerline rights-of-way, and roadsides will to be necessary to maintain habitat for several of the open habitat adapted plant species. Mowing of these habitats every other year in early spring can help maintain the early successional conditions favorable for these plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and their habitat.
- Preserve and expand permanent and seasonal wetlands. The natural hydrology should be maintained and restored. Wet habitats should be thoroughly surveyed for remnant populations of species of concern and other coastal plain affinity species. Remove invasive species to allow native species to expand their populations. Establish vegetated buffers around wet and moist habitats to help protect the water quality entering the system.
- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for forested habitats should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for several populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species.
- Suppress and reverse the establishment and spread of invasive species plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Reduce the deer density in the area. Uncommon species of native plants are particularly

susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape.

- Conserve and expand the forested riparian buffers of all streams and wetlands. Conserve at least a 100 meter (328 feet) buffer of native woody vegetation where it exists along the waterways and establish at least a 100 foot buffer where it is lacking to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- The significant habitats of the area can be strongly affected as a result of nearby land use decisions. Reduce the amount of impervious surfaces in the watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the waterways, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.
- Residents who live adjacent to this area should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - In many cases, their house and yard may occupy formerly highly significant habitats for species of concern. In some cases, species of concern may still persist on their property. Homeowners should consider improving habitat conditions within their property for these species of concern. Permanently or seasonally wet areas of their property are likely areas that can support these species. Reduce the area of mowed lawn and cultivated gardens in favor of existing native plants suitable to the coastal plain habitat. Permanent and seasonal wetland habitats should be protected and expanded to reclaim a portion of the habitat lost to recent development.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.
    - Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.
- Potential Restoration Activities:
    - Former agricultural fields that have been allowed to revert to woody vegetation may require selective management to speed the succession process. Remove weedy woody species and favor native climax community species. Use the higher quality adjacent forests in similar topographic and geologic settings as natural community reference examples and mimic the forest composition. Use local native seed sources and root stock whenever possible in restoration efforts.
    - Areas currently maintained as lawn, particularly in the active floodplain of the streams in

the area, should be restored to native floodplain forest or open meadow habitats appropriate for the region.

- Remove invasive species plants. The creek floodplain and edge habitats associated with agricultural fields and residential neighborhoods are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
  - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
  - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Continual invasive species monitoring and control will be necessary.



Photo Source: Andrew Strassman (PNHP)

The Naamans Creek Woods showing the severe damage from an over-population of deer, which have eaten almost everything in the understory.

Pink Hill Serpentine Barrens

Delaware County, PA

Natural Heritage Inventory



N

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.125 0.25 0.5 Kilometers

0 0.125 0.25 0.5 Miles

PNHP

Pink Hill Serpentine Barrens – *Exceptional significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Arrow-feathered three awned (*Aristida purpurascens*)	P	G5	S2	PT (PT)	2009	AB
Heller's witchgrass (*Panicum oligosanthes*)	P	G5	S3	N (PT)	2009	BC
Plain ragwort (*Senecio anonymus*)	P	G5	S2	PR (PR)	2009	B
Serpentine aster (*Symphyotrichum depauperatum*)	P	G2	S2	PT (PT)	1986	B
A moth (*Amolita roseola*)	L	G5	SNR	N	2010	E
A moth (*Ancylis semiovana*)	L	GNR	SNR	N	2010	E
A moth (*Argyria nummulalis*)	L	GNR	SNR	N	2010	E
Dot-lined white moth (*Artace cribraria*)	L	G5	S1	N	2010	E
Regal or Royal walnut moth (*Citheronia regalis*)	L	G4G5	SU	N	2010	E
Edith's fabiola moth (*Fabiola edithella*)	L	GNR	SNR	N	2010	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This Natural Heritage Area is a small portion of the Tyler Arboretum between Barren Road on the south, Painter Road on the east and Dismal Run on the north. The area is roughly across the street from Penncrest High School, northeast of the town of Lima.

- Municipalities:
  - Middletown Township
- Watersheds:
  - Ridley Creek
- USGS Quadrangles:
  - Media Quadrangle
- 1992 Delaware County Natural Areas Inventory reference:
  - "Pink Hill Serpentine Barrens" – (Media Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Pink Hill is one of a series of small islands of serpentine bedrock geology exposed at the surface in Delaware County. These serpentine habitats occur in isolated patches as the bedrock material, serpentinite, is exposed at the surface of the ground in a scattered fashion much like an archipelago chain of islands. Historically, these areas were relatively small herbaceous openings in the vast unbroken primeval forests of pre-colonial days. The unusual chemistry of serpentine derived soils has restricted the available nutrients to all but those plants evolutionarily adapted to the harsh growing conditions present. The serpentine habitats are often referred to as grasslands, and they do have a strong representation of warm season grasses and grass-like plants, but they also contain a good diversity of other plant species, many uncommon in the state and several unique to serpentine habitats. Pink Hill is named for the "pinks" (*Phlox subulata* ssp. *subulata*) which carpet

the area in the spring. Natural erosion of steep slopes, fire disturbances and animal grazing have maintained these herbaceous openings in the past. Recently, the herbaceous opening at Pink Hill has been gradually closing due to natural succession, reverting to a forested habitat. Active woody vegetation removal will be necessary to maintain these openings in the absence of periodic fire events or other suitable disturbances. Complete closure of the canopy gap will eliminate the suitable habitat for the plant species of concern occurring at this location.

Species of Concern Considerations:

- The four plant species of concern currently known to occur within this Natural Heritage Area: arrow-feathered three awned, Heller's witchgrass, plain ragwort and serpentine aster are found primarily in the strongly serpentine influenced herbaceous openings or within the adjacent thin woodlands. Serpentine aster is only known to occur in the eastern serpentine barrens of Pennsylvania and Maryland. This extremely limited distribution has given this species the status of G2 – globally imperiled. In the past, natural disturbance, such as wild fires, would have helped to keep these areas in an open condition. With the relatively recent suppression of fire, the open areas have gradually closed due to natural succession. Several other serpentine habitat associated species of concern were known historically to this area, but have not been relocated during recent surveys. An active restoration effort to restore the serpentine openings will be necessary to ensure the continued existence of these habitats and the species they contain.
- A recent survey of moths and butterflies at Pink Hill documented six species of concern and 17 species that were not previously recorded in Pennsylvania. Many of these species are limited in distribution in Pennsylvania to serpentine and other grassland habitats, likely due to the specialized host plants required during the larval stage of these insects. Conservation of these species requires protection of the habitat they use during all stages of their life cycles. Maintaining a mosaic of grassland, hardwood, and pine areas at serpentine barrens sites and the surrounding area will create a diverse and healthy habitat capable of supporting the rare Lepidoptera listed above. Plantings of native herbaceous food plants and desirable nectar sources may also help increase the existing Lepidoptera populations. Pesticide application, especially for the control of gypsy moths, can have a devastating effect on populations of Lepidoptera species of concern and should be eliminated in this area.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow “Terrestrial & Palustrine Plant Communities of Pennsylvania” (Fike 1999) where appropriate, and otherwise describe general land cover types (*). A more detailed list of species documented currently and historically at Pink Hill is available in the “Pink Hill Serpentine Barrens Restoration and Management Plan” (Latham 2008).

The area currently contains a small herbaceous opening surrounded by early successional forest that had been a continuation of the herbaceous opening as recently as 1937. Over the past several decades, the forest edge has been expanding into the grassland through natural succession. This habitat was historically less dominated by woody trees and shrubs, but recent fire prevention has favored the expansion of wooded habitats at the expense of herbaceous openings. Invasion of serpentine herbaceous openings by woody trees and shrubs can influence the surrounding habitat. As woody vegetation encroaches on the openings, they tend to trap more organic debris and allow deeper soils to accumulate. As deeper soils occur on the site, they allow the area to succeed to more common woodland and forest types. Fire disturbances have maintained these herbaceous openings in the past. Active woody vegetation removal will be necessary to maintain these openings in the absence of fire. Surrounding

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - Dry oak – mixed hardwood forest
  - modified successional forest*

Ownership: Almost the entire serpentine habitat at this location is privately owned and maintained as part of the John J. Tyler Arboretum, which actively preserves the unique habitat. Two small privately owned parcels are within the boundary delineated for this habitat.

Habitat Disturbances:

- Historic:
  - Historically, naturally sparked and intentionally set wildfires likely helped to maintain the open aspect of these habitats. Early accounts record the intentional setting of fire in these habitats by Native Americans to help open the area for greater potential hunting success.
  - Much of the serpentine habitat was cleared by grazing in the past. Past grazing activities likely helped to maintain the open aspect of the barrens habitat.
  - Based on aerial photos from 1937, the surrounding area was a mix of open fields used for pasture, hay and crops interspersed with variously sized woodlots. The small section of existing serpentine habitat was surrounded by an open field of about 14 acres, and included many more acres of adjacent open fields, significantly increasing the potential serpentine habitat at this location.
  - Early visitors to Pink Hill would occasionally remove wildflowers (sometime by the truckload) for transplanting into private flower gardens. Many of the plants found in this specialized habitat are not able to successfully compete with other plants when transplanted to new locations and likely were unable to persist in their transplanted settings.
- Current:
  - The small barrens habitat remains relatively undisturbed. Ironically, the lack of disturbance poses one of the greatest threats to this habitat. In the absence of natural disturbance events, most of the open serpentine barrens habitats will gradually succeed to more common woody vegetation such as junipers, pines and oaks as the accumulation of organic matter and soil around the bases of successional species allows them to colonize the opening. The existing herbaceous opening has diminished to a critically small area. Further inaction to maintain and expand herbaceous openings will result in the eventual complete loss of the habitat supporting these species of concern. The Tyler Arboretum has pursued a vegetation management program including periodic controlled burning since around 2003.
  - Increased soil accumulation as the result of succession to woody species creates conditions more favorable to non-serpentine restricted plants. Removal of some parts of the accumulated soil may be necessary to thin the soils to depths that favor serpentine adapted species of plants.
  - The small, isolated populations of species of concern found at the Pink Hill barrens are susceptible to unfortunate events that can eliminate entire populations, resulting in a local extinction. Numerous species of plants recorded at Pink Hill in the past were not found during surveys in 2008 (Latham 2008).
  - Development has accelerated south of Barrens Road. Loss of natural vegetation in the surrounding area diminishes the long term viability of the core serpentine habitat and the species that rely on this habitat.
  - Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. Deer have strong, species-specific feeding preferences and tend to favor native plants over introduced plants. The most highly preferred species are the first to decline or disappear when deer numbers are high. The result is greatly impoverished native species diversity and the rapid proliferation of invasive species. Pink Hill is outside of the Tyler Arboretum's deer exclosure fence, subjecting this habitat to increased deer herbivory pressure.
- Exotic Species:
  - Most of the serpentine habitat is naturally resistant to invasion by introduced species of plants due to its unusual chemical makeup, but invasive species are well established in

some areas especially Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), tree-of-heaven (*Ailanthus altissima*), Canada thistle, (*Cirsium arvense*) and black locust (*Robinia pseudoacacia*), which is not considered native to eastern North America.

- Colonization of the herbaceous opening by native woody species can have the same effect on the habitat as invasion by introduced species of plants, eliminating the habitat of concern.

Conservation Actions:

- Overall:
  - A very detailed management plan specifically for Pink Hill Serpentine Barrens was recently completed by Roger Latham of Continental Conservation (Latham 2008). Please consult that plan for a finer level of management detail.
  - Active stewardship of these habitats is necessary. In the absence of natural fire disturbance, or active vegetation removal, these habitats will succeed into woodlands and forests, replacing the globally rare habitat with a more common type.
  - Habitat restoration activities should strive to swiftly expand the herbaceous openings by removing woody and invasive species to increase the habitat potential for the serpentine dependent species occurring at this location.
  - A surrounding agricultural landscape is suitable for properties adjacent to this Natural Heritage Area. The area around these habitats should be considered part of a necessary buffer to allow periodic prescribed burns to sustain the open habitat once the bulk of the woody species have been removed.
- Within the Core Habitat:
  - Please refer to the Pink Hill Serpentine Barrens Restoration and Management Plan for detailed and specific habitat restoration actions.
  - Expand herbaceous openings by removing most trees and other woody plants in the area identified as herbaceous opening in the 1937 aerial photos. In the past, naturally occurring fires helped maintain the open aspect characteristic of the serpentine barren habitat. Today, active vegetation management, in the form of mechanical woody plant removal, prescribed burns, or as necessary, spot application of herbicides, helps to remove trees and shrubs that in the past would have been cleared by fire events.
  - Remove the excessive buildup of soil that has accumulated as the result of recent succession. Measure soil depths throughout the proposed serpentine expansion area and carefully skim the surface soil to a desirable depth. This action will also help to eliminate tough stands of woody vegetation. Remove the soil to an off site location to avoid the soil pile becoming a source for future invasion of woody and invasive species.
  - Rotate prescribed burns so that only a fraction of the opening is burned in any one year to avoid the accidental destruction of these small, tenuous populations of species of concern.
  - Control invasive species of plants. Mechanical (hand pulling, cutting and mowing) and chemical (spot herbicide treatment) management techniques may be necessary to protect the habitat from colonization by aggressive species. Broadcast application of herbicides is not suitable for this delicate habitat.
  - Reduce the deer density in the area. Active management will require a coordinated effort among the surrounding property owners, Ridley Creek State Park, and the Pennsylvania Game Commission.
  - Carefully consider reintroductions of serpentine plant species. Each serpentine habitat has a slightly different species composition, likely due to the slightly different environmental conditions and past land use at each distinct location as well as the size of the available habitat. Any species reintroductions should follow careful surveys of the existing habitat to determine existing species composition. All seed source used to repopulate this habitat

should be collected from this or other nearby serpentine habitats in Delaware or Chester County.

- Survey adjacent and nearby areas that occur on serpentine derived soils (Chrome series soils) for their potential as future expansion of the habitat.
- The plants that characterize these habitats are adapted to the dry, nutrient poor soils and periodic fire events. A priority for the security of these globally rare habitats should be to establish protection for the core habitats as well as to provide for the landscape context in which natural process can be maintained. These systems may be best maintained in an agricultural or rural setting. Residential development near this barren should be strongly discouraged.
- Educate the adjacent landowners on the significance of the globally rare habitat and the need for ongoing management activities.
- Engage other organizations working to actively preserve and manage serpentine habitats in the area. The Friends of the State Line Serpentine Barrens is organized to “encourage community involvement in preserving this globally rare ecosystem” in Pennsylvania and Maryland (http://statelineserpentinebarrens.org/home). Other organizations such as the Natural Lands Trust, The Nature Conservancy of PA, Brandywine Conservancy and Nottingham County Park have also actively participated in various aspects of serpentine habitat conservation.



Photo Source: Andrew Strassman (PNHP)

Pink Hill is named for the "pinks" (*Phlox subulata* ssp. *subulata*) which carpet the area in the spring.

References:

Latham, R. E. 2008. Pink Hill Serpentine Barrens Restoration and Management Plan. John J. Tyler Arboretum, Media, Pennsylvania, and Mt. Cuba Center, Greenville, Delaware. 87 pp.

Riddle Hospital Serpentine Barrens

Delaware County, PA Natural Heritage Inventory



N

Lima

Black Horse

Riddlewood

Elwyn

Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.125 0.25 0.5 Kilometers

0 0.125 0.25 0.5 Miles

PNHP

Riddle Hospital Serpentine Barrens – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Field chickweed (*Cerastium velutinum var. velutinum*)	P	GG5T4?	S3	PT (PT)	2010	BC
Heller's witchgrass (*Dichanthelium oligosanthes*)	P	G5	S3	N (PT)	2010	E
Annual fimbry (*Fimbristylis annua*)	P	G5	S2	PT (PT)	1991	B
Plain ragwort (*Packera anonyma*)	P	G5	S2	PR (PR)	2010	D
Few flowered nutrush (*Scleria pauciflora*)	P	G5	S2	PT (PT)	1991	C
Serpentine aster (*Symphyotrichum depauperatum*)	P	G2	S2	PT (PT)	1991	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This Natural Heritage Area includes most of the remaining open land associated with Riddle Memorial Hospital and Williamson Free School. This area is roughly bounded on the north by Route 1, on the east by Route 352 (New Middletown Road), on the south by the railroad tracks along Williamson Free School and on the west by Chrome Run.

- Municipalities:
  - Middletown Township
- Watersheds:
  - Chester Creek
- USGS Quadrangles:
  - Media Quadrangle
- 1992 Delaware County Natural Areas Inventory reference:
  - "Williamson School Serpentine Barrens" – (Media Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Considered one of the top sites of statewide significance for the protection of biological diversity in the original 1992 Delaware CNHI, this area has been severely impacted by the construction and subsequent recent expansion of hospital facilities which has greatly diminished the extent and quality of this globally rare habitat type. The Riddle Memorial Hospital was built on a globally uncommon bedrock type, serpentinite, which is one of a series of small islands of serpentine bedrock geology exposed at the surface in southeastern Pennsylvania and adjacent Maryland. These serpentine habitats occur in isolated patches as the bedrock material, serpentinite, is exposed at the surface of the ground in a scattered fashion much like an archipelago chain of islands. Historically, these areas were relatively small herbaceous openings in the vast unbroken primeval forests of pre-colonial days. The unusual chemistry of serpentine derived soils has restricted the available nutrients to all but those plants evolutionarily adapted to the harsh growing conditions present. The serpentine habitats are often referred to as grasslands, and they do have a strong representation of warm season grasses and grass-like plants, but they also contain a good diversity of other plant species, many uncommon in the state and several unique to serpentine habitats. It's interesting to note that the small stream running adjacent to the serpentine habitat is named Chrome Run, one of the minerals characteristic of serpentine bedrock. This area was one of very few in the world to support an intact serpentine barrens habitat.

Much of the area has since been converted to hospital buildings and infrastructure leaving scattered remnants of habitat that in many cases still manage to support species of concern. A small portion of the original serpentine habitat was set aside as a preserve for the serpentine species. This habitat is in dire need of management to avoid the succession of this habitat and elimination of the species of concern. Several of the species of concern noted on past surveys have failed to be relocated in recent surveys and may be extirpated from this site. Natural erosion of steep slopes, fire disturbances and animal grazing have maintained these herbaceous openings in the past. Active woody vegetation removal will be necessary to maintain these openings in the absence of periodic fire events or other suitable disturbances. Complete closure of the canopy gap will eliminate the suitable habitat for the plant species of concern occurring at this location.

Species of Concern Considerations:

- The six plant species of concern that are currently known to occur within this Natural Heritage Area, field chickweed, Heller's witchgrass, annual fimbry, plain ragwort, few flowered nutrush and serpentine aster, are found primarily in the strongly serpentine influenced herbaceous openings or within the adjacent thin woodlands. Serpentine aster is only known to occur in the eastern serpentine barrens of Pennsylvania and Maryland. This extremely limited distribution has given this species the status of G2 – globally imperiled. Loss of habitat to development as well as to natural succession has degraded all of the serpentine habitats in Delaware County. In the past, natural disturbances, such as wild fires or animal grazing, would have helped to keep these areas in an open condition. With the relatively recent suppression of fire, the open areas have gradually closed due to natural succession. Several other serpentine habitat associated species of concern were known historically to this area, but have not been relocated during recent surveys. An active restoration effort to restore the serpentine openings will be necessary to ensure the continued existence of this habitat and the species they contain.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow “Terrestrial & Palustrine Plant Communities of Pennsylvania” (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - modified successional forest*

The area currently contains several small herbaceous openings on the edge of hospital buildings and infrastructure and adjacent to patches of modified successional forest and relatively mature second growth forest. Remnants of serpentine habitat exist within a small habitat preserve and along a pipeline rights-of-way while other little pockets of potential habitat are scattered around the area.

Ownership: Most of the remaining exposed serpentine habitat is on Riddle Memorial Hospital property, while the large forested area is owned by the Williamson Free School. Both properties are largely underlain by Chrome series soils, which are derived from serpentine bedrock parent material.

Habitat Disturbances:

- Historic:
  - Historically, naturally sparked and intentionally set wildfires likely helped to maintain the open aspect of these habitats. Early accounts record the intentional setting of fire in these habitats by Native Americans to help open the area for greater potential hunting success.
  - Much of the serpentine habitat was cleared by grazing in the past. Past grazing activities likely helped to maintain the open aspect of the barrens habitat.
  - Based on aerial photos from 1937, the surrounding area was a mix of open fields used for pasture, hay and crops interspersed with variously sized woodlots. The much more expansive open fields of that era offered a much increased area for serpentine habitat adapted species to thrive.

- In the absence of natural disturbance events, most of the open serpentine barrens habitats will gradually succeed to more common woody vegetation such as junipers, pines and oaks as the accumulation of organic matter and soil around the bases of successional species allows them to colonize the opening. Over the past several decades, the forest edge has been expanding into the grassland through natural succession. This habitat was historically less dominated by woody trees and shrubs, but recent fire suppression and prevention has favored the expansion of wooded habitats at the expense of herbaceous openings. Invasion of serpentine herbaceous openings by woody trees and shrubs can influence the surrounding habitat. As woody vegetation encroaches on the openings, they tend to trap more organic debris and allow deeper soils to accumulate. As deeper soils occur on the site, they allow the area to succeed to more common woodland and forest types. Fire disturbances have maintained these herbaceous openings in the past. Active woody vegetation removal will be necessary to maintain these openings in the absence of fire.
- The original Riddle Memorial Hospital was built on the northern portion of the serpentine habitat, eliminating an area of the suitable habitat for serpentine adapted species.

o Current:

- The small, isolated populations of species of concern found at the Williamson School barrens are susceptible to unfortunate events that can eliminate entire populations, resulting in a local extinction.
- An expansion of the Riddle Hospital in the early 1990's resulted in the near elimination of the serpentine habitat at this location. Efforts to preserve the best serpentine habitat from the development footprint resulted in the set aside of a small patch of this globally important habitat. The residual habitat that occurs scattered around the hospital grounds is a degraded relict of the former serpentine barrens habitat that once occupied this site. The set aside preserve has lacked the proper management and periodic maintenance necessary to maintain the open canopy conditions preferred by the serpentine endemic species. The existing herbaceous opening has diminished to a critically small area. Further inaction to maintain and expand herbaceous openings will result in the eventual complete loss of the habitat supporting these species of concern.
- Increased soil accumulation as the result of succession to woody species creates conditions more favorable to non-serpentine restricted plants. Removal of some parts of the accumulated soil may be necessary to thin the soils to depths that favor serpentine adapted species of plants.
- A wire fence was erected around and through part of the serpentine habitat preserve. Though likely intended to protect the habitat from disturbance, the fence has allowed the accumulation of organic debris, soil and resulted in the colonization of parts of the area by woody species. In addition, the fence impedes access for needed maintenance activities.
- Dumping of construction and landscape maintenance debris is occurring within the fenced enclosure of the serpentine habitat.
- Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increases competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences and tend to favor native plants over introduced plants. The most highly preferred species are the first to decline or disappear when deer numbers are high. The result is greatly impoverished native species diversity and the rapid proliferation of invasive species.
- Exotic Species – Most of the serpentine habitat is naturally resistant to invasion by introduced species of plants due to its unusual chemical makeup as long as soil accumulation does not occur, but invasive species are well established in some areas. Some of the dominant invasive species include:
    - tree-of-heaven (*Ailanthus altissima*)

- Japanese barberry (*Berberis thunbergii*)
- oriental bittersweet *(Celastrus orbiculatus)*
- Canada thistle, (*Cirsium arvense*)
- Crown vetch (*Coronilla varia*)
- autumn olive (*Elaeagnus umbellata*)
- privet *(Ligustrum* sp.*)*
- Japanese honeysuckle *(Lonicera japonica)*
- Japanese stiltgrass *(Microstegium vimineum)*
- common reed *(Phragmites australis)*
- Bradford pear (*Pyrus calleryana*)
- multiflora rose (*Rosa multiflora*)

- Colonization of the herbaceous openings and forest by native woody species can have the same effect on the habitat as invasion by introduced species of plants, eliminating the habitat of concern.
- Control options for invasive and woody plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

<u>Conservation Actions</u>:

- Overall:
  - Conservation managers at this location would benefit from reviewing the management plans developed for Tyler Arboretum's Pink Hill Serpentine Barrens (Latham 2008) and the Goat Hill Wild Plant Sanctuary (Furedi 2008).
  - Active stewardship of these habitats is necessary. In the absence of natural fire disturbance, or active vegetation removal, these habitats will succeed into woodlands and forests, replacing the globally rare habitat with a more common type.
  - Habitat restoration activities should strive to swiftly expand the herbaceous openings by removing woody and invasive species to increase the habitat potential for the serpentine dependent species occurring at this location.
  - Identify additional potential serpentine habitat remnants for restoration activities. Areas that currently have en early successional tree and shrub canopy are likely targets for restoration potential.
  - Consider creating conditions favorable for serpentine habitats and incorporating serpentine adapted species into the landscaping around the hospital grounds.
  - Develop outreach opportunities to educate the public, local officials and landowners about the significance and management needs of these globally rare serpentine habitats.
- Within the Core Habitat:
  - Please refer to other Pennsylvania serpentine barrens restoration and management plans for detailed and specific habitat restoration actions that can apply to this site as well.
  - Remove or expand the perimeter of the fence within this habitat to allow for ease of habitat management and restoration.
  - Expand herbaceous openings by removing most trees and other woody plants in the area. In the past, naturally occurring fires helped maintain the open aspect characteristic of the serpentine barren habitat. Today, active vegetation management, in the form of mechanical woody plant removal, prescribed burns, or as necessary, spot application of herbicides, helps to remove trees and shrubs that in the past would have been cleared by fire events.

- Carefully and systematically remove the excessive buildup of soil that has accumulated as the result of recent succession. Measure soil depths throughout the proposed serpentine expansion area and carefully skim the surface soil to a desirable depth. This action will also help to eliminate tough stands of woody vegetation. Remove the soil to an off site location to avoid the soil pile becoming a source for future invasion of woody and invasive species.
- Prescribed fires can help maintain openings once the bulk of the woody species have been removed. Rotate prescribed burns so that only a fraction of the opening is burned in any one year to avoid the accidental destruction of these small, tenuous populations of species of concern.
- Control invasive species of plants. Mechanical (hand pulling, cutting and mowing) and chemical (spot herbicide treatment) management techniques may be necessary to protect the habitat from colonization by aggressive species. Broadcast application of herbicides is not suitable for this delicate habitat.
- Reduce the deer density in the area. Active management will require a coordinated effort among the surrounding property owners, Ridley Creek State Park, and the Pennsylvania Game Commission.
- Carefully consider reintroductions of serpentine plant species. Each serpentine habitat has a slightly different species composition, likely due to the slightly different environmental conditions and past land use at each distinct location as well as the size of the available habitat. Any species reintroductions should follow careful surveys of the existing habitat to determine existing species composition. All seed source used to repopulate this habitat should be collected from this or other nearby serpentine habitats in Delaware or Chester County.
- Survey adjacent and nearby areas that occur on serpentine derived soils (Chrome series soils) for their potential as future expansion of the habitat. Small pockets of exposed serpentine gravel were observed within the adjacent wooded area and should be explored for their potential restoration to open canopy serpentine habitats.
- The plants that characterize these habitats are adapted to the dry, nutrient poor soils and periodic fire events. A priority for the security of these globally rare habitats should be to establish protection for the core habitats as well as to provide for the landscape context in which natural process can be maintained. These systems may be best maintained in an agricultural or rural setting. Residential development and expansion of hospital facilities near this barren should be strongly discouraged.
- Educate the adjacent landowners on the significance of the globally rare habitat and the need for ongoing management activities.
- Engage other organizations working to actively preserve and manage serpentine habitats in the area. The restoration of serpentine habitats in this area may be suitably coordinated with Williamson School staff and students in the horticulture program. The Friends of the State Line Serpentine Barrens is organized to “encourage community involvement in preserving this globally rare ecosystem” in Pennsylvania and Maryland (http://statelineserpentinebarrens.org/home). Other organizations such as the Natural Lands Trust, The Nature Conservancy of PA, Brandywine Conservancy and Nottingham County Park have also actively participated in various aspects of serpentine habitat conservation.



Photo source: PNHP



Above: The small serpentine influenced herbaceous opening has largely succeeded to woody species, diminishing the preferred habitat of several species of concern known from this site. Below: A fence intended to protect the habitat currently impedes needed maintenance activities.

Above: Periodic maintenance and natural erosion along a pipeline right-of-way next to Riddle Hospital help to maintain the necessary open conditions preferred by several characteristic serpentine barrens plant species of concern.



References:

Furedi, M. A., R. Latham, A. Davis, and G. Podniesinski. 2008. Management Plan for Goat Hill Wild Plant Sanctuary. Pennsylvania Natural Heritage Program, Middletown PA, and Continental Conservation, Rose Valley PA. 58 pp.

Latham, R. E. 2008. Pink Hill Serpentine Barrens Restoration and Management Plan. John J. Tyler Arboretum, Media, Pennsylvania, and Mt. Cuba Center, Greenville, Delaware. 87 pp.

Ridley Creek - Crum Creek Mouth Tidal Wetlands

Delaware County, PA Natural Heritage Inventory



Legend

- Core Habitat (focus NHI site)
- Core Habitat (other NHI sites)
- Supporting Landscape
- 100 meter Riparian Buffer
- 100 foot Riparian buffer
- Township Boundary
- County Boundary
- Interior Forest
- Forested habitat

OpenSpace & Recreation

- Public Park
- Homeowner's Association
- Privately Eased Land

0 0.25 0.5 1 Kilometers

0 0.25 0.5 1 Miles

PNHP

Ridley Creek - Crum Creek Mouth Tidal Wetlands – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Osprey (*Pandion haliaetus*)	B	G5	S2B	PT (PT)	2008	E
Peregrine Falcon (*Peregrine Falcon*)	B	G4	S1B,S1N	PE (PE)	2009	E
Indian wild rice (*Zizania aquatica*)	P	G5	S3	PR (PR)	2009	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: The Delaware River shoreline and floodplain includes the tidal marsh remnants between the southern part of the mouth of Darby Creek downstream to the northern part of the mouth of Chester Creek. Between these two points are the mouths of both Ridley Creek and Crum Creek.

- Municipalities:
  - Chester City
  - Eddystone Borough
  - Ridley Township
- USGS Quadrangles:
  - Bridgeport Quadrangle
- Watersheds:
  - Crum Creek
  - Darby Creek
  - Delaware River
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This highly industrialized portion of the Delaware River shoreline supports remnant freshwater tidal marsh and mudflat habitats in a much degraded context. In some areas, the crumbling, paved footprints of past industrial activity are giving way to expanses of early successional vegetation. Vegetation has begun to colonize the unused piers and unpaved portions of the former industrial sites. Where the shoreline vegetation strip widens, it supports trees, shrubs, vines and herbaceous vegetation between the rubble-armored hardened shoreline and the crumbling pavement of the former industrial sites. Along the periphery of the river, native species of plants and animals compete with introduced species for the limited space and resources available for their use.

The abandoned wooden pilings, piers and ramps within the river help to diminish the impact of wave action from passing ships on the river shoreline and may help to encourage the formation of tidal mudflats along this portion of the river. Many of the formerly active piers have been neglected for long enough that trees, shrubs and herbaceous vegetation have colonized them. Between the vacant piers are areas of shallow water and deep mud that, in some cases already support tidal mudflat vegetation. These small estuaries help support young fish populations, an essential ecological function of shallow water habitats along the river.

Species of Concern Considerations:

- Being primarily fish eaters, Ospreys utilize aquatic habitats for food gathering and upland habitats or prominent features as nesting areas. Osprey will nest on artificial structures including poles and towers that support electric or phone lines, cell-phone relay towers, buildings, fences, and channel markers. Osprey populations tend to be clustered where shallow waters and nesting support structures are available. The aquatic habitats provided by the river and tributaries as well as nesting structures are both important components of this species' habitat preferences. Since Osprey forage for fish visually, they are sensitive to poor water quality including loss of clarity. A decrease in water quality or clarity can have a direct negative effect on Osprey foraging efficiency and perhaps nesting success.
- Successfully breeding pairs of Peregrine Falcons have been documented at this site over the past several years. Peregrine Falcons require a combination of large open areas for hunting and tall, inaccessible ledges for nesting. Ledges can either be natural cliffs or human-made structures that have similar structural characteristics. Though buildings and bridges are not the traditional habitat for this species, pairs are nesting successfully in these situations around the country. Peregrines range widely to forage for prey, frequently several kilometers. There is high potential for collisions with structures and automobiles in this hunting territory.
- Indian wild rice is an annual plant that typically grows in tidally influenced shoreline marshes. This plant is adapted to the twice daily flooding disturbance and shallow water conditions that occur in wide floodplain habitats along the Delaware River and do well in habitats otherwise favoring 'weedy' species of plants. Populations of this species can be enhanced by maintaining the natural fluctuations in the river's water level and restoring the natural conditions of its shoreline.

Forest Cover / Natural Communities: The river shoreline at this location is highly industrialized and only a narrow band of remnant vegetation occurs along its banks. A few areas within the tidal zone have emergent aquatic vegetation typical of the habitat.

Ownership:

- This portion of the Delaware River shoreline currently has no publicly owned land but rather is held in several relatively large privately-owned parcels. The large parcel size can be tremendously helpful towards implementation of consistent conservation actions across this significant piece of the landscape. Conservation action should proceed before ownership fragmentation makes this process more difficult.

Habitat Disturbances:

- Historic:
  - Most of the area between the I-95 freeway and the Delaware River has been greatly modified from the extensive system of tidal marshes that used to dominate the shoreline. The tidally influenced shoreline of the Delaware River historically hosted expansive freshwater tidal marshes, especially at the mouths of the tributary creeks. Over the past several centuries and especially this past one, the marshes have been diked, ditched, drained, filled and converted to dry areas of commerce and residence. As late as 1900 there were extensive marshes at the mouth of Crum Creek where a lighthouse was accessed by way of a 2000 foot long wooden walkway through the marsh (Harshberger 1904). Most of this area is still within the floodplain of the river and is likely to be subject to future flooding from increasingly unpredictable weather patterns and an anticipated rise in sea level.
  - Formerly, this area was a very active shipping and industrial part of North America. While still an important entryway for sea freight, much of the riverfront has seen considerable change in the past few decades. Many areas that had been associated with shipping and industry have been demolished, leaving various large and small patches of vacant ground and their associated piers along the riverfront.
  - Rail lines and roadways were built parallel to and though the former marshes.
  - Industrial plants and a coal-fired electric generating plant were built on the banks of the river. One industrial plant was built directly on top of Crum Creek, disconnecting upstream and downstream portions of the creek.

- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with a mix of industrial areas and dilapidated former shipping wharfs.
  - In 2004 the oil tanker Athos I hit an abandoned and uncharted anchor, ruptured its hull, and spilled 30,000 gallons of oil into the Delaware River
  - The impact of wave action from passing boat traffic is significant and acts to constantly scour the southern side of the island, which is exposed to the shipping lane. The large wakes of the ocean-going freighters that use the Delaware River channel are often in excess of six-feet tall and have caused significant erosion on the up, and downstream ends of the island, shortening it by over 800 feet since the 1971 aerial photo was taken.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – This disturbed strip of vegetation is frequently dominated by invasive non-native trees such as tree-of-heaven, princess tree, Norway maple, Siberian elm, white poplar and white mulberry. Invasive shrubs and vines frequently dominate the understory including Japanese honeysuckle, porcelain berry, Asiatic bittersweet, multiflora rose, bush honeysuckles, common privet, barberry, paper mulberry and autumn olive to name a few.

Conservation Actions:

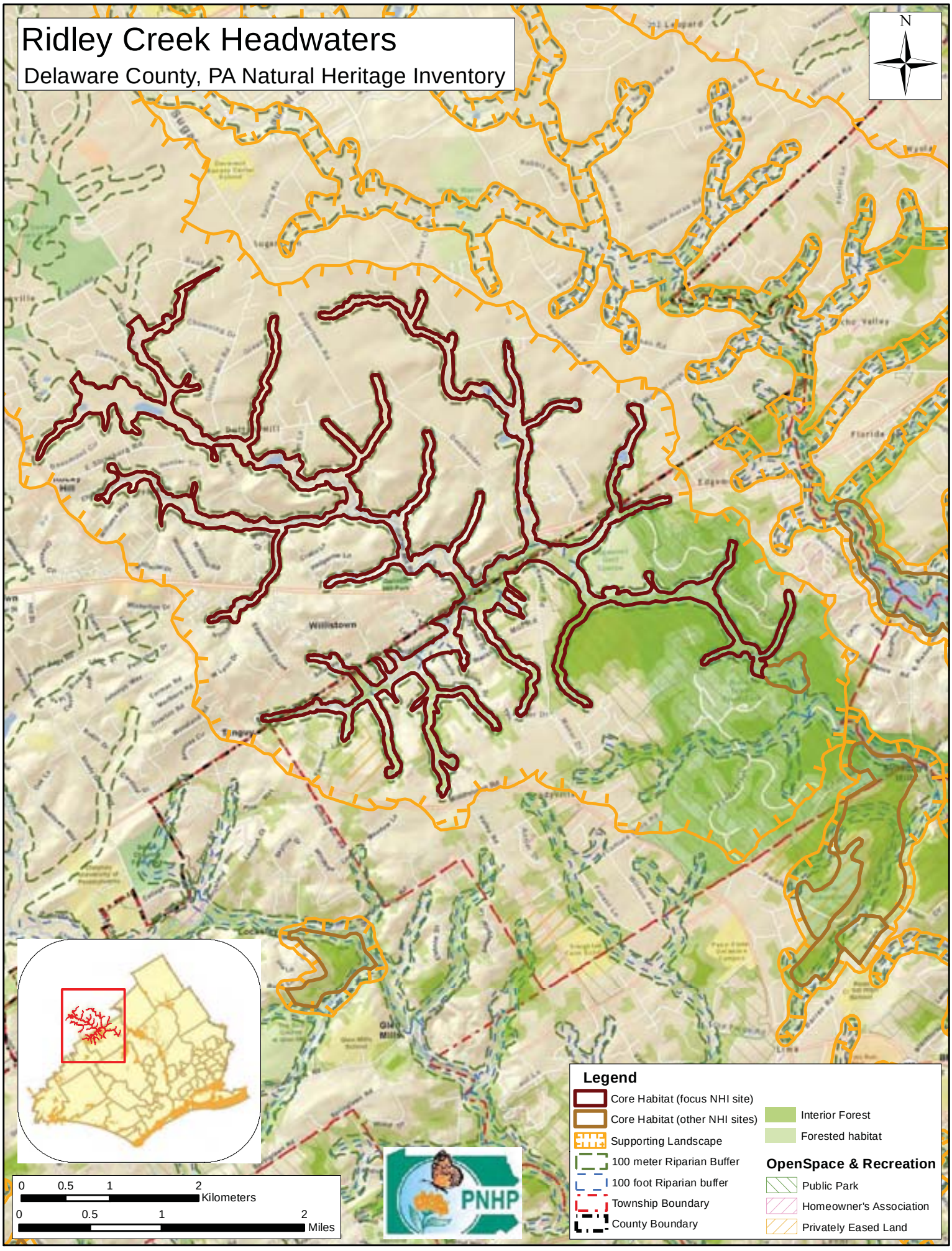
- Future long range goals for this section of the river should be to simultaneously enhance the native ecology of the riverfront as well as provide public access and park space opportunities. Since much of the Delaware River shoreline in Delaware County is currently transitioning from past industrial and shipping activity, the county is presented with an excellent opportunity to recreate a continuous greenway corridor along this stretch of the river. This linear area currently lends itself well to the reestablishment of a ribbon of native vegetation that will help provide habitat for native plants and animals while filtering and trapping runoff from the urban and suburban areas before it enters the river. In addition, the linear corridor can function as a portion of a public greenway along the length of the Delaware riverfront. Such a public amenity would greatly improve the quality of life for all residents and visitors to the area.
- Future developments should be set back from the river shoreline to accommodate a 100-meter wide vegetated riparian buffer between the river's edge and development activity.
- The shoreline habitat can be improved by removing portions of the armored bulkheads and reconnecting the river to a portion of its natural floodplain.
- Restore and protect the natural hydrology of the river and it tributaries. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
- Replant the riparian area in native trees and shrubs to enhance its ecological value.
- Reduce the impact of the wakes from passing ships and small boats. This may entail establishing a shoal that can absorb the wake impact, and/or reducing the speed at which boats may travel through the river.
- Conserve and expand the forested riparian buffers of Ridley Creek, Crum Creek and their tributaries. Establish at least a 100 foot buffer of woody vegetation along the creeks to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the upstream watershed.

References cited:

Harshberger, J. W. 1904. A phyto-geographic sketch of extreme southeastern Pennsylvania. Bulletin of the Torrey Botanical Club 31: 125-159.

Ridley Creek Headwaters

Delaware County, PA Natural Heritage Inventory



Ridley Creek Headwaters – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Tooth cup (*Rotala ramosior*)	P	G5	S3	PR (PR)	2000	B
Sensitive species of concern[3]	---	---	---	---	1997	E
Sensitive species of concern[3]	---	---	---	---	1997	E
Sensitive species of concern[3]	---	---	---	---	1997	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This large riparian area includes much of the upper Ridley Creek watershed floodplain straddling the Delaware-Chester County line.

- Municipalities:
  - East Goshen Township (Chester County)
  - Edgmont Township (Delaware County)
  - Westtown Township (Chester County)
  - Willistown Township (Chester County)
- USGS Quadrangles:
  - Media Quadrangle
  - West Chester Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This portion of Ridley Creek and its tributaries has long been dominated by agricultural activities and more recently by suburban development. Occasional small wetlands, spring seeps and successional old fields occur along and adjacent to the creek floodplain where it widens and the water slows. The riparian zones are for the most part tightly bounded by agricultural fields, residential development and other infrastructure.

Species of Concern Considerations:

- Tooth cup is an annual plant that occurs in exposed shorelines, stream margins and other damp, open places. This plant is adapted to the periodic disturbance associated with natural flooding cycles along streams and rivers. This population of tooth cup can be enhanced by maintaining the natural seasonal fluctuations in the water level of the stream and the natural conditions of its shoreline.
- Three sensitive species of concern, which are not named at the request of the jurisdictional agencies overseeing their protection, occur within this Natural Heritage Area. They each require specific plant communities within a matrix of open canopied habitats. Restoration of the marshy habitats historically associated with the Ridley Creek floodplain will help to provide expanded habitat opportunities for these species of concern.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Red maple terrestrial forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
  - modified successional woodland*
- Palustrine (wetland) communities:
  - Sycamore – (river birch) – box elder floodplain forest

- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality.

Ownership:

- The linear riparian corridor of Ridley Creek and its tributaries has a very fragmented ownership, with many small parcels abutting the creeks. In Delaware County, much of this Natural Heritage Area is within Ridley Creek State Park. The remainder is under a very fragmented ownership including several Homeowners Associations and hundreds of private landowners. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place.
  - Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture. The photos show that agricultural fields abutted wetlands, most of which were grazed, cut for hay or cultivated. Few streams had any tree cover.
  - Roads crisscross the landscape with many roads built along the floodplain of the streams.
- Current:
  - Rapid development converted much of the former agricultural land to suburban development, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the Ridley Creek watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Many wet areas that had been devoid of trees now have considerable tree cover. Unfortunately, many of the areas that now have tree cover are areas that had been open wetlands or wet meadows, which provide critical habitat for a number of species of concern.
  - Exotic Species – The natural disturbance of seasonal flooding in conjunction with reverting agricultural fields creates ideal conditions for many introduced invasive species of plants. Consequently, the creek floodplain is prone to invasion from a large number of invasive species.
    - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to

be a continual and sustained process of monitoring and control efforts.

Conservation Actions:

- Overall:
  - Maintain the riparian corridor and floodplain of Ridley Creek and its tributaries as a linear wetland complex composed of multiple types of wetlands, flowing water, open ponds, swamp forests and wet meadows. Habitat modification by beavers could help to improve the integrity of this Natural Heritage Area by reestablishing the matrix of open and canopied wetland complexes. If beavers expand into this system, they should be left to modify and restore some of the open habitats that previously existed at this site. Beaver numbers are on the rise in Pennsylvania, and it is very possible that they could be documented here in the near future.
- Within the Core Habitat:
  - Long term goals for this Natural Heritage Area should be to reestablish the slow moving marsh systems that dominated this area before modern agricultural practices worked to minimize the areas of lands considered un-cultivatable. Conversion of these wet meadows to drier lands that are more suitable for row crops, involved channelizing these systems to improve drainage and rapidly direct water downstream. Prior to this hydrological modification, light farming and grazing practices were compatible with the species of concern found at this site.
  - All of the species of concern that have been lost from this Natural Heritage Area would benefit from the habitat restoration under the management recommendations provided below. Some key general activities that should be considered within this area include:
    - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Ridley Creek, its tributaries, springs and wetlands. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
    - Forested and open wetlands each require special consideration to maintain their unique attributes. Existing wet meadows should not be modified (i.e. dammed, planted in trees or farmed), as this will deprive the open wetlands adapted species of suitable habitat. Light grazing with pastoral animals can be an effective tool to maintain these soggy meadows in their preferred condition. Once the open habitat within the historic floodplain has been restored, light grazing, often considered compatible with high financial yield organic meat and dairy production, could be an effective tool to maintaining the habitat for all wet meadow species.
    - Ironically, the conversion of wetlands for production of row crops limited the consistent water supplies used for irrigation, livestock watering, and farm fire protection. To compensate for the loss of wetlands, farm ponds were created to provide a consistent supply of water for farming uses. Many of these farm ponds were built where drainage was poor, often on top of existing springs, seeps, and other natural wetlands. These natural wetlands were replaced with highly modified deep, steep sided ponds, which serve little to no use for wildlife. Creation of additional farm ponds should be discouraged to maintain the existing hydrology within the Natural Heritage Area. Additionally, as the existing farm ponds deteriorate and are in need of maintenance, the removal of such ponds should be encouraged, in order to recreate the natural flows of the landscape.
    - Because the species of concern noted from this site rely upon open canopied habitats, programs that support establishment of riparian buffers with trees, such as CREP, should be avoided in areas close to the streams. Instead, these programs may be better suited beyond the historic floodplain of the drainages delineated within this Natural Heritage Area.
  - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and

continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.
- Within the Supporting Landscape:
    - There are numerous landowners that own the property within this Natural Heritage Area. Pursue conservation easements, fee simple acquisition and other programs that may restore the wetlands on the largest parcels along the branches of Ridley Creek and its tributaries to help conserve and improve its effectiveness as a natural corridor.
    - Avoid subdivision of large parcels as this would likely impede broad conservation initiatives. Agricultural zoning is compatible with this Natural Heritage Area.
    - Adjacent parcels currently in agriculture that are of high quality agricultural soils should be zoned agricultural and considered fully built out. Poorer quality agricultural soils should be encouraged to regenerate into natural vegetation cover.
    - Growth should be discouraged within the core or supporting landscape identified for this Natural Heritage Area.
    - Reestablishment of the wide floodplains, and wet meadows would serve as an effective buffer to flooding that may occur downstream.
    - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
    - Streams through forested areas should be considered high priority for conservation. Streams through non-forested areas should be restored with native trees, shrubs and wetland plants as appropriate to the topography and hydrology.
        - Careful determination is needed to avoid planting trees in floodplains that should remain as herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
            - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
            - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
            - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.



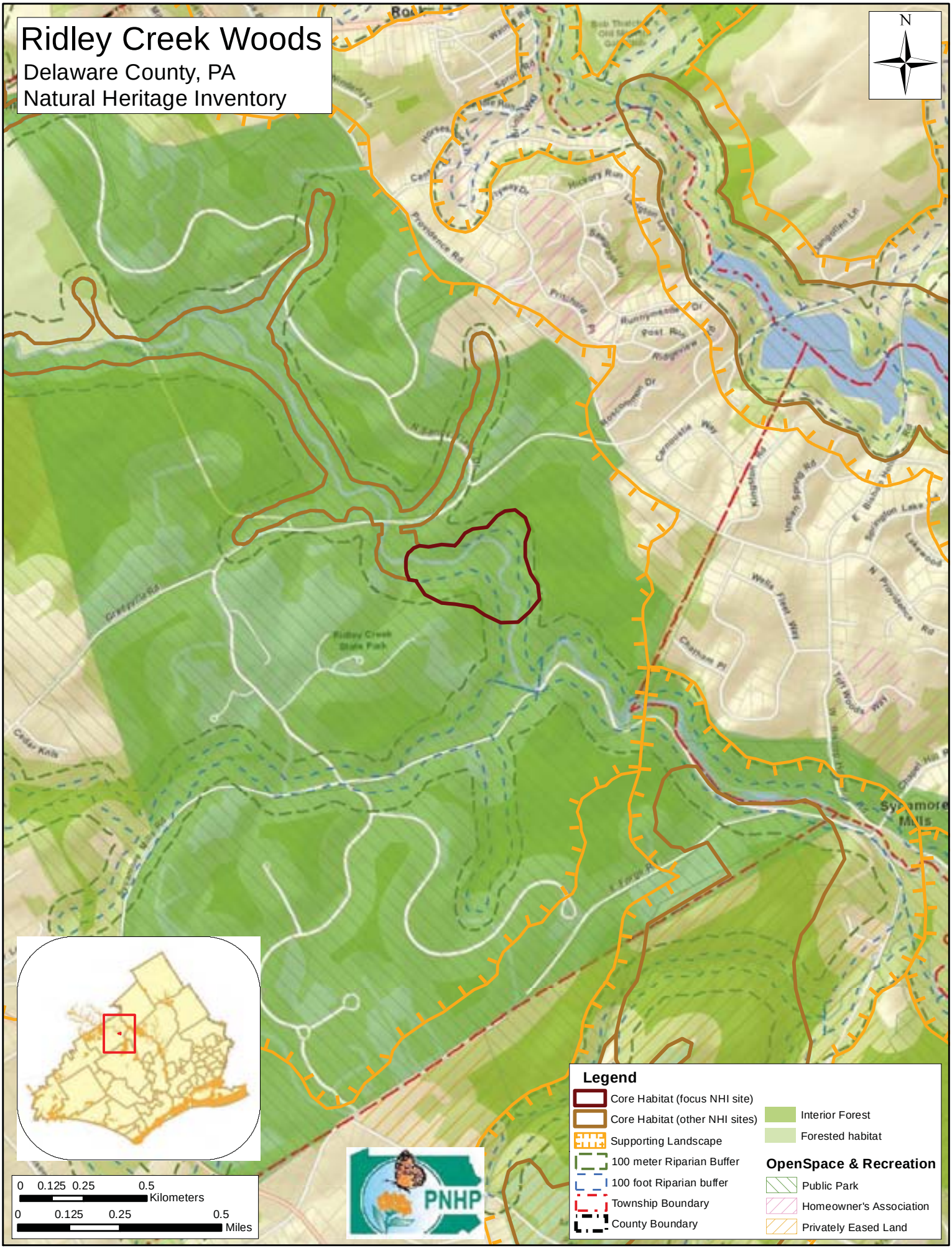
Photo: Andrew Strassman

Skunk cabbage seep

Ridley Creek Woods

Delaware County, PA

Natural Heritage Inventory



Ridley Creek Woods – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	2008	CD

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This area includes forested slopes on either side of Ridley Creek within Ridley Creek State Park.

- Municipalities:
  - Edgmont Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Wooded areas along Ridley Creek includes interior forest habitat interrupted by Ridley Creek. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs within this forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- The forest canopy is dominated by American beech (*Fagus grandifolia*), northern red, black and white oaks (*Quercus rubra, Q. velutina, Q. alba*), tuliptree (*Liriodendron tulipifera*), and white ash (*Fraxinus americana*). The herbaceous understory has a characteristic rich woodland wildflower assemblage including yellow trout lily (*Erythronium americanum*), blue cohosh (*Caulophyllum thalictroides*), maidenhair fern (*Adiantum pedatum*) and ramps (*Allium tricoccum*).

Ownership:

- The small area depicted as this Natural Heritage Area is completely within Ridley Creek State Park.

Habitat Disturbances:

- Historic:
  - The original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture. The patch of forest within this Natural Heritage Area was forested during the 1937 aerial photo session. Though the forest was likely cut for fuel wood and timber several times since colonial times, individual trees have likely been standing for 100-200 years.
- Current:
  - Much of the agricultural land in the surrounding area is currently in the long process of reverting from past agricultural uses.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – Unknown.
  - The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the affect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Allow the forested habitats to achieve and maintain old growth conditions. Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Conserve and expand the forested riparian buffers of Ridley Creek and its tributaries. Establish at least a 100 foot buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Ridley Creek, its tributaries, springs and wetlands.
- The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered

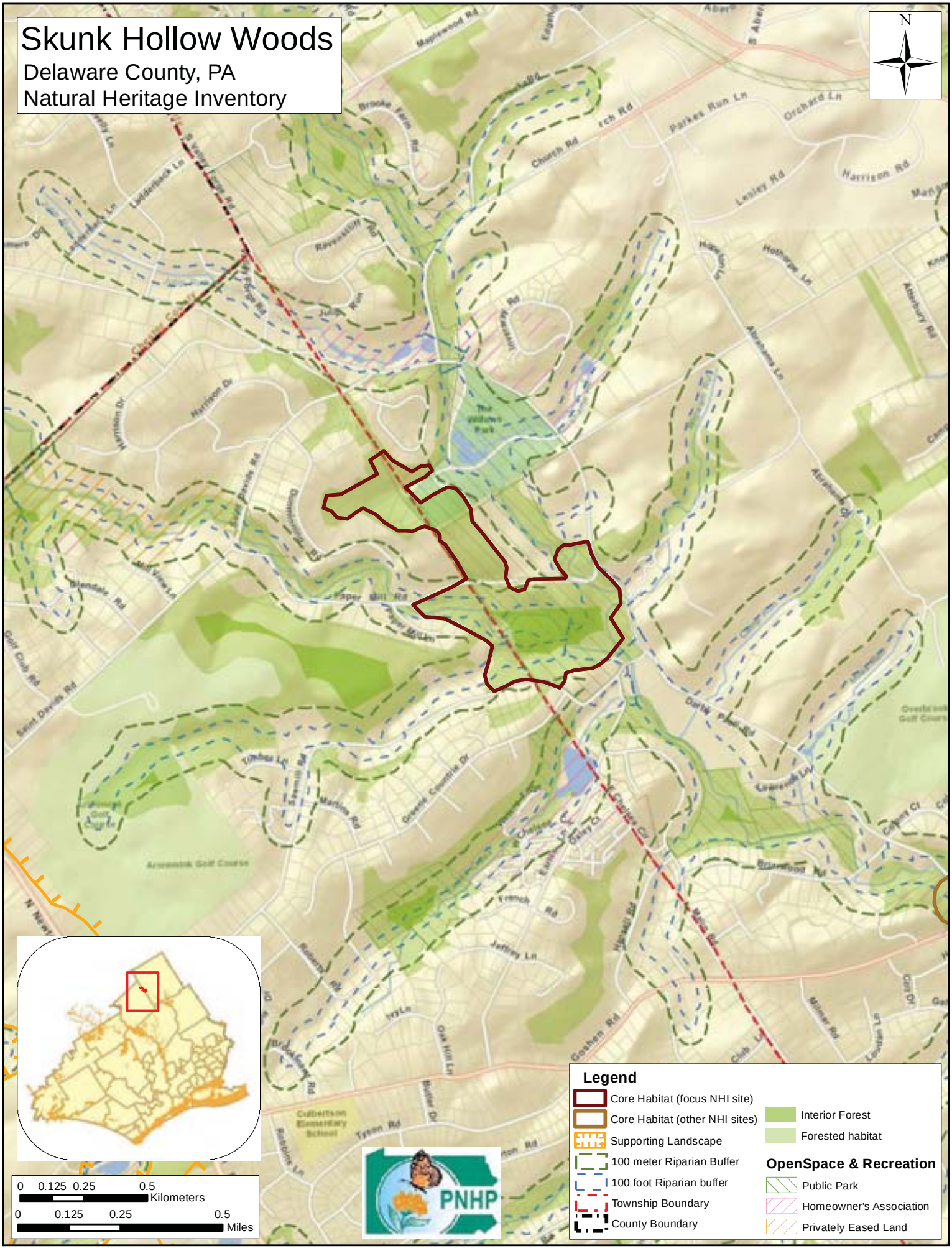
flow into the creek.

- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate of removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

Skunk Hollow Woods

Delaware County, PA

Natural Heritage Inventory



Skunk Hollow Woods – *Local significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Puttyroot (*Aplectrum hyemale*)	P	G5	S3	PR (PR)	1985	F

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location:
- Municipalities:
  - Newtown Township
  - Radnor Township
- USGS Quadrangles:
  - Valley Forge Quadrangle
- Watersheds:
  - Darby Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP522" (Valley Forge Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Forested slopes and riparian habitat along Darby Creek contains some patches of relatively mature trees and roughly 13 acres of interior forest, which is forested habitat at least 100 meters away from any fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds.

Species of Concern Considerations:

- Puttyroot, a plant species of concern, was documented within this mature forested area in the mid-1980's. Its preferred habitat is moist deciduous forests. Several subsequent surveys for this population failed to find the species of concern, though the plant may persist within these woods. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation of the forested habitat. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.



photo source: Andrew Strassman, PNHP

Little Darby Creek as it flows through Skunk Hollow Woods on its way to meet Darby Creek. Little Darby Creek is impaired by numerous dams and dam remnants in the park.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing.

Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Palustrine (wetland) communities:
  - Sycamore – (river birch) – box elder floodplain forest

Ownership:

- Much of this patch of forest is owned and maintained by Radnor Township as a public park.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show portions of this forest in a relatively intact condition, surrounded by active agricultural fields. Though the forest was likely cut for fuel wood and timber several times since colonial times, the many of the existing trees have likely been standing for over 100 years. Some portions of the existing forest in Skunk Hollow Park were in active agricultural production at the time of the 1937 aerial photos, but have been allowed to revert to woody vegetation since that time.
- Current:
  - The farms have mostly been converted to smaller residential and commercial lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure. Increased residential development has diminished the available natural habitat at this location.
  - Stormwater runoff from the highly developed upstream communities flows into Darby Creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - The relatively low volume and diversity of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over-browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:
    - tree-of-heaven(*Ailanthus altissima*)
    - garlic-mustard *(Alliaria petiolata)*
    - Japanese barberry (*Berberis thunbergii*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - burning bush (*Euonymus alatus*)
    - Dame's rocket (*Hesperis matronalis*)

- privet (*Ligustrum* spp.)
- Japanese honeysuckle *(Lonicera japonica)*
- amur honeysuckle *(Lonicera maackii)*
- Japanese stiltgrass *(Microstegium vimineum)*
- pachysandra (*Pachysandra terminalis*)
- common reed *(Phragmites australis)*
- lesser celandine (*Ranunculus ficaria*)
- multiflora rose *(Rosa multiflora)*
- linden viburnum (*Viburnum dilatatum*)

Conservation Actions:

- Overall:
  - Allow the forested habitats to achieve and maintain old growth conditions.
- Within the Core Habitat:
  - Avoid fragmenting the existing forested areas with additional buildings or infrastructure. Avoid logging in this area except as it relates to invasive species removal. The forest cover should be allowed to achieve and maintain old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
  - Conserve and expand the forested riparian buffers of Darby Creek and its tributaries. Establish at least a 100 foot buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
  - Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Darby Creek, its tributaries, springs and wetlands. This may require that road crossings involve bridge systems that would preserve the wide sluggish waters associated with marshes and slow flowing waterways.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.


photo source: Andrew Strassman, PNHP

One of the numerous dams along Little Darby Creek in Skunk Hollow Woods.

  - Remove invasive species of plants. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. The creek floodplain and edge habitats associated with residences and reverting agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort.
    - Target pioneer populations of invasive plants for immediate and continued removal, particularly. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Continual invasive species monitoring and control will be necessary.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.


Springton Reservoir
Delaware County, PA
Natural Heritage Inventory
N
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.5 1 2 Kilometers
0 0.5 1 2 Miles
PNHP

Springton Reservoir – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	2009	E
Sensitive species of concern[3]	---	---	---	---	2011	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: The Springton Reservoir occurs on Crum Creek and is roughly bounded on the east by Route 252, on the south by Providence Road and on the north by Gradyville Road.

- Municipalities:
  - Marple Township
  - Newtown Township
  - Upper Providence Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Crum Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Springton Reservoir was created in 1931 by impounding Crum Creek. Treated water from this reservoir is a source of drinking water. There is currently a narrow band of forested vegetation around the perimeter of the lake beyond which lies extensive suburban development.

Species of Concern Considerations:

- The core habitat for these sensitive species of concern, which are not named at the request of the jurisdictional agencies overseeing their protection, is both the open water of the reservoir, the adjacent upland forest and the upstream riparian corridors. These sensitive species of concern require abundant food source in the reservoir and tributary streams and breeding areas in the adjacent upland forest. This can be achieved by preserving and improving the water quality of the tributaries to the reservoir and by protecting and expanding the natural vegetation buffer along the reservoir.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- Most of the habitat depicted in the area is the open water of the reservoir.

Ownership:

- The reservoir and the immediate upland habitat are owned by Philadelphia Suburban Water Company. Numerous individual residential lots abut the water company property.

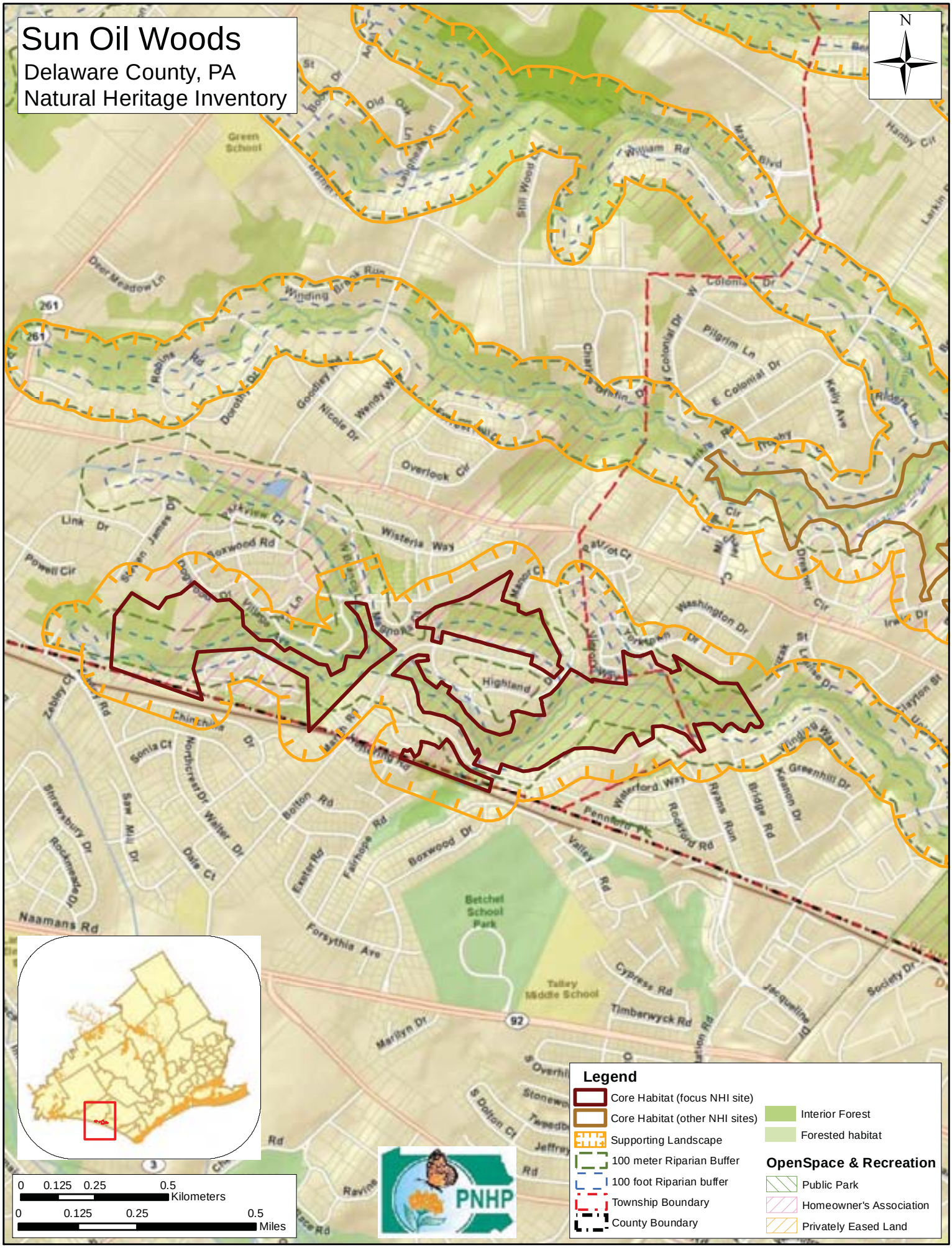
Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place.
  - The Springton Reservoir was created by the damming of Crum Creek in 1931. Aerial photographs from 1937 show the reservoir surrounded by scattered forested woodlots within a landscape dominated by active agriculture.
- Current:
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - Stormwater runoff from the highly developed surrounding communities flows into the reservoir watershed system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – Unknown.
    - Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.
  - The relatively low volume and diversity of understory herbs and shrubs in this forest may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- The sensitive species of concern at this location use the waters of the reservoir, the forested uplands habitat and the riparian areas along the tributary streams, so all these habitats must be considered.
- Protect the natural vegetation along the shore of the reservoir by avoiding additional fragmenting features such as roads, residences and utility rights-of-way around the perimeter of the lake.

- Conserve and expand the forested riparian buffers of Crum Creek and its tributaries. Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat. Establish at least a 100 foot buffer of woody vegetation along the creek and its tributaries to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- Preserve and improve the water quality of Crum Creek to help provide a continued and increased food chain. The stormwater runoff from development should be considered a potential source of significant contamination for the reservoir. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. All tributaries within the adjacent watersheds to this reservoir can help improve water quality by decreasing unfiltered runoff from non-point sources of pollution. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
- Maintain and improve interior forest conditions within the uplands adjacent to the reservoir. Avoid building roads, residences and utility rights-of-way though unfragmented patches of forest. Cluster these amenities in existing locations to avoid unnecessary habitat disturbance.
- Remove invasive species of plants. The reservoir floodplain is naturally susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species along the floodplain will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Continual invasive species monitoring and control will be necessary.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Residents who live adjacent to the Springton Reservoir should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods bordering the reservoir should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.


Sun Oil Woods
Delaware County, PA
Natural Heritage Inventory
N
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP
Green School
Betchel School Park
Talley Middle School
Highland
Wisteria Way
Washington Dr
Naamans Rd
Forsythia Ave
Boxwood Dr
Bolton Rd
Cypress Rd
Timberwyck Rd
Marilyn Dr
Greenhill Dr
Pilgrim Ln
E Colonial Dr
Overlook Cir
Link Dr
Powell Cir
Dorothy Dr
Goodley Rd
Nicole Dr
Wendy Way
Winding Brook Run
Deer Meadow Ln
William Rd
Hanby Cir
Society Dr
Jacqueline Dr
Waterford Way
Rockford Rd
Ryans Run
Bridge Rd
Keanon Dr
Valley Rd
Pennford Pl
Chinchilla Dr
Sonia Ct
Northcrest Dr
Walter Dr
Dale Ct
Saw Mill Dr
Shrewsbury Dr
Rockmeade Dr
Zebley Ct
Stonewood
Jeffrey
Ravine
Rd
261
92
3

Sun Oil Woods – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern [3]	---	---	---	---	2001	D

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: The fragmented habitat along the West Branch Naamans Creek is loosely bounded on the north by Naamans Creek Road, on the east by Meetinghouse Road, on the south by the Pennsylvania / Delaware state line, and on the west by Route 261 (Foulk Road).

- Municipalities:
  - Bethel Township
  - Upper Chichester Township
- USGS Quadrangles:
  - Marcus Hook Quadrangle
- Watersheds:
  - Naamans Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP502, SP505, NC501 - Sun oil Woods" (Marcus Hook Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This fragmented assemblage of forested and open habitats had been considered a relatively good quality Coastal Plain Natural Community in the original 1992 Delaware County Natural Areas Inventory report. In the past 20 years however, residential and commercial development has severely altered and fragmented the landscape, leaving small patches of natural habitat that no longer can be considered a functional distinct natural community although species associated with the habitat still remain.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by fragmentation of the forested habitat, encroachment of invasive species, and over-browsing by deer. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species can help to maintain populations and encourage new population growth. Additional surveys for the species of concern should be conducted to see if the population has survived the recent habitat degradation.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Tuliptree – beech – maple forest
  - modified successional forest*

Ownership:

- Most of the remaining natural habitat is owned by a home-owners association and maintained as ope space.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show a significant forested area in this location within a landscape dominated by active agriculture. Most of this forested habitat was still standing during the 1992 Delaware CNHI survey. Though the forest was likely cut for fuel wood and timber several times since colonial times, much of the existing forest has been standing for over 100 years.
  - A petroleum "tank farm" was constructed on the northwestern portion of the woodlot.
  - A utility corridor was cut east to west through the forested habitat.
  - The area farms were converted to smaller residential lots, fragmenting the landscape with additional buildings, roads and infrastructure.
- Current:
  - Development has steadily increased in the past decade. Much of the primary habitat indicated as hosting species of concern in the original CNHI report has been converted to a residential development, leaving fragments of the former habitat surrounded by houses, lawns, roads and infrastructure. In some cases these habitat fragments can continue to support populations of species of concern, while other habitats are considered destroyed.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - The relatively low volume and diversity of native understory herbs and shrubs in this forest may be attributable to an oversized deer herd.
  - The edge habitat provided by residential development creates conditions favorable for many introduced species of plants. A list of invasive species was not noted at the time of the previous survey, but there are widespread invasive plants in the county that are likely present in the habitat.
  - Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced resulting in aging forest that is not actively regenerating with native species.

Conservation Actions:

- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for forested habitats should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for the species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species.
- Avoid logging in this area except as it relates to invasive species removal and stand improvement. The forest cover should be allowed to approach old-growth characteristics. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.

- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape.
- Conserve and expand the forested riparian buffers of all streams and wetlands. Conserve at least a 100 foot buffer of woody vegetation to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.
- The significant habitats of the area can be strongly affected as a result of nearby land use decisions. Reduce the amount of impervious surfaces in the watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the waterways, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.
- Residents who live adjacent to this area should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - In many cases, their house and yard may occupy formerly highly significant habitats for species of concern. In some cases, species of concern may still persist on their property. Homeowners should consider improving habitat conditions within their property for these species of concern. Permanently or seasonally wet areas of their property are likely areas that can support these species. Reduce the area of mowed lawn and cultivated gardens in favor of existing native plants suitable to the coastal plain habitat. Permanent and seasonal wetland habitats should be protected and expanded to reclaim a portion of the habitat lost to recent development.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Local residents should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.


Tinicum Woods
Delaware County, PA
Natural Heritage Inventory
N
Norwood
Prospect Park
Norwood Elementary School
Amosland Park
Delcroft Elementary School
Darby Creek
Industrial Hwy
291
95
Delaware River
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Tinicum Woods – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Southern red oak (*Quercus falcata*)	P	G5	S1	PE (PE)	2009	C
Willow Oak (*Quercus phellos*)	P	G5	S2	PE (PE)	2010	C
Shrubby camphorweed (*Pluchea odorata*)	P	G5	S1	TU (PE)	2010	E

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: These small fragmented woodlots are on the south side of Interstate 95 and north of Route 291 (Governor Printz Boulevard) near Westinghouse Village.

- Municipalities:
  - Tinicum Township
- USGS Quadrangles:
  - Bridgeport Quadrangle
  - Lansdowne Quadrangle
- Watersheds:
  - Darby Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Small patches of forest and open field host species that reflect a coastal plain affinity within a highly developed context.

Species of Concern Considerations:

- Southern red oak and willow oak are tree species of concern that occasionally occur in the seasonally wet forested habitats and bottomlands in this area. Closely associated with the Atlantic coastal plain habitat, naturally occurring populations of these species are typically restricted to the extreme southeastern counties in Pennsylvania. Known populations of these tree species are threatened by habitat loss, disruptions to the site hydrology, habitat degradation by invasive species of plants, and in some locations, over-browsing by deer. Forests may be negatively altered by habitat fragmentation, which can have a drying effect on the habitat and promote invasive species growth. Establish protective buffers around fragmented habitat and remove invasive species to help maintain populations of these tree species of concern and encourage new population growth. Fencing of seedlings and saplings may be necessary to protect future generation of these trees from deer herbivory.
- Shrubby camphorweed is an annual herb that typically grows in natural coastal wetlands, but may also be found in disturbed ground such as damp clearings, openings, ditches and along roads.

Forest Cover / Natural Communities: These small woodlots and open fields are recovering from past clearing and modification, but have a representation of species with coastal plain affinity. The tree canopy in the woodlots is dominated by sweetgum (*Liquidambar styraciflua*), pin oak (*Quercus palustris*), southern red oak and willow oak. The open wet fields are dominated by common reed (*Phragmites australis*).

Ownership:

- Much of the available habitat is owned by Tinicum Township and managed as public open space.

Habitat Disturbances:

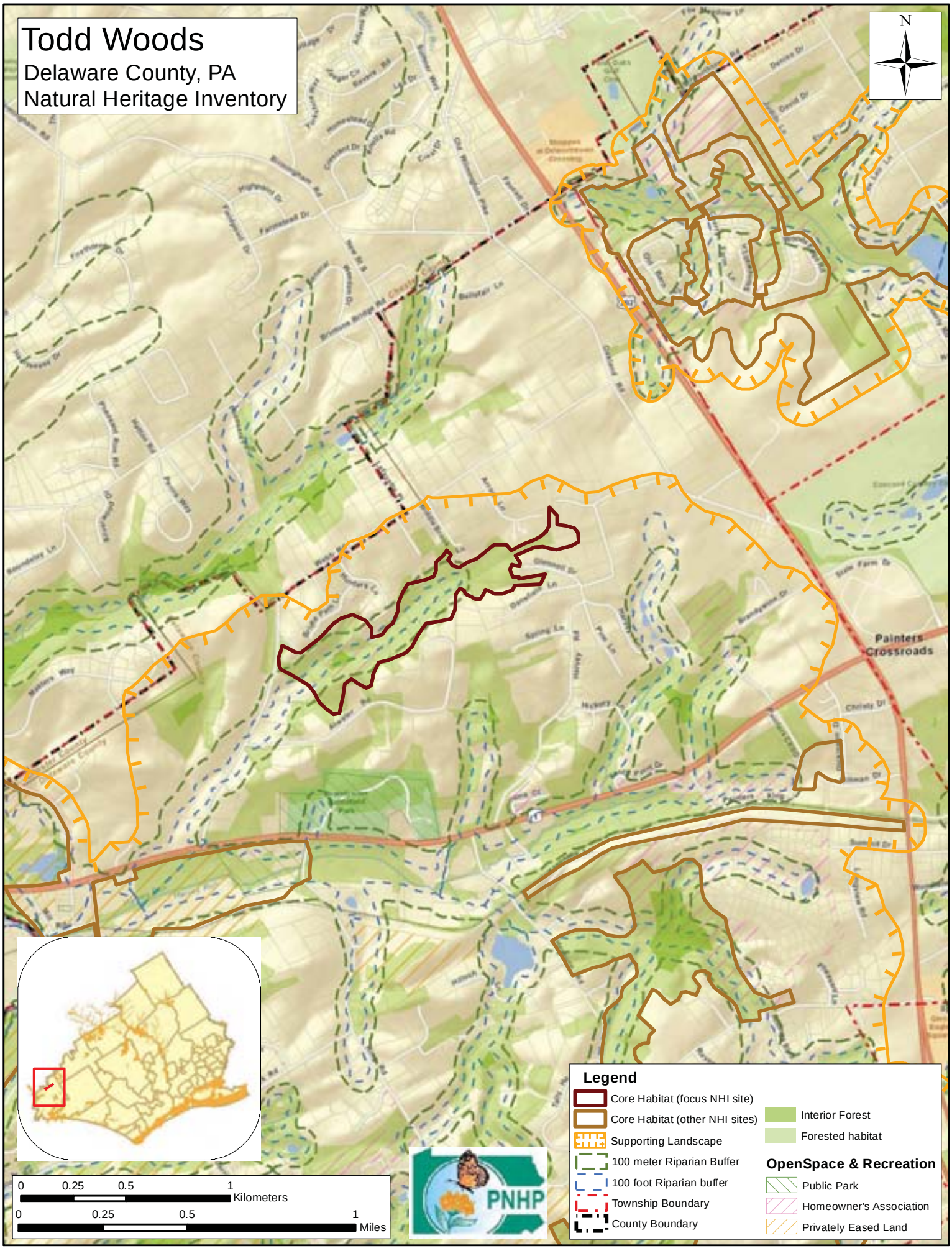
- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots and open space within a landscape dominated by residential and industrial development.
  - Interstate 95 was constructed through the lower edge Tinicum Marsh (John Heinz National Wildlife Refuge.
- Current:
  - Much of the area remains as it was at the time of the 1937 aerial photos, with scattered small woodlots surrounded by industrial and residential development.
  - Stormwater runoff from the highly developed surrounding communities flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. The open habitats that support shrubby camphorweed are dominated by the invasive species common reed.
  - The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Over browsing by white-tailed deer is a serious threat to the overall understory plant diversity.

Conservation Actions:

- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for forested habitats should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for several populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species.
- Because shrubby camphorweed relies on open canopied habitats, removal of woody shrubs and invasive species in early successional habitats such as open fields, pipeline/powerline rights-of-way, and roadsides will to be necessary to maintain habitat for the open habitat adapted plant species. Mowing of these habitats every other year in early spring can help maintain the early successional conditions favorable for this plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and its habitat.
- Preserve and expand permanent and seasonal wetlands. The natural hydrology should be maintained and restored. Wet habitats should be thoroughly surveyed for remnant populations of species of concern and other coastal plain affinity species. Remove invasive species to allow native species to expand their populations. Establish vegetated buffers around wet and moist habitats to help protect the water quality entering the system.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape.
- Conserve and expand the forested riparian buffers of all streams and wetlands. Conserve at least

a 100 meter (328 feet) buffer of woody vegetation where it exists along the waterways and establish at least a 100 foot buffer where it is lacking to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.

- The significant habitats of the area can be strongly affected as a result of nearby land use decisions. Reduce the amount of impervious surfaces in the watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the waterways, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.
- Residents who live adjacent to this area should be informed and continually reminded of the effects their everyday actions have on the natural habitat that adjoins or overlaps their property.
    - In many cases, their house and yard may occupy formerly highly significant habitats for species of concern. In some cases, species of concern may still persist on their property. Homeowners should consider improving habitat conditions within their property for these species of concern. Permanently or seasonally wet areas of their property are likely areas that can support these species. Reduce the area of mowed lawn and cultivated gardens in favor of existing native plants suitable to the coastal plain habitat. Permanent and seasonal wetland habitats should be protected and expanded to reclaim a portion of the habitat lost to recent development.
    - Individual households can be a significant source of pesticide, herbicide, nutrient and other chemical runoff entering the streams and creeks. Neighbors of the woods should be encouraged to minimize the use of yard chemicals and watering by using native species of plants that are already adapted to the local growing conditions. Native plants in the yard can help increase the available habitat for native plants and animals, especially native birds and insect pollinators.
    - Municipal sewage systems may need to be upgraded to help improve water quality.
    - Yard waste dumped into or near natural areas can be a significant source of invasive species of plants.
    - Domestic pets (cats and dogs) can take a significant toll on native animals. Pets should be kept indoors, on leashes or within enclosed yards.
    - Ruts created by trail bikes can fragment the landscape, damage understory vegetation and disrupt wildlife. Off-trail pathways cut through the woods by trail bikers should be blocked and the use of trail bikes discouraged or prohibited.
    - Excessive outdoor lighting can affect the quality of the natural habitat for native animals. Street and residential lighting should have shielding to direct lights downward. Unnecessary outdoor lighting should be minimized or eliminated.


Todd Woods
Delaware County, PA
Natural Heritage Inventory
N
Painters Crossroads
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.25 0.5 1 Kilometers
0 0.25 0.5 1 Miles
PNHP

Todd Woods – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Sensitive species of concern[3]	---	---	---	---	1991	C

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: Wooded riparian corridor along Harvey Run from its headwater seepages to Web Road; between Web Road on the north and Atwater Road on the south.

- Municipalities:
  - Chadds Ford Township
- USGS Quadrangles:
  - West Chester Quadrangle
- Watersheds:
  - Brandywine Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP549"- (West Chester Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: Mature forest cloaks a narrow valley along Harvey Run. The headwaters of Harvey Run are dotted by several residences, but as the stream flows southwest towards Web Road the steep, narrow ravine hosts a mature forested canopy that provides habitat for a plant species of concern as well as provides an essential link in the green infrastructure in this part of the county. This habitat has not been ground surveyed since the original CNHI report, so this description is based on observations from that period. Luckily, there appears to have been little change to the overall canopy structure or size of the wooded area, although negative changes to the understory from deer pressure and invasive species of plants are likely to have occurred.

Species of Concern Considerations:

- A sensitive species of concern, which is not named at the request of the jurisdictional agency overseeing its protection, occurs in several locations within this mature forested area. Its preferred habitat is moist deciduous forests and stream banks. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Red oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- The woodland cloaking the steep north-facing slope consists of a 75-foot tall closed canopy of beech (*Fagus grandifolia*), tulip tree (*Liriodendron tulipifera*), and red oak (*Quercus rubra*) with an understory of beech and flowering dogwood (*Cornus florida*). The patchy shrub layer contains witch

hazel (*Hamamelis virginiana*), maple-leaf viburnum (*Viburnum acerifolium*), and spicebush (*Lindera benzoin*). The diverse herb layer includes mayapple (*Podophyllum peltatum*), Virginia spring beauty (*Claytonia virginica*), perfoliate bellwort (*Uvularia perfoliata*), Christmas fern (*Polystichum acrostichoides*), grape fern (*Botrychium* sp.), rue-anemone (*Thalictrum thalictroides*), jack-in-the-pulpit (*Arisaema triphyllum*), smooth yellow violet (*Viola pensylvanica*), cut-leaved toothwort (*Cardamine concatenata*), Indian cucumber root (*Medeola virginiana*), black snakeroot (*Actaea racemosa*), partridgeberry (*Mitchella repens*), yellow trout-lily (*Erythronium americanum*), bloodroot (*Sanguinaria canadensis*), and dwarf ginseng (*Panax trifolius*).

Ownership:

- The forested ravine is owned by numerous landowners, each of which may have a different view on the future use or role of their portion of the ravine. A significant patch is owned by the Fox Hollow Homeowners Association. Fragmentation of ownership of larger landscapes can make consistent conservation action more difficult, but not impossible to achieve.

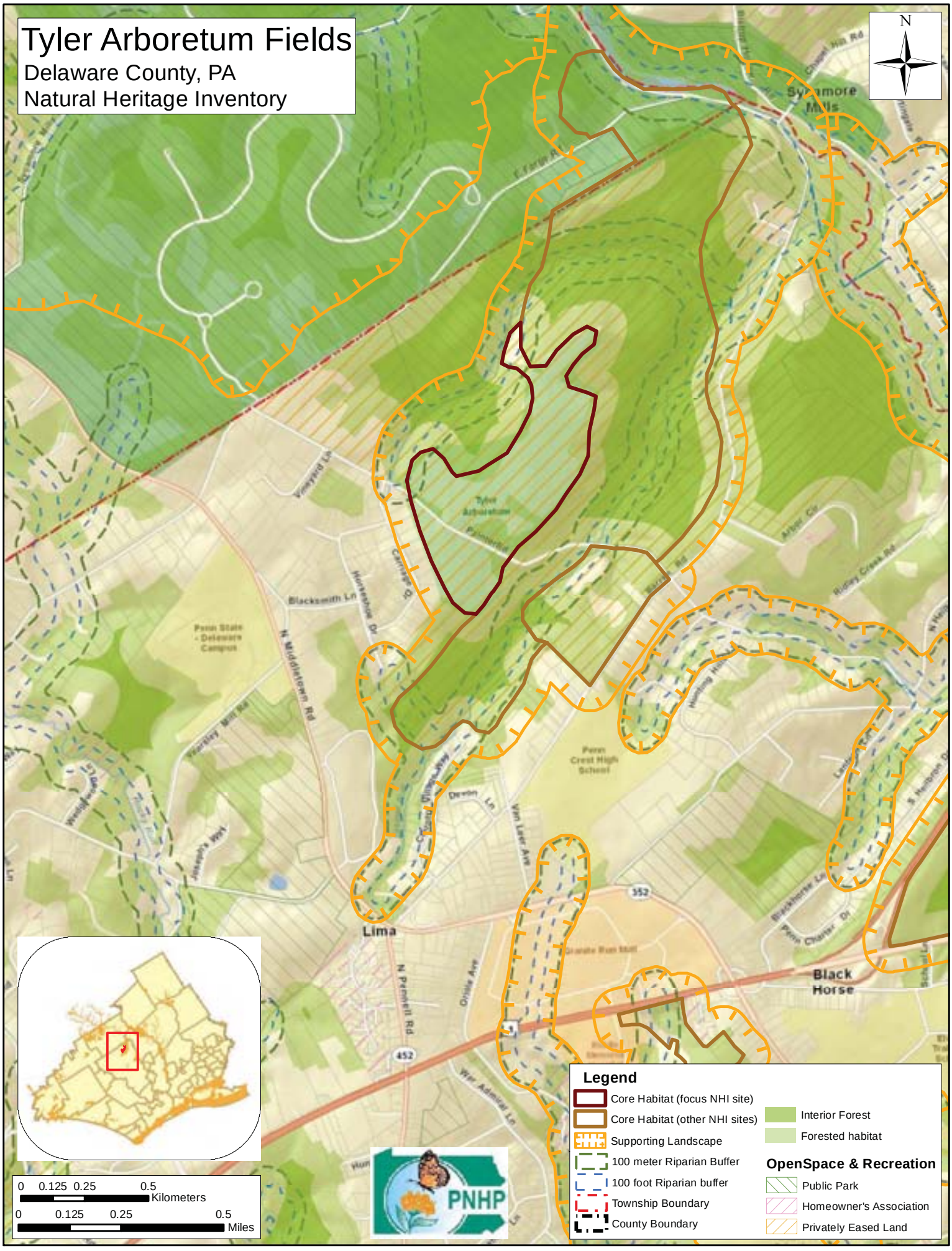
Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 however, show this forested ravine in a relatively intact condition, surrounded by active agricultural fields. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has likely been standing for over 100 years. Most of the headwaters area of Harvey Run was in active agricultural production in 1937aerial photos and some of it has been allowed to revert to woody vegetation since that time.
- Current:
  - The large farms have mostly been converted to smaller residential lots within this area, fragmenting the landscape with additional buildings, roads and infrastructure.
  - The headwaters area that had been in agricultural production is now divided among several suburban homeowners.
  - Stormwater runoff from some portions of the surrounding communities flows into the creek system with little opportunity to be filtered, a potentially significant non-point source of pollution.
  - The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd.
  - Dumping of garden refuse into the ravine can spread invasive species of plants.
- Exotic Species:
  - The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Species observed during previous surveys include:
    - garlic mustard (*Alliaria petiolata*)
    - Asiatic bittersweet (*Celastrus orbiculatus*)
    - wineberry (*Rubus phoenicolasius*)

Conservation Actions:

- Overall:
  - Work with adjacent landowners to achieve a consensus approach to the conservation of the forested ravine.
  - Conserve and expand the forested riparian buffers of Harvey Run. Establish at least a 100 meter (328 feet) buffer of woody vegetation along the creek to help reduce erosion, sedimentation, and pollution. Additionally, best management practices (BMPs) that focus on limiting the introduction of non-point sources of pollution into surface and groundwater should be applied to the surrounding area.

- Within the Core Habitat:
  - The upper part of the valley where Harvey Run is most deeply incised is in very good shape and should be maintained in an undisturbed condition. Work with the numerous adjacent landowners to preserve the wooded ravine in its current intact condition. Limit residential encroachment on the forested ravine and degradation of the habitat by garden refuse dumping.
  - Expand the forested riparian buffer towards the headwaters of Harvey Run. The recharge area of Harvey Run is largely unvegetated and would benefit from additional tree cover.
  - The stormwater runoff from development and agriculture should be considered a potential source of significant contamination for the creek and its floodplain habitat. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to decrease the unfiltered flow into the creek.
  - Remove invasive species of plants.
  - Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Potential Restoration Activities:
    - Streams through forested areas should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
      - Careful determination is needed to avoid planting trees in floodplains that contain herbaceous wetland habitats. These habitats should be maintained in their current open condition, with tree plantings to occur at the periphery of natural wetland openings.
      - Riparian Buffers:
        - An ideal vegetated stream buffer should be at least 100 meters (328 feet) in width from the edge of the 100-year floodplain.
        - An intermediate vegetated stream buffer should be at least 100 feet in width from the edge of the 100-year floodplain.
        - A minimum vegetated buffer should be at least 35 feet in width from the edge of the 100-year floodplain.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
      - Target pioneer populations of invasive plants for immediate and continued removal, particularly tree-of-heaven, non-native bush honeysuckles, Japanese honeysuckle, multiflora rose and common privet. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
      - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
      - Continual invasive species monitoring and control will be necessary.


Tyler Arboretum Fields
Delaware County, PA
Natural Heritage Inventory
N
Lima
Black Horse
Legend
Core Habitat (focus NHI site)
Core Habitat (other NHI sites)
Supporting Landscape
100 meter Riparian Buffer
100 foot Riparian buffer
Township Boundary
County Boundary
Interior Forest
Forested habitat
OpenSpace & Recreation
Public Park
Homeowner's Association
Privately Eased Land
0 0.125 0.25 0.5 Kilometers
0 0.125 0.25 0.5 Miles
PNHP

Tyler Arboretum Fields – *Notable significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Nuttall's tick-trefoil (*Desmodium nuttallii*)	P	G5	S2	TU (TU)	1991	B

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This small open area is a part of Tyler Arboretum.
- Municipalities:
  - Middletown Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - None
- 1998 Delaware County Natural Areas Inventory Update reference:
  - None

Description: This Natural Heritage Area is defined as the early successional open meadow habitat maintained by a periodic mowing regime.

Species of Concern Considerations:
- Nuttall's tick-trefoil grows on relatively dry conditions on open slopes and banks and in clearings, fields, thickets, and open woods. The viability of populations of Nuttall's tick-trefoil may require maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to maintain the proper successional stage and ecological conditions for this species to thrive.

Forest Cover / Natural Communities: This Natural Heritage Area is defined as the early successional open meadow habitat maintained by a periodic mowing regime.

Ownership:
- This early successional meadow habitat is owned by Tyler Arboretum. Single ownership of this habitat will be conducive to implementation of consistent conservation action.

Habitat Disturbances:
- Historic:
  - Most of the original forest cover of the surrounding area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered forested woodlots within a landscape dominated by active agriculture.
- Current:
  - This open meadow has persisted in this state through active management since the 1937 air photos were taken.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants.

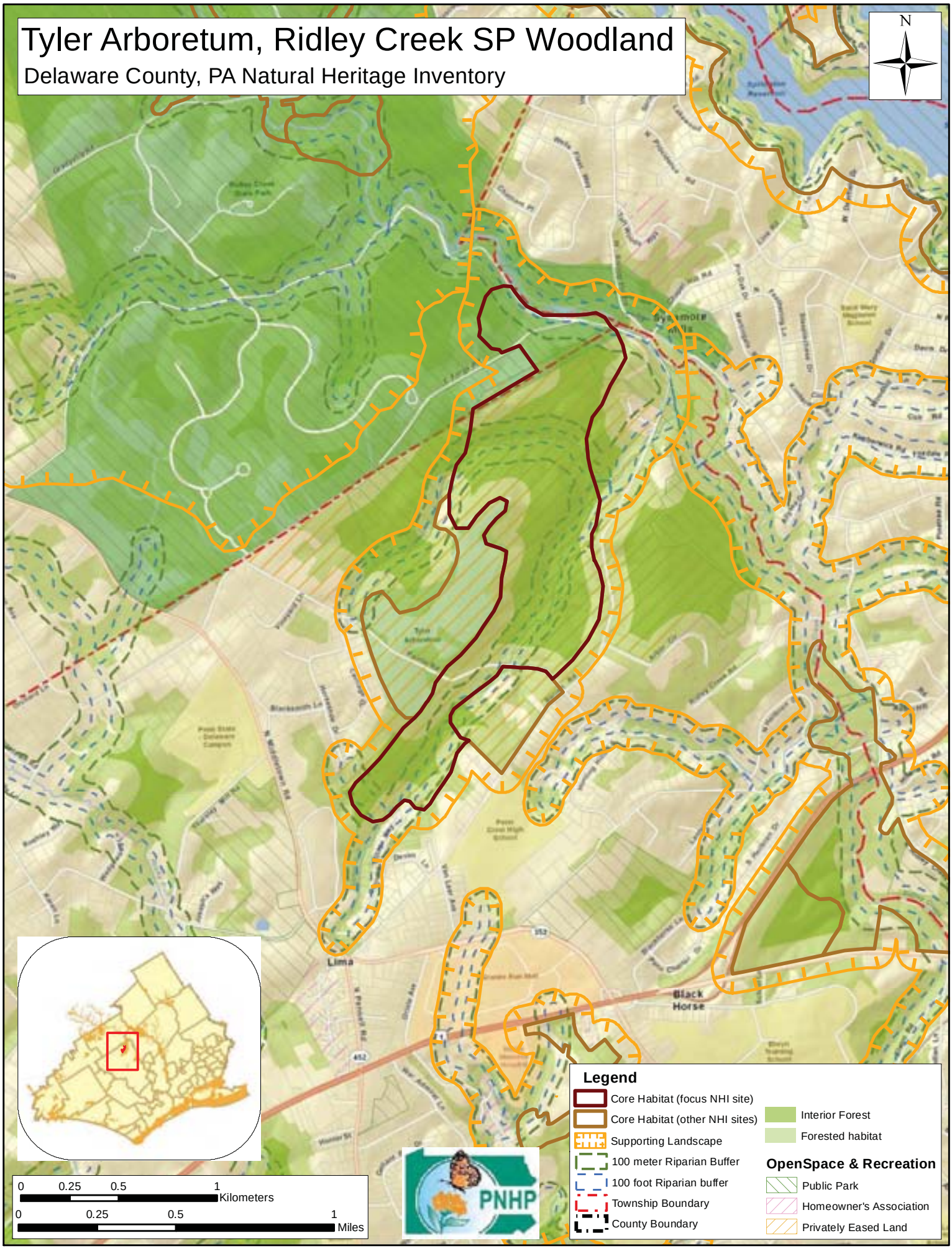
- Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

Conservation Actions:

- Maintain early successional habitats where they currently exist by periodically removing woody vegetation and invasive plant species. Because Nuttall's tick-trefoil relies on open canopied habitats, removal of woody shrubs will be necessary to maintain habitat for the open-habitat adapted plant species. Periodic mowing of the open meadow every other year in early spring can help maintain the early successional conditions favorable for these plant species of concern. Mowing more frequently or broadcast herbicide spraying can have a severely negative impact on the plant species of concern and its habitat.
- Remove invasive species of plants. Aggressive invasive species can have a significant impact on the available habitat for the species of concern. Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present. Edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
    - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
    - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
    - Continual invasive species monitoring and control will be necessary.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.

Tyler Arboretum, Ridley Creek SP Woodland

Delaware County, PA Natural Heritage Inventory



Tyler Arboretum, Ridley Creek SP Woodland – *High significance*

Species of Concern:	Taxa[1]	PNDI Rank[2] Global	PNDI Rank[2] State	Legal Status[2] State (Proposed)	Last Seen	Quality[2]
Puttyroot (*Aplectrum hyemale*)	P	G5	S3	PR (PR)	2007	B
Netted chainfern (*Woodwardia areolata*)	P	G5	S2	N (PT)	2009	B
Sensitive species of concern[3]	---	---	---	---	1984	D
Sensitive species of concern[3]	---	---	---	---	2009	B
Sensitive species of concern[3]	---	---	---	---	2009	BC

[1] A = Amphibian; B = Bird; C = Community; F = Fish; L = Lepidopteran; O = Odonate; P = Plant; M = Mammal; R= Reptile, U = Unionoid (Mussel)
[2] Please refer to Appendix III for an explanation of PNHP ranks and legal status
[3] This species is not named by request of the jurisdictional agency overseeing its protection

Location: This forested habitat is roughly bounded on the northeast by Ridley Creek, on the southeast by Barren Road, on the southwest by Route 352, and on the northwest by the Tyler Arboretum property line.

- Municipalities:
  - Edgmont Township
  - Middletown Township
- USGS Quadrangles:
  - Media Quadrangle
- Watersheds:
  - Ridley Creek
- 1992 Delaware County Natural Areas Inventory reference:
  - "SP532, SP543 & SP553" (Media Quadrangle)
- 1998 Delaware County Natural Areas Inventory Update reference:
  - none

Description: This large forested habitat includes the steep slopes flanking a short section of Ridley Creek, and much of Dismal Run and its tributary seeps and springs. The habitat is fairly mature second growth forest with humus rich soil and a lush growth of spring wildflowers. Forested habitats include several significant patches of interior forest, which is forested habitat at least 100 meters away from any fragmenting feature such as roads, powerlines, residences or open fields. Interior forest is critical nesting habitat for many of Pennsylvania's neotropical migrant songbirds. This area combines two sites from the original 1992 CNHI report "SP542, SP532" and "SP543" into this enlarged area that hosts scattered populations of several species of concern.

Species of Concern Considerations:

- Puttyroot is a wildflower in the orchid family that grows in several locations within this Natural Heritage Area in humus-rich soil under a canopy of mature tuliptree, beech and oak. The known populations of puttyroot are threatened by habitat loss, invasive species and excessive browsing by deer. Maintain the unbroken forest canopy and remove invasive species of plants to help secure these plant populations.
- The moist, forested streambanks and seeps in this habitat support netted chainfern. The viability of populations of this species and its habitat can be enhanced by establishing buffers around wetlands, protecting forested riparian buffers, controlling invasive species and protecting the natural hydrology of the area.
- Three additional sensitive species of concern, which are not named at the request of the jurisdictional

agencies overseeing their protection, also occur within this moist forested habitat. These high quality woodlands may be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth. Maintain the unbroken forest canopy and remove invasive species of plants to help secure these species populations.

Forest Cover / Natural Communities: The plant community types depicted are approximations delineated from 2005 aerial photography interpretation and were followed up with minimal selective ground-truthing. Community types follow "Terrestrial & Palustrine Plant Communities of Pennsylvania" (Fike 1999) where appropriate, and otherwise describe general land cover types (*).

- Terrestrial (upland) communities:
  - Dry oak – mixed hardwood forest
  - Tuliptree – beech – maple forest
  - modified successional forest*
- The forest contains areas of rich woodland slope dominated by mature tulip tree (*Liriodendron tulipifera*), oak (*Quercus* spp.), and beech (*Fagus grandifolia*) with a shrub layer of spicebush (*Lindera benzoin*). Abundant spring wildflowers include wild leek (*Allium tricoccum*), cut-leaved toothwort (*Cardamine concatenata*), Virginia spring beauty (*Claytonia virginica*), bloodroot (*Sanguinaria canadense*), yellow trout-lily (*Erythronium americanum*), cleavers (*Galium aparine*), rue-anemone (*Thalictrum thalictroides*), mayapple (*Podophyllum peltatum*), dwarf ginseng (*Panax trifolius*), and blue cohosh (*Caulophyllum thalictroides*).
- Some of the forest patches are in the long process of reverting from past agricultural uses, while other patches exhibit a much more undisturbed and pristine quality.

Ownership:

- This forested habitat occurs primarily on the Tyler Arboretum property, but also includes a small portion of Ridley Creek State Park. Concentration of ownership of this large piece of the green infrastructure of Delaware County can be tremendously helpful towards implementation of consistent conservation action across this significant piece of the landscape.

Habitat Disturbances:

- Historic:
  - Most of the original forest cover of the area had been removed and converted to agricultural or other uses over the past several centuries, leaving little of the original vegetation in place. Aerial photographs from 1937 show scattered large and small forested woodlots within a landscape dominated by active agriculture. Though the forest was likely cut for fuel wood and timber several times since colonial times, the existing forest has likely been standing for over 100 years.
- Current:
  - The area outlined within this Natural Heritage Area is completely forested, an increase in forested area since the 1937 aerial photos were taken. Much of the former surrounding agricultural area is in the long process of reverting to more natural habitats.
  - Rapid development has occurred outside of and on the periphery of the core habitat area, fragmenting the landscape with additional buildings, roads and infrastructure and increasing the amount of impervious surface and edge habitat in the immediate watershed.
  - The riparian corridor of Dismal Run is currently very well buffered from overland runoff from storm events. Stormwater runoff from the highly developed surrounding communities however, flows into the creek system with little opportunity to be slowed or filtered. This results in increased downstream flooding and erosion and is a potentially significant non-point source of pollution. Runoff from these sources has significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through natural vegetation.
  - Exotic Species – The edge habitat provided by reverting agricultural fields and residential development creates conditions favorable for many introduced species of plants. Some of the primary invasive species occurring in this location include:

- Norway maple *(Acer platanoides)*
- garlic-mustard *(Alliaria petiolata)*
- Japanese barberry (*Berberis thunbergii*)
- Asiatic bittersweet (*Celastrus orbiculatus*)
- autumn olive (*Elaeagnus umbellata*)
- wintercreeper (*Euonymus fortunei)*
- Japanese honeysuckle *(Lonicera japonica)*
- amur honeysuckle *(Lonicera maackii)*
- Japanese stiltgrass *(Microstegium vimineum)*
- mile-a-minute weed *(Persicaria perfoliata)*
- common reed *(Phragmites australis)*
- multiflora rose *(Rosa multiflora)*
- wineberry (*Rubus phoenicolasius*)
- linden viburnum (*Viburnum dilatatum*)

- Control options for invasive plants range from mechanical to chemical. High priority for invasive species control at this site should be targeted towards removing small populations of newly established invasive plants in the most weed-free areas of the Natural Heritage Area. Invasive species control efforts should try to maintain weed-free areas first, and then concentrate on removing invasive species in lightly infested areas, continually pushing back the line of invasion. Invasive species removal should be conducted in coordination with native species replacement to avoid denuding the understory vegetation. This needs to be a continual and sustained process of monitoring and control efforts.

- The relatively low volume of understory herbs and shrubs noted in this forest may be attributable to an oversized deer herd. Overbrowsing by white-tailed deer is a serious threat to the overall understory plant diversity. An overabundance of deer can create the effect of park-like forests in which the understory and vertical stratification is greatly reduced. Removal of understory species eliminates habitat for some nesting songbirds as well as increasing competition between deer and other wildlife due to reduced food sources. Deer have strong, species-specific feeding preferences. The most highly preferred species are the first to decline or disappear when deer numbers are high. Furthermore, deer have been shown to be prolific seed dispersers for many of the most invasive nonnative species. The result is greatly impoverished native species diversity, failure of native tree regeneration, and the rapid proliferation of invasive species. It is likely their selective feeding habits and effective seed dispersal make the spread of invasives much faster than would be the case without deer, even where herds are only moderately oversized.

Conservation Actions:

- Avoid fragmenting the existing forested areas with additional buildings or infrastructure. The primary conservation concern for this habitat should be to focus on safeguarding the quality and expanse of the forested landscape. While providing the primary habitat for the populations of species of concern, the forested landscape also helps to protect water quality of the small streams that drain through this Natural Heritage Area into the Delaware River and provides refuge and habitat for other forest dependent species.
- Allow the forested habitat to achieve and maintain old growth conditions. Avoid logging in this area except as it relates to invasive species removal. Leave fallen trees in place to help provide habitat, soil nutrients, humus and tilth. Trees that have fallen over approved trails can be cut through as necessary.
- Suppress and reverse the establishment and spread of invasive species of plants. Improve the quality of the forest composition by removing aggressive invasive and early successional species of plants in favor of existing native climax species. Enhance the stratification of the canopy by encouraging the establishment of native tree saplings, shrubs, and herbaceous species.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory. This may require erecting deer exclosures coupled with a significant reduction in the deer population to protect these elements of the landscape.

- The forested riparian habitat can be strongly affected as a result of nearby land use decisions. Conservation efforts should focus on protecting and improving the quality of the surface water. Reduce the amount of impervious surfaces in the Crum Creek watershed to diminish the impact of flooding and erosion during storm events. Stormwater runoff through urban and suburban areas can be a significant source of chemical pollutants for the creek, which can severely impact water quality and the food chain of the waterway. The use of herbicides, pesticides and fertilizers in residential developments can also have a significant impact on the water quality at this location. Runoff from these sources have significantly higher levels of sediment, nutrients, pesticides, herbicides and other pollutants than runoff filtered through a natural habitat. Stormwater management measures such as the creation of detention basins or vegetated swales should be implemented to slow and capture water flow in these expanses of urban and cultivated landscapes.
- Restore and protect the hydrology of the landscape. Avoid altering the hydrology of Dismal Run, its tributaries, springs and wetlands.
- Remove invasive species of plants.
- Reduce the deer density in the area. Uncommon species of native plants are particularly susceptible to deer herbivory.
- Potential Restoration Activities:
    - Streams through forested areas such as this should be considered high priority for conservation. The forested riparian corridor helps to regulate the temperature of the stream and creates streamside conditions that contribute to improved water quality and aquatic habitat. Streams through non-forested areas should be restored with native trees and shrubs appropriate to the habitat.
    - Former agricultural fields that have been allowed to revert to woody vegetation may require selective management to speed the succession process. Remove weedy woody species and favor native climax community species. Use the higher quality adjacent forests in similar topographic and geologic settings as natural community reference examples and mimic the forest composition. Use local native seed sources and root stock whenever possible in restoration efforts.
    - Remove invasive species of plants. The creek floodplain and edge habitats associated with agricultural fields are particularly susceptible to weedy plant invasion and will require a sustained and targeted approach to invasive management. Aggressive invasive species along the powerline rights-of-way can have a significant impact on the available habitat for the species of concern. Control of invasive species in the area will require extensive and continual effort. Focus non-chemical control efforts on selected areas surrounding species of concern.
        - Target pioneer populations of invasive plants for immediate and continued removal. It is much easier and more effective to keep a place invasive-free than to try and repair a heavily infested habitat.
        - Invasive species management needs to be coordinated by individuals familiar with the rare species as well as the invasive species present.
        - Continual invasive species monitoring and control will be necessary.

CONCLUSIONS AND RECOMMENDATIONS

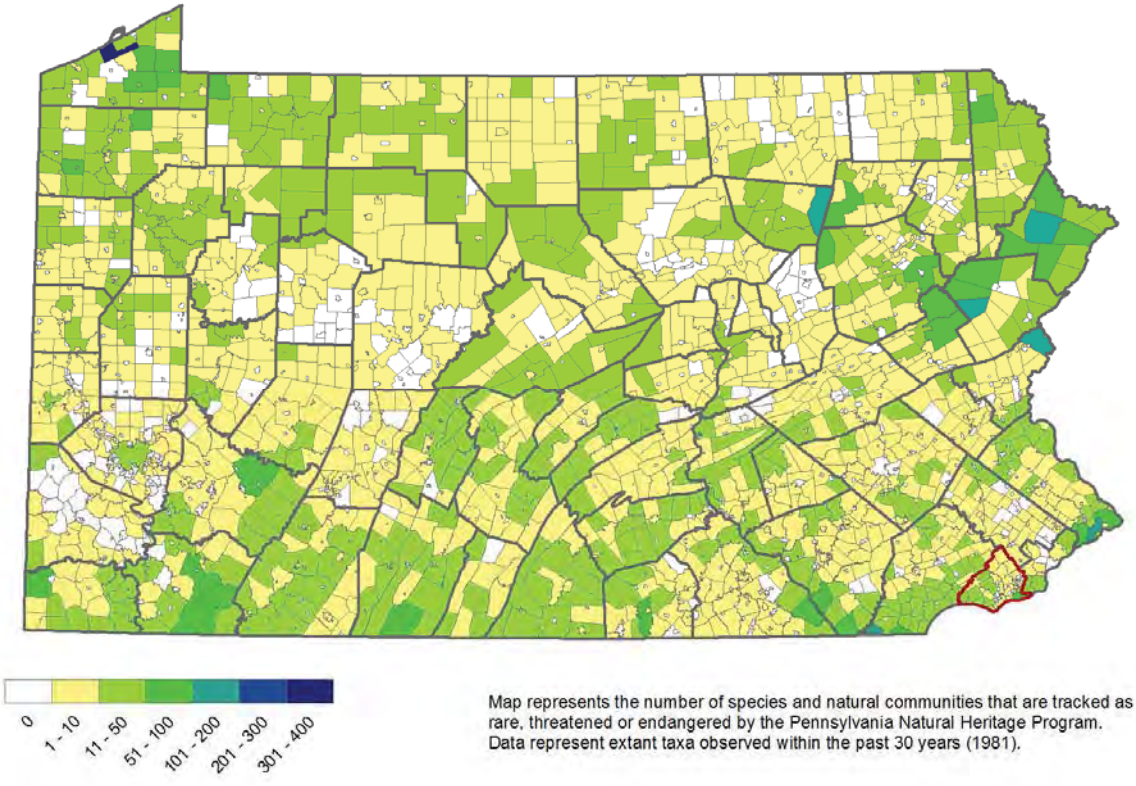
Discussion and General Recommendations

For this County Natural Heritage Inventory Report, the ecologists, zoologists, and botanists of the Pennsylvania Natural Heritage Program and partner organizations have explored the natural resources of Delaware County. This work represents an organized effort to inventory the biodiversity present throughout the County. Earlier survey work in this area was completed by botanists and other naturalists over the past several centuries. Records from these early explorers provided the baseline for this report.

Delaware County's contribution to biodiversity in Pennsylvania

Delaware County has 215 individual occurrences of species tracked by PNHP, including those listed as endangered, threatened, and rare species; it falls 19th out of the Commonwealth's 67 counties. The map below shows the distribution of these species by municipality across the Commonwealth.

Despite extensive land use changes in this heavily developed portion of the state, Delaware County contains a significant number of rare species and communities that represent an important part of the Commonwealth's biodiversity. Two of these, bog turtle, and serpentine aster, are considered globally rare.



Future natural resource research in Delaware County

Though many hours of field research over multiple years were undertaken for this inventory, this is not a comprehensive, final word on Delaware County's natural resources. The data in this report represents a snapshot of Delaware County's natural resources at the time the report was written. Any further work in the County will likely yield additional records of species of concern while future land use changes may result in the extirpation of species documented in this report. This is partially due to the fact that natural systems are dynamic and constantly changing due to natural and human induced pressures. Also, sites were surveyed only when landowner permission was granted and access to some exemplary sites was restricted. Additional

survey efforts are encouraged for these reasons. The PNHP sees this report as a working document – a guide for conservation of known rare, threatened, and endangered species, their habitats, and other resources of conservation importance in Delaware County.

A series of biodiversity and conservation planning services are available through the PNHP to supplement the results of this inventory. Please contact the Pennsylvania Natural Heritage Program for additional information regarding these services (http://www.naturalheritage.state.pa.us/).

A Final Note on Rare, Threatened, and Endangered Species

The rare, threatened, and endangered species highlighted in this report are some of the several hundred species in Pennsylvania that are threatened with extirpation or extinction. If a species becomes extinct, or is lost from a portion of its native range, the ecosystem in which it lived will lose an important element. Often the repercussions of extinctions are not known until the species is gone, and the species is generally irreplaceable in the system. This may be because the habitat has been altered to the point that the biological system no longer functions properly. Species of concern are often indicative of fragile ecosystems that easily degrade; their protection may help monitor the quality of Delaware County's ecosystems. A great example of a species of concern acting as an indicator of environmental quality is the bald eagle - a species which indicated the deleterious effects of the pesticide DDT in our environment. Banning DDT led to the eventual recovery of the species.

Submitting Additional Data

As the state repository for biodiversity data, the Pennsylvania Natural Heritage Program appreciates all potential data regarding rare, threatened, and endangered species and potential survey sites. Species we currently track are listed on our website at: http//www.naturalheritage.state.pa.us/

Another reason for protecting species of concern is for their value as unique genetic resources. Every species may provide significant information for future use in genetic research and medical practices. Beyond these practical considerations, perhaps the most compelling reasons for stewardship are the aesthetic and ethical considerations; there is beauty and recreational value inherent in healthy, species-rich ecosystems.

The protection of rare, threatened, and endangered species depends on several factors, including increasing scientific knowledge and concerted efforts from government agencies, conservation organizations, educational institutions, private organizations, and individuals. The following section outlines general recommendations to begin to protect the species outlined in this report.

Using the Natural Heritage Inventory in the Delaware County Planning Process

One of the main roles of this document is to integrate ecological and conservation information into the planning process. Through early integration, costly conflicts with rare, threatened and endangered species can be avoided and these resources can be protected for future generations. Comprehensive land use planning and its related ordinances can be effective tools for the conservation of Delaware County's biological diversity.

Land use planning establishes guidelines for the kinds of land uses that are suitable in an area and provides a basis for guiding public and private development to benefit communities, the local economy and the environment. Zoning and subdivision ordinances then set out rules that implement the land use plan. Planning, zoning and subdivision ordinances are not only valuable tools for urban and suburban areas where development pressures have already affected the use of open space and the integrity of the natural environment, but also for rural areas where current losses are less pronounced. These areas can apply planning to avoid the haphazard losses of valuable regional resources, while still achieving desirable levels of development. The following is a brief overview on land use tools available in Delaware County as well as a brief commentary of their relevance to the NHI:

- Comprehensive Plan - Delaware County is currently in the process of preparing a comprehensive plan. All of Delaware County's municipalities have individual comprehensive plans, some of which are several years old. The County should integrate information from this report into its new comprehensive plan, specifically in sections that involve development, natural resources, recreation, and open space. Municipalities should also consider integrating this information into their comprehensive plans and future updates.
- Zoning – All of Delaware County's municipalities currently have zoning ordinances. We encourage the integration of Natural Heritage information into their zoning process. Zoning maps can be potentially amended to reflect conservation measures to help preserve Natural Heritage Areas presented in this report.
- Subdivision and Land Development Ordinances (SALDO) – SALDOs can be used as a conservation tool to draw attention to Natural Heritage Inventory information. Many Delaware County municipalities have their own SALDOs, and the County has a new SALDO currently being prepared that will cover municipalities without their own. Both the County and the municipalities should consider incorporating a requirement that any CNHI areas identified in this report to be noted on subdivision and land development plans. The ordinance could also require developers to address potential impacts of their development on the resource/s.

Natural Heritage Areas identified in the County Natural Heritage Inventory reports have been used to form the backbone of many plans for Greenway and Open Space networks in the Commonwealth. After completion of the Greenway the CNHI should be further consulted for site-level planning and trail alignments as it can help decided the best compatibility of the resource with the designated use. Although many of the Natural Heritage Areas outlined in this report will likely be integrated into a greenway plan, additional planning and protection will ensure the viability of the conservation elements present at the site.

Planning for the land use decisions of today and those of the future is an important task and this Natural Heritage Inventory can serve as a useful tool. Pennsylvania Natural Heritage Program staff and expertise are available for additional technical assistance and planning for the conservation of these sites.

General Recommendations

The following are general recommendations for the protection of the Natural Heritage Areas within Delaware County. Approaches to protecting a Natural Heritage Area are wide ranging, and factors such as land ownership, time constraints, and tools and resource availability should be considered when prioritizing protection of these sites. Prioritization works best when incorporated into a long-term county or region-wide plan. Opportunities may arise that do not conform to a plan, and the decision on how to manage or protect a natural heritage area may be made on a site by site basis. Keep in mind that personnel in the Pennsylvania Natural Heritage Program and staff from state natural resource agencies are available to discuss more specific options for preservation. The following are approaches and recommendations for natural heritage area conservation.

1. **Consider conservation initiatives for natural heritage areas on private land.**
   Conservation easements protect land while leaving it in private ownership. An easement is a legal agreement between a landowner and a conservation or government agency that permanently limits a property's use in order to protect its conservation values. It can be tailored to the needs of both the landowner and the conservation organization, and will not be extinguished with new ownership. Tax incentives may apply to conservation easements donated for conservation purposes.

   Lease and management agreements also allow the landowner to retain ownership and temporarily ensure protection of land. There are no tax incentives for these conservation methods. A lease to a land trust or government agency can protect land temporarily, and ensure that its conservation values will be maintained. This can be a first step to help a landowner decide if they want to pursue more permanent protection methods. Management agreements require landowners and land trusts to work together to develop a plan for managing resources (such as plant or animal habitat, watersheds, forested areas, or agricultural lands) with the land trust offering technical expertise.

   Land acquisition by a conservation organization can be at fair market value or as a bargain sale where a purchase price is set below fair market value with tax benefits that reduce or eliminate the disparity. One strategy is to identify areas that may be excellent locations for new county or township parks. Sites that can serve more than one purpose such as wildlife habitat, flood and sediment control, water supply, recreation, and environmental education are ideal. Private lands adjacent to public lands should be examined for acquisition when a natural heritage area is present on either property, and there is a need of additional land to complete protection of the associated natural features.

   Fee simple acquisition is when a buyer purchases land outright, and has maximum control over the use and management of the property and its resources. This conservation initiative is appropriate when the property's resources are highly sensitive, and protection cannot be guaranteed using other conservation approaches.

   Unrestricted donations of land are welcomed by land trusts. The donation of land entitles the donor to a charitable deduction for the full market value, as well as a release from the responsibility of managing the land. If the land is donated because of its conservation value, the land will be permanently protected. A donation of land that is not of high biological significance may be sold, with or without restrictions, to a conservation buyer, and the funds used to further the land trust's conservation mission.

   Land Trusts working in the Delaware County region: The Pennsylvania Land Trust Association website offers a search engine to find land trusts (http://conserveland.org). The primary land trusts operating in the Delaware County region include:

Brandywine Conservancy (http://www.brandywineconservancy.org/) Mission Statement: to conserve the natural and cultural resources of the Brandywine River Watershed and other selected areas with a primary emphasis on conservation of water quantity and quality.

Delaware Nature Society (http://www.delawarenaturesociety.org/) Mission Statement: to foster understanding, appreciation, and enjoyment of the natural world through education; to preserve ecologically significant areas; to advocate stewardship and conservation of natural resources.

Heritage Conservancy **(**www.heritageconservancy.org**)** Mission Statement: to promote open space preservation, natural resource protection, property stewardship, historic preservation, adaptive reuse, wildlife habitat restoration, and biodiversity. These goals are achieved through land use planning and design, public outreach and education, innovative land conservation and historic preservation strategies, and "best management practices" for property stewardship.

Middletown Township Land Conservancy (www.mtlc.org) The Conservancy works to ensure the continued preservation of natural areas throughout the township.

Natural Lands Trust **(**www.natlands.org**)** Mission Statement: to protect land in communities throughout the greater Philadelphia region. We envision and work to build an interrelated system of permanently protected open space comprised of the region's most important natural areas, cultural landscapes, and sustainable agricultural lands. Within this open space network, Natural Lands Trust: - Creates, owns and manages signature preserves; - Protects and monitors lands under conservation easement; - Helps conservation-minded partners and clients conserve land; - Actively manages thousands of preserved acres and teaches others best practices in land stewardship.

Radnor Conservancy **(**www.radnorconservancy.org**)** Mission Statement: to protect and conserve the natural, cultural, and historic landscape of Radnor Township. This mission is founded upon the belief that wise preservation and stewardship of Radnor's resources is essential to the quality of life for current and future generations. Through education, research, and proactive action, the Radnor Conservancy will work to promote collective responsibility for these resources.

Willistown Conservation Trust **(**www.wctrust.org**)** Mission Statement: to preserve the open land, rural character, scenic, historic and ecologically significant resources of the Willistown area and nearby communities, with particular emphasis on the Crum, Ridley and Darby Creek watersheds.

Local zoning ordinances are one of the best-known regulatory tools available to municipalities. Examples of zoning ordinances a municipality can adopt include: overlay districts where the boundary is tied to a specific resource or interest such as riverfront protection and floodplains, and zoning to protect stream corridors and other drainage areas using buffer zones. Often it is overlooked that zoning can prevent municipal or county-wide development activities which are undesirable to the majority of the residents, and allow for planning that can meet the goals of the county residents.

2. **Prepare management plans that address species of concern and natural communities.** Many of the natural heritage areas that are already protected are in need of additional management plans to ensure the continued existence of the associated natural elements. Site-specific recommendations should be added to existing management plans, new plans should be prepared. Recommendations may include: removal of invasive plant species; leaving the area alone to mature and recover from previous disturbance; creating natural areas within existing parks; limiting land-use practices such as mineral extraction, residential or industrial development, and agriculture; or implementing sustainable forestry practices. For example, some species simply require continued availability of a natural community while others may need specific management practices such as canopy thinning, mowing, or burning to maintain their habitat requirements.

   Existing parks and conservation lands provide important habitat for plants and animals at both the county level and on a regional scale. For example, these lands may serve as nesting or wintering areas for birds or as stopover areas during migration. Management plans for these areas should emphasize a reduction in activities that fragment habitat. Adjoining landowners should be educated

about the importance of their land as it relates to habitat value, especially for species of concern, and agreements should be worked out to minimize activities that may threaten native flora and fauna.

3. **Protect bodies of water.**
   Protection of reservoirs, wetlands, rivers, and creeks is vital for ensuring the health of human communities and natural ecosystems; multiple qualities can be preserved by protecting aquatic habitats which harbor biodiversity, supply drinking water, and provide recreational resources. Many rare species, unique natural communities, and locally significant habitats occur in wetlands and water bodies; these are directly dependent on natural hydrological patterns and water quality for their continued existence. Ecosystem processes also provide clean water supplies for human communities and do so at significant cost savings in comparison to water treatment facilities; therefore, protection of high quality watersheds is the only way to ensure the viability of natural habitats and water quality. Scrutinize development proposals for their impact on entire watersheds, not just the immediate project area. Cooperative efforts in land use planning among municipal, county, state, and federal agencies, developers, and residents can lessen the impact of development on watersheds.

4. **Provide for buffers around natural heritage areas.**
   Development plans should provide for natural buffers between disturbances and natural heritage areas. Disturbances may include construction of new roads and utility corridors, non-sustainable timber harvesting, and fragmentation of large pieces of land. Storm runoff from these activities results in the transport of nutrients and sediments into aquatic ecosystems (Trombulak and Frissell, 2000). County and township officials can encourage landowners to maintain vegetated buffer zones within riparian zones. Vegetated buffers (preferably of Pennsylvania native plant species) help reduce erosion and sedimentation while shading and cooling the water. Preserving water quality in rivers and streams is important to fish as some species, such as brook trout and some darters, are highly sensitive to poor water quality. Sensitive fish are readily lost from streams when water quality starts to decline. Creating or maintaining a vegetated buffer benefits aquatic animal life, provides habitat for other wildlife species, and creates a diversity of habitats along the creek or stream. Staff at the Pennsylvania Natural Heritage Program (PNHP) or natural resources agencies can provide further guidance regarding buffer considerations appropriate for various kinds of natural resources.

   Waterways that include natural heritage areas, identified in the *Results* section of this report, are important, sensitive areas that should be protected. For example, conserving natural areas around watersheds that supply municipal water provides an additional protective buffer around the water supply, maintains habitat for wildlife, and may also provide (low impact) recreation opportunities.

5. **Reduce fragmentation of the landscape surrounding natural heritage areas.**
   Encourage development in sites that have already seen past disturbances (especially mined and heavily timbered areas). Care should be taken to ensure that protected natural areas do not become islands surrounded by development. In these situations, the site is effectively isolated, and its value for wildlife is greatly reduced. Careful planning can maintain natural environments along with the plants and animals associated with them. A balance between growth and the conservation of natural and scenic resources can be achieved by guiding development away from the most environmentally sensitive areas.

   The reclamation of previously disturbed areas for commercial and industrial projects, also known as *brownfield development*, presents one way to encourage economic growth while allowing ecologically sensitive areas to remain undisturbed. For example, reclaimed surface mines can be used for development (potentially even wind development) when feasible. Cluster development

can be used to allow the same amount of development on much less land, and leave the remaining land intact for wildlife and native plants. By compressing development into already disturbed areas with existing infrastructure (villages, roads, existing rights-of-way), large pieces of the landscape can be maintained intact. If possible, networks or corridors of woodlands or greenspace should be preserved linking natural areas to each other. Preserving greenspace around development can provide ample recreation opportunities, and potentially increase nearby property value.

6. **Encourage the formation of grassroots organizations.**
County and municipal governments can do much of the work necessary to plan for the protection and management of natural areas identified in this report; however, grassroots organizations are needed to assist with obtaining funding, identifying landowners who wish to protect their land, and providing information about easements, land acquisition, management, and stewardship of protected sites. Increasingly, local watershed organizations and land trusts are taking proactive steps to accomplish conservation at the local level. When activities threaten to impact ecological features, the responsible agency should be contacted. If no agency exists, private groups such as conservancies, land trusts, and watershed associations should be sought for ecological consultation and specific protection recommendations.

7. **Manage for invasive species.**
Invasive species threaten native diversity by dominating habitat used by native species and by disrupting the integrity of the ecosystems they occupy. Management for invasive species depends upon the extent of their establishment. Small infestations may be easily controlled or eliminated but larger, well established populations typically present difficult management challenges. The earlier exotic invasive species are identified and controlled, the greater the likelihood of eradication with the smallest expenditure of resources. Below is a list of sources for invasive species information.

   The *Mid-Atlantic Exotic Plant Pest Council* (MA-EPPC) is a non-profit organization (501c3) dedicated to addressing the problem of invasive exotic plants and their threat to the Mid-Atlantic region's economy, environment, and human health by providing leadership, representing the mid-Atlantic region at national meetings and conferences, monitoring and disseminating research on impacts and controls of invasives, facilitating information development and exchange, coordinating the on the ground removal of invasives, and providing access to training on species identification and management. Information is available at http://www.ma-eppc.org.

   Several excellent websites exist to provide information about invasive exotic species. The following sources provide individual species profiles for the most troublesome invaders, with information such as the species' country of origin, ecological impact, geographic distribution, and control techniques.
   - The Nature Conservancy's Weeds on the Web at http://tncinvasives.ucdavis.edu/
   - The Virginia Natural Heritage Program's invasive plant page at http://www.dcr.virginia.gov/natural_heritage/invspinfo.shtml
   - The Missouri Department of Conservation's Missouri Vegetation Management Manual at http://mdc.mo.gov/nathis/exotic/vegman/
   - U.S. Department of the Interior, National Park Service invasive species monitoring resources at http://www.nature.nps.gov/biology/invasivespecies/ or http://science.nature.nps.gov/im/monitor/invasives/
   - Invasive species information clearinghouse listing numerous other resources on a variety of related topics at http://www.invasivespeciesinfo.gov/

GLOSSARY

Alluvium – material such as sand, silt, or clay that is deposited on land by streams.

Ambystomatid Salamander – a group of salamanders belonging to the family Ambystomatidae. This group is commonly referred to as the "mole salamanders", referring to their secretive, subterranean habits. Pennsylvania's Ambystomatid salamanders are considered vernal pool obligate species, meaning they require the seasonal hydrologic fluctuations of vernal pools to reproduce.

Anadromous – fish that live in saltwater, but migrate to freshwater habitats to reproduce.

Anthropogenic – human caused.

ATV – all-terrain vehicle.

Base flow – the portion of water in a creek, stream, or river resulting from groundwater inputs and not surface runoff..

Bedrock – the solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Bt (Bacillus thuringiensis) – an insecticide produced by the fermentation of a bacterium (Bt), used to control many caterpillar-type pests (e.g., gypsy moth).

Calcareous – composed of, containing, or characteristic of calcium carbonate, calcium, or limestone; chalky.

Canopy – the layer formed by the tallest vegetation.

Carrying capacity – the number of individuals from a single species that a given area of land can naturally sustain for an indefinite time period.

Catadromous – fish that live in freshwater, but migrate to saltwater habitat to reproduce.

Circumneutral – pH between 5.5 and 7.

Co-dominant – where several species together comprise the dominant layer (see "dominant" below).

Community – an assemblage of plant or animal populations sharing a common environment and interacting with each other and the physical environment.

Core Habitat – areas intended to identify the essential habitat of the species of concern or natural community that can absorb very little activity or disturbance without substantial impact to the natural features.

DBH – the diameter of a tree at 4.5 feet above the ground (breast height).

DCNR – Pennsylvania Department of Conservation and Natural Resources.

Deciduous – refers to woody plants that lose their leaves seasonally.

DEP – Pennsylvania Department of Environmental Protection.

Dimilin – a commercially produced, restricted-use insecticide containing diflubenzuron as the active ingredient. Diflubenzuron, which has been used as a method to control gypsy moth, interferes with chitin production during the early stages of certain insects (DCNR, Division of Pest Management).

Dominant – the species (usually plant) exerting the greatest influence on a given community either by numerical dominance or influence on microclimate, soils and other species.

Ecosystem – an ecological community together with its environment, functioning as a unit.

Element – all-inclusive term for species of special concern and exemplary natural communities.

EPT richness – the total number of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) orders in a given sample.

Exceptional Value Waters (EV) – DEP designation for a stream or watershed which constitutes an outstanding national, state, regional or local resource, such as waters of national, state or county parks or forests; or waters which are used as a source of unfiltered potable water supply, or waters of wildlife refuges or State Game Lands, and other waters of substantial recreational or ecological significance. For more detailed information about EV stream designations, the reader is referred to the Special Protection Waters Implementation Handbook (Shertzer 1992).

Exotic – non-native; used to describe plant or animal species that were introduced by humans; examples include Japanese honeysuckle, purple loosestrife and grass carp; exotics present a problem because they may out-compete native species.

Extant – currently in existence.

Extirpation – removal of a species from part of its natural range; also referred to as "localized extinction".

Floodplain – low-lying land generally along streams or rivers that receives periodic flooding.

Forb – non-grass herbaceous plant such as goldenrod.

Georectification – the process of adding coordinates (such as latitude and longitude) to a map to define its location in space.

Graminoid – grass or grass-like plant such as a sedge or a rush.

Gray infrastructure –the built areas (buildings, roads, parking lots, etc.) that may contribute to run-off and the heat island effect.

Green infrastructure – the undeveloped areas (forest, grass, streams, wetlands, etc.) that help mitigate and reduce run-off and the heat island effect while providing habitat.

Ground cover – low shrubs, herbs, and mosses that are found at or close to the ground surface.

Heat island – the area around a large city or other developed area that is kept warmer over night due to the large amount of concrete that, warmed over the course of the day, continues to release stored heat after the sun has set.

Herptile – a reptile or amphibian.

Herpetofauna – the group of reptiles and amphibians found in a particular region.

Hibernacula – a location where animals hibernate.

Hibernation – the period of winter inactivity during which time normal physiological processes are reduced and a significant decrease in body temperature occurs. In Pennsylvania, true hibernation is shown by woodchucks, jumping mice, and bats.

High-Quality Coldwater Fisheries (HQ-CWF) – DEP designation (PA Code, Chapter 93) for a stream or watershed that has excellent quality waters and environmental or other features that require special water quality protection.

Hydrology – water system of an area including both surface water and ground water.

Igneous – formed by solidification from a molten state. Used of rocks.

Invasive species – plants or animals that tend to spread and alter the overall makeup and character of sites. These invasions are either due to the introduction of an exotic species, or due to natural succession. The introduction of invasive species can often cause the breakdown of the natural community.

Lepidoptera – moths and butterflies.

Listed species – species that is monitored and considered to be of concern by PNHP.

Littoral – the area where water meets land, the shoreline.

Lacustrine – any species living in or process involving lakes.

Matrix – the form of land use or habitat that surrounds a focal patch of habitat.

Mesic – moist, not saturated.

Minerotrophic – groundwater fed; influenced by water that has been in contact with bedrock or soil, and is richer in mineral content than rainwater.

Native – describes species that occurred in Pennsylvania or in the area in which they are found prior to European settlement; not introduced by human activities.

Natural Heritage Site – as used in this study, a site with either an exemplary natural community or species of special concern; not to be confused with the State Forest Natural Areas which are specific management units designated by DCNR Bureau of Forestry.

Neo-tropical – referring to the tropical locations in the new world; Mexico, Caribbean Islands, and Central and parts of Northern South America.

Non-point – refers to diffuse sources of pollution such as stormwater runoff contaminated with oil or pesticides.

Obligate species – able to exist or survive only in a particular environment or by assuming a particular role.

Odonate – dragonflies or damselflies.

Oligotrophic – poor to extremely poor in nutrients; typically describes dilute waters with low base metal ion concentrations.

Palustrine – describes wetlands; areas intermediate between aquatic and terrestrial habitats, supporting predominately hydrophytic vegetation, where conditions are at least periodically wet enough during the growing season to produce anaerobic soil conditions and thereby influence plant growth.

Peat – partially decomposed remains of plant material in which at least some of the plant parts are still distinguishable.

PNHP – the Pennsylvania Natural Heritage Program.

Prescribed burning – burning under controlled conditions; needed to maintain communities such as limestone glades and pitch pine barrens.

Respiration – the process that allows organisms of exchanging gases.

Riparian – that habitat or area next to a stream that is generally within the floodplain.

Rookery – the breeding ground of certain birds or animals, such as herons, penguins and seals.

Right-of-way (R-O-W) – strip of land occupied or intended to be occupied by a street, crosswalk, railroad, electric transmission line, oil or gas pipeline, water main, sanitary or storm sewer line, or other special use.

Sedge – grass-like herbaceous plant of the family Cyperaceae, especially members of the genus *Carex*.

Seeps – where water flows from the ground in a diffuse pattern and saturates the soil; lush herbaceous vegetation often grows in these wet areas.

Shrub – a perennial, woody plant that differs from a tree in its short stature (less than five meters in height) and typically multi-growth form.

Soil association – a group of soils that are geographically associated in a characteristic repeating pattern and defined and delineated as a single unit.

Soil series – groups of soils that have vertical profiles that are almost the same, that is, with horizons (layers) that are similar in composition, thickness, and arrangement.

Stream gradient – the average percent change in elevation of a stream bed over a given reach.

Stream reach – referring to a specific stretch of a stream, creek, or river; i.e. the reach of the Schuylkill River between the Walnut Street bridge and the Gray's Ferry Avenue bridge

Subcanopy – in a forest community, the tops and branches of the small trees and tall shrubs that form a distinct layer beneath the high tree canopy and above the shrub layer (if present).

Swamp – a wooded wetland, intermittently or permanently flooded.

Succession – natural process of vegetation change through time; over time, the plant species of a site will change in composition and structure as light and soil conditions change (e.g., a field that is left alone may, over time, be taken over by shrubs, then small trees and eventually a woodland).

Supporting Natural Landscape – identifies areas surrounding or adjacent to Core Habitat that are not considered the primary habitat of the species of concern or natural community, but may serve as secondary habitat. These areas provide support by maintaining vital ecological processes as well as isolation from potential environmental degradation. Supporting Natural Landscape areas may be able to accommodate some types of activities without detriment to natural resources of concern. Each should be considered on a site by site and species by species basis.

Taxa richness – the total number of taxa counted within a site, community of system.

TNC – The Nature Conservancy.

Understory – layer of shrubs and small trees between the herbaceous layer and the canopy.

Upland – sites with well-drained dry to mesic soils.

Wetlands – areas intermediate between aquatic and terrestrial habitats; characterized by a predominance of hydrophytes, where conditions are at least periodically wet enough, during the growing season, to produce anaerobic soil conditions and thereby influence plant growth.

WPC – the Western Pennsylvania Conservancy.

Vernal – occurring in the spring.

Xeric – extremely dry or droughty.

REFERENCES AND LITERATURE CITED

Ashmead, H. G. 1884. *History of Delaware County, Pennsylvania*. L. H. Everts & Co., Philadelphia. 767 pp.

Ashworth, S.M., Foster, B.L. and K. Kindscher. 2006. Relative Contributions of Adjacent Species Set and Environmental Conditions to Plant Community Richness and Composition in a Group of Created Wetlands. Wetlands 26(1): 193-204.

Balcombe, C.K. et al. 2005. A Comparison of Plant Communities in Mitigation and Reference Wetlands in the Mid-Appalachians. Wetlands 25(1): 130-142.

Blaustein, A.R., Wake, D.B., and W.P. Sousa. 1994. Amphibian Declines: Judging Stability, Persistence, and Susceptibility of Populations to Local and Global Extinctions. Conservation Biology 8(1):60-71.

Brody, A.J., and Pelton, M.R. 1989. Effects of Roads on Black Bear Movements in Western North Carolina. Wildlife Society Bulletin 17: 5-10.

Brauning, D.W. (ed.). 1992. Atlas of Breeding Birds in Pennsylvania Univ. of Pittsburgh Press, Pittsburgh, PA. 484 pp.

Brooks, S. 2003. Dragonflies. The Natural History Museum, London.

Ciszek, D. 2002. Lynx rufus. Animal Diversity Web. Available from http://animaldiversity.ummz.umich.edu/site/accounts/information/Lynx_rufus.html (accessed October 2009).

DCNR. 2007. What is the Hemlock Wooly Adelgid? Pennsylvania DCNR, Harrisburg, PA. Available from http://www.dcnr.state.pa.us/forestry/woollyadelgid/index.aspx (accessed October 2009).

Fennessy, M.S., Rokosch, A. and J.J. Mack. 2008. Patterns of Plant Decomposition and Nutrient Cycling in Natural and Created Wetlands. Wetlands 28(2): 300-310.

Fike, J. 1999. Terrestrial & Palustrine Plant Communities of Pennsylvania. PA Dept. of Conservation and Natural Resources, The Nature Conservancy, Western PA Conservancy. 87 pp.

Forman, R.T., and L.E. Alexander. 1998. Roads and their Major Ecological Effects. Annual Review of Ecology and Systematic 29:207-231.

Forman, R.T., and D.R. Deblinger. 2000. The Ecological Road-Effect Zone of a Massachusetts (U.S.A.) Suburban Highway. Conservation Biology 14:36-46.

Furedi, M. A., R. Latham, A. Davis, and G. Podniesinski. 2008. Management Plan for Goat Hill Wild Plant Sanctuary. Pennsylvania Natural Heritage Program, Middletown PA, and Continental Conservation, Rose Valley PA. 58 pp.

Geyer, A.R. and W.H. Bolles. 1979. Outstanding Scenic Geological Features of Pennsylvania. Environ. Geol. Rept. 7, PA Dept. Environ. Resour. Bur. Topo. Surv. 508 pp.

Geyer, A.R. and W.H. Bolles. 1987. Outstanding Scenic Geological Features of Pennsylvania, Vol. 2. Environ. Geol. Rept. 7, PA Dept. Environ. Resour. Bur. Topo. Surv. 270 pp.

Goodrich, L. J., Brittingham, M., Bishop, J.A., and P. Barber. (003. Wildlife Habitat in Pennsylvania: Past, Present, and Future. Pennsylvania Department of Conservation and Natural Resources, Harrisburg, PA. Available at: http://www.dcnr.state.pa.us/wlhabitat/ (accessed October 2009).

Hartzell, D., Bidwell, J.R., and C.A. Davis. 2007. A Comparison of Natural and Created Depressional Wetlands in Central Oklahoma using Metrics from Indices of Biological Integrity. Wetlands 27(4): 794-805.

Harshberger, J. W. 1904. A phyto-geographic sketch of extreme southeastern Pennsylvania. *Bulletin of the Torrey Botanical Club* **31**: 125-159.

Haskell, D.G. 2000. Effects of Forest Roads on Macroinvertebrate Soil Fauna of the Southern Appalachian Mountains. Conservation Biology 14(1):57-63.

Hulse, A.C., C.J. McCoy, and E.J. Censky. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, NY. 419 pp.

Latham, R. 2008. Information sources for reconstructing the vegetation of Philadelphia, lower Bucks, and Delaware Counties, Pennsylvania, around the time of European settlement. Unpublished report for Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown. 74 pp.

Latham, R. E. 2008. Pink Hill Serpentine Barrens Restoration and Management Plan. John J. Tyler Arboretum, Media, Pennsylvania, and Mt. Cuba Center, Greenville, Delaware. 87 pp.

Latham, R.L., J. Beyea, M. Benner, C.A. Dunn, M.A. Fajvan, R.R. Freed, M. Grund, S.B. Horsley, A.F. Rhoads, and B.P. Shissler. 2005. Managing White-tailed Deer from an Ecosystem Perspective: Pennsylvania Case Study. Report by the Deer Management Forum for Pennsylvania Audubon and Pennsylvania Habitat Alliance, Harrisburg. The report is available on Audubon Pennsylvania's website at http://pa.audubon.org/deer_report.html. Accessed: November 19, 2008.

Latham, R. E., D. B. Steckel, H. M. Harper and D. C. Rosencrance. 2003. Conservation and Stewardship Plan for the Crum Woods of Swarthmore College. Report for Swarthmore College, Swarthmore, Pennsylvania by Natural Lands Trust, Media, Pennsylvania and Continental Conservation, Rose Valley, Pennsylvania. 145 pp. + 19 maps.

Lynch, J.F., and D.F. Whigham. 1984. Effects of Forest Fragmentation on Breeding Bird Communities in Maryland, USA. Biological Conservation 28:287-324.

Matlack, G.R. 1993. Microenvironment Variation Within and Among Forest Edge Sites in the Eastern United States. Biological Conservation 66:185-194.

Mazur, K.M., and P.C. James. 2000. Barred Owl (Strix varia). In The Birds of North America, No. 508 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.

Myers, W.L., Brooks, R., and J. Bishop. 2000. Final Report U.S. Geological Survey-Gap Analysis Program. Pennsylvania Gap Analysis Project, Penn State University, University Park, PA. Available at: http://www.orser.psu.edu/PAGAP/gappage.htm (accessed October 2009).

Myers, W., J. Bishop, R. Brooks, T. O'Connell, D. Argent, G. Storm, J. Stauffer, and R. Carline. 2000. The Pennsylvania Gap Analysis Project Final Report. The Pennsylvania State University and U.S. Geological Survey, University Park, PA. 142 p.

Needham, J. G., M. J. Westfall Jr., and M. L. May. 2000. Dragonflies of North America. Scientific Publishers, Gainesville, FL.

Opler, P.A. and G.O. Krizek. 1984. Butterflies East of the Great Plains. The Johns Hopkins Univ. Press, Baltimore, MD. 294 pp.

Opler, P.A. and V. Malikul. 1992. A Field Guide to Eastern Butterflies. The Peterson Field Guide Series, Houghton-Tioga Co., Boston, MA. 396 pp.

Oxley, D.J., Fenton, M.B., and Carmody, G.R. 1974. The Effects of Roads on Populations of Small Mammals. Journal of Applied Ecology 11:51-59.

Pennsylvania Natural Heritage Program (PNHP). 2006. Odonate species list. Unpublished.

Rhoads, A.F. and T.A. Block. 2005. Trees of Pennsylvania: A Complete Reference. University of Pennsylvania Press, Philadelphia.

Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia, PA. 636 pp.

Robbins, C.S. 1980. Effects of Forest Fragmentation on Breeding Bird Populations in the Piedmont of the Mid-Atlantic Region. Atlantic Naturalist 33: 31-36.

Robinson, S.K. 1994. Nesting Success of Forest Songbirds in Northwestern Illinois. Final Report, Project W-115-R-3. Illinois Natural History Survey, Center of Wildlife Ecology, Urbana, IL.

Robinson, S.K., Thompson III, F.R., Donovan, T.M., Whitehead, D.R., and J. Faaborg. 1995. Regional Forest Fragmentation and the Nesting Success of Migratory Birds. Science 267:1987-1990.

Sauer, J. R., J. E. Hines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD.

Schmidt, W. 1989. Plant Dispersal by Motor Cars. Plant Ecology 80 (2): 147-152.

Schweitzer, D.F. 1981. Species Accounts for Species of Special Concern Book. (unpubl. Draft).

Seiler, A. 2001. Ecological Effects of Roads: A Review. Introductory Research Essay No. 9, Swedish University of Agricultural Sciences, Upsala, Sweden.

Shertzer, R.H., ed. 1992. Special Protection Waters Implementation Handbook. PA. Dept. Environ Resources, Harrisburg, PA.

Smith, Aubrey H. 1886. Proceedings of the Academy of Natural Sciences of Philadelphia 38: 253-254.

Snell-rood, E.C. and D.A. Cristol. 2003. Avian Communities of Created and Natural Wetlands: Bottomland Forests in Virginia. The Condor 105: 303-315.

Squires, J.R., and R.T. Reynolds. 1997. Northern Goshawk (Accipiter gentilis). In The Birds of North America, No. 298 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Stanczak, M. and J.B. Keiper. 2004. Benthic Invertebrates in Adjacent Created and Natural Wetlands in Northeastern Ohio, USA. Wetlands 24(1): 212-218.

Steckel, D B. and H. M. Harper. 2008. Stewardship Handbook for Natural Lands in Southeastern Pennsylvania. Natural Lands Trust, Media, Pennsylvania. 234 pp.

Strayer, D.L. and K.J. Jirka. 1997. The Pearly Mussels of New York State. The New York State Education Dept., Albany, NY. 113 pp and plates.

Swearingen, J., K. Reshetiloff, B. Slattery, and S. Zwicker. 2002. Plant Invaders of Mid-Atlantic Natural Areas. National Park Service and U.S. Fish & Wildlife Service, Washington, D.C. 82 pp.

Tiner, R.W. 1990. Use of high-altitude aerial photography for inventorying forested wetlands in the United States. Forest Ecology and Management 33/34: 593-604.

Thompson, S.A., editor. 2002. Biodiversity in Pennsylvania: Snapshot 2002. Pennsylvania Biodiversity Partnership, Pittsburgh, Pennsylvania. 60 pp.

Trombulak, S.C., and C.A. Frissell. 2000. Review of the Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14 (1):18-30.

Voshell, Jr, J.R. 2002. A Guide to Common Freshwater Invertebrates of North America. McDonald and Woodward Publishing Co., Blacksburg, Virginia.Wagner, D. 2005. Caterpillars of Eastern North America - A Guide to Identification and Natural History. Princeton University Press, Princeton, NJ.

Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.

Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

Watkins, R.Z., Chen, J., Pickens, J., and K.D. Brosofske. 2003. Effects of Forest Roads on Understory Plants in a Managed Hardwood Landscape. Conservation Biology 17(2):411-419.

Westfall, M. J. and M. L. May. 1996. Damselflies of North America. Scientific Publishers, Gainesville, FL.

White, J. 1978. Illinois Natural Areas Inventory Technical Report. Volume I: Survey Methods and Results. Illinois Natural Areas Inventory, Urbana, Illinois. 426 pp.

Williams, C.E. 1995. Effects of Powerline Corridors on Forest Ecosystem Integrity. Pages 76-86 in S.K. Majumdar, E.W. Miller, and F. J. Brenner (eds.), Environmental Contaminants, Ecosystems and Human Health. Pennsylvania Academy of Science, Easton, PA.

Wright, D. 2007. Atlas of Pennsylvania Butterflies, 6th edition. Unpublished document.

Yahner, R.H. 2000. Eastern Deciduous Forest: Ecology and Wildlife Conservation. University of Minnesota Press: Minneapolis, MN.

GIS DATA SOURCES

Bishop, Joseph A. (1998). Managed Lands in Pennsylvania. Pennsylvania GAP Analysis Project, Environmental Resources Research Institute. Available from: http://www.pasda.psu.edu/ (accessed: October 2009)

Environmental Resources Research Institute. (1997) ERRI – Small Watersheds. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

ESRI Street Map USA. 2005.

Natural Lands Trust. (2006). Important Bird Areas. Available from: http://www.pasda.psu.edu/ (accessed: October 2009)

Natural Lands Trust. (2006). National Wetlands Inventory. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

North American Commission for Environmental Cooperation. (1997). Ecological regions of North America, Level III. Available online: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm (accessed: October 2009).

Pennsylvania Bureau of Topographic and Geologic Survey, Dept. of Conservation and Natural Resources. (1995). Physiographic Provinces 1:100,000. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

Pennsylvania Bureau of Topographic and Geologic Survey, Dept. of Conservation and Natural Resources. (2001). Bedrock geologic units of Pennsylvania, scale 1:250,000. Available from: http://www.dcnr.state.pa.us/topogeo/gismaps/digital.aspx (accessed: October 2009).

Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry. (2006). Wild and Natural Areas. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

Pennsylvania Department of Transportation, Bureau of Planning and Research, Cartographic Information Division. (2009). PennDOT – Pennsylvania Municipality boundaries 2009. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

Pennsylvania Department of Transportation, Bureau of Planning and Research, Geographic Information Division. (2009). PennDOT - Pennsylvania Stateroads 200901. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

Pennsylvania Natural Heritage Program. (2004). Pennsylvania Natural Diversity Inventory (PNDI) Spatial Database.

U.S. Department of Agriculture (2005). USDA-NAIP County Mosaics for Pennsylvania 2005. Available from: ftp://www.pasda.psu.edu/pub/pasda/naip/NAIP2005/ (accessed: October 2009).

U.S. Geological Survey. (1996). 7.5 minute Digital Raster Graphics for Pennsylvania - UTM grid - NAD 1983 - cropped collars. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

U.S. Geological Survey (2003). National Land Cover Database Zone 60 Land Cover Layer - Pennsylvania and Northeast. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

U.S. Geological Survey in cooperation with U.S. Environmental Protection Agency, USDA Forest Service, and other Federal, State and local partners. (2005). National Hydrography Dataset (NHD) - High-resolution: area features. Available from: http://www.pasda.psu.edu/ (accessed October 2009).

U.S. Geological Survey (USGS), EROS Data Center. (1999). National Elevation Dataset for Pennsylvania. Available from: ftp://www.pasda.psu.edu/pub/pasda/ned/ (accessed October 2009)

APPENDIX I: SPECIES AND COMMUNITIES OF CONCERN IN DELAWARE COUNTY

Scientific Name	Common Name	Global Rank[1]	State Rank[1]	State Status[1]	Proposed Status[1]
	Mammals				
None currently known					
	Birds				
Ardea (*Casmerodius*) *albus*	Great Egret	G5	S1B	PE	PE
Ardea herodias	Great Blue Heron[2]	G5	S3S4B,S4N	N	N
Asio flammeus	Short-eared Owl[2]	G5	S1B,S3N	PE	PE
Botaurus lentiginosus	American Bittern	G4	S1B	N	PE
Circus cyaneus	Northern Harrier	G5	S2B	N	CA
Cistothorus palustris	Marsh Wren	G5	S2S3B	N	CR
Falco peregrinus	Peregrine Falcon	G4	S1B	PE	PE
Haliaeetus leucocephalus[2]	Bald Eagle[2]	G5	S2B	PT	PT
Ixobrychus exilis	Least Bittern	G5	S1B	PE	PE
Nycticorax nycticorax[2]	Black-crowned Night-heron[2]	G5	S2S3B	PE	PE
Pandion haliaetus	Osprey	G5	S2B	PT	PT
Rallus elegans[2]	King Rail[2]	G4	S1B	PE	PE
Rallus limicola	Virginia Rail	G5	S3B	N	N
Tyto alba[2]	Barn Owl[2]	G5	S3B	N	CR
	Herptiles				
Clemmys guttata[2]	Spotted turtle[2]	G5	S3	N	N
Glyptemys muhlenbergii[2]	Bog Turtle[2]	G3	S2	PE	PE
Lithobates sphenocephalus utricularius	Southern Leopard Frog[2]	G5TNR	S1	PE	PE
Pseudemys rubriventris[2]	Redbelly turtle[2]	G5	S2S3	PT	CA
Terrapene carolina[2]	Eastern box turtle[2]	G5	S3S4	N	N
	Fish				
Umbra pygmaea[2]	Eastern mudminnow[2]	G5	S3	PC	CP
	Mussels				
None currently known					
	Invertebrates				
Enallagma durum	Big bluet	G5	S3	N	N
	Plants				
Agalinis paupercula	Small-flowered false-foxglove	G5	S1	PE	PE
Ageratina aromatica	Small white-snakeroot	G5	S3	N	PE
Aletris farinosa	Colic-root	G5	S1	TU	PE
Amaranthus cannabinus	Waterhemp ragweed	G5	S3	N	PR
Amelanchier canadensis	Serviceberry	G5	S1	N	PE
Andropogon gyrans	Elliott's beardgrass	G5	S3	N	PR
Aplectrum hyemale	Puttyroot	G5	S3	PR	PR
Aristida dichotoma var. *curtissii*	Three-awned grass	G5	S1S2	TU	PE
Aristida longespica var. longespica	Slender three-awn	G5T5?	S3S4	N	WATCH
Aristida purpurascens	Arrow-feathered three awned	G5	S2	PT	PT
Baccharis halimifolia	Eastern baccharis	G5	S3	PR	PR
Bartonia paniculata	Screw-stem	G5	S3	N	PR
Bidens bidentoides	Swamp beggar-ticks	G3G4	S1	PT	PE
Bidens laevis	Beggar-ticks	G5	S1	N	PE
Cerastium velutinum var. velutinum	Field chickweed	G5T4?	S3	N	SP
Cuscuta pentagona	Field dodder	G5	S2	N	PT
Cyperus engelmannii	Engelmann's flatsedge	G4	S2	PR	DL
Desmodium nuttallii	Nuttalls' tick-trefoil	G5	S2	TU	TU
Dichanthelium oligosanthes	Heller's witchgrass	G5	S3	N	PT

Scientific Name	Common Name	Global Rank[1]	State Rank[1]	State Status[1]	Proposed Status[1]
Dichanthelium oligosanthes	Heller's witchgrass	G5	S3	N	PT
Dichanthelium scoparium	Velvety panic-grass	G5	S1	PE	PE
Echinochloa walteri	Walter's barnyard-grass	G5	S1	PE	PE
Eleocharis obtusa var. *peasei*	Wrights spike rush	G5	S1	PE	PE
Eleocharis parvula	Little-spike spike-rush	G5	S1	PE	PE
Elephantopus carolinianus	Elephant's foot	G5	S3	PE	PR
Ellisia nyctelea	Ellisia	G5	S2	PT	PT
Eupatorium album	White thoroughwort	G5	S1	PX	PE
Eupatorium rotundifolium	A eupatorium	G5	S3	TU	TU
Euthamia tenuifolia	Grass-leaved goldenrod	G5	S1	PT	PT
Fimbristylis annua	Annual fimbry	G5	S2	PT	PT
Gentiana saponaria	Soapwort gentian	G5	S1S2	TU	PE
Heteranthera multiflora	Multiflowered mud-plantain	G4	S1	PE	PE
Hydrastis canadensis[2]	Golden-seal[2]	G4	S4	PV	PV
Juncus biflorus	Grass-leaved rush	G5	S2	TU	PT
Juncus dichotomus	Forked rush	G5	S1	PE	PE
Lespedeza angustifolia	Narrowleaf bushclover	G5	S1	PE	PE
Leucothoe racemosa	Swamp dog-hobble	G5	S2S3	TU	PT
Lobelia puberula	Downy lobelia	G5	S1	PE	PE
Lycopodiella appressa	Southern bog clubmoss	G5	S2	PT	PT
Lycopus rubellus	Bugleweed	G5	S1	PE	PE
Oxypolis rigidior	Stiff cowbane	G5	S2	TU	PT
Packera anonyma	Plain ragwort	G5	S2	PR	PR
Panicum polyanthes	Panic-grass	GNR	S4	N	SP
Pluchea odorata	Shrubby camphor-weed	G5	S1	TU	PE
Poa autumnalis	Autumn bluegrass	G5	S1	PE	PE
Polygala cruciata	Cross-leaved milkwort	G5	S1	PE	PE
Quercus falcata	Southern red oak	G5	S1	PE	PE
Quercus michauxii	Swamp chestnut oak	G5	S1	N	PE
Quercus phellos	Willow oak	G5	S2	PE	PE
Rotala ramosior	Tooth-cup	G5	S3	PR	PR
Sagittaria calycina var. *spongiosa*	Long-lobed arrow-head	G5	S1	PE	PE
Sagittaria subulata	Subulate arrowhead	G4	S3	PR	PR
Schoenoplectus fluviatilis	River bulrush	G5	S3	PR	PR
Schoenoplectus smithii	Smith's bulrush	G5	S1	PE	PE
Scleria pauciflora	Few flowered nutrush	G5	S2	PT	PT
Senna marilandica	Wild senna	G5	S3	TU	PR
Spiranthes tuberosa	Little ladies'-tresses	G5	S1	TU	PE
Spiranthes vernalis	Spring ladies'-tresses	G5	S1	PE	PE
Symphyotrichum depauperatum	Serpentine aster	G2	S2	PT	PT
Tipularia discolor	Cranefly orchid	G5	S3	PR	PR
Trillium cernuum[2]	Nodding trillium[2]	G5	S2	N	PT
Triplasis purpurea	Purple sandgrass	G4G5	S1	PE	PE
Vernonia glauca	Tawny ironweed	G5	S1	PE	PE
Woodwardia areolata	Netted chainfern	G5	S2	N	PT
Zizania aquatica	Indian wild rice	G5	S3	PR	PR
Natural Communities					
Freshwater intertidal mudflat		G3G4	S1	N	N
Freshwater intertidal marsh		G3G4	S1	N	N

1 = Please refer to Appendix XYZ (pg. XYZ)for an explanation of PNHP ranks and legal status
2 = This species is not named at the site level by request of the jurisdictional agency overseeing its protection

APPENDIX II: EZ EO FORM

PLANT & ANIMAL SPECIES OF SPECIAL CONCERN REPORT

Species Name**:**	**SURVEYOR(S)**:(*Please include your address & phone #)*
Date of Visit:	Time spent at site**:**
USGS Quadrangle:	
Site Name and Directions to Site**:**	**GPS Coordinates**: Latitude:_____ Longitude:_____ **DATUM** (e.g. NAD27, NAD83)_____
Owner Information**:** • **Public Land:** give tract name:_____ • **Private Land:** Please fill out landowner info below. **NOTE**: We cannot accept data collected on private land if you didn't have permission!	
Landowner Name:	Address:
Phone Number:	City / State / Zip code:
Landowner aware of the species of special concern? **YES____ NO____** Landowner aware that data are submitted to PA Natural Diversity Inventory? **YES____ NO____** **IF A SPECIMEN WAS COLLECTED**: Please ask for the landowner's signature **for permission to save the specimen in a museum**: Landowner Signature:_____ Date:_____ Where is the specimen being held_____	
Habitat Description**:** Give a general description of the site. You might include other plant/animal species at site, substrate/soils, topography, land use, weather, etc. If revisiting a site, indicate any obvious changes to the habitat.	
Disturbances/Threats**:** Include human and/or natural disturbances and threats to the species at this site.	
Species Data**:** Fill out as much of the following as you can - include anything else you feel is of importance.	
♣Give general description of what you saw (*i.e.: found scat, heard song, animal crossing road, found plant in bog..*)	
♣Count or estimate the number of plants / animals you observed & estimate the size of the area they occupy.	
♣Age and condition of individual(s) (*i.e.: fresh adult butterfly; healthy mature plants - 50% flowering and with immature fruit...*)	
♣Behavior (*animals*) (*i.e.: nectaring insect, breeding birds, turtle basking...*)	
♣If revisiting this site, compare the heath and size of the population to previous visits.	
♣Confidence level on Identification: ID Positive ID Somewhat Uncertain ID Unknown	
♣Voucher specimen or photo taken? (*Please include if possible*)	
♣Additional information:	

APPENDIX III: PNHP PROGRAM RANKS AND STATE AND FEDERAL STATUS

FEDERAL STATUS

U.S. FISH AND WILDLIFE SERVICE CATEGORIES OF ENDANGERED
AND THREATENED PLANTS AND ANIMALS

The following definitions are extracted from the September 27, 1985 U.S. Fish and Wildlife Service notice in the Federal Register:

LE - **Listed Endangered -** Taxa in danger of extinction throughout all or a significant portion of their ranges.

LT - **Listed Threatened -** Taxa that are likely to become endangered within the foreseeable future through all or a significant portion of their ranges.

PE - **Proposed Endangered -** Taxa proposed to be formally listed as endangered.

PT - **Proposed Threatened -** Taxa proposed to be formally listed as threatened.

C1 - Taxa for which the Service currently has on file substantial information on biological vulnerability and threat(s) to support the appropriateness of proposing to list them as endangered or threatened species.

C2 - Taxa for which information now in possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threats are not currently known or on file to support the immediate preparation of rules.

C3 - Taxa that are no longer being considered for listing as threatened or endangered species. Such taxa are further coded to indicate three categories, depending on the reason(s) for removal from consideration.

3A--Taxa for which the Service has persuasive evidence of extinction.

3B--Names that, on the basis of current taxonomic understanding, usually as represented in published revisions and monographs, do not represent taxa meeting the Act's definition of "species".

3C--Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat.

N - Taxa not currently listed by the U.S. Fish and Wildlife Service.

STATE STATUS-NATIVE PLANT SPECIES

Legislative Authority: Title 25, Chapter 82, Conservation of Native Wild Plants, amended June 18, 1993, Pennsylvania Department of Environmental Resources.

PE - **Pennsylvania Endangered -** Plant species which are in danger of extinction throughout most or all of their natural range within this Commonwealth, if critical habitat is not maintained or if the species is greatly exploited by man. This classification shall also include any populations of plant species that have been classified as Pennsylvania Extirpated, but which subsequently are found to exist in this Commonwealth.

PT - **Pennsylvania Threatened -** Plant species which may become endangered throughout most or all of their natural range within this Commonwealth, if critical habitat is not maintained to prevent further decline in this Commonwealth, or if the species is greatly exploited by man.

PR - **Pennsylvania Rare -** Plant species which are uncommon within this Commonwealth. All species of native wild plants classified as Disjunct, Endemic, Limit of Range, and Restricted are included within the Pennsylvania Rare classification.

PX - **Pennsylvania Extirpated -** Plant species believed by the Department to be extinct within this Commonwealth. These plant species may or may not be in existence outside this Commonwealth. If plant species classified as Pennsylvania Extirpated are found to exist, the species automatically will be considered to be classified as Pennsylvania Endangered.

PV - **Pennsylvania Vulnerable -** Plant species which are in danger of population decline within Pennsylvania because of their beauty, economic value, use as a cultivar, or other factors which indicate that persons may seek to remove these species from their native habitats.

TU - **Tentatively Undetermined -** Plant species which are believed to be in danger of population decline, but which cannot presently be included within another classification due to taxonomic uncertainties, limited evidence within historical records, or insufficient data.

N - **None -** Plant species which are believed to be endangered, rare, or threatened, but which are being considered by the required regulatory review processes for future listing

APPENDIX III (continued)

STATE STATUS-ANIMALS

The following state statuses are used by the Pennsylvania Game Commission for (1990, Title 34, Chapter 133 pertaining to wild birds and mammals) and by the Pennsylvania Fish and Boat Commission (1991, Title 30, Chapter 75 pertaining to fish, amphibians, reptiles, and aquatic organisms):

PE - **Pennsylvania Endangered** - Game Commission - Species in imminent danger of extinction or extirpation throughout their range in Pennsylvania if the deleterious factors affecting them continue to operate. These are: 1) species whose numbers have already been reduced to a critically low level or whose habitat has been so drastically reduced or degraded that immediate action is required to prevent their extirpation from the Commonwealth; or 2) species whose extreme rarity or peripherality places them in potential danger of precipitous declines or sudden extirpation throughout their range in Pennsylvania; or 3) species that have been classified as "Pennsylvania Extirpated", but which are subsequently found to exist in Pennsylvania as long as the above conditions 1 or 2 are met; or 4) species determined to be "Endangered" pursuant to the Endangered Species Act of 1973, Public law 93-205 (87 Stat. 884), as amended.

Fish and Boat Commission - Endangered Species are all species and subspecies: (1) declared by the Secretary of the United States Department of the Interior to be threatened with extinction and appear on the Endangered Species List or the Native Endangered Species list published in the Federal Register; or, (2) declared by the Executive Director (PaFC) to be threatened with extinction and appear on the Pennsylvania Endangered Species List published in the Pennsylvania Bulletin.

PT - **Pennsylvania Threatened** - Game Commission - Species that may become endangered within the foreseeable future throughout their range in Pennsylvania unless the causal factors affecting the organism are abated. These are: 1) species whose populations within the Commonwealth are decreasing or have been heavily depleted by adverse factors and while not actually endangered, are still in critical condition; or 2) species whose populations may be relatively abundant in the Commonwealth but are under severe threat from serious adverse factors that have been identified and documented; or 3) species whose populations are rare or peripheral and in possible danger of severe decline throughout their range in Pennsylvania; or 4) species determined to be "Threatened" pursuant to the Endangered Species Act of 1973, Public law 93-205 (87-Stat. 884), as amended, that are not listed as "Pennsylvania Endangered".

Fish and Boat Commission - Threatened Species are all species and subspecies: (1) declared by the Secretary of the United States Department of the Interior to be in such small numbers throughout their range that they may become endangered if their environment worsens and appear on a Threatened Species List published in the Federal Register; or, (2) have been declared by the Executive Director (PaFC) to be in such small numbers throughout their range that they may become endangered if their environment worsens and appear on the Pennsylvania Threatened Species List published in the Pennsylvania Bulletin.

PC **Pennsylvania Concern** - Animals that could become endangered or threatened in the future. All of these are uncommon, have restricted distribution, or are at risk because of certain aspects of their biology.

CP **Candidate Proposed** - Species comprising taxa for which the Pennsylvania Biological Survey (PBS) currently has substantial information on hand to support the biological appropriateness of proposing to list as Endangered or Threatened.

CA **Candidate at Risk** - Species that although relatively abundant now are particularly vulnerable to certain types of exploitation or environmental modification.

CR **Candidate Rare** - Species which exist only in one of a few restricted geographic areas or habitats within Pennsylvania, or they occur in low numbers over a relatively broad area of the Commonwealth.

CU **Condition Undetermined** - Species for which there is insufficient data available to provide an adequate basis for their assignment to other classes or categories.

N **None** - No current legal status, but is under review for future listing.

PNHP GLOBAL ELEMENT RANKS

G1 = **Critically imperiled** globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = **Imperiled** globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either **very rare** and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = **Apparently secure** globally, though it may be quite rare in parts of its range, especially at the periphery.

G5 = **Demonstrably secure** globally, though it may be quite rare in parts of its range, especially at the periphery.

GH = Of **historical** occurrence throughout its range, i.e., formerly part of the established biota, with the expectation that it may be rediscovered (e.g., Bachman's Warbler).

GU = Possibly in peril range wide but status **uncertain**; need more information.

GX = Believed to be **extinct** throughout its range (e.g., Passenger Pigeon) with virtually no likelihood that it will be rediscovered.

GNR = Global rank has **yet to be assessed**. A GNR rank indicates neither commonness nor rarity

APPENDIX III (continued)

PNHP STATE ELEMENT RANKS

S1 = **Critically imperiled** in state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2 = **Imperiled** in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 = **Rare** or uncommon in state (on the order of 21 to 100 occurrences).

S4 = **Apparently secure** in state, with many occurrences.

S5 = **Demonstrably secure** in state and essentially ineradicable under present conditions.

SA = **Accidental** in state, including species which only sporadically breed in the state.

SE = An **exotic** established in state; may be native elsewhere in North America (e.g., house finch).

SH = Of **historical** occurrence in the state with the expectation that it may be rediscovered.

SN = Regularly occurring, usually migratory and typically **non-breeding** species for which no significant or effective habitat conservation measures can be taken in the state.

SNR = State rank has **yet to be assessed**. An SNR rank indicates neither commonness nor rarity

SR = **Reported** from the state, but without persuasive documentation which would provide a basis for either accepting or rejecting (e.g., misidentified specimen) the report.

SRF = **Reported falsely** (in error) from the state, with this error persisting in the literature.

SU = Possibly in peril in state but status **uncertain**; need more information.

SX = Apparently **extirpated** from the state.

DL = Recently removed (**delisted**) from the list of species of concern.

PENNSYLVANIA ELEMENT OCCURRENCE QUALITY RANKS

Quality Rank*	Explanation
A	**Excellent** occurrence: all A-rank occurrences of an element merit quick, strong protection. An A-rank community is nearly undisturbed by humans or has nearly recovered from early human disturbance; further distinguished by being an extensive, well-buffered occurrence. An A-rank population of a sensitive species is large in area and number of individuals, stable, if not growing, shows good reproduction, and exists in natural habitat.
B	**Good** occurrence: protection of the occurrence is important to the survival of the element in Pennsylvania, especially if very few or no A-rank occurrences exist. A B-rank community is still recovering from early disturbance or recent light disturbance, or is nearly undisturbed but is less than A-rank because of significantly smaller size, poorer buffer, etc. A B-rank population of a sensitive species is at least stable, in a minimally disturbed habitat, and of moderate size and number.
C	**Fair** occurrence: protection of the occurrence helps conserve the diversity of a region's or County's biota and is important to statewide conservation if no higher-ranked occurrences exist. A C-rank community is in an early stage of recovery from disturbance, or its structure and composition have been altered such that the original vegetation of the site will never rejuvenate, yet with management and time partial restoration of the community is possible. A C-rank population of a sensitive species is in a clearly disturbed habitat, small in size and/or number, and possibly declining.
D	**Small** occurrence: protection of the occurrence may be worthwhile for historical reasons or only if no higher ranked occurrences exist. A D-rank community is severely disturbed, its structure and composition been greatly altered, and recovery to original conditions, despite management and time, essentially will not take place. A D-rank population of a sensitive species is very small with a high likelihood of dying out or being destroyed, and exists in a highly disturbed and vulnerable habitat.
E	Verified as **extant**, but has not been given a rank; additional information needed to evaluate quality.
F	While know from the site, the last survey **failed to find** sufficient evidence to verify the element still occurred at the site

* Intermediate ranks may also be assigned.

APPENDIX IV: GREENSPACE ANALYSIS

Delaware Greenspace data layer explanation:

Data Layer (Layer Name)		Explanation
Variable	Value	
Within/outside Delaware County (UPDATE)		This attribute indicates whether the polygon is within Delaware County or outside of Delaware County. It is based off ctypa24k.shp.
Outside Delaware County	0	
Inside Delaware County	1998	
Steep slopes (SLOPE_SCR)		This layer is derived from the Delaware County 5-foot contours. It was created using the slope analysis tool in the Spatial Analysis tool in ArcCatalog.
<15% Slope	0	
15% – 25% Slope	1	
>25% Slope	2	
Existing Trails (TRAIL_SCR)		This layer was created by buffering the Delaware County trail line file by XYZ feet to create a polygon layer showing the locations of trails.
No Trail	0	
Trail within 25 meters	1	
Abandoned Railways (ABRAIL_SCR)		This layer was created by buffering the Delaware County abandoned railway line file by XYZ feet to create a polygon layer showing the locations of abandoned railways.
No Abandoned Railway	0	
Abandoned Railway within 25 meters	1	
FEMA Floodplain (FLDP_SCR)		This layer is derived from the FEMA floodplain maps, which depict the 100- and 500-year floodplains within the United States.
Outside the Floodplain	0	
500-year Floodplain	1	
100-year Floodplain	2	
Greenspace Connectivity (GRNSP_SCR)		This analysis was based of the Fike community classification of Delaware County. This allowed us to visually assign values to the greenspace within the county. The largest intact habitats were classified as hubs, with smaller intact habitats interspersed as nodes, all connected by existing corridors of natural habitat.
Not connected greenspace	0	
Corridor	1	
Node	2	
Hub	3	
Landcover (LNDU_SCR)		This analysis is based off the reclassification of the Delaware Valley Region Planning Commission's (DVRPC) landcover layer. PNHP staff examined landcover using PAMAP aerial imagery and reclassified the DVRPC layer according to Fike, 1999. The reclassified layer was then given a value dependent on the quality and size of the mapped natural community (per DESCRIPTO column).
Not a recognizable community	0	
Non-recognizable natural community	1	
Recognizable community with negative modifiers	2	
Recognizable community without negative modifiers	3	
Forest Blocks (FRST_SCR)		This analysis was based on the landcover analysis. All forests were joined together and then separated into individual polygons. These polygons were then classified into group based on acreage with patches of forest under 1 acre removed.
Not forest	0	
1-10 acres forest	1	
10-100 acres forest	2	
Greater than 100 acres forest	3	
Interior Forest Blocks (IFRST_SCR)		This analysis was based on the forest block analysis. Forest blocks were buffered inward 100m to remove forest edge habitat. These polygons were then classified into group based on acreage with patches of forest under 1 acre removed.
Not interior forest	0	
1-10 acres interior forest	1	
10-100 acres interior forest	2	
Greater than 100 acres interior forest	3	
Green versus Gray Infrastructure (GRASS_SCR)		This analysis was based off the DVRPC landuse layer. Landuse was split between built environments (gray) and unbuilt environments (green).
Gray Infrastructure	0	
Green Infrastructure	1	
Tracked species and Communities (EO_SCR)		This column is based upon a multi-step process. This process is explained stepwise below.

1. Core and supporting habitat CPP-based polygons are built for every species of concern, natural community of concern, and selected geological and other features in and adjacent to the county. See the table below for scores for G, S, Quality, and Protection status. Mixed scores take the mean rounded up (an S2S3 would score a 3.5 rounded to 4). At an individual layer level, the supporting polygons are then merged by species to collapse each species/community/other feature into one polygon showing supporting habitat.
2. Step 2 deals with either core OR supporting habitat polygons, one at a time. Select only the core OR supporting polygons for all the EO layers and UNION them into a single layer. It works more quickly if <30 layers are unioned at once and then these unioned layers are unioned together to form a final single layer. Remove all the unnecessary columns from the attribute table.
3. In the layer created in step 2 create 2 new columns called CORE_SCR and SUPP_SCR in the appropriate layer. Using the field calculator enter the following equations

   for CORE_SCR: ((([G_SCR] +(2* [S_SCR]))*([RANK_SCR] /3))*([PROT_SCR] /3))
   for SUPP_SCR: (([G_SCR] +(2* [S_SCR])))/10

The above formula is replicated for each unique set of score, which represent a species within the polygon (G_SCR, G_SCR_1, G_SCR_12, etc…). These formulas are explained below.

4. Sort the CORE_SCR column, select all polygons with a negative value, and change this to a "0". Do the same thing for SUPP_SCR.
5. Once the negative values have been set to zero union the core habitat layer with the supporting habitat layer; remove all the unnecessary columns. Create a new column called EO_SCR. Calculate the value for this column using the formula:

   Log ((([G_SCR] +(2* [S_SCR]))) +0.1)

   This log normalizes the result to provide a value in-line with the values given to other variables in the landscape assessment (a range of 0 – 10) allowing for easier weighting in the final equation; the 0.1 is added on to ensure that no zeros are returned (log 1 = 0).
6. This new layer is now ready to union with all the other layers that provide information for the greenspace analysis.

Formula Explanation:

- Core: The core habitat formula takes the numeric values, assigned per the table below, and weights them to provide a final number that takes into account the G-rank, S-rank, quality rank, and protection status of each individual element occurrence. The formula initially weights the state rank of the species twice as high as its global rank to account for rare species otherwise common throughout their range; it relies on the fact that a globally rare species will, necessarily, be rare and important in Pennsylvania too. This rarity score is then multiplied by the quality of the occurrence with a rank of D or less decreasing the score and a rank of B or greater increasing the score; a rank of C or E does not modify the score. An A occurrence of a species will score 1 and 2/3 times higher than a C/E occurrence of that species with an F/H/X occurrence scoring 1/3 as high as a C/E occurrence. Finally, this quality adjusted rarity score is multiplied by the legal protection afforded the species with strong legal protection increasing the score and lacking legal protection decreasing the score. A PA Endangered (PE) species will score 1 and 2/3 times higher than a PA Concern, Rare, or Vulnerable (PC, PR, PV) and unprotected (N, blank) species score only 1/3 as high as a PC, PR, or PV occurrence.
- Supporting: The supporting habitat formula takes the numeric values, assigned per the table below, and weights them to provide a final number that takes into account only the G-rank and S-rank of each individual species. Thus, that supporting habitat for each species is treated separately instead of treating the supporting habitat for each occurrence of the species separately. The formula initially weights the state rank of the species twice as high as its global rank to account for rare species otherwise common throughout their range; it relies on the fact that a globally rare species will, necessarily, be rare and important in Pennsylvania too. This number is then log normalized to provide a value in-line with the

values given to other variables in the landscape assessment (a range of 0 – 10) allowing for easier weighting in the final equation; the 0.1 is added on to ensure that no zeros are returned (log 1 = 0). Finally, this value is divided by 10 to give it one-tenth the weight of the core polygon. This assumes that the supporting polygon, while important to the longterm survival of the species, will be made of a mosaic of habitats of different qualities and levels of protection.

EO characteristics Scoring Conversion				
G-Rank	S-Rank	State Status	EO Quality Rank	Numeric Score
G_SCR	S_SCR	PROT_SCR	QUAL_SCR	Column Name
1	1, X	PE	A	5
2	2	PT	B	4
3	3	PR, PV, PC	C, E	3
4	4	TU, PX	D, U	2
5, GNR	5, SNR	N, Blank	F, H, X	1

APPENDIX V: AQUATIC COMMUNITY CLASSIFICATION FACT SHEETS

Atlantic Coolwater Community 1

Typified by: Slimy sculpin (*Cottus cognatus*), stocked brown trout (*Salmo trutta*), fathead minnow (*Pimephales promelas*), pearl dace (*Margariscus margarita*)

Community Description and Habitat: This community generally occurs in high gradient streams, slightly downstream of the watershed headwaters. The community typically is found in relatively small headwater streams, but may also be found in valley streams. In contrast to coldwater communities, the Coolwater Community 1 stream habitats are influenced by some non-natural conditions. Watersheds surrounding the Coolwater Community 1 may be influenced by agricultural practices and by human settlements.

The fish that indicate this community type prefer cool, rocky streams that may occur in transitional areas between cold-water streams and warm-water ones. The Atlantic Coolwater Community 1 may represent streams with put-and-take trout fisheries or cool streams with seasonally warm temperatures. Community fish may tolerate some acidic conditions, low dissolved oxygen, suspended sediments, or other water quality impairments. An example of the Coolwater Community 1 habitat is Dismal Run, a tributary of Chester Creek. Dismal Creek is also a High Quality- Trout Stocked Stream.



photo source: http://www.cnr.vt.edu/efish

Fathead Minnow



photo source: PNHP

Small to medium size streams are typical of Cool water Community 1.

Stream Quality Rating: Low

Threats and Disturbances: This community occurs downstream of headwaters and exists in streams not usually protected from human influences. The most common threats to water quality for Atlantic Coolwater Community 1 are pollution from poorly managed agricultural areas or runoff from impervious surfaces. Excess silt and nutrients are contributed from agricultural runoff. Removal of stream bank vegetation and livestock grazing in streams also contribute to poor conditions. Water temperatures may be warmer than natural temperatures in these altered streams.

Conservation Recommendations: Restoration of stream habitat and water quality to natural conditions is recommended. Management of storm water runoff and riparian vegetation restoration are critical to improvement of community conditions. Excess nutrient runoff and sedimentation impair some community habitats.

Where stocking of non-native fish is occurring with the cool-water community, native fish are displaced. Restoration of fish community to native fish is recommended. The habitat for the Atlantic Coolwater Community 1 represents an important transition between cold headwater streams and warm, larger streams; the habitat is distinct among other habitat types and should be protected and restored.

References

- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Atlantic Coolwater Community 2

Typified by: Blacknose dace (*Rhinichthys atratulus*), white sucker (*Catostomus commersoni*), golden shiner (*Notemigonus crysoleucas*)

Community Description and Habitat: This community type is similar to Atlantic Coolwater Community 1 since it occurs in small to medium size in valley streams. Streams may be low gradient and slow moving compared to streams of a similar size flowing from ridges. Examples of streams with Coolwater Community 2 habitat are Ridley Creek, Rocky Run and Chester Creek.



photo source: http://www.ohiodnr.com/dnap

Blacknose Dace

Fish found in this community type are habitat generalists and generally pollution tolerant. There are few fish species present in the Atlantic Coolwater Community 2. In some locations this community is coincident with PA DEP designated Trout-Stocked Fishery or Warm Water fishery streams. Generalist fish, such as the blacknose dace and white sucker can, tolerate cool to warm waters. Stocked trout streams can be seasonally warm and can still support relatively tolerant brown trout during part of the year.



photo source: PNHP

Coolwater Community 2 is found in a variety of habitats in medium-sized streams and small rivers. Habitat-generalist fish can tolerate slow and silty streams.

Stream quality rating: Low

Threats and Disturbances: Poor habitat conditions and water quality are the most pressing threat to Atlantic Coolwater Community 2. Excess siltation, suspended solids and habitat modification from runoff and altered hydrology degrade stream conditions. Chester Creek is designated as "Impaired" by PA DEP for organic pollution from an industrial point source as well as for the aforementioned reasons (PA DEP 2009). The tributaries of Ridley Creek as classified as "Impaired" from urban runoff and storm sewers (PA DEP 2009). Runoff from impervious surfaces, such as buildings, roads, and parking lots, altered hydrology and contributes pollution to many streams in southeastern Pennsylvania.

Conservation Recommendations: Sedimentation and excess nutrient loading impair some habitats for the Atlantic Coolwater Community 2. Restoration of stream temperature may be particularly important to improving the habitats for this community type. Re-vegetation of stream banks and restoration of in-stream habitats will bring back more natural conditions where the Atlantic Coolwater Community 2 occurs. Mitigating impervious surfaces will reduce sedimentation and altered hydrology. Reducing non-point source pollution and habitat degradation from storm runoff is important to improve water quality for the mussel community. Watershed managers should addressing storm sewers that contribute to these problems.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Common Large Stream Community

Typified by: Nemourid broadback stonefly (Nemouridae), Ameletid mayfly (Ameletidae), Taeniopterygid broadback stonefly (Taeniopterygidae)

Community Description and Habitat: The streams that support the Common Large Stream Community have high gradient with a diverse assemblage of organisms. Typical community habitats are small to large streams in relatively good condition. Streams that are slow flowing, but are influenced by watershed agriculture are representative of this community habitat in Delaware County. Preston Run and Crum Creek in the upper part of the Crum Creek watershed are habitat for this community.



photo source: www.dec.state.ny.us

Nemourid broadback stonefly

Stream quality rating: Medium

Threats and Disturbances: In the upper parts of the watershed of Delaware County (on the western county border) are influenced by the agricultural landscape. Excess siltation and nutrients from agricultural sources may disturb the community streams. Poorly managed runoff, soil erosion, and livestock access to streams may degrade water quality and habitats. In some locations, runoff from roads, parking lots, and other impervious surfaces can contribute to poor stream quality. The occurrence of unnatural stream flows resulting from storm water can lead to eroding streambanks and loss of stream habitat.



photo source: PNHP

Small to large sized high gradient streams are typical of the community type. Non-point source pollution can cause excess stream sediment or other poor water quality conditions.

Conservation Recommendations: While non-point source pollution occurs in watersheds with the Common Large Stream community, pollution is usually less severe than in other valley streams. In areas where non-point source agricultural pollution occurs, runoff and stream bank erosion can be controlled by installing vegetative buffers of an adequate width along streams in pastures and crop fields. Excluding livestock from streams and riparian zones will also help improve stream habitats over time.

In areas of community development, the establishment or maintenance of vegetative riparian buffers and storm water detention will help to mitigate the effects of increased levels of stormwater. Efforts to create water recharge into the watershed (where impervious surfaces are creating runoff) should be considered.

References

- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh, PA.

PNHP
Pennsylvania Natural Heritage Program

Eastern Elliptio Community

Typified by: Eastern Elliptio (*Elliptio complanata*)

Community Description and Habitat: The Eastern Elliptio Community is widely distributed across the study area and is found in a variety of streams and rivers. The Eastern Elliptio, tolerates many habitats. The community indicator is found in habitats ranging from brooks to large rivers and lakes. The mussel is often the most abundant mussel where it occurs. It can tolerate disturbed and some types of pollution. Stream bottom habitats can be variable, but this community requires some sand and silt mixed with larger cobble and gravel. In Delaware County, the community was found in the Ridley Creek.

Stream Quality Rating: Medium

Threats: The tributaries of Ridley Creek as classified as "Impaired" from urban runoff and storm sewers (PA DEP 2009). Runoff from impervious surfaces, such as buildings, roads, and parking lots, altered hydrology and contributes pollution to many streams in southeastern Pennsylvania. Mussels are not found in many streams in Delaware County because of pollution and altered habitat. Dams in Delaware River tributaries disrupts mussel habitat and may eliminate fish-hosts required to complete the mussel life cycle.



photo source: PNHP

Eastern Elliptio (*Elliptio complanata*)

Conservation Recommendations: Although the Eastern Elliptio is not rare in Pennsylvania, some of the associated species that may occur with this community are less common. Protection of current mussel habitats and high water quality will mean that communities will endure and potentially be reintroduced where they have been lost.

Zebra Mussels have been reported in the Delaware River basin. Monitoring of Zebra Mussel infestation will document the spread and effects of the non-native species on native mussel populations.

Reducing non-point source pollution and habitat degradation from storm runoff is important to improve water quality for the mussel community. Watershed managers should addressing storm sewers that contribute to these problems.



photo source: PNHP

The Eastern Elliptio Community can occupy diverse habitats from small streams, such as Ridley Creek, to large rivers, such as the Delaware River.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Limestone / Agricultural Stream Community

Typified by: Scud (Amphipoda), black fly (Simuliidae), aquatic sowbug (Isopoda), Planaria (Turbellaria), segmented worms (Annelida), midge (Chironomidae), common pond snail (Physidae), predacious diving beetle (Dytiscidae), ram's horn snail (Planorbidae)

Community Description and Habitat: This community is found in small to large streams with low gradients. It often occurs at moderate to low elevation in valley streams with calcareous geology. In southeastern Pennsylvania, there is little limestone, but waterways have similar disturbances to streams in calcareous geologies - a mix or urban and agricultural watershed influences.

When community members, such as scuds and sowbugs, are present in large numbers, they indicate a disturbed community. Example of the community type occurs in Darby Creek and tributaries to West Branch Chester Creek.



photo source: www.dec.state.ny.us

Scud

Stream Quality Rating: Low

Threats and Disturbances: Tributaries to West Branch Chester Creek are influenced by the agricultural setting. Where as Darby Creek is a very urbanized watershed. Pollution and habitat alteration associated with poorly managed agricultural land (e.g., sedimentation, nutrient enrichment, changes in temperature regime) might affect this stream type. DEP (2009) classifies Darby Creek as "Impaired" because of metal contamination and other disturbance from urban runoff and storm sewers.



photo source: PNHP

Low gradient streams valley streams with disturbance are habitat for the Limestone / Agricultural Stream Community.

Conservation Recommendations:
Where this community is common, non-point source pollution from the surrounding watershed may be contributing to degraded water quality and habitat conditions. Although this community type does not signify extremely poor stream quality, some stresses to stream condition are indicated.

Watersheds with large amounts of agriculture and roads have the potential for non-point source pollution. In agricultural streams, runoff and stream bank erosion can be controlled by installing riparian buffers of an adequate width along pastures and crop fields and excluding livestock from streams and riparian zones.

Management of storm water from roads and urban developments and mitigation of any direct stream discharges are recommended. Retention and treatment of storm water would ideally ameliorate water quality in streams receiving urban effluents.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Lower Delaware River Community

Typified by: white perch (*Morone americana*), channel catfish (*Ictalurus punctatus*), blueback herring (*Alosa aestivalis*), eastern silvery minnow (*Hybognathus regius*), white catfish (*Ameiurus catus*), striped bass (*Morone saxatilis*), gizzard shad (*Dorosoma cepedianum*), American shad (*Alosa sapidissima*), banded killifish (*Fundulus diaphanus*)



photo source: http://www.cnr.vt.edu/efish

White perch

Community Description and Habitat: This community mainly occurs in the lower Delaware River and its tributaries at low elevation in the coastal plain where stream gradients are low.

The Delaware River provides a unique riverine habitat in Pennsylvania. One of the only large, free-flowing rivers in North America, the river is influenced by tides downstream of Trenton, NJ. Consequently, the Delaware River has a suite of fauna suited to its coastal environment. The Lower Delaware River Community includes coastal fish that spawn in the lower Delaware River and associated freshwater fish. Several fish like the white perch, blueback herring, striped bass and American shad migrate into the Delaware River for spawning. Other community fish, like the channel catfish, are common in larger rivers.



photo source: PNHP

The lower Delaware River is one of the few un-impounded rivers in North America, and provides a home to the unique Lower Delaware River Community.

Stream Quality Rating: Medium to low

Threats and Disturbances: In typical large rivers, the cumulative degradation from a number of upstream watershed sources contributes to the challenging nature of managing this community's habitat. Although the mainstem of the Delaware River is unimpounded, the number of accumulated dams in the tributaries is large.

The Delaware River faces many challenges in water quality and habitat. The industrial legacy in the watershed leaves waters and sediments polluted. A fish consumption advisory because of PCBs on the Delaware River (PA DEP 2009) is indicative that much pollution remains despite improved regulations on water quality. The large areas of impervious surfaces concentrated in the lower watershed create excessive stormwater. Because of dense human populations surrounding the lower Delaware River, it is subject to typical urban threats such as combined sewer overflows, runoff from residential areas, stormwater discharges and road runoff. In addition, the shipping and commercial industries on the river can contribute to habitat destruction and pollution from dredging, discharges, or spills from boats and barges. Altered shorelines add to other habitat issues.

Conservation Recommendations: Protection of the variety of habitats in large rivers is critical to maintaining a diverse fish community. Shallow and deep pools (slow moving areas) and swift current habitats are examples of habitat types in a large river. Control of combined sewer overflows, residential and road runoff, and stream habitat improvements in populated areas would improve conditions for the fish community. Protecting upland habitats along tributaries help to protect water quality as the river flows into the lower reaches. Remediating legacy industrial pollution, stormwater runoff and combined sewer overflows will restore water quality as the Delaware River flows out to its estuary.

Additionally, preventing major habitat destruction from dredging, improving shoreline habitat, and restoring in-stream conditions will allow fish communities to thrive.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

River and Impoundment Community

Typified by: Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Black Crappie (*Pomoxis nigromaculatus*), Goldfish (*Carassius auratus*)

Community Description and Habitat: The River and Impoundment Community habitat is relatively low gradient large streams and rivers at low elevations. Dam impoundments along rivers create deep pools with soft-sediment stream bottoms. This environment occurs at moderate elevation in slow moving streams and rivers.

An example of community habitat is Chester Creek. The presence of game fish in large streams and rivers, where there is diverse flowing water habitat, is indicative of this community type. Although this community type usually occurs in larger waterbodies, the Delaware River contributes to the Chester Creek fish community. In some locations, the community habitats are designated as a Trout Stocked Fishery by PA DEP. However, cold water species are not dominant where this community occurs. Some River and Impoundment Community streams are considered a Warm Water Fishery by PA DEP.



photo source: http://www.cnr.vt.edu/ef

Yellow perch

Stream Quality Rating: Medium

Threats and Disturbances: Large streams and rivers, downstream of many human settlements, are subject to many types of pollution. Waterways in southeastern Pennsylvania face challenges from runoff, habitat degradation, and a number of industrial facilities. The community habitat may receive effluents from industrial, sewage treatment plants, and storm water discharges. Chester Creek water quality is impaired by organic pollution for industrial point source, and suspended solids from municipal point sources (PA DEP 2009).



photo source: PNHP

Large streams, like Chester Creek, and rivers are common habitats of this community type.

Runoff from impervious surfaces reaches the rivers, carries road contaminants, and alters hydrology. Habitat degradation because of poor riparian buffers or destructive stormwater peak flows may occur. Other concerns for Chester Creek include hydromodification, siltation, and habitat modification (DEP 2009).

This community is primarily composed of fish that are not native to the Delaware River watersheds. Walleye, Black Crappie, and Goldfish are introduced species to the Delaware River basin in eastern Pennsylvania. Many game fish have also been introduced and are actively stocked around Pennsylvania. These fish may have naturalized.

Conservation Recommendations: Large stream and river habitats in good quality condition are rare. The widespread pollution and habitat degradation from stormwater runoff must be addressed in order to clean up streams in southeastern Pennsylvania. Reducing pollution impacts from storm sewers, sewage treatment plants, and any industrial point sources could improve some water quality. Additionally, local watershed managers and municipal planners should work to improve riparian buffers for the sake of fish cover and water quality.

References

- PA Department of Environmental Protection. 2006. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.

Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Small Urban Stream Community

Typified by: Netspinning caddisfly (*Cheumatopsyche*), Stenelmian riffle beetle (*Stenelmis*), blackfly (*Simulium*), dancefly (*Hemerodromia*)

Community Description and Habitat: This community type is typical of small streams flowing through highly urbanized watersheds. It is mainly found in urban watersheds in southeastern Pennsylvania. This community represents a stream that has poor biological integrity and community members that are pollution tolerant.



photo source: www.epa.gov

Netspinning Caddisfly

This community type occurs in streams of low to moderate gradient alkaline streams in the Piedmont region. This community is commonly found in areas of crystalline silicic geology.

Darby Creek, tributaries to Darby Creek, including Foxes Run, Ridley Creek, and Crum Run are habitat for this community.

Stream Quality Rating: Low

Threats and Disturbances: This community has many threats from the surrounding landscape. Community streams are classified as "Impaired" by DEP because of hydro-modification, siltation, habitat modification, urban runoff, storm sewers, and metal pollution. Urbanization can be severely damaging to streams, generally because of road or stormwater runoff and industrial discharges. Runoff from roads and parking lots may be laden with metals, sediments, hydro-carbons and other pollutants. Channelization and other permanent habitat modifications are also common in urban streams. Industrial discharges are frequently found in developed areas and carry a number of pollutants to stream channels. Runoff containing excess nutrients and toxins from residential areas (lawns, parks, etc.) can lead to a variety of stream impairments.



photo source: PNHP

Streams influenced by storm sewers and urban run off are represented by this community.

Conservation Recommendations:
This community type is common in the Piedmont region of southeastern Pennsylvania, where geology types are unique to the study region. Crystalline silicic geology may represent specialized habitats for this community type.

In urban settings, the retention and treatment of municipal discharges and stormwater helps improve stream water quality and habitat condition. This may be accomplished through mitigated wetlands or stormwater retention ponds. Additionally, both in-stream and riparian habitats can be restored through stream bank riparian zone plantings and restoration of natural stream channels.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Sluggish Headwater Community

Typified by: Common pond snail (Physidae), leech (Hirudinea), ram's horn snail (Planorbidae), midge (Chironomidae), agabian predaceous diving beetle (*Agabus*), dextral pond snail (Lymnaeidae).

Community Description and Habitat: The Sluggish Headwater Stream Community is usually found in headwater streams of slow waterways impaired by human influence. Examples of community habitat are Green Creek, a tributary to West Branch Chester Creek, Little Crum Creek, a tributary to Crum Creek, and Whetstone Creek, a tributary to Darby Creek, in Delaware County. Warm waters, soft sediments and slow-moving waters are typical of the community habitat.

Most taxa occurring in this community group are tolerant to organic pollution.



photo source: NWNature.net

Pond snail

Stream quality rating: Low



photo source: PNHP

Small streams with pollution problems are typical of this community type.

Threats and Disturbances:
Crum Creek is designated as "Impaired" by DEP (2009) for urban runoff and storm sewers resulting in hydro-modification, siltation, thermal modification, flow variability; habitat modification. Whetstone Creek is "Impaired" for similar pollution problems from urban runoff.

Conservation Recommendations: Where this community is common, pollution from the surrounding watershed may be contributing to degraded water quality and habitat conditions. Some stresses to stream condition are indicated by the reduced number of organisms including those that are pollution tolerant that occur in the community.

In instances where urban runoff is degrading water quality, retention and treatment of stormwater draining from roads, buildings, and parking lots is ideal to water quality problems in streams receiving urban effluents. Encouraging storm water infiltration through rain gardens, detention basins in new developments and buffer strips will minimize additional runoff.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

Warmwater Community

Typified by: Sunfish (*Lepomis spp.*), Rock Bass (*Ambloplites rupestris*), Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), Common Shiner (*Luxilus cornutus*), Satinfin Shiner (*Cyprinella analostana*), Spotfin Shiner (*Cyprinella spiloptera*), Spottail Shiner (*Notropis hudsonius*), Swallowtail Shiner (*Notropis procne*), Shield Darter (*Percina peltata*), Tessellated Darter (*Etheostoma olmstedi*), American Eel (*Anguilla rostrata*), Bluntnose Minnow (*Pimephales notatus*), Common Carp (*Cyprinus carpio*)



photo source: http://www.ohiodnr.com/dnap

Redbreast Sunfish

Community Description and Habitat: The Atlantic Warmwater Community is found in many larger waterways. The typical habitat is low-gradient, medium-to-large sized streams at low elevations. The pH is neutral and water temperatures are warm.

The community fish prefer pools in warm streams. Some indicator fish are tolerant of low dissolved oxygen and turbid waters. Many community fish are habitat generalists including game fish, like Smallmouth Bass and Bluegill, which were likely stocked in many locations and have since become naturalized.

The larger valley creeks in Delaware County were classified as the Warmwater Community. Sections of Darby Creek, Ridley Creek, Chester Creek, and West Branch Chester Creek are some examples of community habitat. Fish communities are influenced by assemblages in the nearby Delaware River and support a variety of warm water fish species. The community streams are also designated as Trout Stocked Fishery and Warm Water Fishery by PA DEP. The streams may seasonally support trout in some locations. However, coldwater fish species are not dominant in this community.

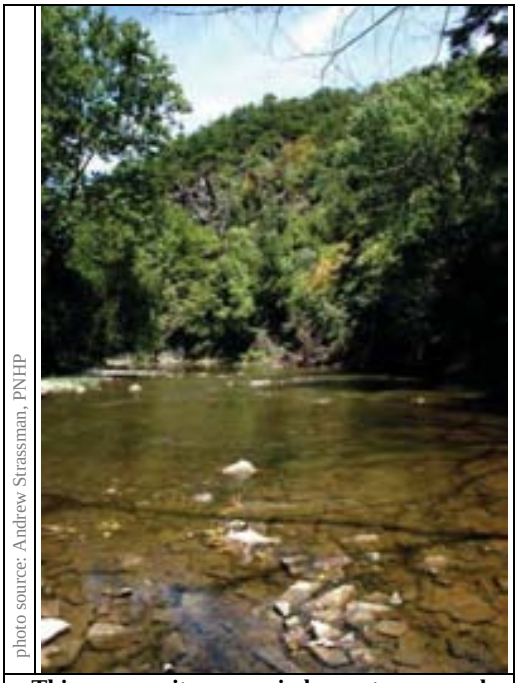


photo source: Andrew Strassman, PNHP

This community occurs in large streams and rivers with warmwaters, because of variety of habitats supports a diverse fish community.

Stream Quality Rating: medium

Threats and Disturbances: Degradation of habitat and water quality in Delaware County threaten the community. Urban runoff, metal-laden storm sewer discharge, siltation, habitat modification, altered hydrology, and municipal point sources are some reasons that Darby Creek, Chester Creek and tributaries to West Branch Chester Creek are considered "Impaired" by PA DEP (2009).

Because developments and roads occur near valley streams, poor urban land management and associated stream discharges are particularly detrimental to this community group. Some larger streams are degraded from residential and municipal discharges. Urban runoff and sewer discharge contain silt, nutrients, and other pollutants that damage stream conditions.

Many fish in the community were not originally present in the Delaware River watershed that covers the eastern region of Pennsylvania. For instance, rock bass and smallmouth bass were introduced into the Delaware River basin and are widely stocked.

Conservation Recommendations: This community is downstream of many human settlements and has been altered to some degree from its natural condition. Protection of the variety of habitats in small rivers is key to maintaining a diverse fish community. Shallow and deep pools (slow moving areas) and swift current habitats are examples of habitat types in a small river. Control of combined sewer overflows, residential and road runoff, and stream habitat improvements in populated areas would improve community quality.

References

- PA Department of Environmental Protection. 2009. Pennsylvania Integrated Water Quality Monitoring and Assessment Report.
- Walsh, M., J. Deeds, and B. Nightingale. 2007a. Classifying lotic systems for conservation: project methods and results of the Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program.
- Walsh, M. C., J. Deeds, and B. Nightingale. 2007b. User's manual and data guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy, Middletown, PA, and Pittsburgh

PNHP
Pennsylvania Natural Heritage Program

APPENDIX VI: SELECTED SPECIES OF CONCERN FACT SHEETS

Great Egret (*Ardea alba*)

Pennsylvania Endangered Bird Species

State Rank: S1B (Critically Imperiled, Breeding) Global Rank: G5 (Secure)

Identification

The Great Egret (*Ardea alba*, formerly *Casmerodius albus*) is a large brilliant white heron slightly smaller than a Great Blue Heron (*Ardea herodias*) standing about 3 feet (1m) tall with a 4.5-foot (1.4m) wingspan. This species is easily told from Pennsylvania's other white herons by its large size and the combination of a yellow bill with black legs.

Hunted to near extinction for the feather trade in the early 1900's, the persecution of this species is a primary reason for the founding of the Audubon Society and the creation of Pelican Island National Wildlife Refuge, the nation's first National Wildlife Refuge. Since its protection the Great Egret has been slowly reclaiming its former range including numerous colonies in the Commonwealth. Today, the main threats faced by the Great Egret are wetland habitat loss, water pollution, and disturbance of nesting colonies.

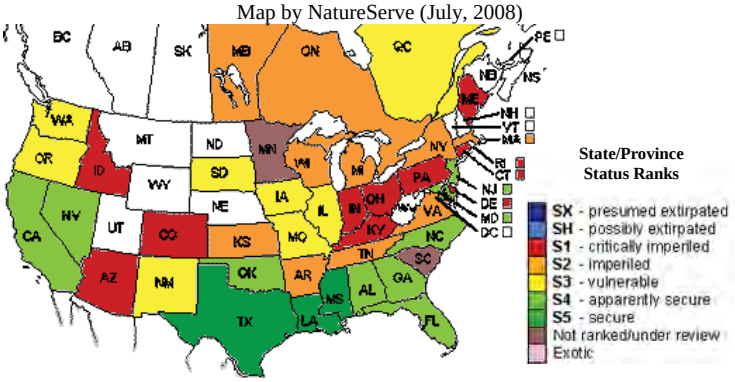


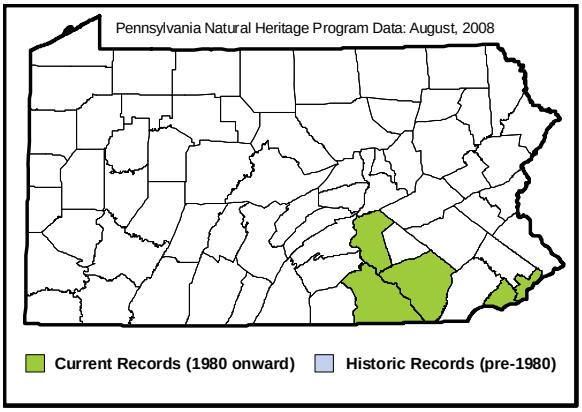
photo source: C. Singletary, Cornell Lab of Ornithology

A Great Egret (*Ardea alba*) stalking prey.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)





Range

The majority of this species population if found south of Pennsylvania in large wetland and estuary complexes with the Mid-Atlantic portion of the population mainly concentrated along the coastline and the major connected rivers including the Delaware and Susquehanna.

Habitat

This egret is typically found feeding in shallow rivers, streams, ponds, lakes and marshes. Nests are found in adjacent trees or shrubby growth, preferable on islands or in trees surrounded by standing water. The birds usually nest in colonies that may include other colonial nesting species.

Conservation Status

Colonial nesting birds are vulnerable to disturbance and direct persecution. Additionally, nesting colonies are susceptible to invasion by predatory animals, which can result in the abandonment of the site. All known nesting colonies should be closed to public intrusion and preserved and buffered from developmental pressures. Additionally, the maintenance, preservation, and restoration of riparian buffers and the few remaining large wetland complexes is essential for this species continued survival.

References

- McCrimmon, Jr., Donald A., John C. Ogden and G. Thomas Bancroft. 2001. Great Egret (*Ardea alba*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/570
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

Pennsylvania Natural Heritage Program

Pennsylvania Bird Species of Concern

State Rank: S3S4 (vulnerable/apparently secure), Global Rank: G4 (apparently secure)

Identification

A rookery is a colony of nesting birds. Great blue herons build their nests as high as 30 meters off the ground, in wooded areas isolated from human disturbance. Although they are wading birds, living on fish caught at the edges of rivers, in ponds, and in wetlands, Great blue heron rookeries may be located well away from water features; one colony found in Pennsylvania was as much as 17 miles from good fishing grounds. They may also nest in mixed-species rookeries with other heron species, other waterbirds, or even raptors such as owls and hawks.



Great Blue Heron (*Ardea herodias*) Rookery.

Habitat/Behavior

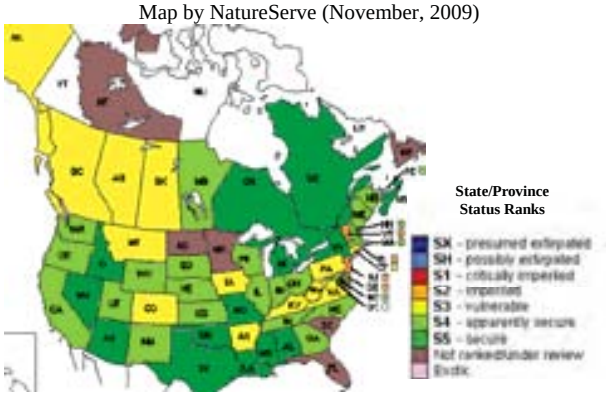
Great blue herons usually return to the same rookery site every year, starting in the spring when males arrive to scout the area and claim their nests, from which they court the later-arriving females. Nests are re-used and expanded year-to-year – they start as simple platforms of sticks but can eventually become saucers up to a meter deep. Each mated pair builds up the nest together, the male bringing new twigs and other materials to the female, who adds them to the structure.

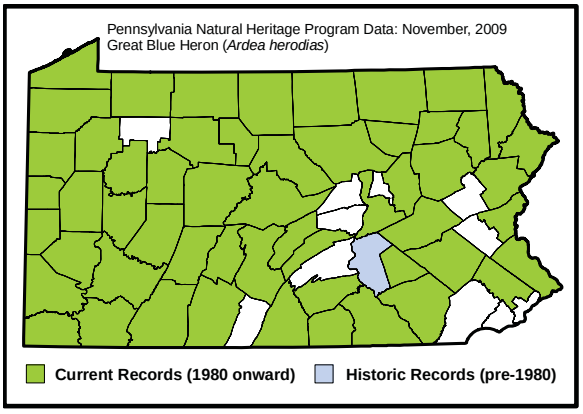
In Pennsylvania, the eggs are laid from mid-March to early June, after the female has had access to sufficient food for a period of about a week. Chicks hatch about a month later, usually a little less than two days apart, in the order in which their eggs were laid with brood contain two or three chicks. The parents share the tasks of incubating feeding, catching more than 20 percent of their own body weight in fish every day.

Great blue heron chicks are covered with a light gray down. Chicks require the most food between 26 and 41 days after hatching, when they may eat 0.6 pounds of fish each day. The chicks are ready to leave the nest by the end of the summer.

North American State/Province Conservation Status

Map by NatureServe (November, 2009)





Conservation

Protection of breeding grounds is one of the keys to conserving bird species. Great Blue Herons tolerate fewer disturbances to their breeding colonies than most waterbirds. It is recommended that human activity be excluded from a buffer zone of 300 meters (roughly 1000 feet) around heron rookeries to prevent people from scaring the herons off their nests. Severe or prolonged disturbance may cause the birds to abandon the nesting site, though they may re-colonize nearby if they find suitable habitat. Rookeries are also vulnerable to destruction of forest habitat and, when they are located in wetlands, changes to the flood regime that may kill trees.

References

Bennett, Darin C., Philip E. Whitehead, and Leslie E. Hart. 1995. "Growth and energy requirements of hand-reared Great Blue Heron (*Ardea herodias*) chicks." *The Auk*, 112(1): 201-9.

Brauning, Daniel W., ed. 1992. Atlas of Breeding Birds in Pennsylvania. Pittsburgh: University of Pittsburgh Press. 50-1.

Butler, Robert. W. 1992. "Great Blue Heron." *In* The Birds of North America, No. 25 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer . (Accessed: November 6, 2009).

Rodgers, James A. and Henry T. Smith. 1995. "Set-back distances to protect nesting bird colonies from human disturbance in Florida." *Conservation Biology*, 9(1): 89-99.

PNHP
Pennsylvania Natural Heritage Program

Short-eared Owl (*Asio flammeus*)

Pennsylvania Endangered Bird Species

State Rank: S1B (critically imperiled breeding), S3N (vulnerable non-breeding) Global Rank: G5 (secure)

Identification

The short-eared owl received its name from its lack of "ear" tufts. It is about the size of a crow, 13 to 17 inches high, and has a 38- to 44-inch wingspan. Their color varies from light to dark brown with darker patches on the undersides of their wings, and large buff-color patches on the upper sides being distinctive. Short-eared owls are grassland birds that nest on the open ground, sometimes in lose colonies. The nest is a sight depression, which is lined with grass and feathers and is often invisible within the matrix of grassland plants. Unlike most other owls, the short-eared is active at dusk, dawn and – at times – even in mid-day; therefore, they are seen more often than many other owl species.

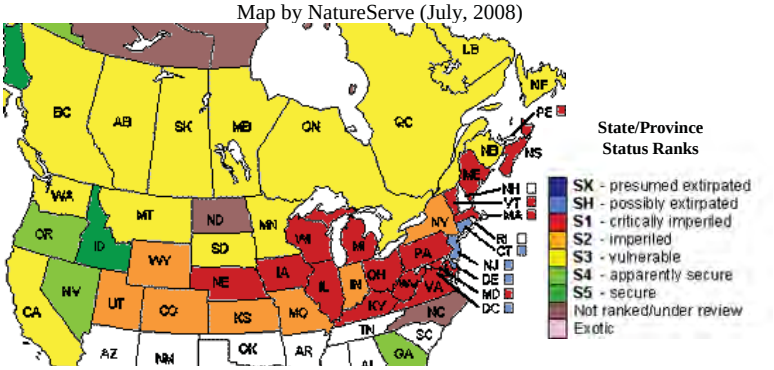


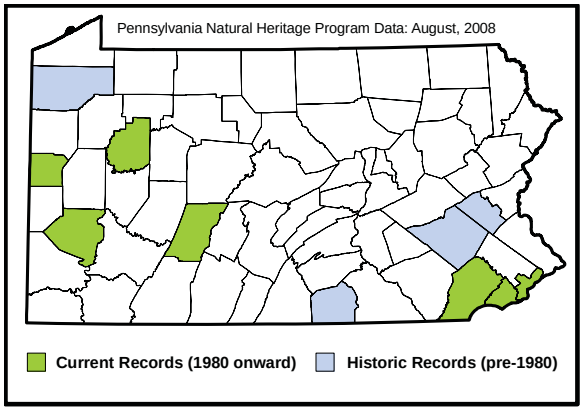
photo source: Rita Hawrot, PNHP

Short-eared Owl (*Asio flammeus*) chick in nest

North American State/Province Conservation Status

Map by NatureServe (July, 2008)





Range

Short-eared Owls occur in grasslands in many part of the world including North and South America, Eurasia, and even isolated islands such as Iceland and Hawaii. They both breed and winter in the Commonwealth allowing them to be found in the state year-round.

Habitat

This owl is found in grasslands and shrublands. Generally preferring large to expansive areas of contiguous habitat during the breeding season, Short-eared Owls can be found in a wider range of habitats during the winter. They are commonly observed during the winter in fallow farm fields and similar habitat.

Management Practices

Suitable nesting habitat for the Short-eared Owl is extremely limited in Pennsylvania, and intensive agricultural practices make many potential habitats unsuitable. Most substantial areas of open lands are farmlands and, therefore, subject to repeated disturbance. Accordingly, the welfare of grassland nesting birds is threatened. This may be why the only known nests of http://www.dcnr.state.pa.us/wrcf/define1.aspxshort-eared owls are found in extensive, low-disturbance open lands, e.g. reclaimed strip mines and wildlife refuges. Future management should include the creation and maintenance of large, herbaceous preserves suitable for all grassland nesters. Primary management of these areas must assure minimal disturbance during nesting and prevention development or succession to an unusable habitat.

References:

- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Wiggins, D. A., D. W. Holt and S. M. Leasure. 2006. Short-eared Owl (Asio flammeus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/062

Pennsylvania Natural Heritage Program

American Bittern (*Botaurus lentiginosus*)

Pennsylvania Endangered Bird Species

State Rank: S1B (Critically Imperiled, Breeding) Global Rank: G4 (Apparently Secure)

Identification

This large, cryptically-colored heron is most often seen when flushed from marshes, but instantly identified by its unique water-pump-like "oong-ka' choonk" call. A large compact heron up to 34 inches tall and with a 50-inch wingspan, its streaked brown plumage, and black moustache-like cheek markings are diagnostic. When threatened, individuals stand upright with their bill pointing upward causing them to blend into the surrounding vegetation. At times they even sway from side to side, moving like the tall reeds and grasses surrounding it.

Occasionally seen stalking along shorelines and marsh edges, American Bitterns prey on amphibians, fish, snakes, crayfish, insects, and even small mammals. Nesting singly rather than colonially like many herons, this bittern defends a hunting territory around its nest. Generally, American Bitterns build platform nests of woven reeds and grasses above the water's surface, but are know to occasionally nest in thick tall grassy uplands next to large wetlands.



photo source: Mary Tremaine, Cornell Lab. of Ornithology

American Bittern (*Botaurus lentiginosus*) in a frozen defensive stance imitating vegetation.

Range

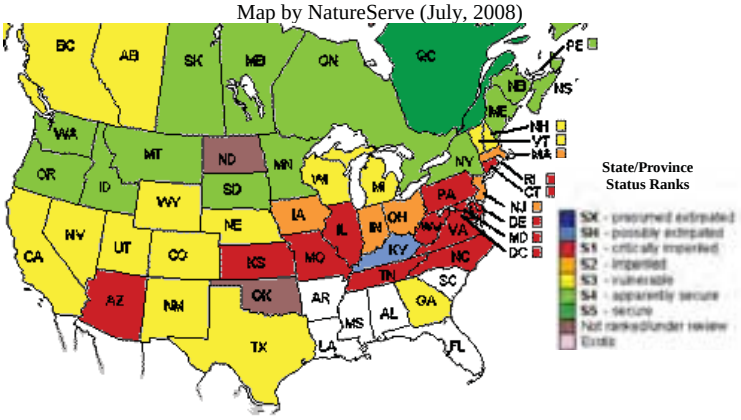
American Bitterns nest in large marsh complexes across the central and northern United States and southern Canada and are rarely found in smaller wetlands. Wintering across the southern United States and into Mexico and Central America, they are limited by the need for open water. This allows bitterns to stay in southwestern Pennsylvania year round, but generally they are most commonly seen the during spring and fall migrations.

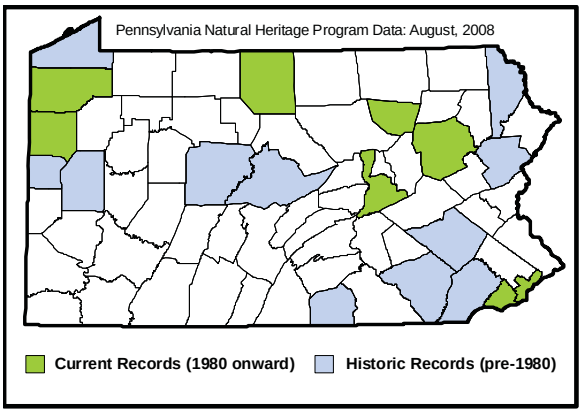
Habitat

American Bitterns require wetland habitats and prefer large, extensive wetlands complexes composed of a mixture of different vegetation types and water depths.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)





Conservation Status

The continuing degradation and disappearance of the wetland habitats across the continent has resulted in American Bittern showing continent-wide population decreases since 1986. Additional concerns include the invasion of wetlands by non-native plant species, increased runoff from high-input agriculture, and incidental take during game-bird hunting. Measures necessary for the conservation of this species include the protection and restoration of large marsh complexes in both the breeding and wintering range of this species along with islands of suitable and sufficient wetland habitat along the species migratory route.

References

- Felbaum, Mitchell, et al. Endangered and Threatened Species of Pennsylvania. Harrisburg, PA: Wildlife Conservation Resource Fund, 1995.
- Gibbs, J. P., S. Melvin and F. A. Reid. 1992. American Bittern (Botaurus lentiginosus), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/018
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

PNHP
Pennsylvania Natural Heritage Program

Northern Harrier (*Circus cyaneus*)

Pennsylvania at Risk Bird Species

State Rank: S3B; S4N **(Vulnerable, Breeding; Apparently Secure, Non-Breeding)** **Global Rank: G5** **(Secure)**

Identification

Northern Harriers are medium-sized, long-winged, long-tailed hawks with rounded wings that can appear pointed while gliding. This species is typically 16.5 inches long with a wingspan of 42 inches, with the females averaging a bit larger than the males. Field marks include a white rump, short, dark, hooked beak, and flat face with an owl-like facial disk. This species has the behavior of flying low over marshes and fields harrying the ground in a constant back and forth flight. The male is pale gray above and even paler on the underside with a dark gray head, with dark tips on the flight feathers, and narrow dark bars on the tail. The female and juveniles are dark brown above, with buff underparts and dark streaks on their breast, belly, and under wing coverts, dark barring on the tail, and dark patch on inner wing created by dark secondaries and secondary coverts.

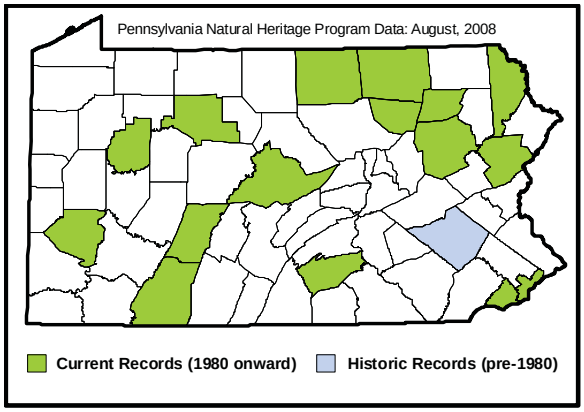


photo source: Ron Austing

Adult male Northern Harrier (*Circus cyaneus*)

Range

This species breeds widely across North America, but is limited to areas with extensive grassland and marshland habitat.

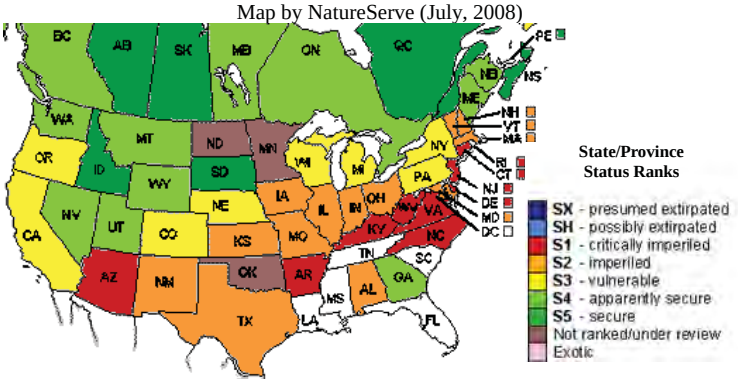


Habitat

Northern Harriers use areas with extensive and interconnected wetland, marshland, and grassland habitat. open wetlands, including marshy meadows, wet lightly grazed pastures, old fields, freshwater and brackish marshes, and dry uplands composed of open habitat. In Pennsylvania, this species also uses reclaimed strip mines for nesting in some areas.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Conservation Status

Northern Harriers declined slowly from 1966 to 1987 throughout North America, including Pennsylvania. Loss of wetlands and suitable field habitat are the primary causes of the widespread decline. Other reasons for decline may include suburban development, reforestation of abandoned fields, the conversion of hay fields to row crops and increasingly intense farming practices, and use of organochlorine pesticides such as DDT. This species is listed as an endangered or threatened species in numerous states with the protection of large, open wetland and grassland complexes across its range needed to secure the future for the Northern Harrier.

References

- Gough, G.A., Sauer, J.R., Iliff, M. Patuxent Bird Identification Infocenter. 1998. Version 97.1. Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/Infocenter/infocenter.html
- MacWhirter, R. Bruce and Keith L. Bildstein. 1996. Northern Harrier (*Circus cyaneus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/210
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

PNHP
Pennsylvania Natural Heritage Program

Marsh Wren (*Cistothorus palustris*)

Pennsylvania Candidate Rare Bird Species

State Rank: S2S3B (Imperiled/Vulnerable, Breeding) Global Rank: G5 (Secure)

Identification

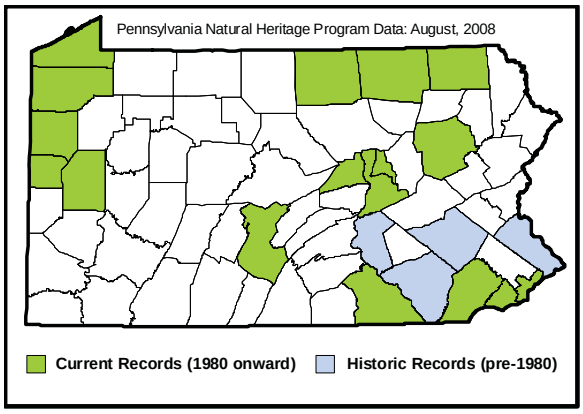
A secretive little bird often confused with the Sedge Wren (*Cistothorus platensis*), Marsh Wrens are uncommon, but regular residents of wetlands dominated by rank vegetation such as cattails (*Typha* spp.) and common reed (*Phragmites australis*). Often first identified by its distinctive, complex, and varied song, this wren is easily identified when heard calling within a wetland. Some males are recorded as having up to 200 unique songs that they use in vocal duels with neighboring males. Noted for the strong white eyebrow, rufous wings, and black-and-white stripped shoulder, this species rarely sits still long enough to be positively identified in one look as it scrambles through the vegetation.

Marsh Wrens lead interesting family lives with one male defending a territory that can contain several nesting females. Within this territory will be numerous "dummy" nests built by the male to exhibit his nest-building and territory defense skills. On average, a male will build six nests for every female nesting within his territory.



photo source: http://www.naturespicsonline.com/

Singing Marsh Wren (*Cistothorus palustris*)

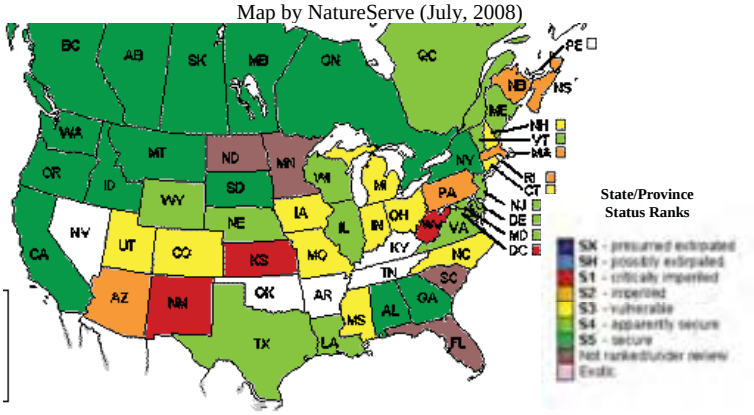


Range

The Marsh Wren is found in two distinct populations that overlap along a line running through the Great Plains, but otherwise do not overlap during the breeding season. They are found breeding in appropriate habitat along the coast lines of the Atlantic, Pacific, and Gulf of Mexico in North America north to Maine and British Columbia and south to approximately Mexico with a band colonizing the central US and southern Canada. Wintering in the southern US and Mexico, Marsh Wrens are also know to reside year-round in southeastern Pennsylvania.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Habitat

A resident of marshland and wetlands with emergent vegetation, Marsh Wrens tend to build their nests over shallow water near the edge of the wetland. As the summer progresses or during dry years, nests will be built further into the marsh where it is less likely to dry out. Wintering habitat is generally similar to breeding habitat, but may extend into upland grassy and low shrubby areas.

Conservation Status

This species, like all species dependent on large complex marsh systems, is suffering from a severe reduction in available habitat, which has generally been drained to allow other land uses. Additionally, hydrology altering practices and the invasion of non-native species is also reducing existing habitat further endangering this species. Key conservation actions for this species are the preservation of existing large marshes and the management of the marshes to preserve the quality of the habitat they provide.

References

- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.
- Kroodsma, D.E., and J. Verner. 1997. Marsh Wren (Cistothorus palustris). In The Birds of North America, No. 308 (A. Poole and F Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

PNHP
Pennsylvania Natural Heritage Program

Peregrine Falcon (*Falco peregrinus*)

Pennsylvania Endangered Bird Species

State Rank: S1B;S1N (Critically Imperiled Breeding and Non-breeding) Global Rank: G4 (Apparently Secure)

Identification

A larger 15- to 22-inch falcon, adults have dark-bluish gray upperparts and wings contrasted against a dark-barred buff breast. The head has a nearly black helmet-like appearance against the buff cheeks. Like all falcons, the Peregrine has long pointed wings, rapid steady wing beats, and can fly exceptionally fast.

Peregrine historically nested across the planet utilizing cliff-faces along rivers as their preferred nesting location. However, by 1961 there were no Peregrines left in Pennsylvania. Their decline and extirpation has been attributed to egg collecting, falconry and shooting, but chiefly to organochlorine pesticides such as DDT. Today some cliff nests are being recolonized, but Peregrine Falcons have adapted amazingly well to the urban cliff-faces of skyscrapers and bridges enjoying the easy dining of city-dwelling Pigeons (*Columba livia*).

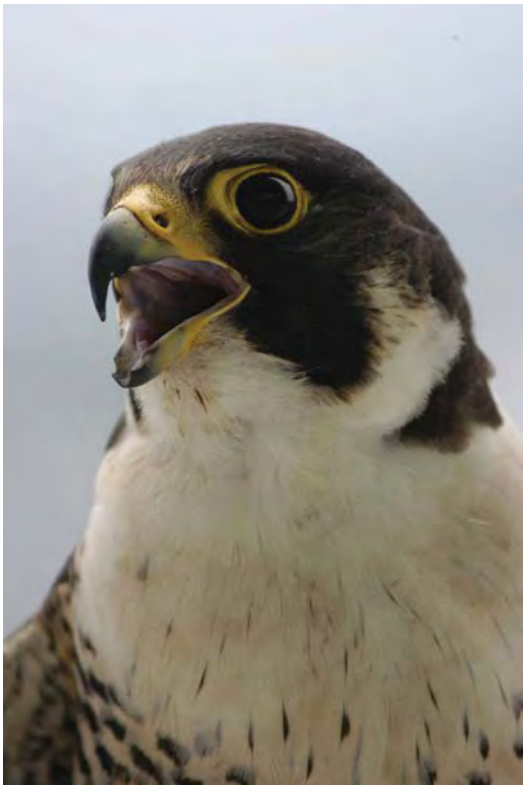
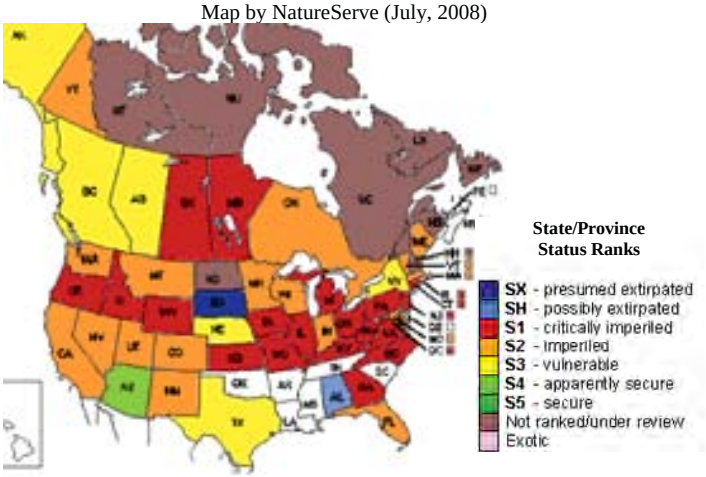


photo source: Joe Kosack, PA Game Commission

Peregrine Falcon (*Falco peregrinus*)

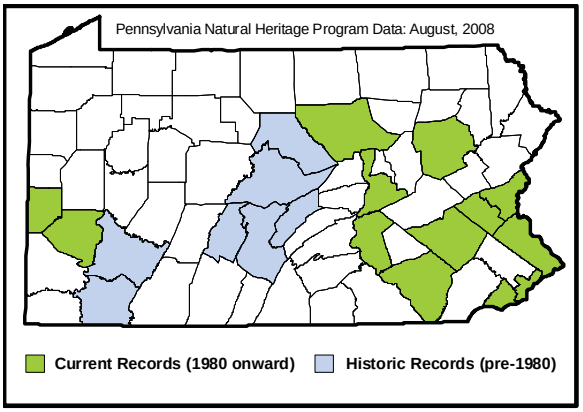
North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

Per its name, the Peregrine Falcon is found almost everywhere on the planet where sufficient prey and habitat exist. Well adapted to the human environment, this species in know from most major urban areas around the globe with nests in some of the Commonwealth's major cities including Philadelphia, Pittsburgh, Reading, and at the Three Mile Island power plant.



Habitat

The combination of a sufficient prey base and a safe nesting location seem to be the limitations to where this species can nest including riparian, grassland, forested, desert, tundra, and urban environments.

Conservation Status

The plan to restore this species includes annual surveys for new nest sites; protection of known nest sites, including hazard reduction to increase survival of young peregrines; restoration of peregrines at suitable historic sites; and promotion of public support. A successful reintroduction program has released birds in Harrisburg, Reading, and Williamsport, PA.

References

- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.
- White, Clayton M., Nancy J. Clum, Tom J. Cade and W. Grainger Hunt. 2002. Peregrine Falcon (*Falco peregrinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/660

PNHP
Pennsylvania Natural Heritage Program

Pennsylvania Threatened Bird Species

State Rank: S2B (imperiled, breeding) Global Rank: G4 (apparently secure)

Identification

Bald Eagles are large raptors with a body length up to 32 inches and a wingspan up to 80 inches. Male and female Bald Eagles are similar in plumage. The most notable features are a white head and upper neck, whiter tail, dark brown body, and a heavy yellow bill. Juveniles are dark brown overall, and gradually acquire adult plumage over a period of four years. Juveniles have a dark bill and cere, dark brown body plumage, including head and tail, variable amounts of white on the undertail coverts, belly, and back.



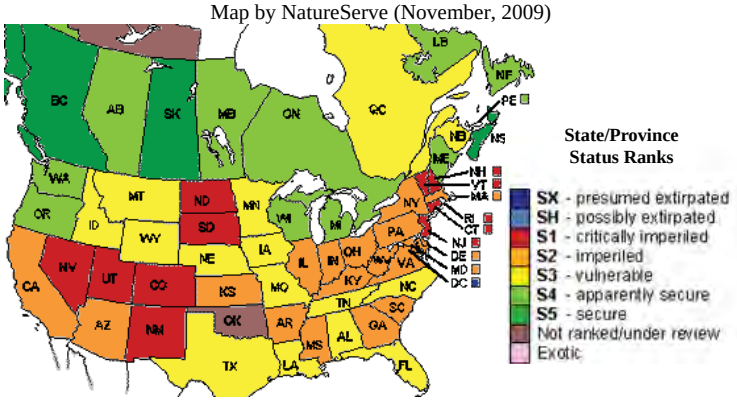
Bald Eagle (*Haliaeetus leucocephalus*).

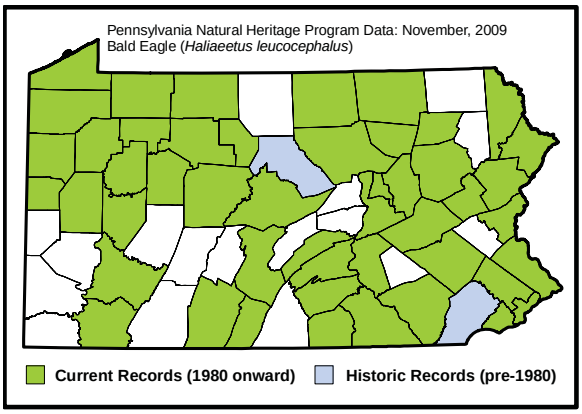
Range

Bald Eagles have extensive breeding populations in Alaska, with major populations in the coastal regions. This species breeds throughout most of Canada, especially along coastal areas. In the continental United States, Bald Eagles breed extensively along the Atlantic Coast from Florida to the Maritime Provinces of Canada. Also, this species breeds in the Great Lake States in Minnesota, Michigan, and Wisconsin, and in the Pacific Northwest (California, Oregon, and Washington). Breeding populations occur along the Gulf Coast in Louisiana and Texas. In Pennsylvania, Bald Eagle populations have been increasing, and can now been found throughout Pennsylvania, with most sightings concentrated in the northwestern and southeastern corners of the state.

North American State/Province Conservation Status

Map by NatureServe (November, 2009)





Habitat

This species is typically associated with forested areas adjacent to large bodies of water. Bald Eagles nest in trees, rarely on cliff faces, and ground nest in treeless areas. The majority of Bald Eagle nesting areas are found in mature and old-growth forests with some habitat edge, usually within 2 kilometer to water with suitable foraging opportunities. The quality of foraging areas are defined by diversity, abundance, and vulnerability of the prey base, structure of aquatic habitats, such as the presence of shallow water, and the absence of human development and disturbance. In Pennsylvania, this species nests on islands in major rivers and in forested areas and erected platforms along major rivers, reservoirs, large wetlands, lakes, ponds, and streams.

Conservation Status

This species is currently listed as a Threatened species at the state and federal level. Bald Eagles breeding in Pennsylvania have made a major contribution to the downgrading of this species from Endangered. In the 1970's, Bald Eagle nesting pairs were at an all time low of two due to the effect of the insecticide DDT and pollution of major waterways. Since then, this species has made a comeback, and recently, over 100 nests have been recorded across the state. Continued success of the breeding areas will depend on protection from human persecution and environmental contaminants. Other threats include water quality degradation, disturbance of nesting areas, and disease. If ecological conditions in Pennsylvania continue to improve, there is no reason why this species will not increase nesting populations to increase assurance that Bald Eagles will be around for generations to come.

References

Buehler, David A. 2000. The Birds of North America, No. 506: Life Histories for the 21st Century Bald Eagle (Haliaeetus leucocephalus).

Brauning, D.W. (ed). 1992. Atlas of Breeding Birds in Pennsylvania Univ. of Pittsburg Press, Pittsburgh, PA. 484 pp.

Gough, G.A., Sauer, J.R., Iliff, M. Patuxent Bird Identification Infocenter. 1998. Version 97.1 Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/Infocenter/infocenter.html

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer (Accessed: November 6, 2009).

Pennsylvania Natural Heritage Program

Least Bittern (*Ixobrychus exilis*)

Pennsylvania Endangered Bird Species

State Rank: S1B (Critically Imperiled, Breeding) Global Rank: G5 (Secure)

Identification

The Least Bittern (*Ixobrychus exilis*) is an inconspicuous 11 to 14 inches in length with a wingspan of only 16 to 18 inches making it the smallest member of the heron family. The plumage of this species is evolved to blend in; its black and tan body, blackish-green cap and back, and white and brown streaked throat make the bird very difficult to pick out in wetlands. When disturbed, the least bittern is more likely to run than fly, and like its relative, the American Bittern (*Botaurus lentiginosus*), it also has the habit of freezing with its bill pointed straight up when alarmed allowing it to readily blend in with the marsh vegetation.



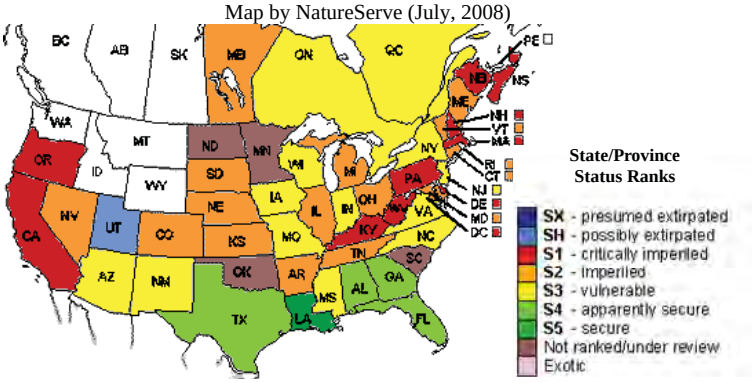
photo source: A. & E. Morris, VIREO

Least Bittern (*Ixobrychus exilis*)

Hunting where the marsh transitions from vegetation to open-water, this species is know to build hunting platforms from the vegetation and is able to catch fast moving prey including small fish and dragonflies. The least bittern arrives in Pennsylvania in April and both parents help build a nest platform of reeds and grasses near open water. Four or five pale blue or green eggs are laid in the 6-inch nest in mid or late May with hatching in slightly less than three weeks. Hatchlings leave the nest at two weeks and fledge in only four to six weeks from hatching.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)

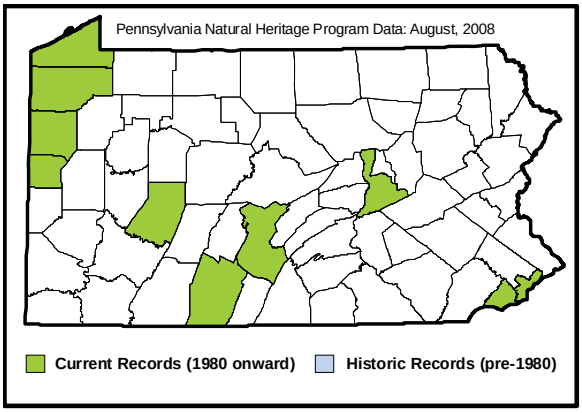


Range

The Least Bittern nests in wetland areas throughout the eastern United States and along the Pacific coast with resident populations throughout Mexico and South America. This species winters along the Gulf of Mexico coast, and down through Mexico into South America. A regular migrant through the state, it generally nests in the Commonwealth's northwest and southeast corners, with possibly a few other central locations in the larger marshes.

Habitat

Least Bitterns thrive in dense extensive marshland environments containing cattails and reeds, along the coast and inland, where they feed primarily on small fish, amphibians, and both aquatic and terrestrial insects. In exceptional habitat as many as 6 nests per acre (15 per hectare) have been documented.



Conservation Status

Nesting opportunities for this species in Pennsylvania are limited and decreasing as the wetland habitat it needs have been extensively drained or impounded. Areas where this species is known to nest must be protected. Surveys are being conducted to determine where it does actually nest, and marshland habitats can be managed to provide additional nesting habitat.

References

- Gibbs, J. P., F. A. Reid and S. M. Melvin. 1992. Least Bittern (Ixobrychus exilis), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/017
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

PNHP
Pennsylvania Natural Heritage Program

Black-crowned Night-heron (*Nycticorax nycticorax*)

Pennsylvania Endangered Bird Species

State Rank: S2S3B (Imperiled/ Vulnerable, Breeding) Global Rank: G5 (Secure)

Identification

A common though secretive species, Black-crowned Night-herons (*Nycticorax nycticorax*) are becoming common resident in urban areas as their populations once again increase. Experiencing significant population declines in the 1960's, this species and many others were adversely affected by the use of DDT. Crepuscular to nocturnal, Black-crowned Night-herons are most often seen along ponds and river near dusk. Very distinctive when seen, adults are noted for their black back and crown, grey wings, and white breast they also have a blood-red eye and a thin white plume on their crown.

Nesting in trees usually in groups and often with other heron species, some nesting colonies on islands have been noted to host several 1,000 pairs. During the day these colonies are home to the Black-crowned Night-heron, which leave at dusk to hunt for fish, crustaceans, amphibians, and even small mammals, the parents return to the nest over the night to feed the young and return to roost at dawn.

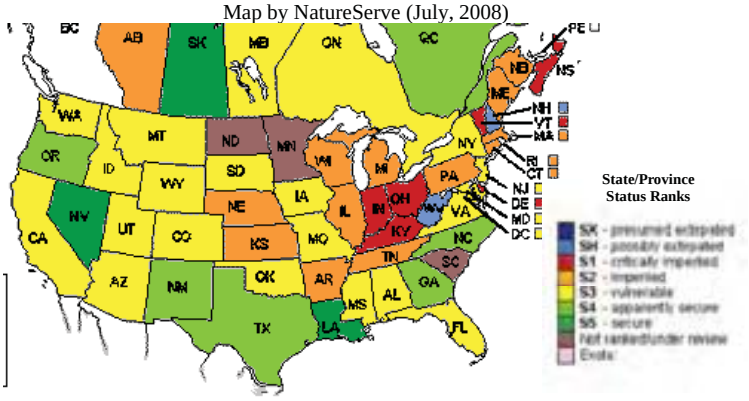


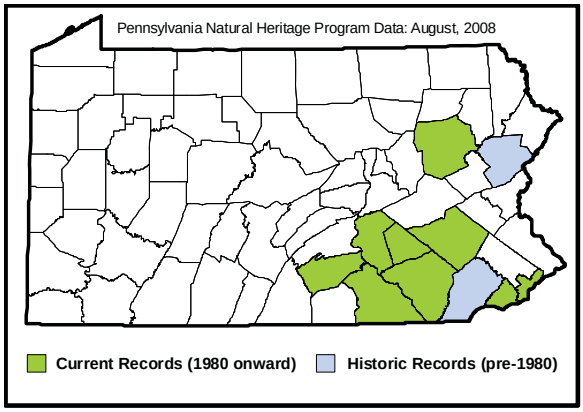
photo source: Andrew Strassman

Black-crowned Night-heron (*Nycticorax nycticorax*)

North American State/Province Conservation Status

Map by NatureServe (July, 2008)





Range

Breeding range extends across the continental US with population density related to the presence of quality nesting and foraging habitat. Winter range includes is limited by the presence of open water with birds noted in southeastern Pennsylvania year round.

Habitat

Mostly associated with large wetland complexes, but also along large riparian systems with adequate hunting locations. Nesting colonies generally found in trees on islands or otherwise protected from predation.

Conservation Status

The protection and expansion of large, healthy wetland complexes is important for this species survival. Additionally, as nesting colonies expand into urban areas there is the potential for intentional disturbance by humans given the "noise and mess" associated with colonies.

References

- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.
- Davis, W.E., Jr. 1993. Black-crowned Night-heron (*Nycticorax nycticorax*). *In* The Birds of North America, No. 74 (A. Poole and F. Gill, Eds.). Philadelphia Academy of Natural Sciences; Washington, D.C.: the American Ornithologists' Union.

Pennsylvania Natural Heritage Program

Osprey (*Pandion haliaetus*)

Pennsylvania Threatened Bird Species

State Rank: S2B (Imperiled, Breeding) Global Rank: G5 (Secure)

Identification

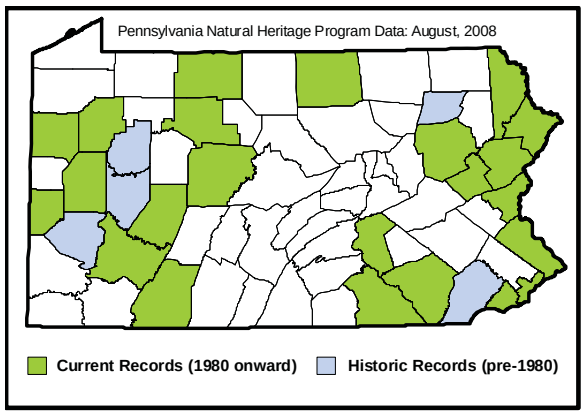
The Osprey is a distinctive bird of prey most often seen around open water. With white underparts, a brown back and wings, and a white head with a small crest, Osprey are know for their striking yellow eyes and brown eye stripe. Fish make up the vast majority of the Osprey's diet with hunting Osprey commonly attached by gulls, crows, and eagles intent on stealing their catch.

Like the Bald Eagle (*Haliaeetus leucocephalus*), the Osprey suffered a significant population decline linked to the use of organochlorine pesticides. These toxins bioaccumulated in the environment with the Osprey, a top predator, ingesting large quantities of the chemical from the fish they ate. This chemical interfered with the creation of the shell on their eggs causing the eggs to crack as the adults incubated them. Several generations of Osprey chicks were lost as a result and Osprey populations began to plummet. With the cessation of DDT use in the US Osprey populations have begun to recover.



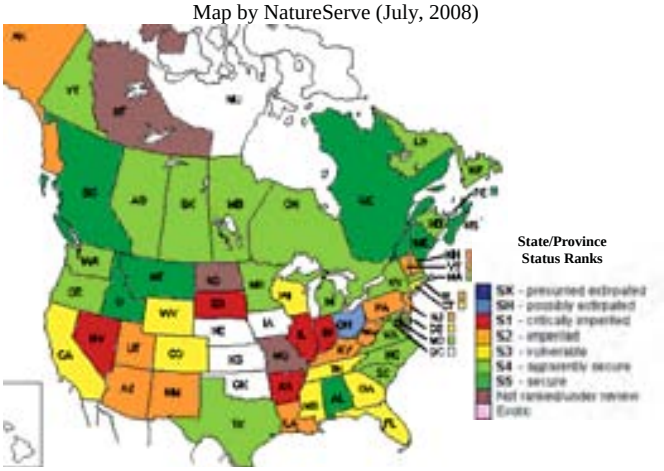
photo source: Kirk Piehler, US Army Corps of Engineers

Young Osprey (*Pandion haliaetus*) on nest



North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

Ospreys inhabit every continent but Antarctica, nesting in trees, snags, and ever-increasing man-made structures located near high quality fresh- or saltwater fishing grounds.

Habitat

Nesting in both "wild" and highly urban environments, the habitat requirements for Osprey seeming to be quality fishing grounds near a suitable nesting platform.

Conservation Status

Osprey populations can be supported by the construction of nesting platforms, protection of breeding and fishing habitat, and monitoring the environment for possible sources of bioaccumulating toxins. Continued reduction and monitoring of pollutants including pesticides and heavy metals will also be necessary, since top predators such as the Osprey are particularly vulnerable to these poisons. Reduction of organochlorine pesticide use in the species' South American range, where DDT is still commonly used, is a high priority.

References

McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.

Pennsylvania Natural Heritage Program. 2008.

Poole, Alan F., Rob O. Bierregaard and Mark S. Martell. 2002. Osprey (*Pandion haliaetus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/683

PNHP

Pennsylvania Natural Heritage Program

King Rail (*Rallus elegans*)

Pennsylvania Endangered Bird Species

State Rank: S1B (Critically Imperiled, Breeding) Global Rank: G4 (Apparently Secure)

Identification

The King Rail (*Rallus elegans*) is so named because of its large size and bright coloration. Approximately chicken-sized, this species is a bright rusty color with a brown-tipped yellow bill. With a wingspan of up to 25 inches (63cm), males of this species are larger than females. Nesting on platforms built on hummocks, nests are generally built 12-inches above the water to prevent flooding during rains. Wading in shallow water, King Rails feed on crustaceans, small fish, frogs, and insects.

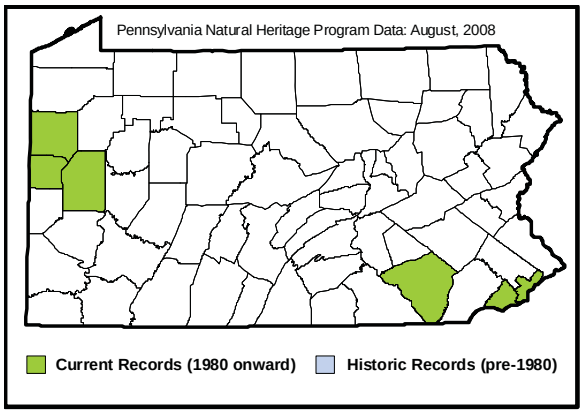
This species is extremely secretive and will generally run through the vegetation rather run than fly to escape detection. They are rarely seen, therefore, and are most often located by their loud calls, a resonant grunting bup-bup, bup, bup, bup, more rapid at the end.

King Rails, never common in Pennsylvania, have shown persistent population declines in recent decades. This apparent decline is considered to be due primarily to the loss of wetland habitat.



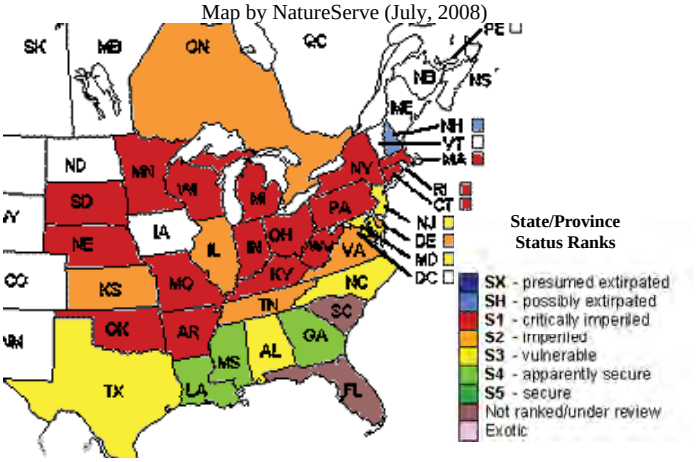
photo source: L. B. Wales, Cornell Lab of Ornithology

King Rail (*Rallus elegans*) hunting for invertebrates



North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

Found year-round in the coastal marshes from Florida to Texas, northern population, including those in Pennsylvania, are migratory. The northern extent of this species in near Canada in the Great Plains and southern New York along the Atlantic coast.

Habitat

This rail lives in freshwater and brackish marshes and occasionally roadside ditches in eastern North America. It is a very rare breeder in the few larger marshes remaining in Pennsylvania.

Conservation Status

As with many other endangered and threatened species, the King Rail needs wetlands in order to exist. Maintaining healthy, large, functional wetlands is the only way to maintain population of this species within the Commonwealth.

References

- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.
- Poole, Alan F., L. R. Bevier, C. A. Marantz and Brooke Meanley. 2005. King Rail (*Rallus elegans*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/003

PNHP
Pennsylvania Natural Heritage Program

Virginia Rail (*Rallus limicola*)

Pennsylvania Bird Species of Concern

State Rank: S3B (Vulnerable, Breeding) Global Rank: G5 (Secure)



Virginia Rail (*Rallus limicola*)

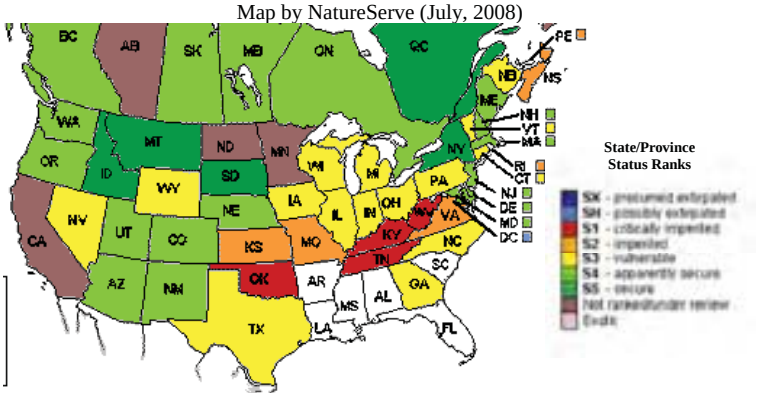
Identification

A denizen of the cattail edges of large marsh complexes and small isolated wetlands, the Virginia Rail (*Rallus limicola*) is probably the most common rail species in the Commonwealth. Distinguished from similar species by the combination of smaller size (9-inches) and a long bill (1.5-inches), this species is a rusty brown with a grey cheek patch. The bill and legs, a noticeable red to orange-brown, are also easily picked out among the marsh vegetation.

Migrating into Pennsylvania as wetlands re-green in the spring, nesting begins in May with the chicks hatching in June and fledging in July. Fall migration may begin as early as mid-August and generally most birds have left by mid-October, but individuals have been recorded in marshes until freezes force them south.

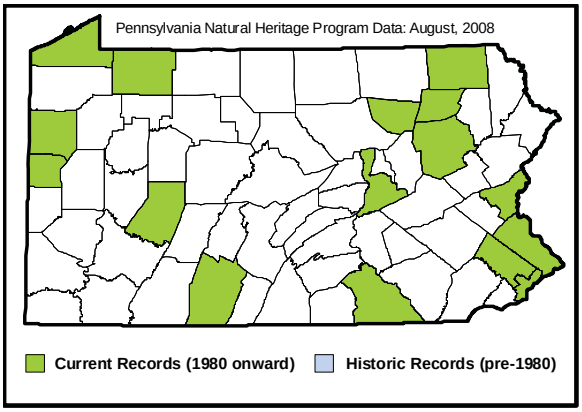
North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

Found breeding in suitable habitat throughout northern North America with wintering grounds composed by wetlands along the Gulf Coast and into Mexico.



Habitat

Prefers early-successional marshlands with little standing-dead vegetation to impede movement and foraging. Nests in similar habitat over water in a woven nest concealed by marsh vegetation. Utilizes mudflats and shallow water (<6 in deep) in emergent wetlands for foraging with a vegetative canopy seeming to be an important component. Areas of open water near foraging habitat are important for increased invertebrate production.

Conservation Status

This species faces to different threats to its continued presence and prevalence in the Commonwealth. The first is the destruction of existing marsh habitat through draining, filling, flooding, development, and invasion by non-native invasive species. The second is the succession of existing wetland habitat into an unsuitable tangle of standing-dead vegetation that the Virginia Rail cannot use. To maintain this species in the Commonwealth existing marshlands must be protected from modification or destruction. Additionally, early-successional marsh habitat composed of native wetland species must be created on a regular basis to provide for adequate nesting and foraging habitat.

References

- Conway, Courtney J. 1995. Virginia Rail (*Rallus limicola*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/173
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

Pennsylvania Natural Heritage Program

Barn Owl (*Tyto alba*)

Pennsylvania Candidate Rare Bird Species

State Rank: S3B; S3N (Vulnerable, Breeding and Non-breeding), Global Rank: G5 (secure)

Identification

The Barn Owl (*Tyto alba*) is a member of the family Tytonidae, the only representative of that family occurring in the United States. Barn Owls are on average 14 inches long with a wingspan of 44 inches. It is a large, nocturnal, and predatory bird with a large rounded head. It has pale facial disks with a dark frame. This species has tawny and gray upperparts with small black and white spots, and white underparts with scattered dark spots. The two sexes are similar to each other. The Barn Owl is easily distinguished from other owls by its face pattern. Flight patterns are similar to Long-eared and Short-eared Owls but lacks dark wrist marks.



photo source: Jim Malone

Barn Owl (*Tyto alba*) owlets in nest box and adult perched in a barn.

Range

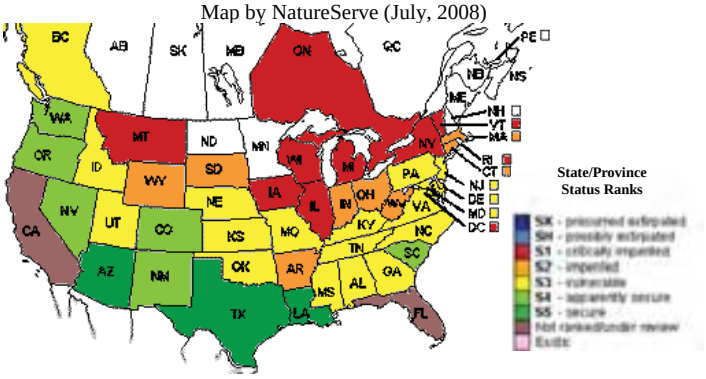
Barn Owls have a nearly worldwide distribution, being absent from only the high latitudes. It is found throughout most of the United States and it frequents open areas with suitable nesting areas in Pennsylvania.

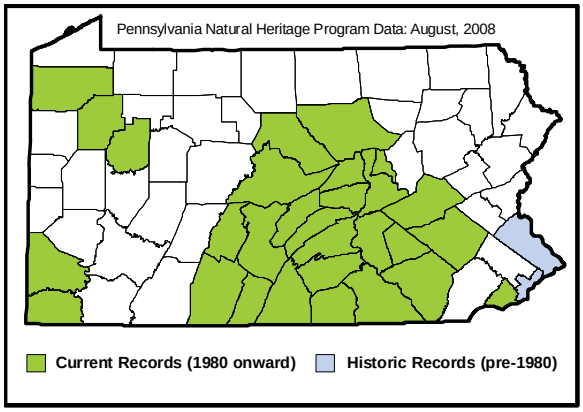
Habitat

Barn Owls require open areas with cavities for nesting. These cavities can be natural tree cavities or human-made structures such as church steeples, barns, abandoned buildings, or even nest boxes. This species needs a good population of small rodents, especially meadow voles (*Microtus pennsylvanicus*). In winter, Barn Owls will sometimes roost in dense conifer trees, even plantations.

North American State/Province Conservation Status

Map by NatureServe (July, 2008)





Conservation/Status

Barn Owls were undoubtedly rare in Pennsylvania before the cutting of the primeval forests. This species became common in the early 20th century, with many open farmlands containing optimum habitat for this species and their major prey, meadow voles. Changing land use and agricultural practices have led to a decline in Barn Owl populations. Shifting from pasture to row crops and a loss of nesting sites are the most serious problems for this species, which also result in lower meadow vole populations. This species, despite populations being secure globally, should be monitored to ensure that the Barn Owl continues to be a breeder in Pennsylvania.

References

- Austing, Ron. Wildlife Photography, Barn Owl. http://www.ronausting.com/barnowl.htm
- Gough, G.A., Sauer, J.R., Iliff, M. *Patuxent Bird Identification Infocenter*. 1998. Version 97.1. Patuxent Wildlife Research Center, Laurel, MD. http://www.mbr-pwrc.usgs.gov/Infocenter/infocenter.html
- McWilliams, G.M. and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.

PNHP
Pennsylvania Natural Heritage Program

BOG TURTLE (*GLYPTEMYS MUHLENBERGII*)

Pennsylvania Endangered Species

State Rank: S2 Global Rank: G3

Identification

The bog turtle (*Glyptemys muhlenbergii*) is Pennsylvania's smallest turtle, growing only 3 to 4.5 inches in length. Its most distinguishing feature is the large orange blotches on each side of the head. The shell and body are a dark brown with no distinctive markings. The bog turtle can be confused with the spotted turtle (*Clemmys guttata*). Spotted turtles have small yellow spots on the carapace, or shell and small orange spots on the head and body. Sometimes, few spots are present and initially the two species may appear very similar. The presence of large orange patches on the bog turtle's head is the best way to differentiate the two species.



photo source: Charlie Eichelberger

Habitat

This turtle has very specific habitat requirements, which is a major factor in its rarity throughout the United States. Bog turtles occur in wet meadows and bogs where tussock sedge and grasses dominate the wetlands. They require open conditions associated with early-successional wetland habitats. The substrate must consist of deep mucky soils fed by groundwater seeps, with only modest amounts of open water. If any of these conditions change, the population can decline and may eventually disappear from the area.

Status



The bog turtle occurs in very low numbers in southeastern Pennsylvania and is imperiled or critically imperiled throughout its entire range in North America. The species is classified as Federally threatened on the U.S. Fish and Wildlife Service Endangered Species List. Habitat loss, habitat fragmentation and succession are major factors in the decline of this species. In the past, natural wetland succession would occur causing populations to relocate nearby as appropriate habitat became available. With the extreme habitat fragmentation in southeastern Pennsylvania, remaining habitat has been isolated and wetland succession can lead to localized extinctions.

Additionally, this species is threatened by decreased water quality, roadway mortality, and predation of nests and juveniles by unnaturally high raccoon populations. Another major threat to the bog turtle is collection. Reptile collectors consider this turtle a valuable prize, as it is the most rare of all North American turtles. In Pennsylvania, fines for illegal collection and possession range from $250 to $5000 with the possibility of jail time and additional charges from the U.S. Fish and Wildlife Service. State and federal protection for this species have helped conservation efforts so far, but more resources are needed to continue species recovery efforts in the eastern United States.

References

Hulse, A.C., C.J. McCoy and E.J. Censky. 2001. Amphibians and Reptiles of Pennsylvania and theNortheast. Cornell University Press, New York. 419pp.

NatureServe Explorer: An online encyclopedia of life [web application]. 2002. Version 1.6. Arlington,Virginia. Website: www.natureserve.org/explorer.

PA Department of Conservation and Natural Resources Website. Wild Resource Conservation Fund, Endangered and Threatened Species in Pennsylvania. Bog Turtle: www.dcnr.state.pa.us/wrcf/bogt.htm.

PNHP
Pennsylvania Natural Heritage Program

Southern Leopard Frog (*Lithobates sphenocephala*)

Pennsylvania Endangered Frog Species

State Rank: S1 (Critically Imperiled) Global Rank: G5 (Secure)

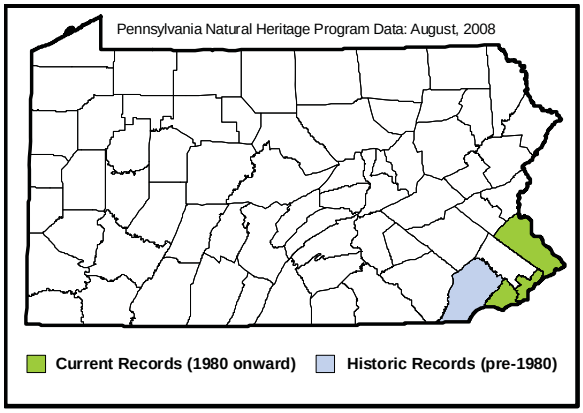
Identification

The Southern Leopard Frog is typically 50-80mm (2" to 3¼") long, and has a narrow snout. The color of the Southern Leopard Frog is quite variable, with some individuals being green, some dark brown, and every shade in between. The belly of the frog is white. A conspicuous white spot can be found in the center of the tympanum, or ear spot. Breeding calls of this species has been likened to the sound of muffled laughter, and this species is known to only call after dark. The Southern Leopard Frog may be confused with the Northern Leopard Frog (*Lithobates pipiens*) or the Pickerel Frog (*Lithobates palustris*). The Northern Leopard Frog has been found nearly statewide, but does not tolerate the brackish waters often inhabited by its southern cousin. Lacking the Southern Leopard Frog's tympanic white spot, the Northern Leopard Frog has suffered declines and is also considered a species of concern in the Commonwealth. The Pickerel Frog is a very common species, and while spotted like the Leopard Frogs, the Pickerel Frog has squarish spots and a yellow tinge between the hind legs and on the lower portion of the belly. The Pickerel Frog can be found statewide, and is typically associated with vegetated flowing streams and creeks.



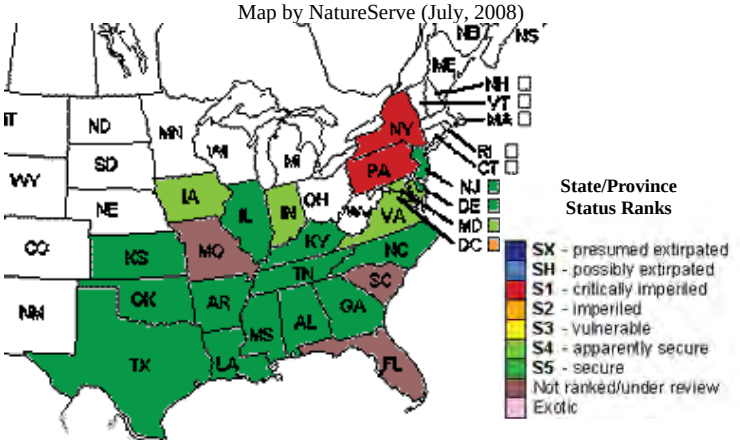
photo source: Tom Diez

Southern Leopard Frog (*Lithobates sphenocephala*) with prominent white spot on the tympanum.



North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

The Southern Leopard Frog's range in the Commonwealth is limited to the southeastern corner. Outside of Pennsylvania this species' range extend from coastal New York south along the seaboard to Texas.

Habitat

Southern Leopard Frogs frequent vegetated edges of shallow wetlands, along the Coastal Plain Province of Pennsylvania. The species is very skittish, and will flee into water, or into thick vegetation at the slightest sign of alarm. Breeding typically occurs in April, with tadpoles transforming into froglets and becoming terrestrial in June. While the breeding wetlands are typically open habitats, outside of the breeding season, Southern Leopard Frogs are known to frequent shaded areas with large areas of grass, rush, and sedge cover. Adults may travel quite a ways from the breeding wetlands.

Conservation Status

The Southern Leopard Frog has always been rare in Pennsylvania. Limited Coastal Plain habitat exists in the state, and the remaining areas were habitat for these frogs exists are under continual developmental pressure. Populations of Southern Leopard Frogs have declined due to habitat destruction and many historic locations are now developed and will never be suitable for Southern Leopard Frogs. The apparent population decline, and the widespread destruction and modifications of habitat for these frogs has led the Pennsylvania Fish and Boat Commission to list the Southern Leopard Frog as an endangered species.

References

- Gibbs, J.P., A.R. Breisch, P.K. Ducey, G. Johnson, J.L. Behler, R.C. Bothner. 2007. The Amphibians and Reptiles of New York State: Identification, Natural History, and Conservation. Oxford University Press: New York. 422pp.
- Hulse, A.C., C.J. McCoy and E.J. Censky. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, New York. 419pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2008.

Pennsylvania Natural Heritage Program

Red-bellied Turtle (*Pseudemys rubriventris*)

Pennsylvania Threatened Turtle Species

State Rank: S2 (Imperiled) Global Rank: G5 (Secure)

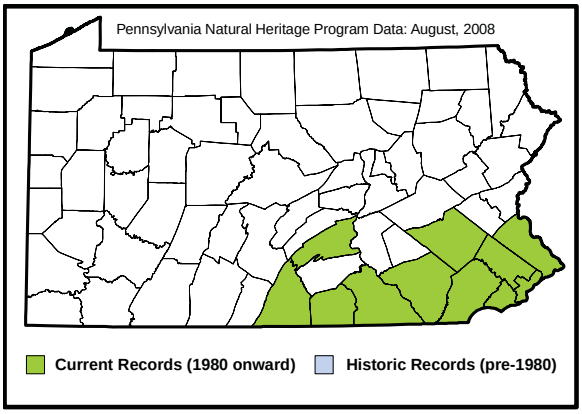


photo source: Jay Drasher

An adult Red-bellied Turtle (*Pseudemys rubriventris*) showing the distinctive reddish bars on its scutes.

Identification

The Red-bellied Turtle (*Pseudemys rubriventris*) is one of Pennsylvania's largest turtles. The carapace, or upper shell, is brown to black with reddish bars on some of the plate-like scutes. The plastron, or under shell, varies from pink to red and the head, neck and legs are covered with bright yellow lines in younger individuals. Markings may become less obvious with age and some older turtles are almost completely black above with few distinguishing characteristics. Confusing species are Painted Turtles (*Chrysemys picta*) and the introduced Red-eared Slider (Trachemys scripta). Painted Turtles can be distinguished by the light borders along the carapace seams and smaller size in adults. Red-eared Sliders are similar in size and coloration; however the presence of a red "ear patch" can sometimes be used to identify this species. Like the Red-bellied Turtle, Painted Turtles and Sliders may darken with age making it difficult to differentiate between the species.



Range

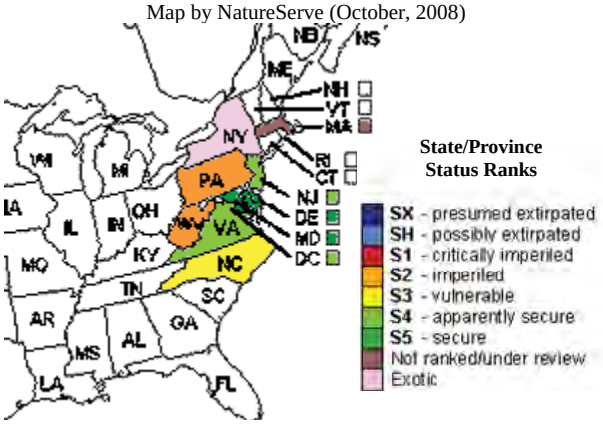
Red-bellied Turtles range from New York to North Carolina and has been introduced into some areas around the United States.

Habitat

This aquatic species is primarily found in large water bodies including lakes, ponds, marshes, slow-moving rivers and creeks. Red-bellied Turtles prefer deeper water with sandy or muddy substrate and require aquatic vegetation. This species also depends on abundant basking sites and spend a great deal of time perched on logs and downed trees. Nesting sites are in upland habitat and usually within 100 meters of the water, though they have been known to nest up to 250m from water. Eggs are laid in sandy or loamy soil, in clutches of 10 to 12.

North American State/Province Conservation Status

Map by NatureServe (October, 2008)



Conservation Status

The Red-bellied Turtle is listed as a threatened species in our state. Though we are on the edge of its range, many factors contribute to the threatened status of this species in Pennsylvania. In the late 1800's, this species was captured and sold as a food item in large metropolitan markets. The population in the east was significantly reduced through collection. Currently, threats to this species include loss of habitat through development, reductions in site and water quality, and threats from exotic species. The range of the Red-eared Slider is expanding and the Red-bellied Turtle may have to compete with the exotic Slider in some areas. Road mortality is an issue for females traveling away from water to lay eggs. Also, nest predators such as raccoon, opossum, skunk and fox can significantly decrease nesting success of this species. More information is needed on the life history of this species and factors affecting populations in the state.

References

- Hulse, A.C., C.J. McCoy and E.J. Censky. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, New York. 419pp.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- PA Department of Conservation and Natural Resources Website. Wild Resource Conservation Fund, Endangered and Threatened Species in Pennsylvania. Redbelly Turtle: www.dcnr.state.pa.us/wrcf/rbturt.htm.

PNHP
Pennsylvania Natural Heritage Program

Eastern Mudminnow (*Umbra pygmaea*)

Pennsylvania Proposed Freshwater Fish Species of Concern

State Rank: S3 (Vulnerable) Global Rank: G5 (Secure)

Identification

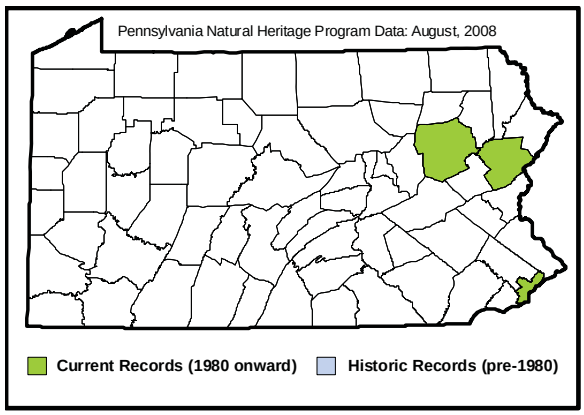
The eastern mudminnow is a small fish that grow up to 15 cm in total length, but is generally much smaller. This small fish may be confused with a darter (family Cyprinodontidae), but it is actually in the same order as trout and salmon (Salmoniformes). It has cycloid (round) scales, one dorsal fin, small abdominal pelvic fins, and no fin spines. A black bar is present at the base of the tailfin. The back and sides have 10-14 dark brown stripes noticeable on the paler body.



photo source: Paul Overbeck, ANSP

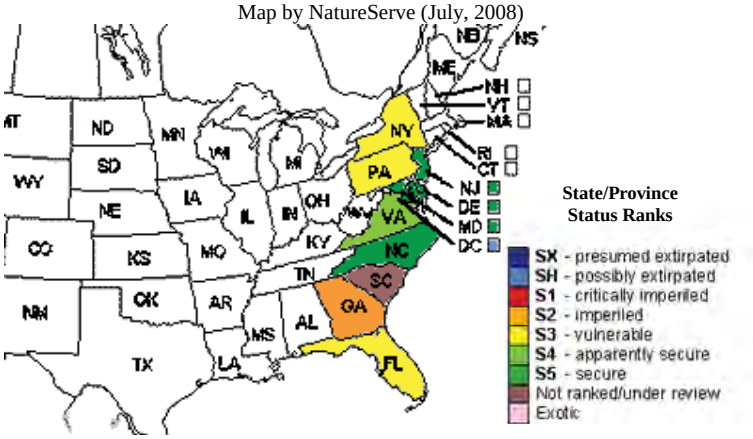
Eastern mudminnow (*Umbra pygmaea*) collected in the Philadelphia area.

Spawning in spring, the eastern mudminnow deposits adhesive eggs singly on aquatic plants or in a hollowed out nest in algae, which it guards. The eastern mudminnow is able to tolerate extremely low levels of oxygen and hides by burrowing beneath debris. Feeding opportunistically, their diet is noted for containing insects, crustaceans, gastropods, and many other small aquatic fauna and they are noted for occasionally leaping from the water while feeding.



North American State/Province Conservation Status

Map by NatureServe (July, 2008)



Range

Found only within the lower Delaware River watershed in Pennsylvania, eastern mudminnows occur along the Atlantic and Gulf slopes from New York to Florida.

Habitat

Found in quiet, mud-bottomed, often heavily vegetated streams, sloughs, swamps, and ponds, eastern mudminnows prefer the margins of their habitat and areas over sand, mud, and debris where there is the potential to quickly burrow into the substrate and escape from predators.

Conservation Status

The eastern mudminnow is common over most of its wide U.S. Atlantic slope range, but at the extremes of its range it is relatively uncommon. In Pennsylvania the species is uncommon with it primary habitat, backwater wetland in the lower Delaware River watershed, highly degraded where they still exist.

References

- Cooper, Edwin L. Fishes of Pennsylvania and the Northeastern United States. The Pennsylvania StateUniversity Press and University Park and London. 1983
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Page, L.M. and B.M. Burr, 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.
- Pennsylvania Natural Heritage Program. 2008.

PNHP
Pennsylvania Natural Heritage Program

Small-flowered False-foxglove
Agalinis paupercula

Description

Small-flowered False-foxglove is an herbaceous annual with a smooth, somewhat wiry, 4-sided stem that may grow to 3 feet (1 m) in height. The leaves are mostly oppositely arranged (but may become alternate on the upper stem or its branches), unstalked, linear in shape, untoothed on the margin, hairless, pointed at the tip, and to 1½ inches (4 cm) in length and to 1/8 inch (3 mm) in width. The purple flowers, appearing in August and September, are about ¾ inch (2 cm) in length and occur alternately or paired on very short (1-4 mm) stalks on the upper stem and its branches. The colored petals are united at their base and have spreading lobes near the tip. The calyx, located below the petals, is similarly united at its base and has apical lobes that are 2/5 to nearly as long as the united base, which is an important identification feature. The fruit is a globe-shaped capsule about 1/4 inch (4-6 mm) in length that contains many small seeds.

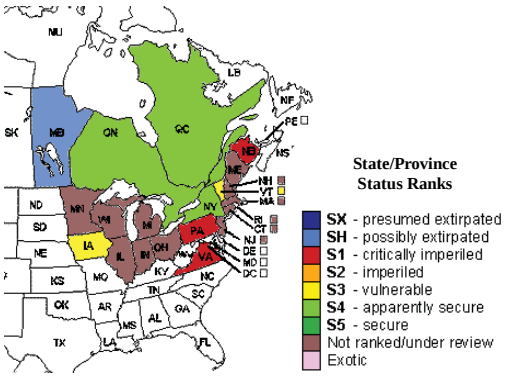


USDA-NRCS. PLANTS Database

Distribution & Habitat

Small-flowered False-foxglove ranges from southern Canada south into Virginia and the Great Lakes states. In Pennsylvania, it has been documented historically in the northwestern and southeastern counties. It grows in open woods and woods borders, shorelines, barrens, and clearings.

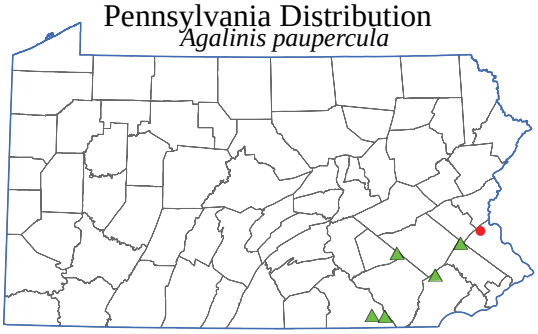
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Small-flowered False-foxglove to be a species of special concern, based on the very few locations that have been recently confirmed and the small population sizes. It has a PA legal rarity status and a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Agalinis paupercula



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Small-flowered False-foxglove often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Excessive deer browse may be a threat in some locations.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

Reference

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Small White Snakeroot
Ageratina aromatica

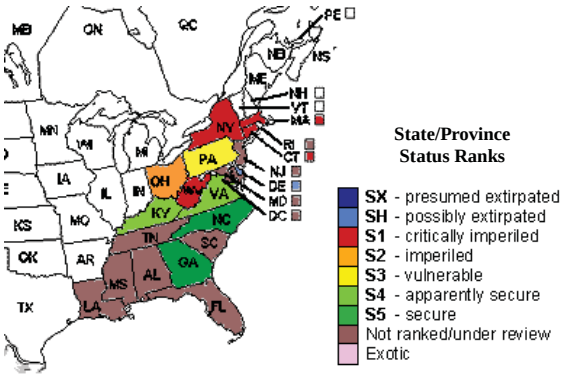
Description
Small White Snakeroot is an herbaceous perennial with a hairy stem that may grow to 2 feet (ca 60 cm) in height, but may be much shorter. The leaves are oppositely arranged, short-stalked, egg-shaped to broadly lance-shaped, toothed on the margin, variably hairy, thickish in texture, and to 3 inches (7 cm) in length and to 2 inches (ca 5 cm) in width. The white flowers, appearing from August to October, are individually minute and are aggregated in small clusters, or "heads", at the tips of the branches. The fruits are minute, dry, one-seeded, with a tuft of hairs at the tip that promotes wind dispersal. This species greatly resembles a very common and widespread species, White Snakeroot (*Ageratina altissima*), but the latter tends to be a larger plant with larger, thinner, and more sharply toothed leaves, and is found in a wide variety of habitats.



Photo source: PNHP

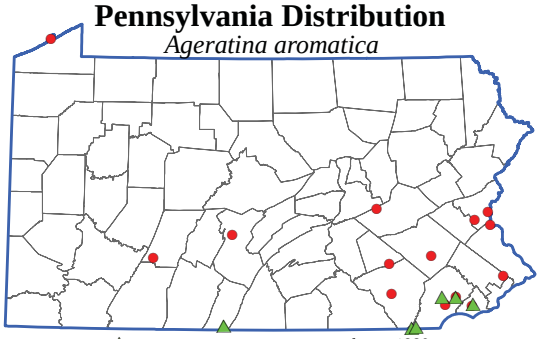
Distribution & Habitat
Small White Snakeroot has a range from southern New England south into the Gulf Coast states. In Pennsylvania, it has been documented historically mostly in the southeastern counties. It grows in various types of well drained openings and open woods, but is especially a characteristic species of the serpentine barrens in the southeastern part of the state.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Small White Snakeroot to be a species of special concern, based on the limited number of locations that have been recently confirmed. It does not have a PA legal rarity status, but has been assigned a PABS suggested rarity status of Rare.

Pennsylvania Distribution
Ageratina aromatica



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Small White Snakeroot often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Quarrying and habitat loss are threats in some locations.

NatureServe conservation status ranks
G5 – Globally secure; **S3** – Vulnerable in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

Colic-root
Aletris farinosa

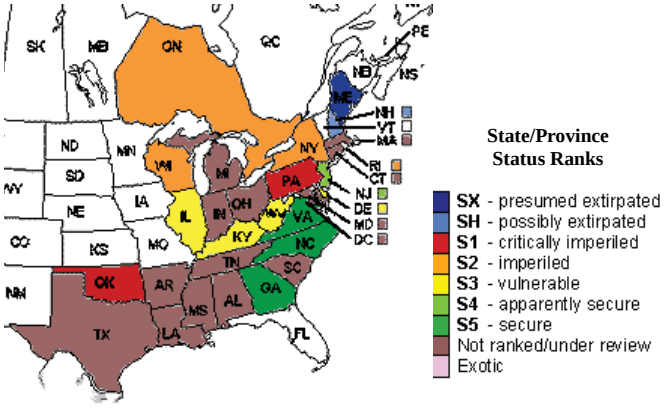
Description
Colic-root is a perennial herb that grows from 1½ to 3 feet (0.5-1 m) in height. The leaves are narrow, lance-shaped, ca 2 to 7 inches (5-18 cm) long, parallel veined, and mostly clustered at the base of the plant. The flowers, appearing from May to July, are relatively numerous and on the middle and upper part of the stem. The individual flowers are whitish, ¼ to 3/8 inch (6-10 mm) long, with six petal-like lobes that have a rough texture, and which persist after blooming time and enclose the capsular fruit.



Photo source: Thomas G. Barnes, University of Tennessee Herbarium

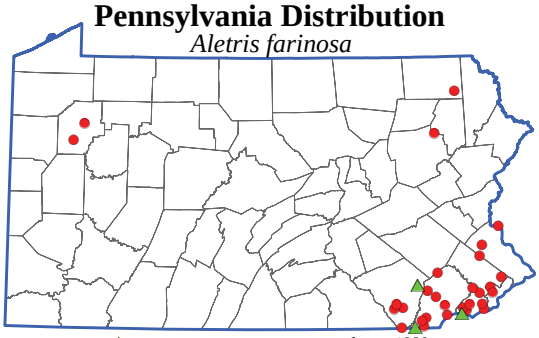
Distribution & Habitat
Colic-root has a wide range in eastern North America, from Maine west into Wisconsin and south into Texas and the Gulf Coast states. In Pennsylvania, it occurs primarily in the southeastern counties. The species grows in a variety of habitats, including clearings and openings, thickets, open woods, serpentine barrens, and wetlands, especially on sandy or peaty substrates.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Colic-root to be a species of special concern, based on the very few occurrences that have been recently confirmed and its apparent decline in numbers from historical levels. It has a PA legal rarity status of Undetermined, but has been assigned a suggested rarity status of Endangered by PABS. Fewer than 10 populations, mostly with few individuals, are currently known from the state.

Pennsylvania Distribution
Aletris farinosa



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The remaining populations of Colic-root in the state are threatened by human-related habitat loss, natural succession, invasive species, and collection by gardeners and herbal medicine enthusiasts. Given the preference of the species for open habitats, active management - such as fire, mowing, or invasive species removal - is often required to maintain the proper successional stage at sites where it grows.

NatureServe conservation status ranks
G5 – Globally Secure; **S1** – Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania. Rhoads, A.F. and T.A. Block.
- 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.
- USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions*. Vol. 1: 20.

Salt-marsh Water-hemp
(*Amaranthus cannabinus*)

Description

Salt-marsh Water-hemp is a perennial herb with a hairless stem that may grow up to 8 feet (2.5 meters) in height. The leaves are alternately arranged, lance-shaped, not toothed on the margin, up to 6 inches (15 cm) in length and 1.5 inches (4 cm) in width, with a well developed stalk at the base and pointed at the tip. The flowers, appearing from July to September, lack petals and are greenish in color, and are arranged in elongate spikes at the top of the stem. The male and female flowers occur on separate plants. The individual fruit is sac-like, to about 4 mm in length, and contains a single seed.



Photo source: PNHP

Distribution

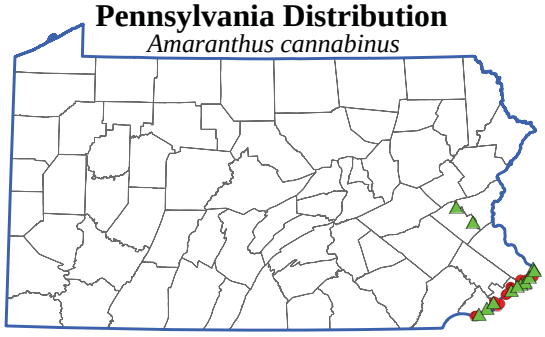
Salt-marsh Water-hemp has a distribution from Maine south along the coast into Florida and west into Louisiana. In Pennsylvania, it has been documented in a few southeastern counties along the Delaware River.

Habitat

Salt-marsh Water-hemp grows in intertidal marshes, mudflats, and river shores, where it is subjected to daily fluctuations in water levels.

Pennsylvania Distribution

Amaranthus cannabinus

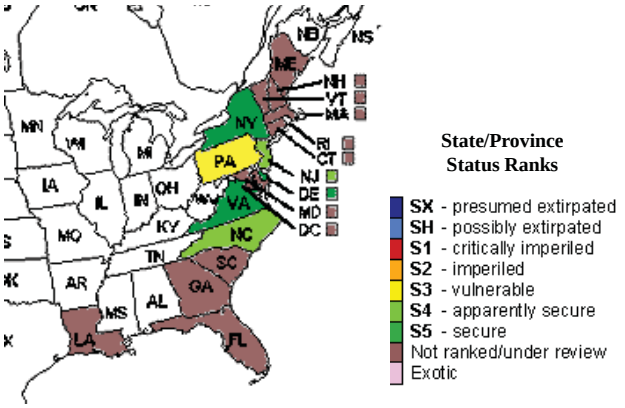


▲ records since 1980 ● records pre-1980

Pennsylvania Natural Heritage Program Data 3-2011

North American State/Province Conservation Status

Map by NatureServe 2010



State Status & Conservation

The PA Biological Survey (PABS) has assigned Salt-marsh Water-hemp a rarity status of Rare. The species has a very limited state range and a specialized habitat, yet appears to be relatively successful in maintaining itself, and does not appear to be endangered or threatened with extirpation. The habitat of this species has threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks

G5 –Globally Secure; **S3 –** Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Canada Serviceberry
Amelanchier canadensis

Description



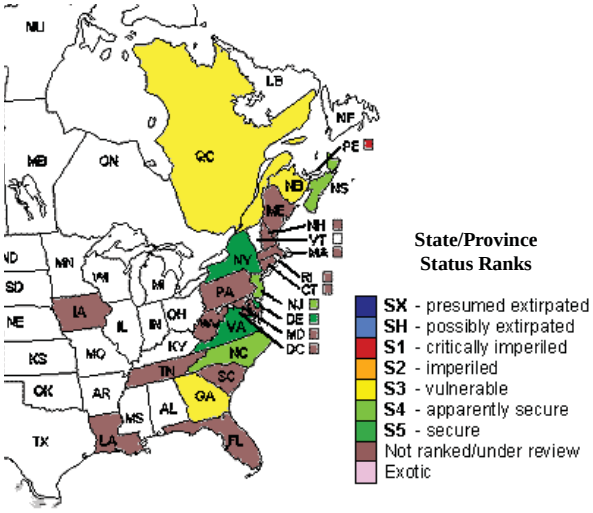
Photo source: B. Eugene Wofford, University of Tennessee Herbarium

Canada Serviceberry is a large shrub or small tree, often with several trunks, which can grow to 25 feet (8 m) in height. The leaves are alternately arranged, simple, tending to be oblong in shape, usually 1 to 2½ inches (2.5-6 cm) in length and ½ to 1½ inches (1-4 cm) in width, toothed on the margins, more-or-less hairless at maturity, and with a bluntish tip. The white flowers, which appear in April and May, are grouped in a cluster containing several flowers. The individual flowers have five white petals that are about 3/8 inch (8-10 mm) in length. The edible fruit, which resembles a tiny apple, is dark purple or black at maturity, with the sepals tending erect or nearly so. Identification of this species must be done carefully, as the various species of serviceberry resemble each other closely and exhibit much variability.

Distribution & Habitat

Canada Serviceberry ranges from eastern Canada south into the Gulf Coast states, particularly along the coast. In Pennsylvania, it has been documented historically primarily from the southeastern counties. The species grows in swamps and wet thickets.

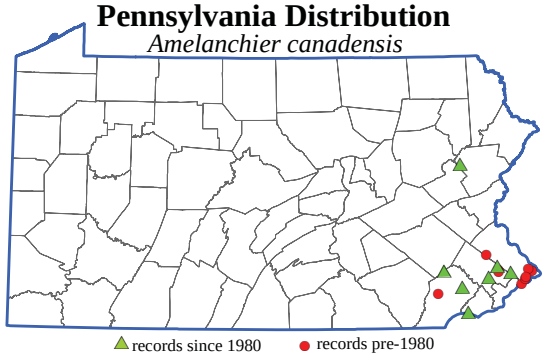
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Canada Serviceberry to be a species of special concern, based on the few locations that have been recently confirmed and the small population sizes. It does not have a PA legal status, but has been assigned a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Amelanchier canadensis



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Canada Serviceberry and its habitat may be enhanced by creating buffers and protecting the natural hydrology surrounding wetlands and controlling invasive species. Excessive deer browse may be a threat at some locations.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Elliott's Beardgrass
Andropogon gyrans

Description

Elliott's Beardgrass is an erect, bunched, perennial grass that may grow to 3 feet (1 m) in height. The upper part of the stem, just below where a leaf sheath begins, has tufts of relatively long, soft, upwardly-oriented hairs. The leaves are alternately arranged, often turn brown or orangish as they age, and consist of a sheathing basal portion and an elongate blade portion that is about approximately 3/16 inch (3-6 mm) in width on the lower stem leaves but up to ½ inch (12 cm) on the more crowded and conspicuous upper stem leaves that subtend the flowering clusters. The individual flowers, appearing in late August to October, are minute and are grouped in small spikelets that at their tip have a twisted hair-like projection, or awn, and at their base have a tuft of hairs similar to those on the upper stem. Linear groupings of the hairy spikelets, with their subtending crowded and enlarged leaves, often give the inflorescence a distinctive appearance in autumn.

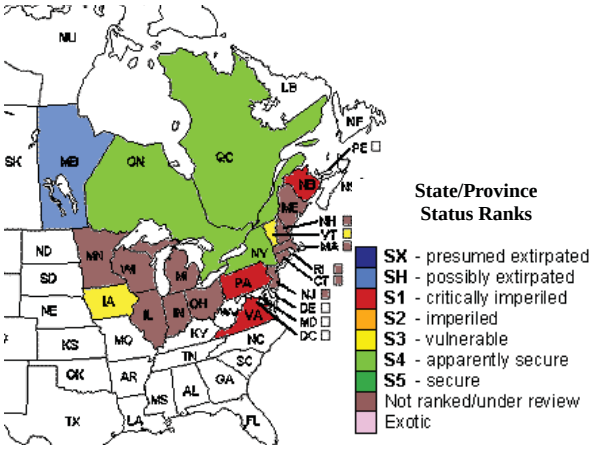


Photo source: PNHP

Distribution & Habitat

Elliott's Beardgrass ranges from New Jersey to Illinois and South into Florida and Texas. In Pennsylvania, it is considered a southerly species and has been documented historically in the southeastern counties. It grows in dry to damp grasslands, clearings, open slopes, and successional old fields.

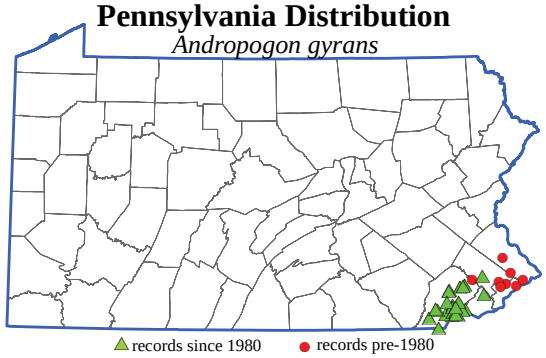
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Elliott's Beardgrass to be a species of special concern, based on the moderate number of locations that have been recently confirmed. It does not have a PA legal rarity status, but has been assigned a PABS suggested rarity status of Rare.

Pennsylvania Distribution
Andropogon gyrans



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of Elliott's Beardgrass and its habitat may require maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Some populations have threats from the indiscriminate spraying of herbicide.

NatureServe conservation status ranks

G5 – Globally secure; **S3** – Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Puttyroot
Aplectrum hyemale

Description

Puttyroot is a perennial herbaceous plant, arising from a roundish rootstock containing a mucilaginous substance that gives the plant its name. Each rootstock produces a single leaf at ground level in autumn. The leaf, which is easily recognized by its elliptical shape, wrinkled texture and whitish veins, remains evergreen over the winter, withers in late spring, and is replaced by a new leaf in autumn. The flowers, appearing in May and June, are clustered at the top of an erect leafless stalk that may reach 2 feet (6 dm) in height. The individual flowers are variously marked with purple, brown, white, and yellow. The fruit is a capsule that hangs downward and often persists over the winter.

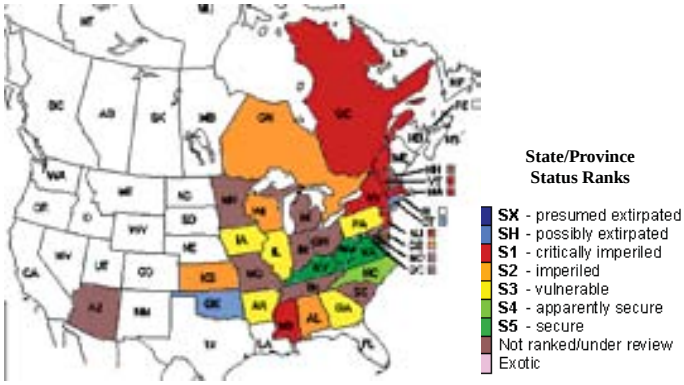


Photo source: jack and Sally Ray (PNHP)

Distribution & Habitat

Puttyroot has a range from southern New England south and west into Arizona and the Gulf Coast states. In Pennsylvania, it has been documented historically in numerous southern, particularly southeastern, counties. It grows in moist woodlands and on forested slopes and stream banks.

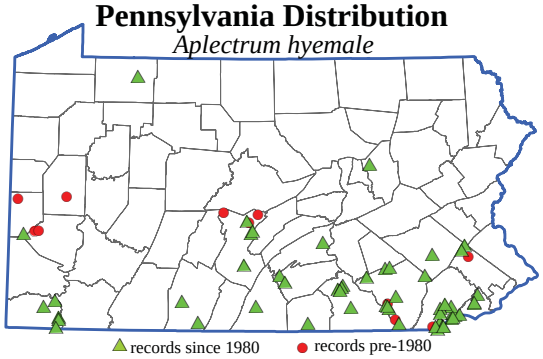
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Puttyroot to be a species of special concern, based on the relatively few occurrences that have been recently documented. It has a PA legal rarity status and a PABS suggested rarity status of Rare. About 40 populations are currently known from the state

Pennsylvania Distribution
Aplectrum hyemale



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The known populations of Puttyroot have threats from habitat loss, invasive species, and in some locations, excessive browsing by deer. Establishing buffers around fragmented forested habitat and removal of invasive species will help to maintain populations.

NatureServe conservation status ranks

G5 – Globally Secure; **S3** – Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania. Rhoads, A.F. and T.A. Block.
- 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Three-awned Grass
Aristida dichotoma var. curtissii

Description



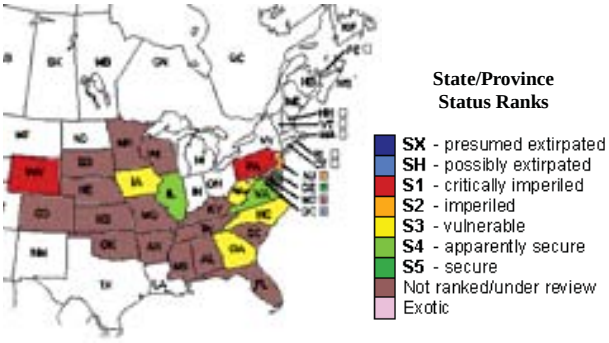
Photo source: PNHP

Three-awned Grass is a slender annual grass that may grow to 2 feet (.6 m) in height, but is often one-half or less as tall. The leaves are alternately arranged and consist of a basal sheathing portion that envelopes the stem and a blade-like portion that is 1-4 inches (2.5-10 cm) in length and 1/16 inch (2 mm) or less in width, and may appear even narrower because the blade often becomes inrolled or folded. The individual flowers, appearing in late summer or early fall, occur singly within a cluster of elongate scales called a spikelet, which in this plant averages about 3/8 inch (1 cm) in length. The 2 lowest scales, known as glumes, are slender, taper to a very pointed tip, and are unequal in length, a key identification feature that contrasts with *Aristida dichotoma* var. *dichotoma*, which has the glumes equal in length. The scale inside the pair of glumes, known as a lemma, is also long and slender, but has 3 hair-like projections, or awns, at its tip. The middle awn, besides being longer than the other 2, is coiled once or twice at its base and is oriented perpendicularly to the lemma, while the 2 shorter awns are straight and erect. Variety *dichotoma* is much more common and widespread in Pennsylvania than variety *curtissii*.

Distribution & Habitat

Three-awned Grass ranges from New Jersey to Wyoming and south into Florida and Colorado. In Pennsylvania, it has been documented historically in a few southern counties. It grows in dry openings, clearings, rights-of-way, and open woods.

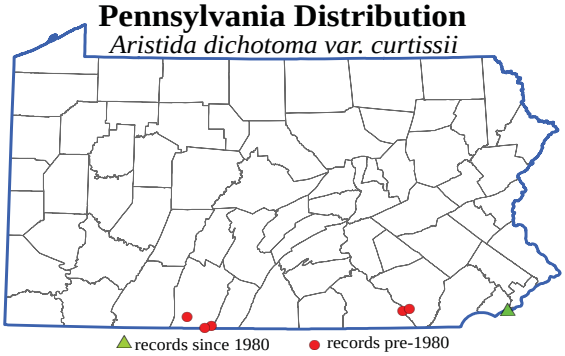
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Three-awned Grass to be a species of special concern, based on the few locations that have been recently confirmed. It has a PA legal rarity status of Tentatively Undetermined, but has been assigned a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Aristida dichotoma var. curtissii



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Three-awned Grass may require maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Additional field surveys are needed to determine the distribution and habitat requirements of this species.

NatureServe conservation status ranks

G5T5 – Globally secure; S1S2 – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Arrow-feather, Three-awn
Aristida purpurascens

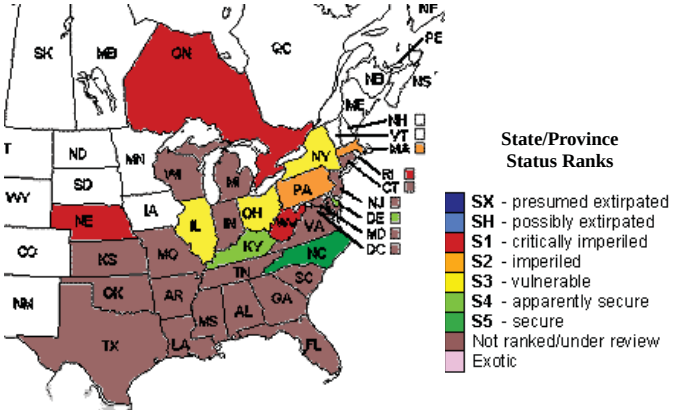
Description
Arrow-feather is a slender perennial grass that grows from 16 to 30 inches (4-7 dm) high. The leaves are linear, elongate, less than 1/8 inch (1-2 mm) wide and 4 inches (10 cm) long. The individual flowers are in spikelets, with their most conspicuous feature being 3 hair-like projections, or awns, that are ½ to 1 inch (1.5 to 2.5 cm) long, protrude from the top of the spikelet, and are oriented more-or-less perpendicular to the spikelet. The overall cluster of spikelets, located on the middle and upper stem, has a bristly appearance due to these awns.



Photo source: PNHP

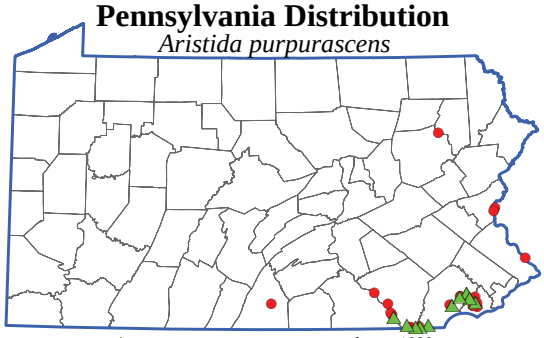
Distribution & Habitat
Arrow-feather has a range in eastern North America, from Ontario east into New England, and south into Texas and Florida. In Pennsylvania, it has been documented historically primarily in the southeastern counties. The species grows in dry to seasonally dry, open, rocky places, especially on serpentine barrens.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Arrow-feather to be a species of special concern, based on the few occurrences that have been recently confirmed and its specialized habitat. It has a PA legal rarity status and a PABS suggested rarity status of Threatened. Fewer than 10 populations are currently known from the state.

Pennsylvania Distribution
Aristida purpurascens



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The populations of this species in the state are mainly on serpentine barrens and the seasonally scoured riverbed and shoreline rock outcrops along the lower Susquehanna River. The viability of the species on serpentine will require maintaining early successional, grassland conditions and controlling invasive species. The riverine populations will require maintaining the natural hydrology of the Susquehanna River, with its seasonal fluctuations in water levels, as well as retaining the natural conditions of the shorelines and islands.

NatureServe conservation status ranks
G5 – Globally Secure; **S2** – Imperiled in Pennsylvania.

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania. Rhoads, A.F. and T.A. Block.
- 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Swamp Beggar-ticks
Bidens bidentoides

Description
Swamp Beggar-ticks is an annual herb that can grow to 3 feet (1 meter) in height, but is often smaller. The leaves are oppositely arranged, lance-shaped, from 1.5 to 4 inches (4 to 10 cm) in length and to 0.75 inch (2 cm) in width, pointed at the tip, stalked at the base, and variably toothed on the margin. The flowers, appearing from August to October, have a yellow central disk and lack the conspicuous yellow ray flowers found in other species of the genus *Bidens*. The small individual fruits, less than ½ inch (about 1 cm) in length, have 2 slender barbed projections that aid in dispersal.

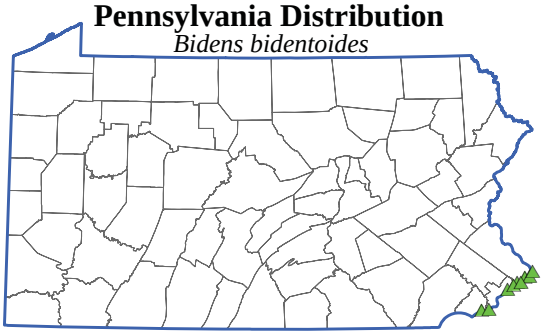


Photo source: Ann Rhoads, Morris Arboretum

Distribution
Swamp Beggar-ticks has a relatively narrow range along the coast from New York south into Maryland. In Pennsylvania, it occurs on the edge of its range, and has been documented historically in a few southeastern counties along the Delaware River.

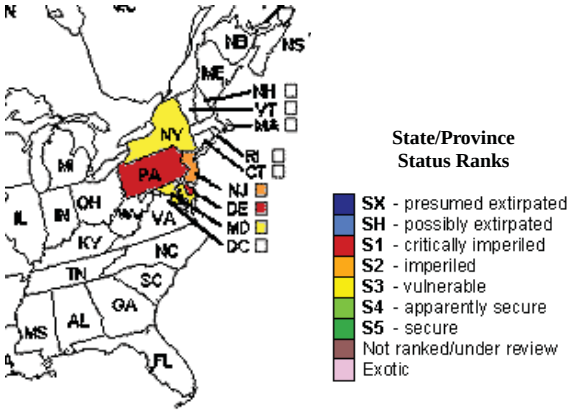
Habitat
Swamp Beggar-ticks grows in intertidal marshes, mudflats, and shores. The plants have a tendency to root on decaying wood, such as pieces of driftwood and old piers and boat docks.

Pennsylvania Distribution
Bidens bidentoides



Pennsylvania Natural Heritage Program Data 3-2011

North American State/Province Conservation Status
Map by NatureServe 2010



State Status & Conservation
The PA Biological Survey (PABS) has assigned Swamp Beggar-ticks a rarity status of Endangered, based on the limited global and state range, the relatively few populations that have been confirmed, the small population sizes, and the very specialized habitat. The known populations have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks
G3G4 – Vulnerable/Apparently Secure**; S1 –** Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania. Rhoads, A.F. and T.A. Block.
- 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania

Beggar-ticks
(*Bidens laevis*)

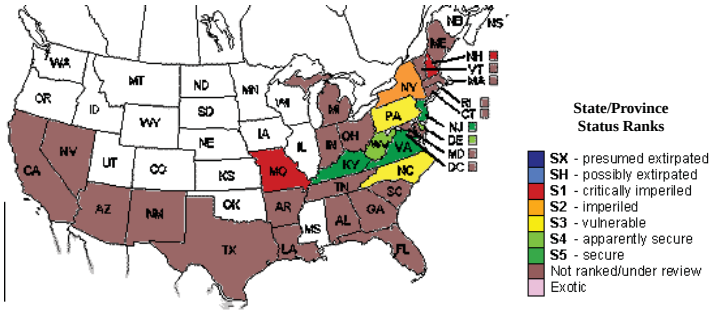
Description

Beggar-ticks is an annual or perennial herb with a hairless stem that may grow to 3 feet (1 meter) in height. The leaves are oppositely arranged, without a obvious stalk at the base, linear to lance-shaped, from 1.5 to 6 inches (4 to 15 cm) in length and to 1.5 inches (4 cm) in width, hairless on both surfaces, and toothed on the margin. The flowers, appearing from August to October, have conspicuous yellow ray flowers that are 0.5 to 1.25 inches (1.5 to 3 cm) in length. The individual fruits have slender barbed projections that aid in dispersal.



Photo source: Ann Rhoads, Morris Arboretum

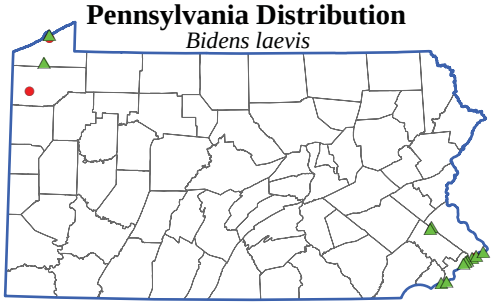
North American State/Province Conservation Status
Map by NatureServe 2010



Distribution & Habitat

Beggar-ticks has a range throughout much of the eastern and southern United States. In Pennsylvania, it has been documented historically in several southeastern and northwestern counties. Beggar-ticks grows in marshes, swamps, and on shorelines.

Pennsylvania Distribution
Bidens laevis



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Beggar-ticks a rarity status of Endangered. The general habitat of this species has threats from exotic species and draining and filling.

NatureServe conservation status ranks

G5 – Globally Secure**; S1 –** Critically Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania. Rhoads, A.F. and T.A. Block.
- 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Field Dodder
Cuscuta pentagona

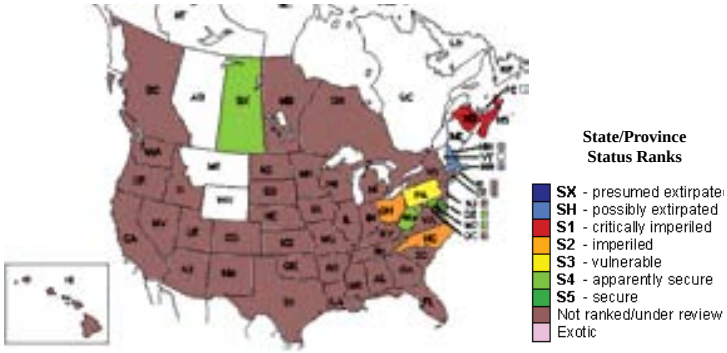
Description
Field Dodder is an annual parasitic herbaceous vine, with the stems usually yellowish or orangish in color. The leaves are reduced to minute scales, which are scattered in an alternate arrangement along the stem. The flowers, appearing from June to September, are white and only 1 to 2 mm in length. The corolla lobes of individual flowers are about 1.0 mm in length, 5-parted and pointed in outline, distinguishing this species from numerous other species in the genus. The fruit is a many-seeded capsule.



Photo source: Ann Rhoads, Morris Arboretum

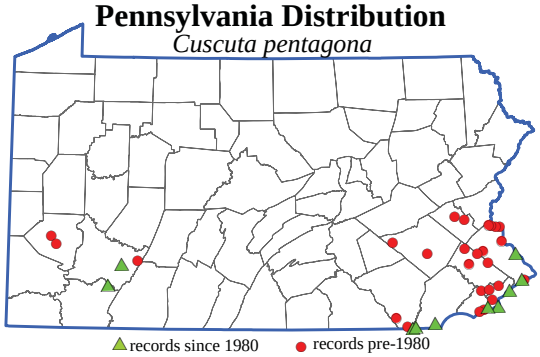
One of the dodders (*Cuscuta* sp.) on a host plant.

North American State/Province Conservation Status
Map by NatureServe 2010



Distribution & Habitat
Field Dodder has a range throughout North America. In Pennsylvania, it has been documented historically in numerous southern, especially southeastern, counties. Field Dodder grows in various types of open habitats, including old fields, clearings, thickets, and various sorts of open ground.

Pennsylvania Distribution
Cuscuta pentagona



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Field Dodder a rarity status of Threatened.

NatureServe conservation status ranks
G5 – Globally Secure**; S2 –** Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Nuttall's Tick-trefoil
Desmodium nuttallii

Description



Photo source: Margaret Rhinehart @ University of Tennessee Herbarium

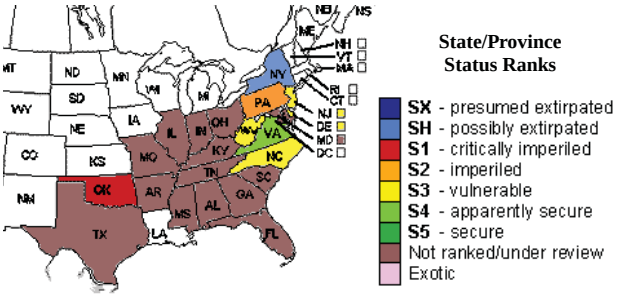
Tick-trefoils (genus *Desmodium*) are perennial herbs that receive their common name from the combination of the 3 untoothed leaflets making up each leaf and the flattened and pod-like fruit, which is covered with tiny hook-like hairs and divided into 1-seeded sections, which at maturity detach easily and readily stick ("like a tick") to clothing or hair. Seventeen species have been documented in Pennsylvania, and their identification is difficult, as it relies on relatively inconspicuous or transient features. Nuttall's tick-trefoil is one of the more distinctive species, primarily because the stem and leaves, particularly the lower sides of the leaves, usually have a velvety covering of hairs, which is not present in most other species of the genus. The pink or purple flowers, appearing in summer, have 5 petals and are about ¼ inch (6 mm) in length. The fruits in this species have from 2-4 segments, with the upper margin of the each segment tending to be convex in outline and the lower margin of each segment tending to be rounded or obtusely angled.

6

Distribution & Habitat

Nuttall'sTick-trefoil ranges from New York south and southwest into Florida and Texas. In Pennsylvania, it has been documented historically mostly in the southeastern counties. It grows on relatively dry conditions on open slopes and banks and in clearings, fields, thickets, and open woods.

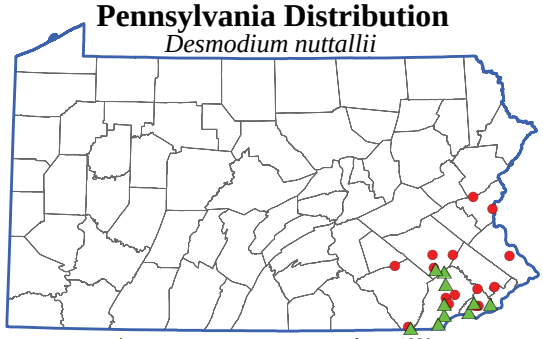
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Nuttall's Tick-trefoil to be a species of special concern, based on the few locations that have been recently confirmed. It has a PA legal rarity status of Tentatively Undetermined and a PA suggested status of Threatened.

Pennsylvania Distribution
Desmodium nuttallii



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Nuttall's Tick-trefoil may require maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive.

NatureServe conservation status ranks

G5 – Globally secure; S2 – Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Heller's Witchgrass
Dichanthelium oligosanthes

Description

Heller's Witchgrass is a perennial clump or bunch grass that may grow to 2 feet (60 cm) in height, but is often much shorter. The leaves are alternately arranged, consisting of a basal sheathing portion, which often has a purplish tinge and is frequently hairy, that envelops the stem and a lance shaped, flattened, and untoothed blade that is 2 to 5 inches (5-13 cm) in length and about ½ inch (12 mm) in width, pointed at the tip, and usually somewhat hairy on the lower side. The flowers, appearing first in June and July, and again later in the fall, occur in a compactly-branched inflorescence containing many individual broadly-ovoid spikelets that are about 1/8 inch (3-4 mm) long and have, at least compared to many of other species in the genus *Dichanthelium* relatively thick veins running from top to bottom. There are many species of panic-grass in Pennsylvania, and they are difficult to identify since they mostly require the use of microscopic features to distinguish the species; in general, this species has a combination of relatively broad leaves, prominently-veiny and rounded spikelets, and compact inflorescences.

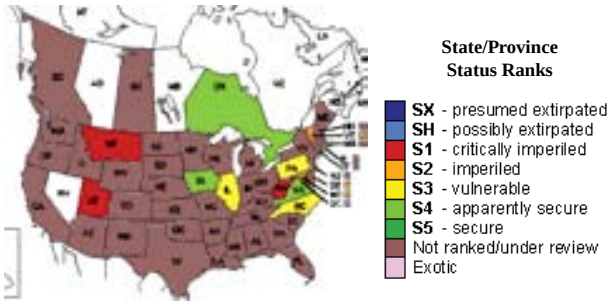


Photo source: PNHP

Distribution & Habitat

Heller's Witchgrass has a transcontinental range across North America. In Pennsylvania, it has been documented historically mostly in the southeastern counties. It grows in open, sunny places, such as grasslands, fields, thickets, and rocky openings, especially on well-drained serpentine, limestone and diabase substrates.

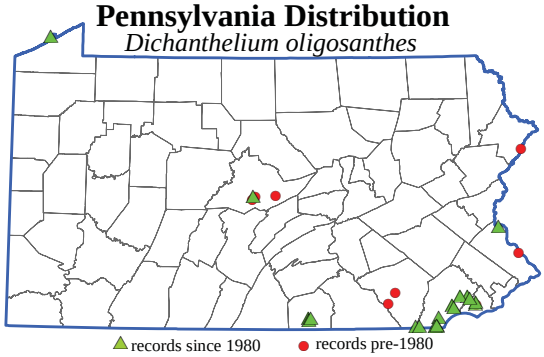
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Heller's Witchgrass to be a species of special concern, based on the moderate number of locations that have been recently confirmed. It does not have a PA legal rarity status, but has been assigned a PABS suggested rarity status of Threatened.

Pennsylvania Distribution
Dichanthelium oligosanthes



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Heller's Witchgrass often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Quarrying and habitat loss are threats in some locations.

NatureServe conservation status ranks

G5 – Globally secure; S3 – Vulnerable in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

Many-flowered Panicgrass
Dichanthelium polyanthes

Description

Many-flowered Panicgrass is a perennial that forms tufts or clumps and may grow to 3 feet (1 m) in height. The leaves are alternately arranged, consisting of a basal sheathing portion, which envelopes the stem and is usually hairy on the edges, and a broadly lance-shaped, flattened, and untoothed blade that is 4 to 8 inches (10-20 cm) in length and about ½ to 1¼ inches (1.5-3.0 cm) in width, heart-shaped at the base, and long-pointed at the tip. The flowers, appearing first in June and July, and again later in the fall, occur in a branched inflorescence containing many individual nearly round spikelets that average about 1/16 inch (1.5 mm) in length and are minutely hairy. There are many species of Panicgrass in Pennsylvania, and they are difficult to identify. Many-flowered Panicgrass is one of the less difficult to recognize, particularly in its combination of relatively broad leaves and very small spikelets; this combination is in contrast with most other species that have relatively broad leaves, as they tend to have relatively large spikelets, which are mostly 1/8 inch (2-4 mm) in length and more elliptic-shaped.



Photo source: PNHP

Distribution & Habitat

Many-flowered Panicgrass ranges from New York to Indiana and south into Georgia and Texas. In Pennsylvania, it has been documented historically mostly in the southern counties. It grows in open woods, woods borders, clearings and openings, and utility rights-of-way.

North American State/Province Conservation Status

No NatureServe map available

Current State Status

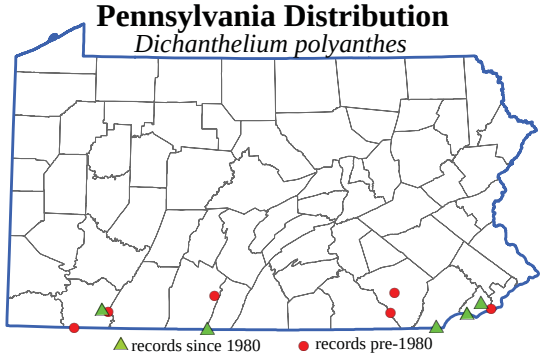
The PA Biological Survey (PABS) considers Many-flowered Panicgrass to be a species of special concern, based on the relatively few locations that have been recently confirmed. It does not have a PA legal rarity status, but has been assigned a PABS status of Watch list.

Conservation Considerations

The viability of populations of Many-flowered Panicgrass may require maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or the use of prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Additional field surveys are needed to determine the distribution and habitat requirements of this species.

Pennsylvania Distribution

Dichanthelium polyanthes



Pennsylvania Natural Heritage Program Data 3-2011

NatureServe conservation status ranks

GNR – Globally not ranked; S4 – Apparently secure in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

Velvety Panic-grass
Dichanthelium scoparium

Description

Velvety Panic-grass is a perennial herb that may grow up to 4 feet (1.3 meters) in height. The stems are covered with short, soft, dense, spreading hairs that give the species its name. The portion of the stem just below each node or joint usually has a ring that is sticky to the touch. The leaf blades are alternately arranged, lance-shaped, with parallel veins, not toothed on the margin, and covered with the same sort of hairs as the stem. The flowers, appearing from June to October, are individually only a few millimeters in length and are arranged in clusters that are found at the top of the stem and its branches. Of the many species of panic-grass in the Pennsylvania, this one can be recognized by the velvety hairs on the stems and leaves.



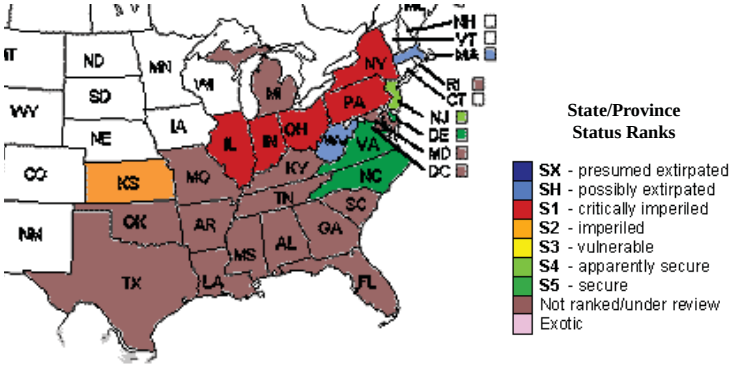
Photo source: John Roemer

Distribution & Habitat

Velvety Panic-grass has a range from Massachusetts south and west into Florida and Texas. In Pennsylvania, it represents a southerly species, and has been documented in a few southeastern counties. Velvety Panic-grass grows in damp to seasonally wet clearings, abandoned fields, marshes, and disturbed ground.

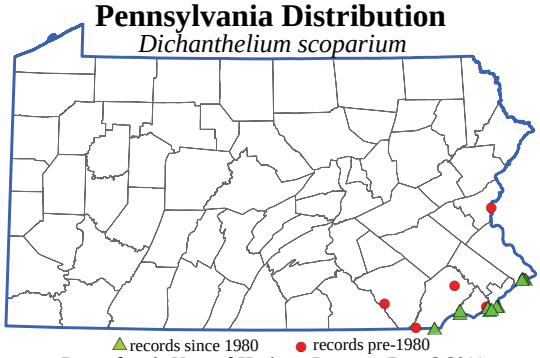
North American State/Province Conservation Status

Map by NatureServe 2010



Pennsylvania Distribution

Dichanthelium scoparium



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Velvety Panic-grass a rarity status of Endangered, based on the limited number of populations documented for the species and its small state range. Recent field surveys have been successful in discovering more populations of the species, so this rarity status may be amended to reflect a lesser degree conservation significance. Some of the known populations of Velvety Panic-grass have threats from habitat loss, competition, and exotic species.

NatureServe conservation status ranks

G5 – Globally Secure**; S1 –** Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Walter's Barnyard-grass
Echinochloa walteri

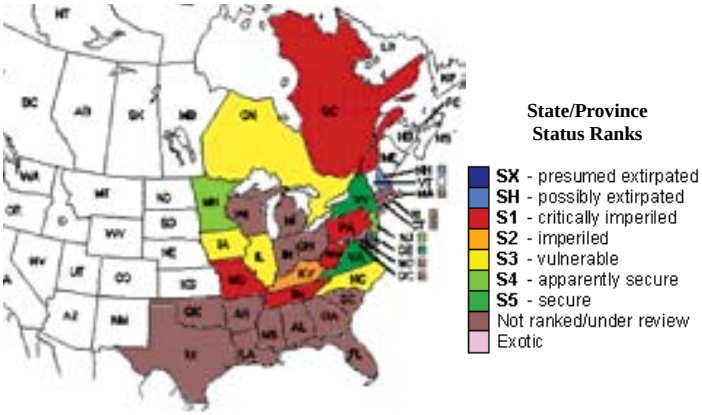
Description
Walter's Barnyard-grass is an annual herb that may grow to 6 feet (2 meters) in height. The leaves are alternately arranged, lance-shaped, to about 1 foot (ca 30 cm) in length and about 1 inch (ca 2.5 cm) in width, usually long-hairy on the sheath portion that encloses the stem, parallel-veined, and not toothed on the margin. The flowers, appearing from August to September, are individually only a few millimeters in length and are aggregated in a branched cluster at the top of the stem. The small scales at the base of each flower have elongate needle-like projections, or awns, that give a bristly appearance to the flowering and fruiting clusters.



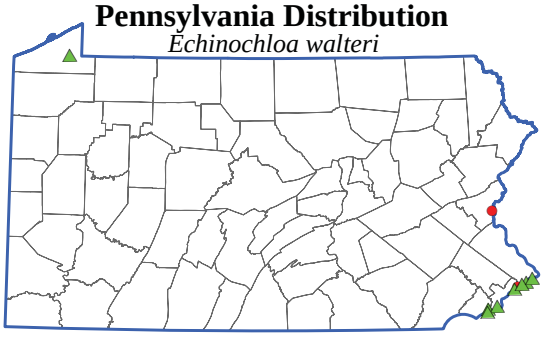
Photo source: PNHP

Distribution & Habitat
Walter's Barnyard-grass has a range throughout the eastern half of North America. In Pennsylvania, it has been documented historically only in a few southeastern counties. Walter's Barnyard-grass grows in marshes, ditches and on shorelines, including intertidal wetlands.

North American State/Province Conservation Status
Map by NatureServe (July, 2010)



Pennsylvania Distribution
Echinochloa walteri



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Walter's Barnyard-grass a rarity status of Endangered, based on the relatively few populations that have been documented and the restricted state range. The species does appear able to thrive in certain types of disturbed ground. The general habitat of this species has threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks
G5 – Globally Secure**; S1 –** Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Little-spike Spike-rush
Eleocharis parvula

Description
Little-spike Spike-rush is a diminutive perennial herb typically only a few inches in height. The leaves are reduced to scales that are located at the base of the stem, which is the main photosynthetic portion of the plant. The flowers, appearing from June to September, are microscopic in size and are grouped together inside a scaly cluster at the top of the stem. The individual fruits are only about 1 millimeter in length and are 3-sided.



Photo source: Larry Allain @ USDA-NRCS PLANTS Database

Distribution & Habitat
Little-spike Spike-rush has a range throughout North America. In Pennsylvania, it has been documented historically in a few southeastern counties and in Erie County. Little-spike Spike-rush grows in intertidal marshes, mudflats, and on shorelines. The intertidal populations are subjected to daily cycles of exposure and inundation.

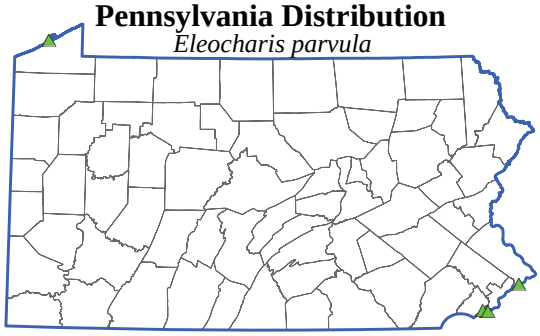
North American State/Province Conservation Status
Map by NatureServe 2010



State/Province Status Ranks

- **SX** - presumed extirpated
- **SH** - possibly extirpated
- **S1** - critically imperiled
- **S2** - imperiled
- **S3** - vulnerable
- **S4** - apparently secure
- **S5** - secure
- Not ranked/under review
- Exotic

Pennsylvania Distribution
Eleocharis parvula



▲ records since 1980 ● records pre-1980
Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Little-spike Spike-rush a rarity status of Endangered, based on the limited number of populations that have been confirmed, the small population sizes, the limited state range, and the specialized habitat. The known populations have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks
G5 – Globally Secure**; S1 –**Critically Imperiled in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.
- USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions*. Vol. 1: 20.

Pennsylvania Natural Heritage Program

Elephant's Foot
Elephantopus carolinianus

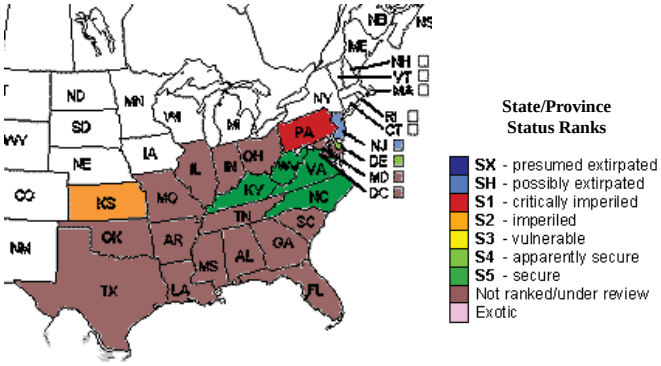
Description
Elephant's Foot is a perennial herb with a variably hairy stem that may grow to 3 feet (ca 1 m) tall. The leaves are arranged alternately, broadly elliptic in shape, shallowly toothed on the margin, hairy below, and to 10 inches (25 cm) long. The small, whitish or purplish individual flowers are grouped in flower heads, each of which is subtended by several leaf-like bracts that give the plant one of its distinctive features.



Photo source: R Harrison Wiegand

Distribution & Habitat
Elephant's Foot has a range from Pennsylvania west into Kansas and south into Texas and Florida. In Pennsylvania, it represents a southerly species and occurs at a northern border of its range, and has been found in a few southern, particularly southeastern, counties. It grows in open woodlands, woodland borders, and serpentine barrens, often in somewhat disturbed conditions.

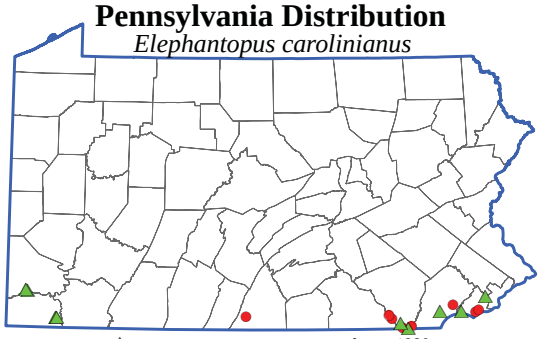
North American State/Province Conservation Status
Map by NatureServe 2010



Current Status
The PA Biological Survey (PABS) considers Elephant's Foot to be a species of special concern, based on the few occurrences that have been recently confirmed and its limited state range. It has a PA legal rarity status and a PABS suggested rarity status of Rare. About 10 populations are currently documented from the state.

Conservation Considerations
Populations of Elephant's Foot are threatened by human-related habitat loss, natural succession, and invasive species. Since the species may occupy disturbed habitats, active management may be required to create the proper successional stage and ecological conditions for the species to thrive. Deer browsing may be a problem in some locations.

Pennsylvania Distribution
Elephantopus carolinianus



Pennsylvania Natural Heritage Program Data 3-2011

NatureServe conservation status ranks
G5 – Globally Secure; **S3** – Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Ellisia; Waterpod
Ellisia nyctelea

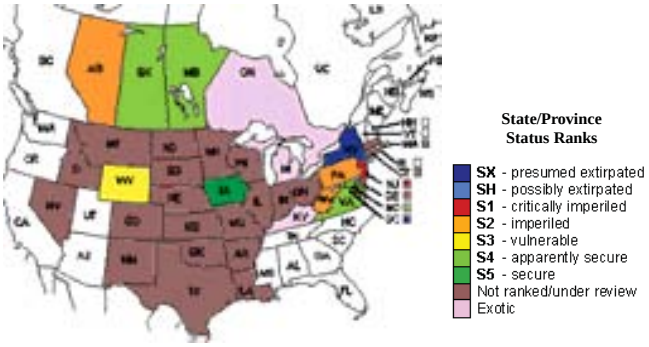
Description
Ellisia is a spring annual herb that grows 4 to 16 inches (1-4 dm) tall. Its stems are light green or light purple and usually hairy along their length. The leaves tend to be oppositely arranged on the lower stem and alternately arranged on the upper stem. The hairy leaves are up to 4 inches (10 cm) long and deeply dissected into toothed lobes. The flowers appear in April and May and grow individually from the upper leaf axils. The ¼ inch (6.5 mm) flowers are whitish-blue and have 5 petal-like lobes that are fused near the base to form a bell shaped flower. The sepals are united near the base and persist on the usually 4-seeded, capsule-like fruit.



Photo source: Tony Davis (PNHP)

Distribution & Habitat
Ellisia occurs throughout much of the United States, but is apparently absent from northern New England, the Southeast, and the West Coast. In Pennsylvania, it grows on damp, shady stream banks with rich alluvial soils and sometimes in disturbed ground.

North American State/Province Conservation Status
Map by NatureServe 2010

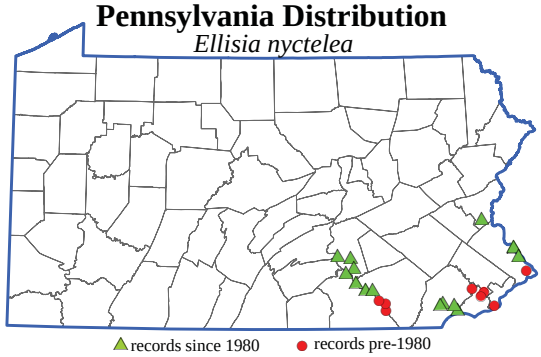


Current State Status
The PA Biological Survey (PABS) considers Ellisia to be a species of special concern, based on the relatively few occurrences that have been recently confirmed. It has a PA legal rarity status and a PABS suggested rarity status of Threatened. The rich shady stream banks that Ellisia depends upon are highly influenced by flooding events. Alteration of the natural flood cycle, dam building, increased erosion, and clearing of floodplain forests all affect the quality of suitable habitat. Populations are also threatened by loss of habitat from development and displacement by invasive plants.

Conservation Considerations
Protection of Ellisia will require maintenance of known populations and preservation of rich, shaded stream bank communities. This may include sustaining appropriate hydrology, removal of invasive plants, and establishment of buffers that can moderate the effects of scouring events and run-off. Management of the known sites requires long term monitoring of populations.

NatureServe conservation status ranks
G5 – Globally secure; **S2** – Imperiled in Pennsylvania

Pennsylvania Distribution
Ellisia nyctelea



Pennsylvania Natural Heritage Program Data 3-2011

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

White Thoroughwort
Eupatorium album

Description

White Thoroughwort is an herbaceous perennial with a hairy stem that may grow to 3 feet (1 m) in height. The leaves are oppositely arranged, unstalked or nearly so, narrowly elliptic to lance-shaped, with 3 prominent veins oriented from base to tip, toothed on the margin, resin-dotted and more-or-less hairy, to 4 inches (10 cm) in length and to 1 inch (2.5 cm) in width, and obtuse to rounded at the tip. The white flowers, appearing from August to October, are individually minute and are aggregated in small clusters ("heads") at the tips of the branches, which tend to reach the same height and give the overall plant a flat-topped appearance. Each individual head has numerous overlapping white and hairy scales, or bracts, below where the flowers are attached. In this species the bracts of the head, especially the upper ones, have an exceptionally long and pointed white tip as compared with the lower bracts, a feature not found in most of the other species of the genus *Eupatorium*. The fruits are minute, dry, and 1-seeded, with a tuft of hairs at the tip that promotes wind dispersal.



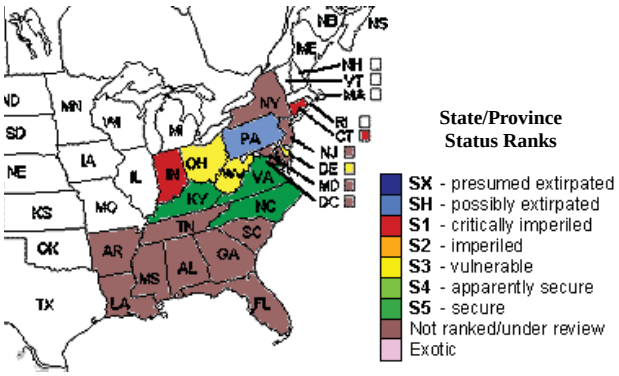
Photo source: John Kunsman (PNHP)

Distribution & Habitat

White Thoroughwort ranges from Connecticut to Indiana and south into Florida and Louisiana. In Pennsylvania, it represents a southerly species and has been documented historically in the southeastern counties. It grows in openings, clearings, rights-of-way, thickets, and open woods.

North American State/Province Conservation Status

Map by NatureServe 2010

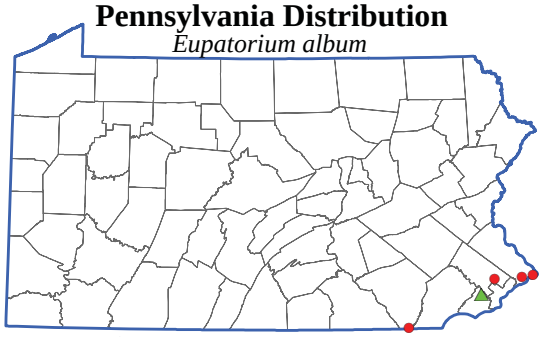


Current State Status

The PA Biological Survey (PABS) considers White Thoroughwort to be a species of special concern, based on the very few locations that have been recently confirmed. It has a PA legal rarity status of Extirpated, but has been assigned a PABS suggested rarity status of Endangered since the species was recently documented as still occurring in the state.

Pennsylvania Distribution

Eupatorium album



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of White Thoroughwort often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Round-leaved thoroughwort
Eupatorium rotundifolium

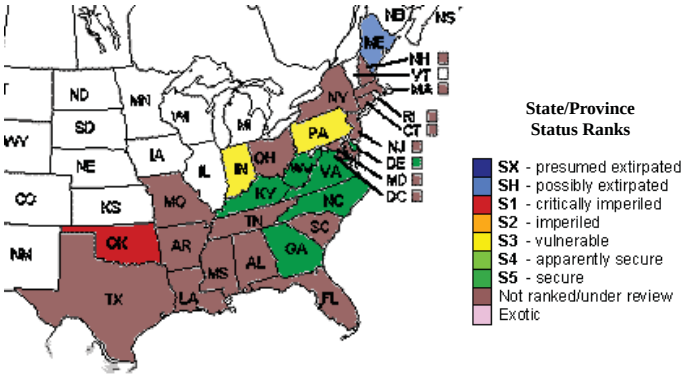
Description
Round-leaved Thoroughwort is a perennial herb with a hairy stem that may grow to 4 feet (1.3 meters) in height. The leaves are oppositely arranged, egg-shaped to orbicular, more-or-less stalkless at the base, rounded at the tip, toothed on the margin, prominently veined, and hairy on both surfaces. The flowers, appearing from June to October, are white and are grouped in clusters at the top of the stem.



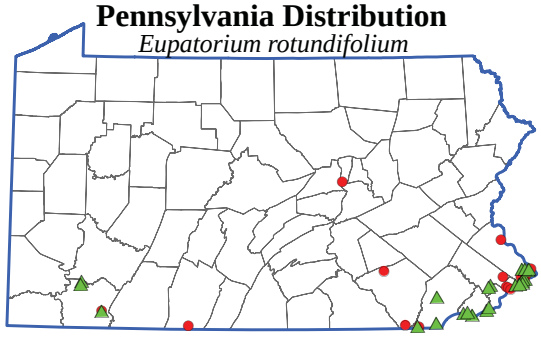
Photo source: Ann Rhoads, Morris Arboretum

Distribution & Habitat
Round-leaved Thoroughwort has a range from Maine south and west into Florida and Texas. In Pennsylvania, it has been documented historically in numerous southern, particularly southeastern, counties. Round-leaved Thoroughwort grows in open woods and woods borders, clearings, thickets, old fields, and disturbed ground.

North American State/Province Conservation Status
Map by NatureServe 2010



Pennsylvania Distribution
Eupatorium rotundifolium



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Round-leaved Thoroughwort a rarity status of Undetermined, meaning that additional field surveys and analysis are required before a more permanent rarity status, if appropriate, can be applied. The known populations have threats from habitat loss, competition, and exotic species, and will generally require some sort of disturbance, such as mowing or fire, in order to maintain the proper successional stage for the species to thrive over the long term.

NatureServe conservation status ranks
G5 – Globally Secure**; S3 –** Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania

Annual Fimbry
Fimbristylis annua

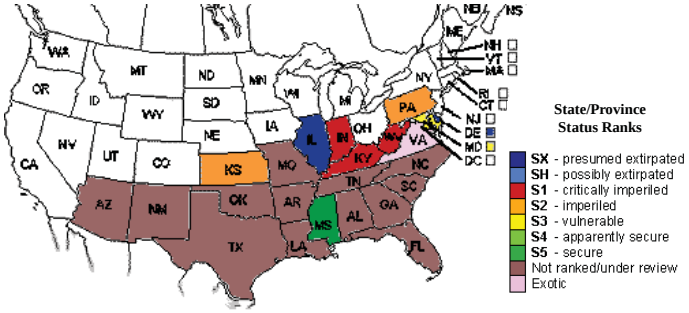
Description
Annual Fimbry is an annual graminoid herb that usually is less than 6 inches (15 cm) in height. The plants grow in tufted clumps and have thin, wiry stems that emerge from slender roots. The leaves are relatively few, less than 1/10 inch (3 mm) wide, have flat or inrolled edges, and occur mostly at the base of the plant. The flowers, appearing from July to October, are minute and are grouped in brown, egg-shaped spikelets. Up to 10 spikelets are clustered at the top of each stem, with the spikelets seeming to emerge from one point on the stem. The mature fruits are about 1/16 inch (1-1.5 mm) long.



Photo source: John Kunsman PNHP

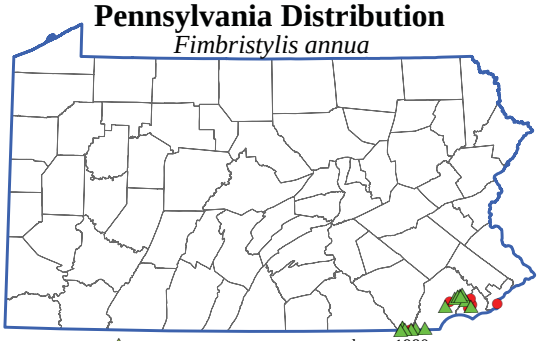
Distribution & Habitat
Annual Fimbry has a wide range in the southern states, with an extension to the northeast into Pennsylvania. In Pennsylvania, it is at a northern border of its range, and has been documented historically in a few southeastern counties. It grows in damp depressions or seasonal seepages on serpentine barrens.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Annual Fimbry to be a species of special concern, based on the few occurrences that have been recently confirmed and its specialized habitat on serpentine barrens. It has a PA legal rarity status and a PABS suggested rarity status of Threatened. About 12 populations are currently known from the state.

Pennsylvania Distribution
Fimbristylis annua



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Annual Fimbry and its serpentine habitat will require maintaining early successional conditions and natural hydrology patterns, and controlling invasive species. Active management, through the use of fire, scraping, or mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive.

NatureServe conservation status ranks
G5 – Globally Secure; **S2** – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Soapwort Gentian
Gentiana saponaria

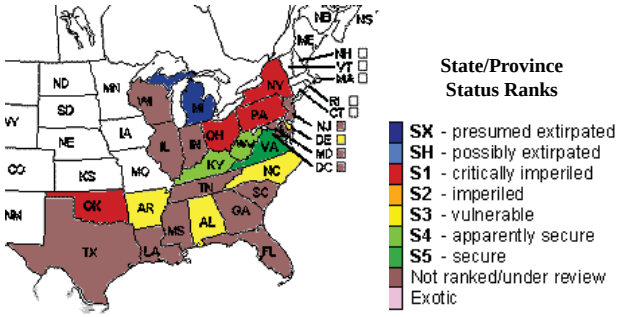
Description
Soapwort Gentian is an herbaceous perennial with a hairless stem that may grow to 2 feet (ca 60 cm) in height. The leaves are oppositely arranged, without a well-developed stalk, elliptic in shape, untoothed and usually hairy on the margin, and to 3 inches (7.5 cm) in length and to ½ inch (12 mm) in width. The blue tube-like flowers, appearing in September and October, are about 1½ inches (4 cm) in length and clustered at the top of the stem. The individual flowers, when unfolded, have 5 blue lobes that are united at their bases, but toward the flower tip are separated from each other by folds, or "plaits," which contrast in color and texture with the lobes. In Soapwort Gentian, the plaits are slightly shorter (by 2 mm or less) than the lobes at the top of the flower, and have small teeth along their margin. The green calyx of the flower, located beneath the petal tube, is partly united at the base and has lobe-like tips that have marginal hairs. The fruit is pod-like and contains many seeds.



Photo source: Carol and Hugh Nourse @ University Tennessee Herbarium

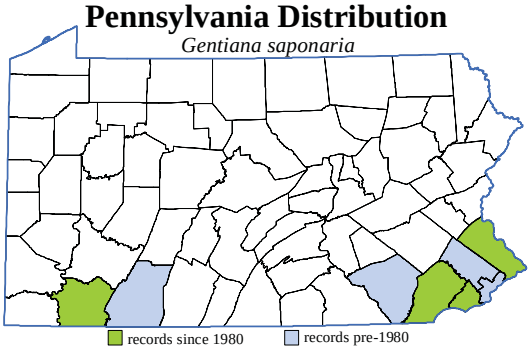
Distribution & Habitat
Soapwort Gentian ranges from New York to Wisconsin and south into Florida and Texas. In Pennsylvania, it has been documented historically mostly in the southeastern and southwestern counties. It grows in moist openings and clearings, open woods, utility rights-of-way, and swamps

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Soapwort Gentian to be a species of special concern, based on the limited number of locations that have been recently confirmed. It has a PA legal rarity status of Tentatively Undetermined, but has been assigned a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Gentiana saponaria



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Soapwort Gentian and its habitat often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing or prescribed fire, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Habitat loss and deer browse are threats in some locations.

NatureServe conservation status ranks
G5 – Globally secure; **S1S2** – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Multiflowered Mud-plantain
Heteranthera multiflora

Description

Multiflowered Mud-plantain is a creeping perennial herb with hairless stems. The leaves are alternately arranged, broadly heart-shaped or kidney-shaped, untoothed on the margin, stalked at the base, rounded or very blunt at the tip, hairless on both surfaces, and with numerous curving veins on the fleshy blades. The flowers, appearing from July to October, are white to very pale purple and have 6 lobe-like segments. The male portion of the flower, the stamen, has purplish hairs, which helps to distinguish this species from the more common species *Heteranthera reniformis*, which has whitish hairs. The fruit is a many-seeded capsule.



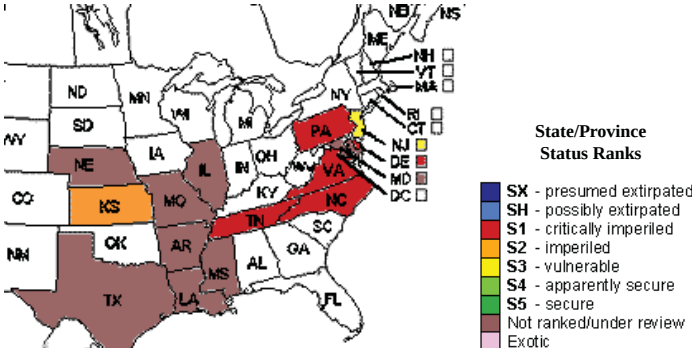
Photo source: Andrew Strassman PNHP

Distribution & Habitat

Multiflowered Mud-plantain has a range in central and coastal mid-Atlantic portions of North America. In Pennsylvania, the species has been documented historically only in a few southeastern counties along the Delaware River. Multiflowered Mud-plantain grows in intertidal marshes, mudflats, and shorelines along the lower Delaware River. The plants are subjected to daily cycles of exposure and inundation

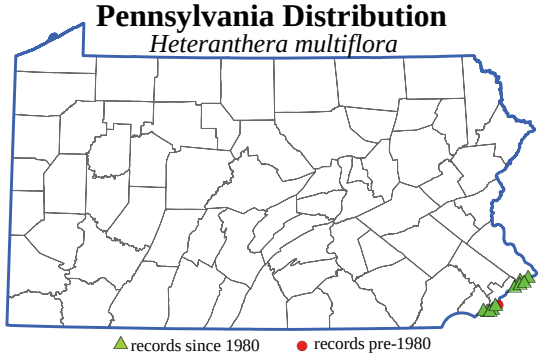
North American State/Province Conservation Status

Map by NatureServe 2010



Pennsylvania Distribution

Heteranthera multiflora



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Multiflowered Mud-plantain a rarity status of Endangered, based on the few populations that have been documented, its restricted state range, and the very specialized habitat. The known populations have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks

G4 – Apparently Secure; **S1** – Critically Imperiled in Pennsylvania

---

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Goldenseal
Hydrastis canadensis

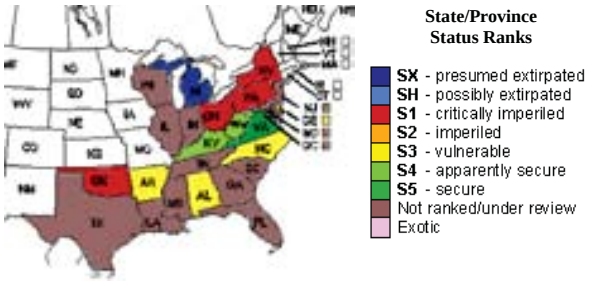
Description
Goldenseal is an herbaceous perennial with a hairy erect stem that may grow to 1 foot (ca 30 cm) or more in height. The plant receives its common name from the thick yellow underground stem, which is often considered to have medicinal value. The number of leaves per stem is usually 3, with a stalked pair at the top and another long-stalked one at the base. The leaves enlarge greatly after flowering. The leaves are veiny-looking on the surface and prominently 5-7 lobed, often with a maple-like shape, and are also finely toothed on the margin. The white flower, appearing in April and May, occurs singly on a short stalk above the base of the uppermost leaf. The flower has no petals and loses the sepals quickly, so the bloom consists only of the male stamens and the female pistils. The individual fruits are 3/16 inch (5 mm) in length and 1-2 seeded, and at maturity are aggregated together and resemble a raspberry (but should not be ingested).



Photo source: Andrew Strassman (PNHP)

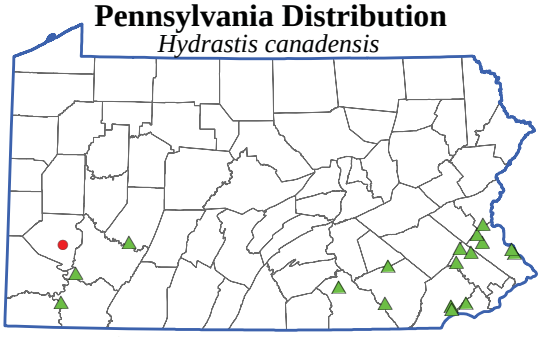
Distribution & Habitat
Goldenseal ranges from southern New England to Wisconsin and south into Georgia and Mississippi. In Pennsylvania, it has been documented historically mostly in the southern and western counties. It grows in moist woods, particularly on limestone and diabase substrates.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Goldenseal to be a species of special concern, based on the limited number of locations that have been recently confirmed and potential of collection for herbal medicine. It has a PA legal rarity status and a PABS suggested rarity status of Vulnerable.

Pennsylvania Distribution
Hydrastis canadensis



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Goldenseal may be threatened by intensive logging, invasive species, excessive deer browse, and especially collection of the plant for the herbal medicine trade.

NatureServe conservation status ranks
G4 – Apparently globally secure; **S4** – Apparently secure in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

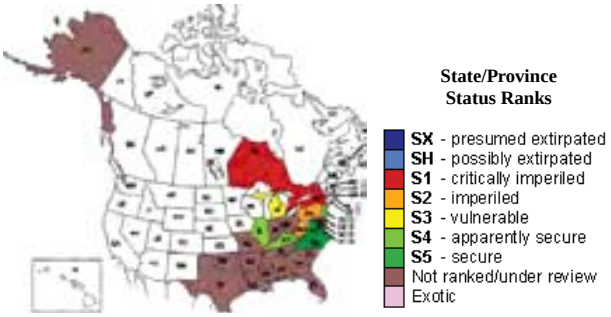
Grass-leaved Rush
Juncus biflorus

Description
Grass-leaved Rush is a perennial grass-like plant that may grow to 3 feet (1 m) in height, but is often much shorter. The stem arises from an underground bulb-like base that also produces spreading horizontal stems, or rhizomes. The leaves are alternately arranged, consisting of a basal sheath portion that envelopes the stem and a linear, flattened, and untoothed blade that is ¼ inch (4-6 mm) in width. The leaf blades give the plant its common name, and are in contrast to the leaves in most other species of rushes that are narrower and more-or-less rounded in cross section. The flowers, appearing in summer, are grouped in a terminal branching cluster that tends to be narrow at the base and then spreading outward. The individual flowers have 3 sepals and 3 petals that are usually red-brown in color and about 1/8 inch (3 mm) in length). Each flower has 3 stamens that often persist after shedding the pollen and even at the fruiting stage. The fruit is a dry, many-seeded capsule, usually brownish or reddish brown at maturity, averaging about 1/8 inch (2.5 mm) in length.


Photo Source: PNHP

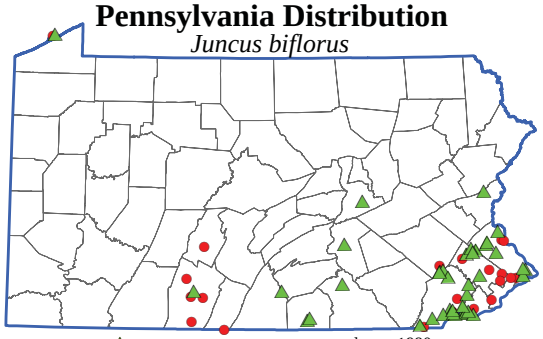
Distribution & Habitat
Grass-leaved Rush ranges from New England to Ontario and south into Florida and Texas. In Pennsylvania, it has been documented historically mostly in the southern, particularly the southeastern, counties. It grows in damp, sunny places, such as grasslands, meadows, clearings, old fields, thickets, and utility rights-of-way, and seems to have an affinity for diabase substrates.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Grass-leaved Rush to be a species of special concern, based on the moderate number of locations that have been recently confirmed. It has a PA legal rarity status of Tentatively Undetermined, but has been assigned a PABS suggested rarity status of Threatened.

Pennsylvania Distribution
Juncus biflorus



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Grass-leaved Rush often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Quarrying and habitat loss are threats at some locations.

NatureServe conservation status ranks
G5 – Globally secure; S2 – Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania

Pennsylvania Natural Heritage Program

Forked Rush
Juncus dichotomus

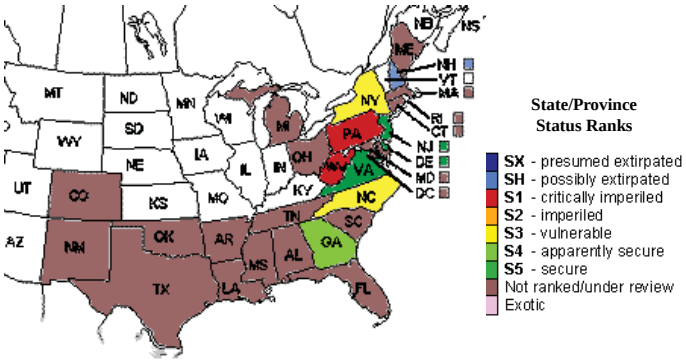
Description
Forked Rush is a perennial herb with rounded, slender stems that may be from 1 to 3 feet (3-9 dm) tall. The leaves are elongate, about 1/16 inch (2 mm) wide, rounded in cross-section and indented or channeled near the top, and only about ⅓ to ½ as long as the length of the stem. The flowers, appearing in late spring and summer, are grouped in an open branched cluster at the top of the stem. Flowers have 6 pointed petals and sepals that average about 3/16 inch (5 mm) long. The petals and sepals remain around the fruit, a brownish, many-seeded capsule, as it ripens.



Photo source: John Kunsman (PNHP)

Distribution & Habitat
Forked Rush has a range mostly near the coast from Maine south into Florida and west into the southwestern states. In Pennsylvania, it has been documented historically in some southern, particularly southeastern, counties. It grows in moist to damp old fields, openings, clearings, and open woods.

North American State/Province Conservation Status
Map by NatureServe 2010

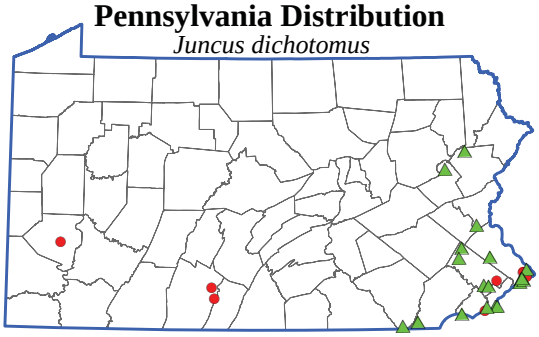


Current State Status
The PA Biological Survey (PABS) considers Forked Rush to be a species of special concern, based on the few occurrences that have been recently confirmed. It has a PA legal rarity status and a PABS suggested rarity status of Endangered. About 15 populations are currently known from the state.

Conservation Considerations
The viability of populations of this species and its habitat may be enhanced by creating buffers around wetlands, controlling invasive species, and protecting the natural hydrology around wetlands. Active management – such as fire, mowing, or invasive species removal – may be required to maintain the proper successional stage at sites where it grows.

NatureServe conservation status ranks
G5 – Globally Secure; **S1** – Critically Imperiled in Pennsylvania

Pennsylvania Distribution
Juncus dichotomus



Pennsylvania Natural Heritage Program Data 3-2011

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

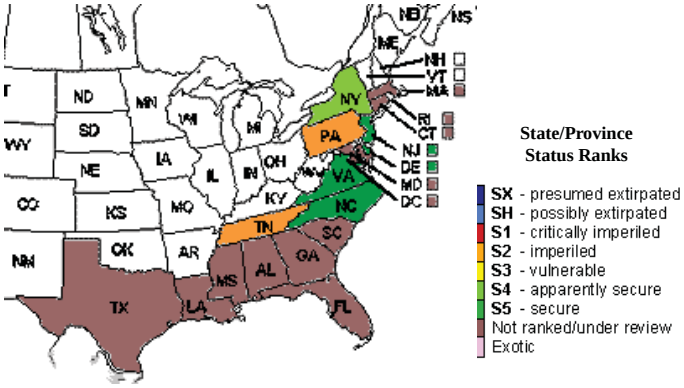
Swamp Dog-hobble
Leucothoe racemosa

Description
Swamp Dog-hobble is a deciduous shrub or small tree that may grow up to 9 feet (3 m) in height. The leaves are alternately arranged, sharply toothed on the margin, egg-shaped to elliptic, pointed at the tip, usually more-or-less hairy on the veins below, and typically 1 to 3 inches (3-8 cm) in length. The white flowers, appearing in May or June, are grouped in slender, elongate clusters, with all the flowers tending to point to the same side. The individual flowers, about 3/8 inch (7-9 mm) in length, have a tubular or bell shape. The fruit is a globe-shaped, many-seeded capsule.


Photo source: PNHP

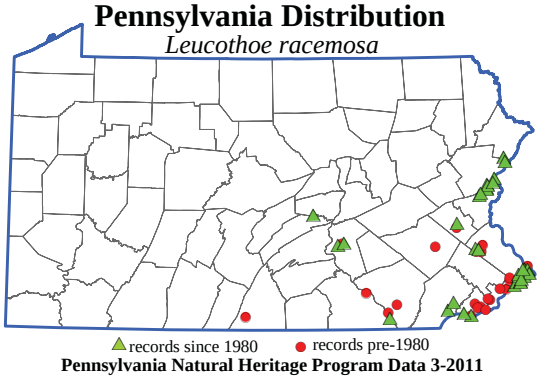
Distribution & Habitat
Swamp Dog-hobble has a mostly coastal range from New York west and south into Texas and Florida. In Pennsylvania, it represents a southerly species and has been documented historically in numerous southeastern counties. It grows in wetlands, particularly swamps, wet thickets, and the margins of ponds and streams.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey considers Swamp Dog-hobble to be a species of special concern, based on the relatively few occurrences that have been recently documented and the wetland habitat. It has a PA legal rarity status, but has been assigned a rarity status of Undetermined and a PABS suggested rarity status of Threatened. About 30 populations are known from the state.

Pennsylvania Distribution
Leucothoe racemosa



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of known populations of Swamp Dog-hobble and its habitat may be enhanced by establishing buffers around wetlands, controlling invasive species, and protecting the natural hydrology surrounding wetlands

NatureServe conservation status ranks
G5 – Globally Secure; **S2S3**– Imperiled to Vulnerable in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Downy Lobelia
Lobelia puberula

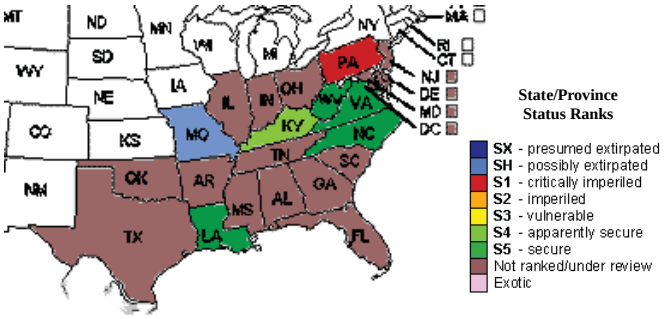
Description
Downy Lobelia is an herbaceous perennial with a hairy stem that may grow to 3 feet (1 m) in height. The leaves are alternately arranged, short-stalked or stalkless, egg-shaped to oblong, usually toothed on the margin, rounded at the base and pointed at the tip, and to 4 inches (10 cm) in length and to 2 inches (5 cm) in width. The blue flowers, appearing in August and September, are about ¾ inch (1.5-2 cm) in length, hairy on the outside, and scattered in an alternating sequence, and often 1-sided, along the middle and upper part of the stem. The individual flowers have a two-lipped appearance, with 3 lower lobes and 2 upper lobes, with the basal part of the flower fused in one tube-like unit. The greenish sepals that subtend the petals have long slender tips and are hairy on the margins. The fruit is pod-like and contains many seeds.



Photo source: Rocky Gleason (PNHP)

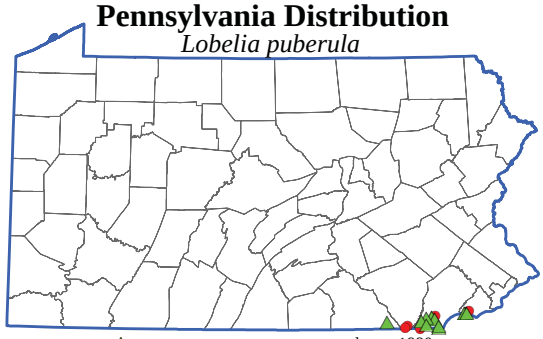
Distribution & Habitat
Downy Lobelia ranges from New Jersey to Illinois and south into Florida and Texas. In Pennsylvania, it is considered a southerly species and has been documented historically in the southeastern counties. It grows in moist clearings and openings, grasslands, woods borders, and rights-of-way.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Downy Lobelia to be a species of special concern, based on the limited number of locations that have been recently confirmed and the generally small population sizes. It has a PA legal rarity status and a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Lobelia puberula



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Downy Lobelia often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive.

NatureServe conservation status ranks
G5 – Globally secure; **S1** – Critically imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Southern Bog Clubmoss
Lycopodiella appressa

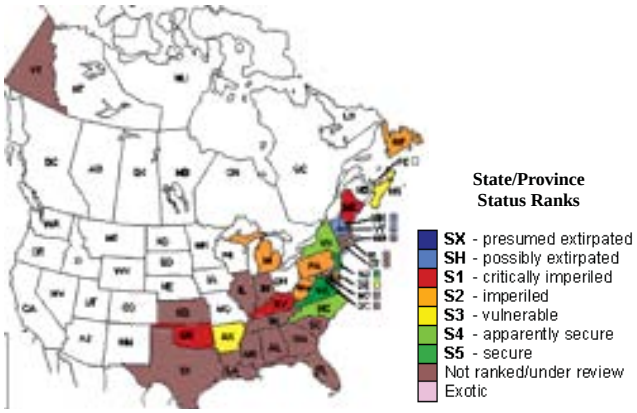
Description
Southern Bog Clubmoss is a perennial with leafy, creeping, horizontal stems that occasionally produce erect fertile stems. The fertile stems grow up to 16 inches (40 cm) tall. The leaves are scale-like, with at least a few teeth on the margins, and are pressed flat against the stem in an upward direction and cover the entire length of the stem. The species does not have flowers, fruits or seeds, but produces spores in a club-like structure, called a strobilus, located at the top of each fertile stem. The strobilus in this species makes up less than 1/3 of the total height of the fertile stem.



Photo source: John Kunsman (PNHP)

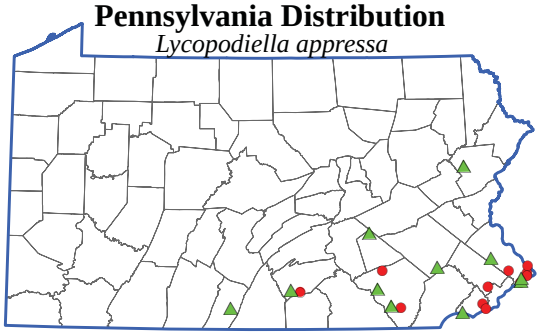
Distribution & Habitat
Southern Bog Clubmoss has a mostly coastal distribution from Nova Scotia west and south into Texas and Florida. In Pennsylvania, it occurs mainly in the southeastern counties, where it grows in sandy to peaty seepages, depressions, and damp successional openings.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Southern Bog Clubmoss to be a species of special concern, based on the few occurrences that have been recently confirmed and its wetland habitat. It has a PA legal rarity status and a PABS suggested rarity status of Threatened. About 12 populations are currently documented from the state.

Pennsylvania Distribution
Lycopodiella appressa



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of known populations of Southern Bog Clubmoss and its habitat type can be enhanced by creating buffers around wetlands, controlling invasive species, and protecting the hydrology of the wetland and its surroundings. This species can colonize certain types of disturbed ground, such as abandoned quarries and utility rights-of-way, if the proper substrate and moisture conditions are present. Natural succession, invasive species, and the indiscriminate application of herbicide can be threats at these sites.

NatureServe conservation status ranks
G5 – Globally Secure; **S2** – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Bugleweed
Lycopus rubellus

Description

Bugleweed is a perennial herb that may grow to 3 feet (1 meter) in height. The stem may be hairy or hairless, and when broken lacks the mint-like aroma that is characteristic of most members of the mint family. The leaves are oppositely arranged, lance-shaped to elliptic, from 2 to 4 inches (5 -10 cm) in length and ½ to 1 inch (1-3 cm) in width, stalked at the base, pointed at the tip, and variably toothed on the margin. The flowers, appearing from July to September, are arranged in dense clusters above the base of the leaf stalk. The sepal lobes in this species are relatively long and pointed at the tip.

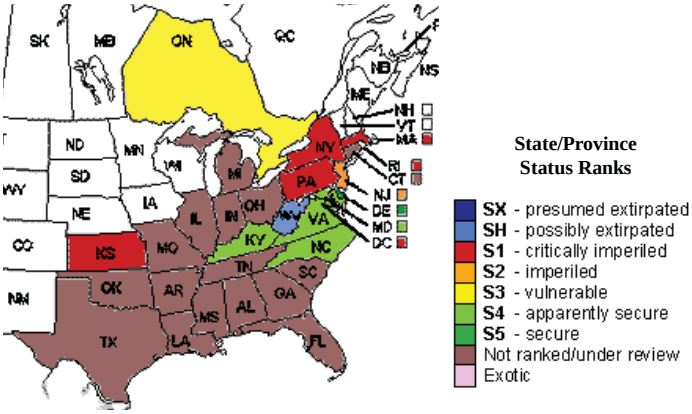


Photo source: PNHP

Distribution & Habitat

Bugleweed has a range from southern New England to Quebec and south into Florida and Texas. In Pennsylvania, the species has been documented historically in several eastern counties, but particularly along the lower Delaware River. Bugleweed grows in intertidal marshes, mudflats, shorelines, and ditches.

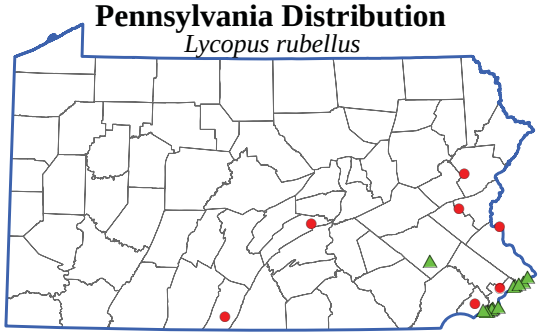
North American State/Province Conservation Status
Map by NatureServe 2010



State Status & Conservation

The PA Biological Survey (PABS) has assigned Bugleweed a rarity status of Endangered, based on the relatively few populations that have been documented and the limited state range. The populations have threats from exotics species, dredging and filling, and water pollution.

Pennsylvania Distribution
Lycopus rubellus



Pennsylvania Natural Heritage Program Data 3-2011

NatureServe conservation status ranks

G5 – Globally Secure; **S1** – Critically imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Stiff Cowbane
Oxypolis rigidior

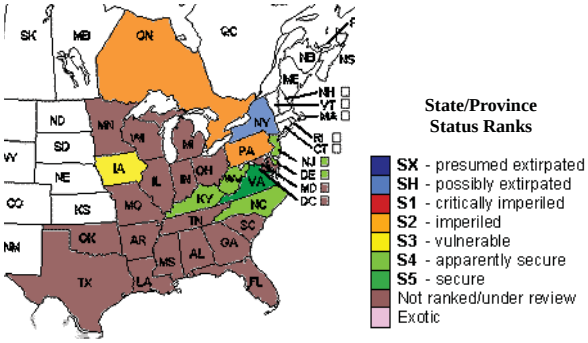
Description
Stiff Cowbane is an herbaceous perennial with a hairless, striated stem that may grow to 4 feet (ca 1.2 m) in height, but may be much shorter. The leaves are alternately arranged, rather thick in texture, divided into 5-9 leaflets that are untoothed or with a few scattered teeth near their tips, lance-shaped or egg-shaped or oblong, hairless, and from 2.5-5.5 inches (6-14 cm) in length and to 1.5 inches (4 cm) in width. The white flowers, appearing from August to September, are individually minute and are arranged in a flowering cluster, or inflorescence, called an umbel, in which the main branches arise from the same level or point and then radiate outward. The fruits are dry, flattened, 3/16 inch (4-6 mm) in length, with longitudinal striations or ribs in the central portion and a thin border or "wing" around the perimeter.



Photo source: Wm. Justice @ USDA-NRCS PLANTS Database/

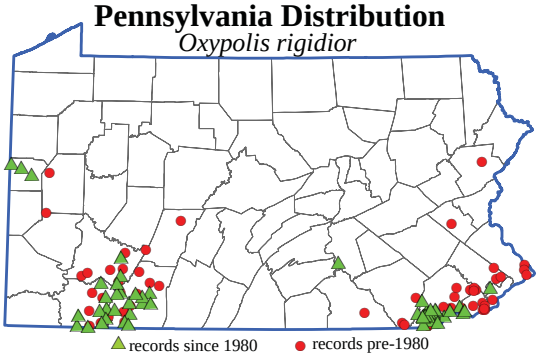
Distribution & Habitat
Stiff Cowbane ranges from New York to Minnesota and south into Florida and Texas. In Pennsylvania, it represents a southerly species and has been documented historically in the southeastern and southwestern counties. It grows in marshes, swamps, damp or wet meadows, and along streams.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Stiff Cowbane to be a species of special concern, based on the moderate number locations that have been recently confirmed and the mostly small population sizes. It has a PA legal rarity status of Tentatively Undetermined, but has been assigned a PABS suggested rarity status of Threatened.

Pennsylvania Distribution
Oxypolis rigidior



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of Stiff Cowbane often requires maintaining early successional conditions and controlling invasive species. Active management, such as periodic mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Excessive deer browse may be a threat in some locations.

NatureServe conservation status ranks
G5 – Globally secure; **S2** – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

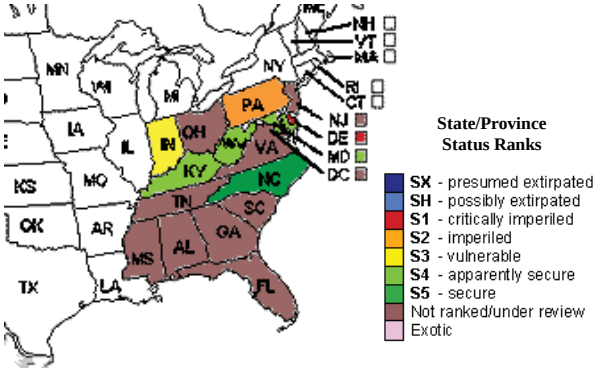
Plain Ragwort
Packera (Senecio) anonymus

Description
Plain Ragwort is a perennial member of the aster family that bears numerous yellow, aster-like flower heads between 1 and 2¾ feet (3-8 dm) tall and are densely wooly at the base. The leaves grow from the base of the plant as well as along the stems. Basal leaves are toothed, lance-shaped to elliptic, and taper at their base to a petiole. Stem leaves are smaller, deeply dissected, and may attach without a petiole. The flowers are displayed in terminal, flat-topped clusters of 20 to 100 flower heads. Individual flower-heads are about ½ to ¾ inch (13-20 mm) wide and have a yellow central disk surrounded by 8 to 15 yellow rays.


Photo source: PNHP

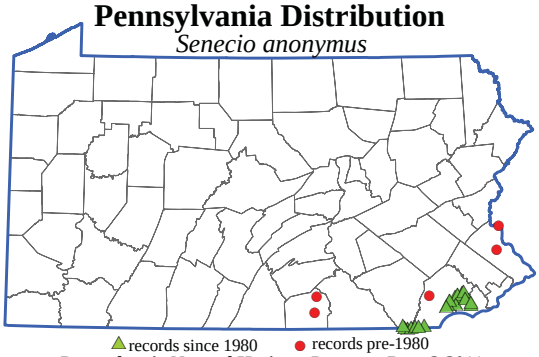
Distribution & Habitat
Plain Ragwort can be found from New Jersey and Pennsylvania south to Florida and west to Indiana through Mississippi. In Pennsylvania this species is most commonly found growing in serpentine barrens and in dry, open woods.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Plain Ragwort to be a species of special concern, based on the relatively few occurrences that have been recently confirmed and its serpentine habitat. It has a PA legal rarity status and a PABS suggested rarity status of Rare.

Pennsylvania Distribution
Senecio anonymus



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of plain ragwort and its serpentine habitat will require maintaining early successional conditions and controlling invasive species. Active management, through the use of fire, scraping the substrate, or mowing, may be needed to create the proper successional stage and ecological conditions for this species to thrive. Quarrying and habitat loss are threats in some locations.

NatureServe conservation status ranks
G5 – Globally Secure; **S2**– Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Shrubby Camphor-weed
Pluchea odorata

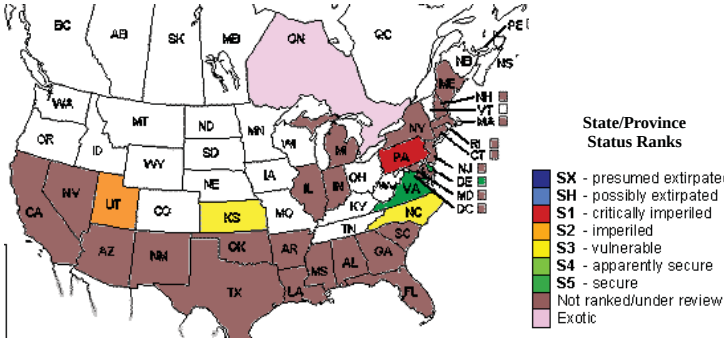
Description
Shrubby Camphor-weed is an annual herb with a more-or-less hairy stem that may reach 3 feet (1 meter) in height, but may be much smaller. As the name implies, the entire plant has a camphor-like aroma and is somewhat sticky or greasy to the touch. The leaves are alternately arranged, lance-shaped to egg-shaped, from 1.5 to 6 inches (4-15 cm) in length and ½ to 3 inches (1-7 cm) in width, stalkless or short-stalked at the base, pointed at the tip, often somewhat hairy on both surfaces, and usually toothed on the margin. The flowers, appearing from August to October, are pinkish to purple and are grouped in a cluster at the top of the stem.



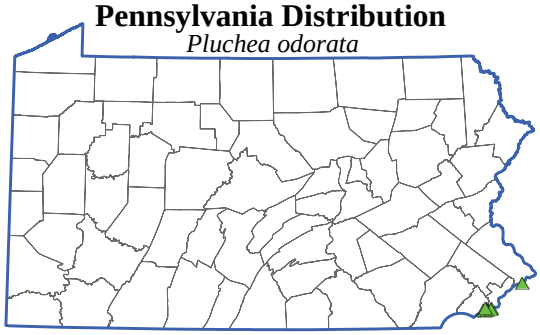
Photo source: PNHP

Distribution & Habitat
Shrubby Camphor-weed has a wide range in northeastern and southern North America, with the species being mostly coastal in the northeastern states. In Pennsylvania, it has been documented historically in a few southeastern counties. Shrubby Camphor-weed grows in natural coastal wetlands, but may also be found in disturbed ground, such as damp clearings, openings, ditches, and along roads.

North American State/Province Conservation Status
Map by NatureServe 2010



Pennsylvania Distribution
Pluchea odorata



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Shrubby Camphor-weed a rarity status of Endangered, but has concentrated on identifying locations where the species is occupying relatively natural habitats, and has given a lower conservation priority to populations inhabiting disturbed sites. The more natural habitats have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks
G5 – Globally Secure; **S1 –** Critically Imperiled in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

Autumn Bluegrass
Poa autumnalis

Description
Autumn Bluegrass is a perennial herb with a slender hairless stem that may grow to 2 feet (60 cm) in height. The leaves are alternately arranged, linear in shape, not toothed on the margin, parallel-veined, up to 6 inches (15 cm) in length and 1/16 inch (2-3 mm) in width, and pointed at the tip. The flowers, appearing in May and June, are individually only a few millimeters in length. They are grouped in an open branched cluster at the top of the stem, with the main lower branches of the cluster tending to be arranged in pairs or occurring singly along the stem. Despite the common name, this species flowers and fruits in spring.

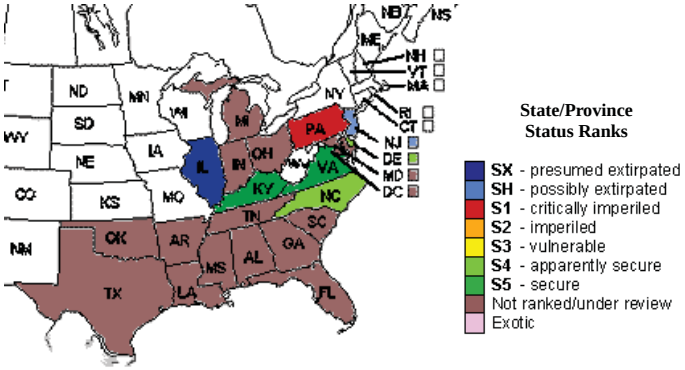


Arboretum

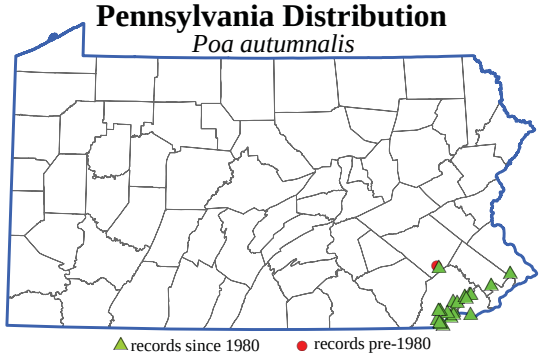
Autumn bluegrass (*Poa autumnalis*) seed head

Distribution & Habitat
Autumn Bluegrass has a range from New Jersey west into Michigan and south into Florida and Texas. In Pennsylvania, it has been documented historically in several southeastern counties. Autumn Bluegrass grows in moist woods and on stream banks and slopes.

North American State/Province Conservation Status
Map by NatureServe 2010



Pennsylvania Distribution
Poa autumnalis



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Autumn Bluegrass a rarity status of Endangered, based on the relatively few populations that are documented and the small state range. Some populations are threatened by habitat loss and exotic species.

NatureServe conservation status ranks
G5 ─Globally Secure; **S1** ─ Critically Imperiled in Pennsylvania

---

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Cross-leaved Milkwort
Polygala cruciata

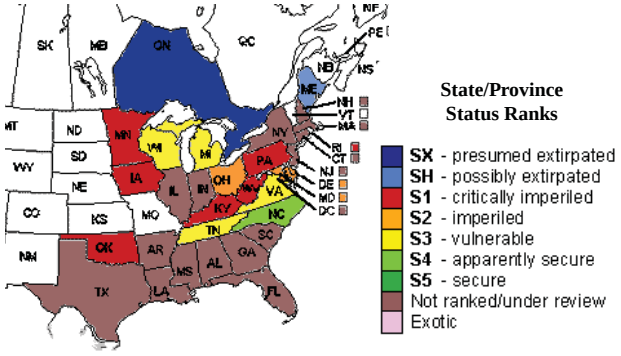
Description
Cross-leaved Milkwort is an herbaceous annual with a hairless, more-or-less 4-sided stem that may grow to 1 foot (ca 30 cm) in height, but is usually shorter. The leaves are arranged in whorls of 3 or 4, unstalked, linear to narrowly elliptic in shape, untoothed on the margin, and to 1.5 inches (4 cm) in length and to 1/8 inch (3 mm) in width. The greenish or greenish-purple flowers, appearing from July to September, are individually small and are aggregated in a dense, apically rounded, barrel-shaped cluster, which has at most a very short stalk, at the end of the stem or the branches of the stem. The most notable parts of the individual flower are the 2 inner sepals, which are larger and shaped differently from the 3 outer sepals and the 3 petals, being broadly-triangular in outline, heart-shaped at the base, and long-pointed at the tip. The fruit is a dry capsule containing 2 seeds.



Photo Source: John Kunsman (PNHP)

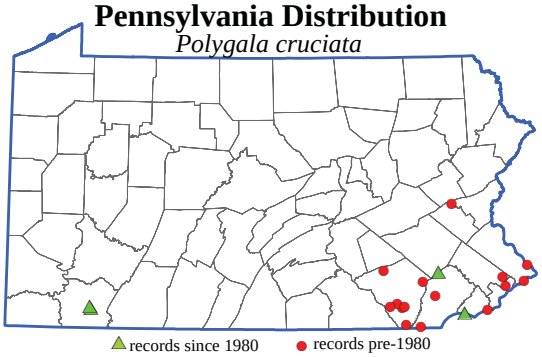
Distribution & Habitat
Cross-leaved Milkwort ranges from Maine to Minnesota and south into Florida and Texas. In Pennsylvania, it has been documented historically in the southeastern and southwestern counties. It grows in damp or wet openings, bogs, shorelines, and marshes.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Cross-leaved Milkwort to be a species of special concern, based on the limited number of locations that have been recently confirmed and the wetland habitat it typically occupies. It has a PA legal rarity status and a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Polygala cruciata



Conservation Considerations
The viability of populations of Cross-leaved Milkwort and its habitat may be enhanced by creating buffers and protecting the natural hydrology around wetlands and controlling invasive species.

NatureServe conservation status ranks
G5 – Globally secure; **S1** – Critically imperiled in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

PNHP
Pennsylvania Natural Heritage Program

Southern Red Oak
Quercus falcata

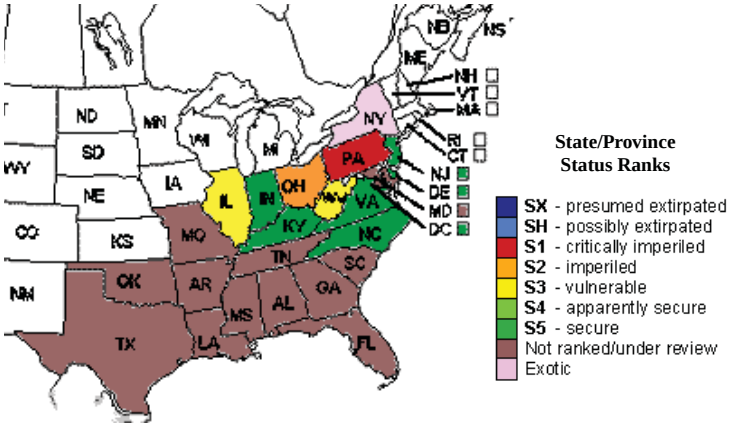
Description
Southern Red Oak is a deciduous tree that may grow to 80 feet (25 meters) in height. The bark is gray and furrowed. The leaves are alternately arranged, broadly "U" shaped at the base, densely and permanently hairy on the undersurface, and with 3 to 7 bristle-tipped lobes that tend to have relatively few secondary lobes or teeth. The flowers, appearing from late April to May, are unisexual, with female flowers occurring singly or in pairs and male flowers arranged in much more conspicuous clusters of long, drooping catkins. The fruit is an acorn averaging about 1/2 inch (1.0-1.5 cm) in length, and is covered about ⅓ of its length by a scaly saucer-like cup.



Photo source: John Kunsman PNHP

Distribution & Habitat
Southern Red Oak has a distribution from New York south and west into Texas and Florida. In Pennsylvania, it represents a southerly species and has been documented historically in a few southeastern counties. The species grows in well-drained woods, thickets, serpentine barrens, and dry slopes.

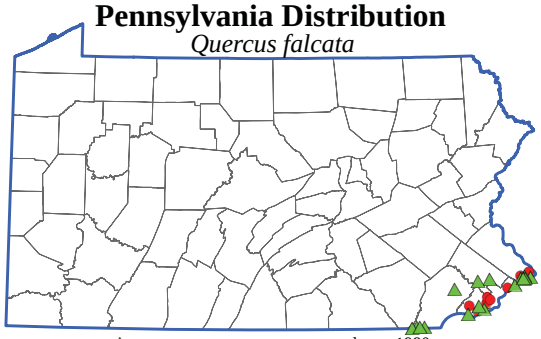
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey considers Southern Red Oak to be a species of special concern, based on the relatively few occurrences that have been confirmed and the small state range. It has a PA legal rarity status and a PABS suggested rarity status of Endangered. Fewer than 15 populations are known from the state.

Conservation Considerations
The known populations of Southern Red Oak are threatened by habitat loss, invasive species, and in some locations, excessive browsing by deer. Establishing buffers around fragmented forested habitat and removal of invasive species will help to maintain populations.

Pennsylvania Distribution
Quercus falcata



Pennsylvania Natural Heritage Program Data 3-2011

NatureServe conservation status ranks
G5 – Globally Secure; **S1** – Critically Imperiled in Pennsylvania

References
- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Swamp Chestnut Oak
Quercus michauxii

Description



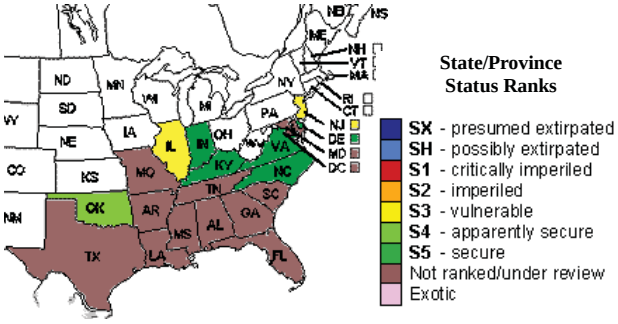
Photo source: John Kunsman (PNHP)

Swamp Chestnut Oak is a large tree with grayish bark that can grow to 100 feet (30 m) in height. The overwintering buds are reddish-brown and minutely hairy. The leaves are alternately arranged, tending to be widest in the middle or nearer to the tip, usually 4 or more inches (10 cm or more) in length and 2½ to 4 inches (to10 cm) in width, with 8-16 pairs of more-or-less parallel secondary veins that end in rounded teeth. The leaf undersurface (under high magnification) has sparse to dense hairs that are erect and few-branched (not flattened to the leaf surface and many-branched, as in some related species). The flowers, which appear in spring as the leaves emerge, are separated into male and female; the former are more conspicuous, being grouped in slender, dangling clusters, or "catkins." The fruit is the well-known acorn, which in this species consists of a nut averaging about 1 inch (2.5 cm) in length enclosed about halfway by a bowl-like cup, which is covered by small, overlapping, triangular-shaped scales.

Distribution & Habitat

Swamp Chestnut Oak ranges from New Jersey to Missouri and south into Florida and Texas. In Pennsylvania, it has been documented historically in two southeastern counties. The species grows in swamps, seasonally wet woods, and bottomlands.

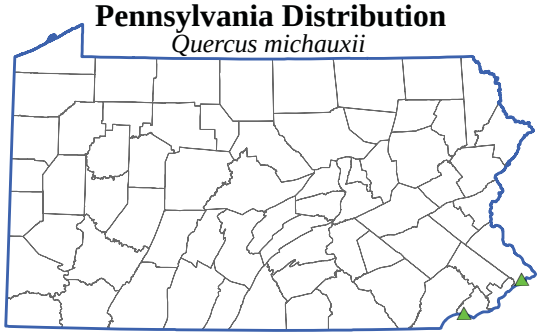
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Swamp Chestnut Oak to be a species of special concern, based on the few locations that have been recently confirmed. It does not have a PA legal status, but has been assigned a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Quercus michauxii



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Swamp Chestnut Oak and its habitat may be enhanced by creating buffers and protecting the natural hydrology surrounding wetlands and controlling invasive species. Excessive deer browse is a threat at the known locations.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Willow Oak
Quercus phellos

Description

Willow Oak is a deciduous tree that may grow to 80 feet (25 meters) in height. The bark is dark gray and furrowed. The leaves are alternately arranged, lance-shaped, without the lateral teeth and lobes typical of most Pennsylvania species of oaks, 2 to 4 inches (5 to 10 cm) long and 3/8 to ¾ inch (less than 2 cm) wide, bristle-tipped, and usually hairless on both surfaces at maturity. The flowers, appearing from late April to May, are unisexual, with female flowers occurring singly or in pairs and male flowers arranged in much more conspicuous clusters of long, drooping catkins. The fruit is an acorn averaging about 3/8 inch (about 1 cm) in length, and is covered about ¼ to ½ of its length by a scaly saucer-like cup.



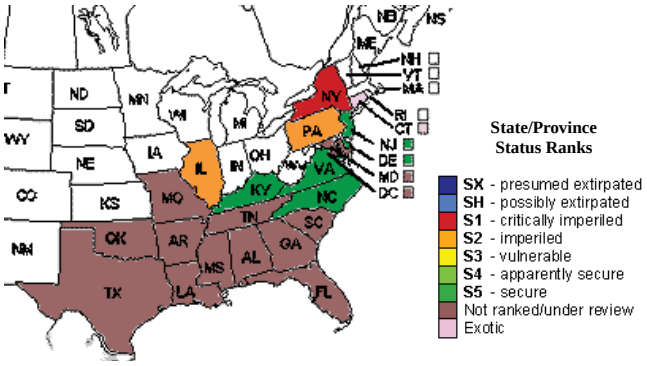
Photo source: PNHP

Distribution & Habitat

Willow Oak has a range from New York south and west into Texas and Florida, and is primarily coastal in the eastern portion of its distribution. In Pennsylvania, it represents a southerly species and has been documented historically in a few southeastern counties. Willow Oak grows in damp to swampy woods, thickets, and bottomlands.

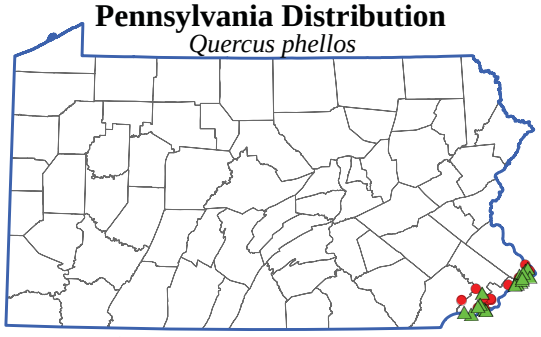
North American State/Province Conservation Status

Map by NatureServe 2010



Pennsylvania Distribution

Quercus phellos



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Willow Oak a rarity status of Endangered, based on the relatively few populations that have been documented and the limited state range. Some populations of Willow Oak are threatened by habitat loss, invasive species, and in some locations, excessive browsing by deer. Establishing buffers around fragmented forested habitat and removal of invasive species will help to maintain populations.

NatureServe conservation status ranks

G5 – Globally Secure**; S2 –** Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Toothcup
Rotala ramosior

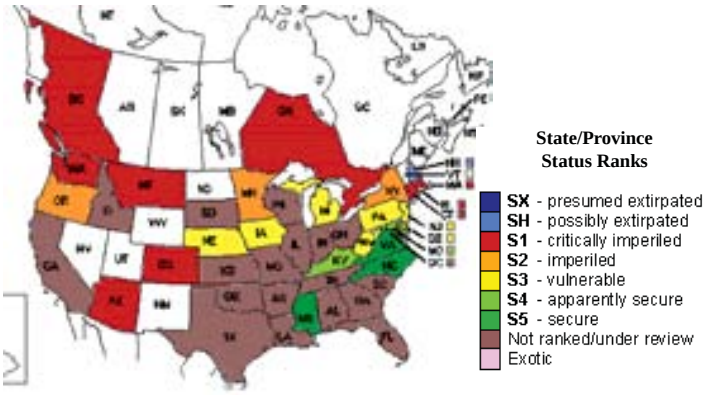
Description
Toothcup is a small annual herb that has smooth stems that may grow up 12 inches (30 cm) in height, but in some cases may be less than 1 inch. The leaves are oppositely arranged, stalkless, averaging about 1 inch (2.5 cm) long, untoothed, generally elliptic in shape with a rounded tip and tapering base. The flowers, appearing from July to September, are located in the leaf axils. Each flower has 4 light pink or whitish petals, which tend to fall off early. The fruit is a many-seeded capsule that is about 3/16 inch (3-5 mm) long and usually becomes red in color as it matures.



Photo source: R. Harrison Wiegand

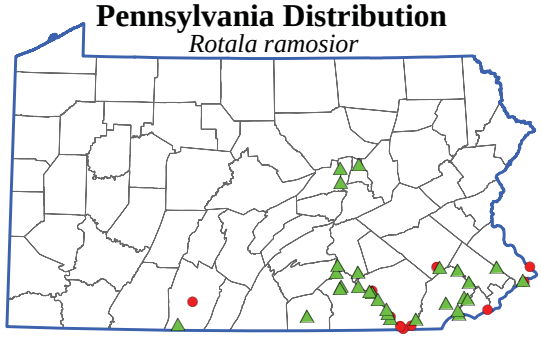
Distribution & Habitat
Toothcup has a very wide range in North America. In Pennsylvania, it has been documented historically in numerous southern counties, particularly along the Susquehanna River. It grows on exposed shorelines, stream margins, streambed outcrops, and other damp, open places.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Toothcup to be a species of special concern, based on the relatively few occurrences that have been recently confirmed and its wetland habitat. It has a PA legal rarity status and a PABS suggested rarity status of Rare. About 30 populations are currently known from the state.

Pennsylvania Distribution
Rotala ramosior



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The populations of Toothcup that occur along streams and rivers can be enhanced by maintaining the natural seasonal fluctuations in the water level of the stream and the natural conditions of its shoreline. Despite its somewhat narrow habitat requirements, this species appears to be fairly successful in reproducing itself and colonizing new areas. Invasive species may be a threat in some locations.

NatureServe conservation status ranks
G5 – Globally Secure; **S3** – Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Long-lobed Arrowhead
Sagittaria calycina var. *spongiosa*

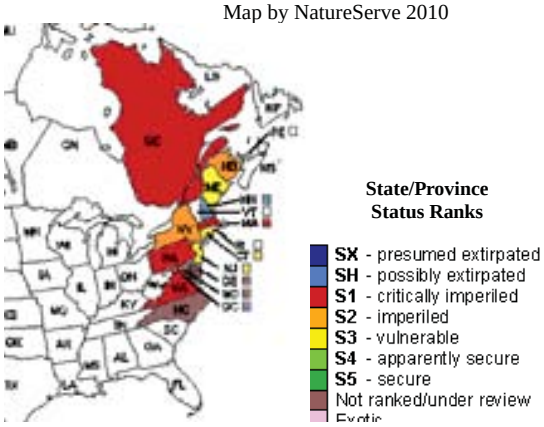
Description
Long-lobed Arrowhead is a small annual herb growing to about 1 foot (30 cm) in height. The leaves have a relatively broad spongy leaf stalk that expands slightly at the tip into a spatula-like or elliptic blade. The flowers, appearing from July to September, have 3 white petals that are only a few millimeters in length. The flowers occur singly or up to a few in a whorl, with the stalks somewhat broad and spongy like the leaf stalks. The sepals of each flower are persistent and enclose the fruiting head, which consists of many small one-seeded, flattened fruits that are up to 2 millimeters in length.



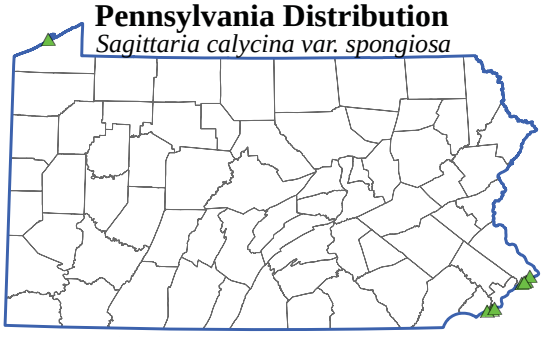
Photo source: PNHP, Andrew Strassman

Distribution & Habitat
Long-lobed Arrowhead has a range along the Atlantic coast from maritime Canada south into North Carolina. In Pennsylvania, this species has been documented in the southeastern counties, and along Lake Erie in Erie County. Long-lobed Arrowhead grows in intertidal marshes, mudflats, and shorelines. The intertidal populations are subjected to daily cycles of exposure and inundation.

North American State/Province Conservation Status
Map by NatureServe 2010



Pennsylvania Distribution
Sagittaria calycina var. spongiosa



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation
The PA Biological Survey (PABS) has assigned Long-lobed Arrowhead a rarity status of Endangered, based on the limited number of populations that have been confirmed, the small population sizes, the limited state range, and the specialized habitat. The known populations have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks
G5T4 – Globally Secure; **S1 –** Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Subulate Arrowhead
Sagittaria subulata

Description

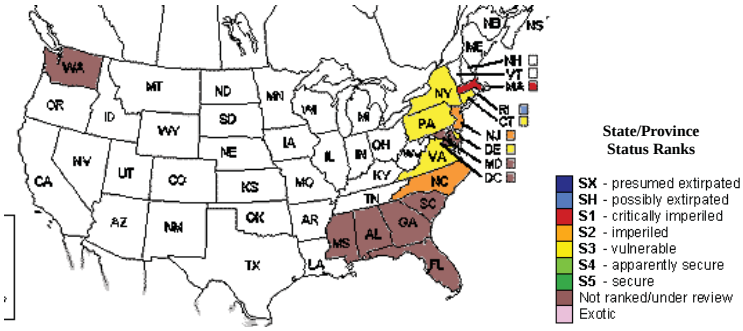
Subulate Arrowhead is a small perennial herb generally only a few inches in height that forms small mats due to its horizontally-spreading stems. The leaves are linear to strap-shaped, up to 3 inches (7.5 cm) in length and 1/8 inch (4 mm) in width, somewhat spongy, and do not have an expanded leaf blade at the tip. The flowers, appearing from June to September, have 3 white petals that are only a few millimeters in length. The individual flowers are grouped in a whorl-like cluster. The sepals of each flower are persistent, and are spreading or bent down beneath the fruiting heads, which consist of a group of flattened, one-seeded fruits that are 1 or 2 mm in length.



Photo source: Andrew Strassman (PNHP)

North American State/Province Conservation Status

Map by NatureServe 2010

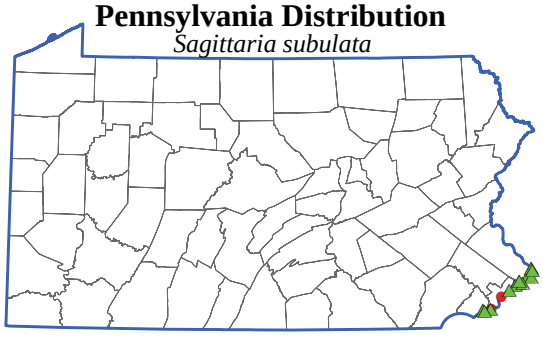


Distribution & Habitat

Subulate Arrowhead has a range from Massachusetts south along the coast into Florida and Alabama. In Pennsylvania, it has been documented recently only in a few southeastern counties along the Delaware River. Subulate Arrowhead grows in intertidal marshes, mudflats, and river shores. The intertidal populations are subjected to daily cycles of exposure and inundation

Pennsylvania Distribution

Sagittaria subulata



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Subulate Arrowhead a rarity status of Rare. The species appears to be successful enough in maintaining its populations so as not to be endangered or threatened with extirpation, yet has a very limited range in the state and a very specialized habitat. The populations of Subulate Arrowhead have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks

G4 – Apparently Secure; **S3** – Vulnerable in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

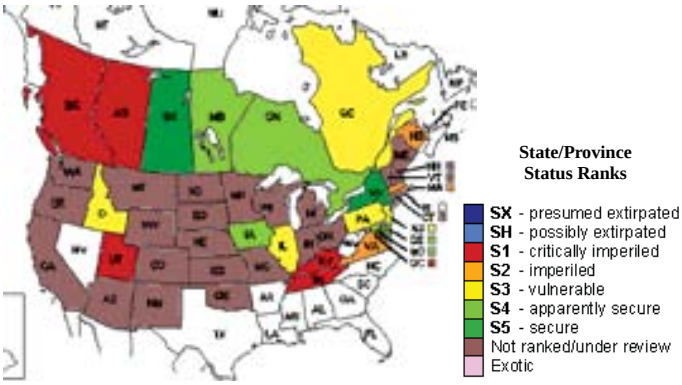
River Bulrush
Schoenoplectus fluviatilis

Description
River Bulrush is a perennial herb that forms colonies from underground stems. The triangular aerial stems are robust and may grow from 2½ to 6½ feet (0.7-2 m) in height. The leaves are alternately arranged, grass-like, elongate, averaging about 3/8 inch (1 cm) wide, and somewhat V-shaped in cross-section. The flowers, appearing from June to August, are grouped in ½ to 1½ inch (1.5-4 cm) spikelets. The spikelets are grouped in a branching cluster at the top of the stem that is subtended by several spreading, leaf-like bracts. The individual fruits are about 3/16 inch (3.5-5 mm) long.


Photo source: PNHP

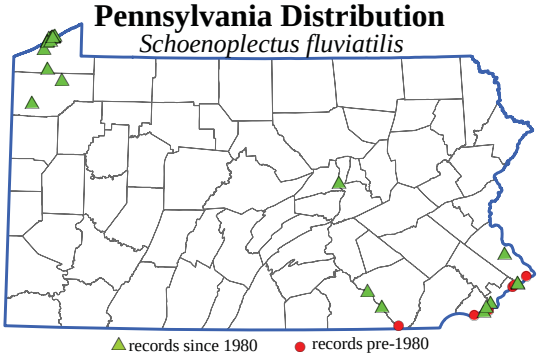
Distribution & Habitat
River Bulrush has a very broad range with the exception of the southeastern states, across North America. In Pennsylvania, it has been documented historically in the northwestern and southeastern counties. It grows on the shorelines of rivers and streams, and also in marshes and other wet places.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers River Bulrush to be a species of special concern, based on the relatively few occurrences that have been recently confirmed and its wetland habitat. It has a PA legal rarity status and a PABS suggested rarity status of Rare. About 30 populations are currently known from the state.

Pennsylvania Distribution
Schoenoplectus fluviatilis



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of the riverine populations of River Bulrush may be enhanced by maintaining the water quality and natural hydrology of the streams, with their seasonal fluctuations and scouring, as well as retaining natural conditions along the shoreline areas. For non-riverine populations, establishing buffers and protecting the hydrology around wetlands are necessary. Invasive species represent a threat to the habitat of river bulrush.

NatureServe conservation status ranks
G5 – Globally Secure; **S3**– Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Smith's Bulrush
Schoenoplectus smithii

Description

Smith's Bulrush is an annual herb with a soft, three-sided stem that may grow to 1.5 feet in height (0.5 meters), but is usually much smaller. The leaves, which may be absent, are mostly clustered at the base of the stem, linear in shape, entire on the margin, and variable in length. The flowers, appearing from July to September, are individually only 1 to 2 mm length, being aggregated in stalkless clusters that are attached at a single point on the middle to upper portion of the stem, and are overtopped by a slender leaf-like bract. The individual fruits are black at maturity, about 2 mm in length, and lack the subtending bristles found in *Schoenoplectus purshianus*, which is a more common, similar-looking species.



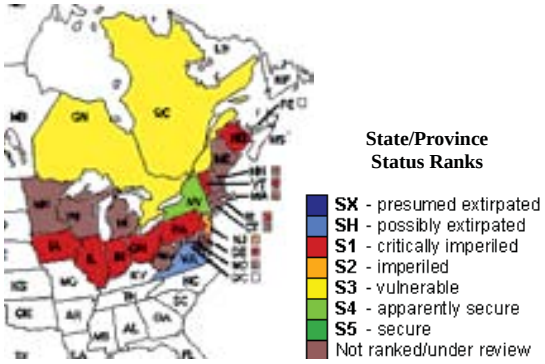
Photo source: Steve C. Garske, Robert W. Freckmann Herbarium

Distribution & Habitat

Smith's Bulrush has a range in northeastern North America and the Great Lakes states. In Pennsylvania, it has been documented historically in scattered locations, particularly in the southeastern counties along the Delaware River and in the northwestern counties. Smith's Bulrush grows in intertidal marshes, mudflats, and on shorelines. The populations in intertidal marshes are subjected to daily cycles of exposure and inundation.

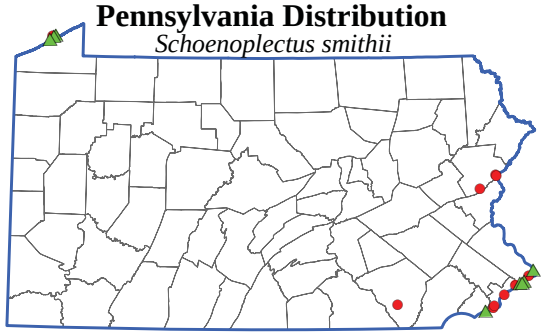
North American State/Province Conservation Status

Map by NatureServe 2010



Pennsylvania Distribution

Schoenoplectus smithii



Pennsylvania Natural Heritage Program Data 3-2011

State Status & Conservation

The PA Biological Survey (PABS) has assigned Smith's Bulrush a rarity status of Endangered, based on the relatively few populations that have been confirmed, the usually small population sizes, the limited state range, and the specialized habitat. The known populations have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks

G5? – Globally Secure; **S1** – Critically Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Wild Senna
Senna marilandica

Description

Wild Senna is an erect, bushy perennial herb that can grow up to 6 ½ feet (2 meters) tall. The leaves are alternate, have dome-shaped gland near the base of the leaf stalk, and are divided into 4 to 8 pairs of oblong to elliptic leaflets. The flowers are yellow, appear in July, and are up to 1 inch (2.5 cm) wide, with five yellow petals and 10 dark-red stamens. The fruit is a flattened pod marked with distinct segments.



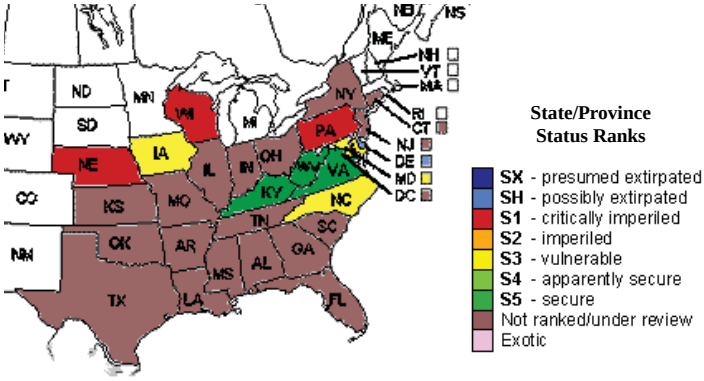
Photo source: PNHP

Distribution & Habitat

Wild Senna has a distribution from New York west into Nebraska and south into Florida and Texas. In Pennsylvania, the occurrences are well distributed in the state. It grows in a variety of habitats, including clearings, woods borders, roadbanks, open slopes, and in thickets.

North American State/Province Conservation Status

Map by NatureServe 210

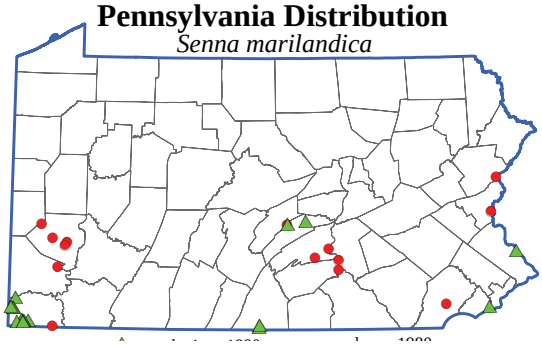


Current State Status

The PA Biological Survey considers the Wild Senna to be a species of special concern, based on the relatively few occurrences that have been documented. It has been assigned a rarity status of Rare.

Pennsylvania Distribution

Senna marilandica



Conservation Considerations

Wild Senna will benefit from protection of its habitat and of known populations. Removal of overgrowth and invasive species with the integration of fire regimes when appropriate will help to preserve the integrity of the sites.

NatureServe conservation status ranks

G5 – Globally Secure; **S3** – Vulnerable in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Little Ladies'-tresses
Spiranthes tuberosa

Description

Little Ladies'-tresses is an herbaceous perennial with a hairless stem from 6 inches to 1 foot (15-30 cm) in height. The aerial stem arises from a solitary, finger-like root, unlike the multiple roots typical of its relatives. The leaves are alternately arranged, egg-shaped and short-stalked, to about 1 inch (2.5 cm) in length and 3/8 inch (1 cm) in width, and blunt at the tip. They typically wither by flowering time in late summer and fall, so the lower stem of a flowering plant appears leafless, although several leaf sheaths may be present. The white flowers, appearing in late August to October, are arranged in a loose spiral or coil around the stem. The surface of the stem along which the flowers are attached is hairless, a key identification feature. The individual flower has its sepals and petals, which average about 1/8 inch (3 mm) in length, projecting forward together in a tube-like manner, with the lowermost petal (called a "lip" in orchids) being all white (not marked in the center with green or yellow as in some relatives) and having crisped margins around its exposed tip.

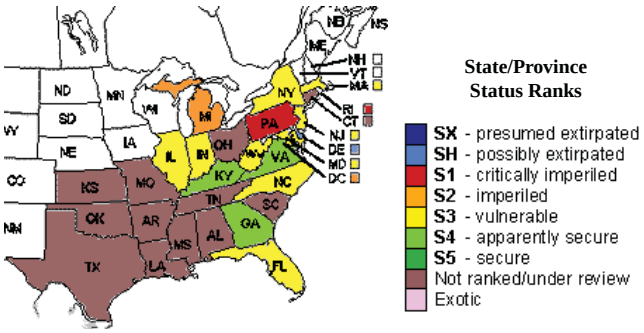


Photo source: Dick Sooy, University of Tennessee Herbarium

Distribution & Habitat

Little Ladies'-tresses ranges from southern New England to Michigan and south into Florida and Texas. In Pennsylvania, it has been documented historically mostly in the southern, particularly the southeastern, counties. It grows in grasslands, meadows, clearings, and open woods.

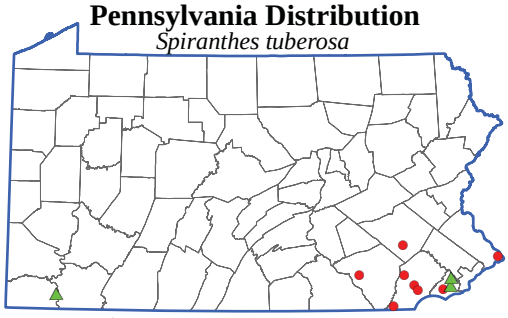
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Little Ladies'-tresses to be a species of special concern, based on the very few locations that have been recently confirmed. It has a PA legal rarity status of Tentatively Undetermined and has been assigned a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Spiranthes tuberosa



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Little Ladies'-tresses and its habitat may require active management, such as periodic mowing or invasive species removal, in order to maintain the proper ecological stage for the species. Excessive deer browse may be a threat. Additional field surveys are needed for species, which can be difficult to detect because of its inconspicuous and unpredictable nature.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Spring Ladies'-tresses
Spiranthes vernalis

Description

Spring Ladies'-tresses is an herbaceous perennial that may grow to 1½ feet (ca 0.5 m) in height. The aerial stem arises from several fingerlike roots. The leaves occur at the base and on the lower stem and have an alternate arrangement, and have a linear or narrowly lance-like shape, to 6 inches or more (to 15 or more cm) in length and 3/8 inch (1 cm) in width. They are usually present at flowering time, unlike some other species of Ladies'-tresses where the leaves are not evident at blooming time. The white flowers, appearing from May to August, are arranged in a loose spiral or coil around the stem. The surface of the stem along which the flowers are attached usually has a dense covering of very short (0.2-0.3 mm) pointed hairs, a key identification feature. The individual flower has its sepals and petals, which average about 5/16 inch (7 mm) in length, projecting forward together in a tube-like manner, with the lowermost petal (called a "lip" in orchids) marked with yellow in its center and having crisped margins around its exposed tip.

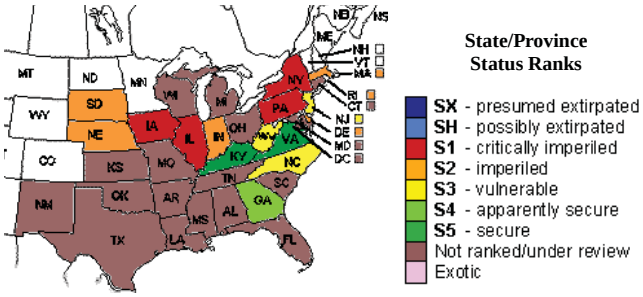


Photo source: Thomas Barnes @USDA-NRCS PLANTS Database.

Distribution & Habitat

Spring Ladies'-tresses ranges from southern New England to South Dakota and south into Florida and New Mexico. In Pennsylvania, it has been documented historically in the southeastern counties. It grows in grasslands, meadows, clearings, and open woods.

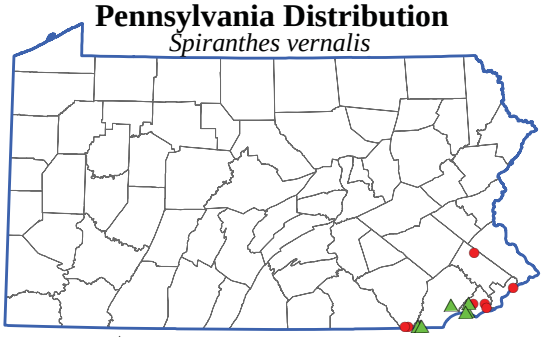
North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status

The PA Biological Survey (PABS) considers Spring Ladies'-tresses to be a species of special concern, based on the relatively few locations that have been recently confirmed. It has a PA legal rarity status and a PABS suggested rarity status of Endangered.

Pennsylvania Distribution
Spiranthes vernalis



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Spring Ladies'-tresses and its habitat may require active management, such as periodic mowing and invasive species removal, in order to maintain the proper ecological stage for the species. Excessive deer browse may be a threat at some locations. Additional field surveys are needed for this species, which can be difficult to detect because of its inconspicuous and unpredictable nature.

NatureServe conservation status ranks

G5 – Globally secure; **S1** – Critically imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

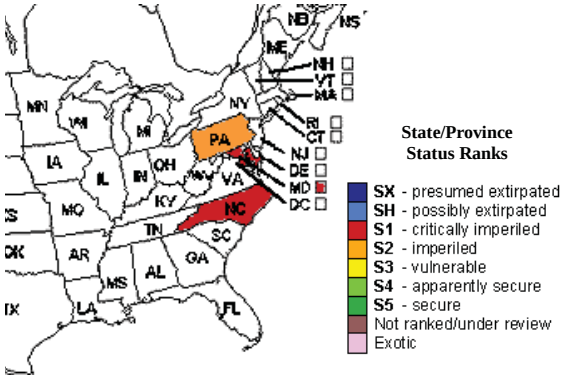
Serpentine Aster
Symphyotrichum depauperatum

Description
Serpentine Aster is a perennial herb that grows in spreading clumps. Its smooth, wiry flowering stems are erect or reclining and reach up to 16 inches (4 dm) in length. The leaves are produced from the base of the plant as an over-wintering basal rosette. Basal leaves are oblong to egg-shaped and up to 1½ inches (4 cm) long. Leaves also grow alternately along the stem but are narrow and often pressed flat against the stem. The flowers are held at the top of flowering stems in open, branched clusters that contain many flower heads. The small, daisy-like flower heads have a yellow disk surrounded by 7 to 14 white rays. Flowers are displayed from August through October.


Photo source: John Kunsman (PNHP)

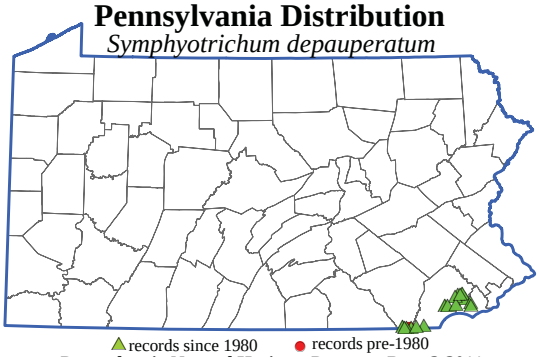
Distribution & Habitat
Serpentine Aster is endemic to the eastern serpentine barrens that occur in Pennsylvania and Maryland. This extremely limited distribution has given this species the status of G2 – globally imperiled. Populations in open areas of the serpentine barrens in Lancaster, Chester and Delaware Counties represent a stronghold of the species.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
Serpentine Aster occurs in a limited portion of the eastern serpentine barrens, which are a globally rare plant community. This habitat is threatened by land conversion for development, dumping, ATV use and road widening. Serpentine Aster is typically found in the more open areas of serpentine barrens, suggesting that fire may be needed to weed out woody overgrowth and maintain this preferred habitat.

Pennsylvania Distribution
Symphyotrichum depauperatum



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
Maintenance of known populations and preservation of the serpentine barrens where Serpentine Aster grows will be crucial to its survival. Removal of overgrowth and invasive species with the integration of fire regimes, when appropriate, will help to preserve the integrity of the sites. The management of the known sites requires long term monitoring of populations. Potential sites for restoration should be evaluated.

NatureServe conservation status ranks
G2 – Globally Imperiled; **S2**– Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Cranefly Orchid
Tipularia discolor

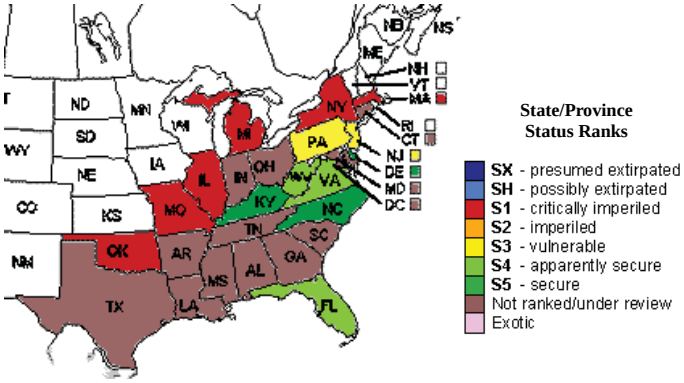
Description
Cranefly Orchid is an upright perennial herb. Its single flowering stem grows from a swollen, bulb-like base and reaches 8 to 20 inches (2-5 dm) in height. The leaves are broadly oval and parallel veined. The leaf undersides are purple, while the upper surfaces are green and may have raised purple spots. Each plant has a solitary basal leaf that is only present in the fall and winter. The flowers are greenish-purple and consist of 3 petals and 3 sepals. A long spur extends from the back of the flower. Flowers are held along the upper potions of the flowering stem and bloom from July through August.



Photo source: S Ray-flowers; J. Kunsman -leaves (PNHP)

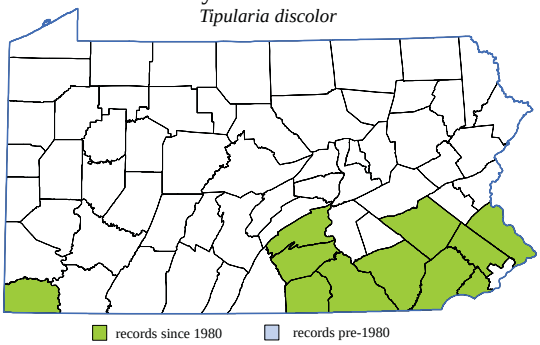
Distribution & Habitat
Cranefly Orchid occurs from New York and Massachusetts south to Florida, west to Michigan, and southwest to Texas. In Pennsylvania, it can be found mostly in the southeast where it grows in moist deciduous forests and along stream banks.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
Cranefly Orchid populations are threatened by the loss of their rich woodland habitat. These high quality woodlands may also be altered by encroachment of invasive species, over-browsing by deer, and fragmentation. Fragmentation can have a drying effect on the habitat and promote invasive species growth.

Pennsylvania Distribution
Tipularia discolor



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
Maintenance of known populations and preservation of the communities where Cranefly Orchid grows will be crucial to its survival. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth. The management of the known sites requires long term monitoring of populations. Potential sites for restoration should be evaluated.

NatureServe conservation status ranks
G4G5 – Globally Apparently Secure; **S3**– Vulnerable in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Nodding Trillium
Trillium cernuum

Description

Nodding Trillium is a perennial herb that grows up to 16 inches (4 dm) tall. The leaves occur in a whorl of 3, with the leaf blades being stalkless or nearly so, oval to diamond-shaped, 2 to 6 inches (5-15 cm) long, and hairless. The single flower has a drooping stalk and hangs below the leaves. Each 1 to 1½ inch (2.5-4 cm) flower has 3 white to pinkish petals backed by 3 alternating green sepals. The petals curve strongly upward toward the bottom of the leaves. The blooming time is in April and May.



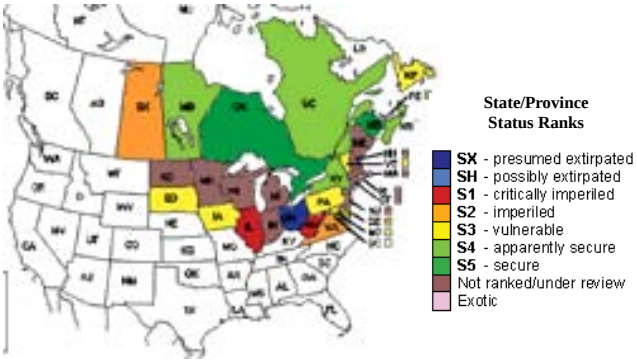
Photo source: John Kunsman (PNHP)

Distribution & Habitat

Nodding Trillium can be found in the U. S. from Maine south to Virginia and west to North and South Dakota. In Pennsylvania, it occurs mostly in the southeastern counties, where it grows in rich, moist woods.

North American State/Province Conservation Status

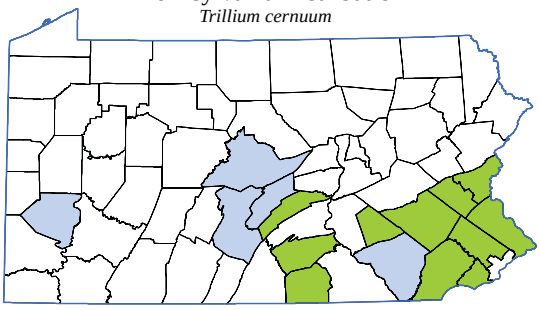
Map by NatureServe 2010



Current State Status

The PA Biological Survey considers Nodding Trillium to be a species of special concern, based on the relatively few occurrences that have been recently documented. It does not have a PA legal rarity status, but has been assigned a PABS suggested rarity status of Threatened. Fewer than 10 populations, habitat loss, land conversion for development and displacement by invasive species have all played a part in the decline of Nodding Trillium populations. Many of the remaining rich, moist forests in southeastern and south-central Pennsylvania have become increasingly fragmented, which further degrades habitat quality. Over-abundant deer populations have also contributed to reduced Nodding Trillium numbers.

Pennsylvania Distribution
Trillium cernuum



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

Maintenance of known populations and preservation of the communities where Nodding Trillium grows will be crucial to its survival. Creating buffers around fragmented habitat and removal of invasive species will help to maintain populations and encourage new population growth. The management of the known sites requires long term monitoring of populations.

NatureServe conservation status ranks

G5 – Globally Secure; **S2**– Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Purple Sandgrass
Triplasis purpurea

Description

Purple Sandgrass is an annual grass that may grow to 2 feet (60 cm) in height, but is usually much shorter and in some situations may be prostrate on the ground. The small swellings, or nodes, on the stem often have a tuft of hairs, or "beard." The leaves are alternately arranged, consisting of a basal sheath portion that envelops the stem and is often hairy or rough to the touch, and a linear or lance shaped, flattened, and untoothed blade that is 0.5-3 inches (1-7.5 cm) in length and about 1/8 inch (1-5 mm) in width, often hairy or rough to the touch, and pointed at the tip. The leaf blades often get shorter in length upward on the stem, and may become inrolled, making them appear narrower than they really are. The flowers, appearing in August and September, occur in a branched inflorescence (although some inflorescences may be partially hidden in the leaf sheaths) containing many individual spikelets, about ¼ inch (5-8 mm) in length and often with a purplish cast, each of which contains 2-5 individual flowers. The main scale, or lemma, which subtends an individual flower, has 3 prominent and hairy veins.



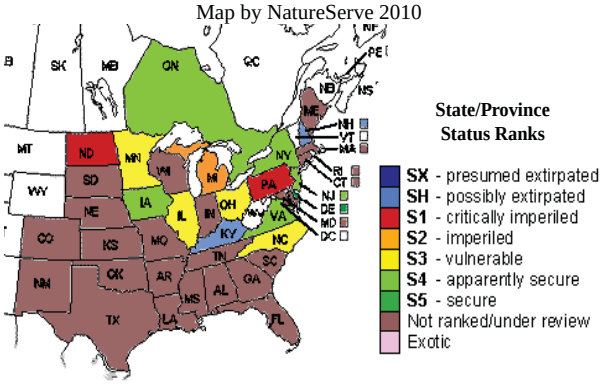
Photo source: John Kunsman PNHP

Distribution & Habitat

Purple Sandgrass ranges from Maine to North Dakota and south into Florida and New Mexico. In Pennsylvania, it has been documented historically in the northwestern and southeastern counties. It grows in open, sandy places, such as beaches, dunes, and shores.

North American State/Province Conservation Status

Map by NatureServe 2010

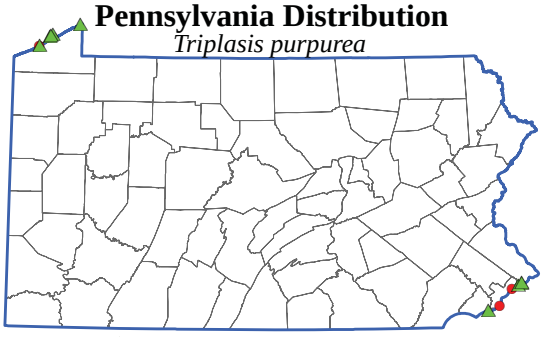


Current State Status

The PA Biological Survey (PABS) considers Purple Sandgrass to be a species of special concern, based on the few locations that have been recently confirmed and the restricted habitat. It has a PA legal rarity status and a PABS suggested rarity status of Endangered.

Pennsylvania Distribution

Triplasis purpurea



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations

The viability of populations of Purple Sandgrass may require active management in order to maintain early successional conditions and to control invasive species.

NatureServe conservation status ranks

G4G5 – Globally secure; S1 – Critically Imperiled in Pennsylvania

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Pennsylvania Natural Heritage Program

Tawny Ironweed
Vernonia glauca

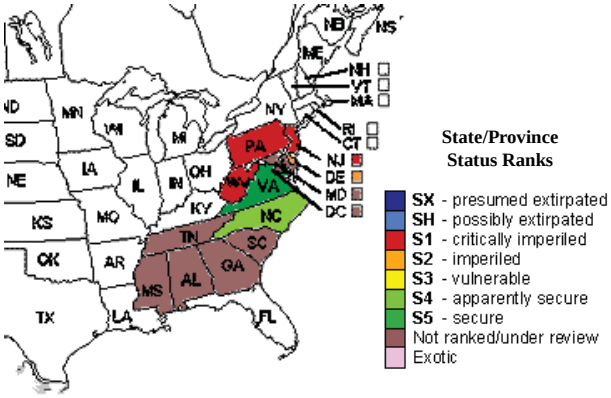
Description
Tawny Ironweed is a perennial herb that may grow to 5 feet (15 dm) in height. The leaves are alternately-arranged, narrowly egg-shaped to oblong in shape, noticeably paler below, with short-pointed tips and bases that taper to a short petiole. The flowers, which appear from July to October, are purplish and are grouped into dense flowering heads, which are clustered at the top of the stem in a branched, flat or round-topped grouping. This species has lighter-colored bristles at the top of its fruits than does the much more common species *Vernonia noveboracensis*.



Photo source: PNHP

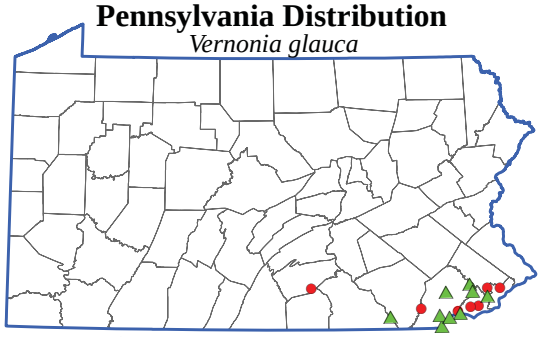
Distribution & Habitat
Tawny Ironweed occurs from Pennsylvania and New Jersey south and west into Louisiana and Georgia. In Pennsylvania, it reaches a northern limit of its range and has been documented in a few southeastern counties. It grows in successional clearings, dry fields, and upland forests.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey considers Tawny Ironweed to be a species of special concern because of the few occurrences that have been recently confirmed. It has a PA legal rarity status and a PABS suggested rarity status of Endangered. Fewer than 10 populations are currently known from the state.

Pennsylvania Distribution
Vernonia glauca



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The currently-known populations of Tawny Ironweed in the state are threatened by human-related habitat loss, natural succession, invasive species, and the indiscriminate spraying of herbicides. Given the preference of the species for open habitats, active management is usually required to maintain the proper successional stage.

NatureServe conservation status ranks
G5 – Globally Secure; **S1**– Critically Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Netted Chainfern
Woodwardia areolata

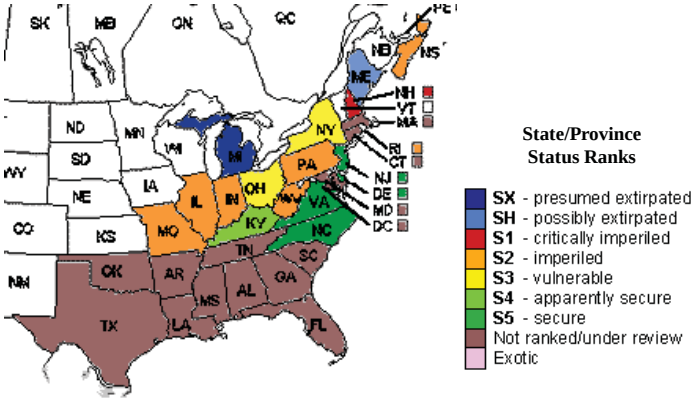
Description
Netted Chainfern grows from 1½ to 2½ feet (5-8 dm) in height, and may form small colonies due to the presence of creeping underground stems. The leaves are easily distinguishable into vegetative and fertile types. The vegetative leaves have a typical fern-like appearance, being green, flattened, and divided into 7 to 12 very deep lobes (or distinct leaflets on the lower part of the leaf) that are not further subdivided into smaller lobes. The leaf veins are conspicuous and have a net-like or chain-like arrangement, as the common name implies. The fertile leaves of Netted Chainfern are dark colored, much narrower, not flattened and leaf-like, and have spore-producing structures on their underside. The vegetative leaf of this species resembles the leaf of the Sensitive Fern (*Onoclea sensibilis*), a common species in Pennsylvania, but the lobes in Netted Chainfern tend to be alternately arranged along the leaf stalk while the lobes of Sensitive Fern tend to be oppositely arranged.



Photo source: Andrew Strassman (PNHP)

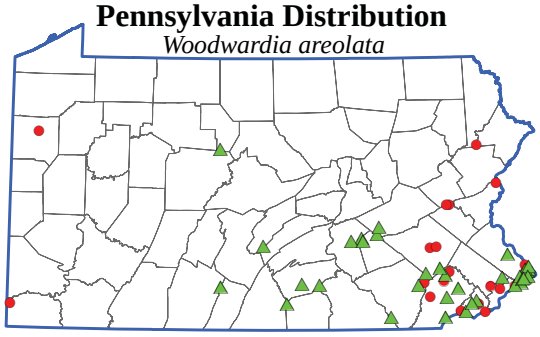
Distribution & Habitat
Netted Chainfern has a distribution centered mainly on the Atlantic coastal plain from Nova Scotia south and west into Texas and Florida. In Pennsylvania, the species has been documented historically in scattered counties, particularly in the Delaware River drainage. It grows in swamps, seepages, wet woods, boggy wetlands and along the margins of streamlets.

North American State/Province Conservation Status
Map by NatureServe 2010



Current State Status
The PA Biological Survey (PABS) considers Netted Chainfern to be a species of special concern, based on the relatively few occurrences that have been recently confirmed and the wetland habitat. It has no PA legal rarity status, but has been assigned a suggested rarity status of Threatened by PABS. About 30 populations are currently known from the state.

Pennsylvania Distribution
Woodwardia areolata



Pennsylvania Natural Heritage Program Data 3-2011

Conservation Considerations
The viability of populations of netted chainfern and its habitat may be enhanced by establishing buffers around wetlands, controlling invasive species, and protecting the natural hydrology surrounding wetlands.

NatureServe conservation status ranks
G5 – Globally Secure; **S2** – Imperiled in Pennsylvania

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Annual Wild Rice
Zizania aquatica

Description

Annual Wild Rice has very tall, hairless stems that may grow to 9 feet (3 meters) in height. The leaf blades are alternately arranged, linear to lance-shaped, pointed at the tip, not toothed on the margin, parallel-veined, and often well over 1 foot (30 cm) in length and up to 2 inches (5 cm) in width. The flowers are grouped in a large branched cluster at the top of the stem, with the female flowers located on the ascending upper branches and the male flowers located on the spreading or drooping lower branches. The small bracts subtending each female flower have an elongate bristle-like projection, or awn, up to 2.25 inches (6 cm) in length.

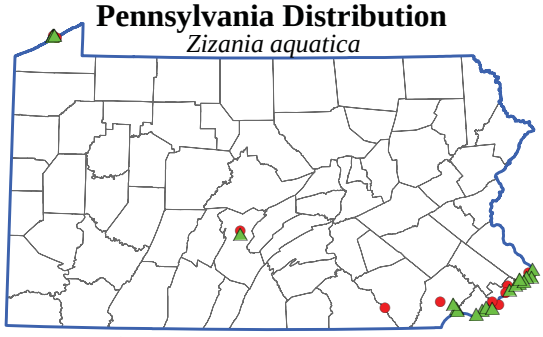


Photo source: PNHP

Distribution & Habitat

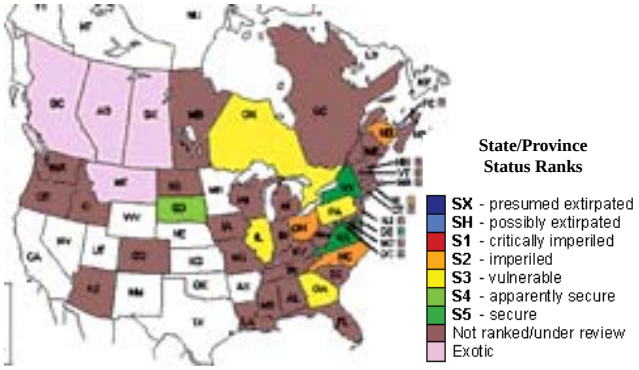
Annual Wild Rice has a range throughout much of North America, with part of the distribution expanded by deliberate introduction. In Pennsylvania, it has been documented historically in several southeastern counties, as well as the counties of Erie and Huntingdon. Annual Wild Rice grows in marshes, particularly intertidal marshes along the Delaware River in southeastern Pennsylvania, as well as on shorelines and in shallow water elsewhere.

Pennsylvania Distribution
Zizania aquatica



Pennsylvania Natural Heritage Program Data 3-2011

North American State/Province Conservation Status
Map by NatureServe 2010



State Status & Conservation

The PA Biological Survey (PABS) has assigned Annual Wild Rice a rarity status of Rare. The species appears to have an ample number of populations and to be adaptable enough so as not to be endangered or threatened with extirpation, yet has a very localized distribution in the state. Some populations of Annual Wild Rice have threats from exotic species, dredging and filling, and water pollution.

NatureServe conservation status ranks

G5 – Globally Secure; **S3 –** Vulnerable

Pennsylvania Natural Heritage Program

References

- NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2011.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania. American Philosophical Society, Philadelphia, Pennsylvania.
- Rhoads, A.F. and T.A. Block. 2007. The Plants of Pennsylvania: An Illustrated Manual. 2nd edition. University of Pennsylvania Press, Philadelphia, Pennsylvania.