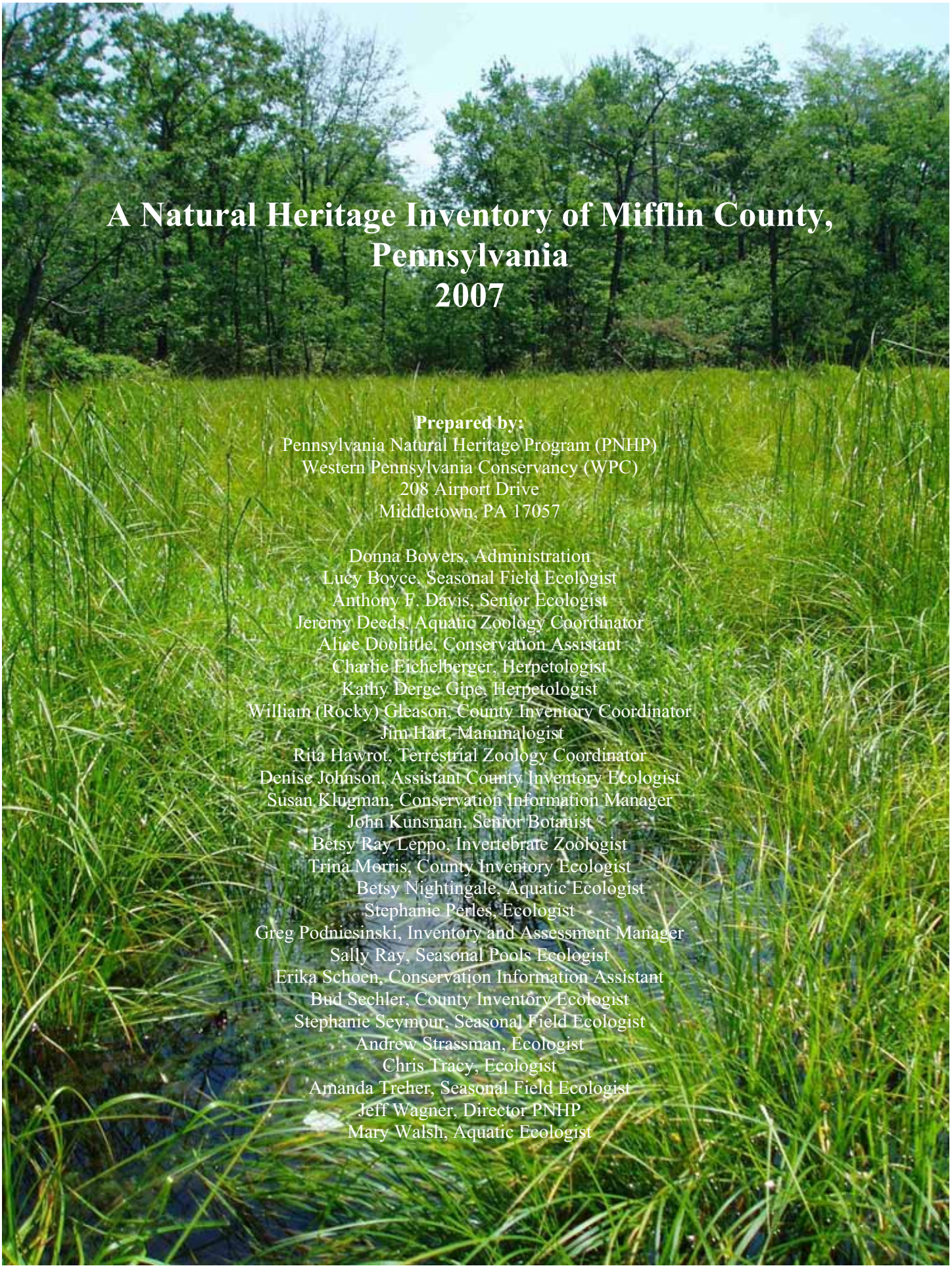
A NATURAL HERITAGE INVENTORY OF MIFFLIN COUNTY, PENNSYLVANIA
June 2007

Prepared by:
Pennsylvania Natural Heritage Program
Western Pennsylvania Conservancy
208 Airport Drive
Middletown, Pennsylvania 17057

Submitted to:
Mifflin County Planning Commission
20 North Wayne Street
Lewistown, PA 17044

This project was funded in part by a state grant from the Department of Conservation and Natural Resources Wild Resource Conservation Program. Additional support was provided by the Department of Community & Economic Development. Additional funding was provided by the U.S. Fish and Wildlife Service through State Wildlife Grants program grant T-2, administered through the Pennsylvania Game Commission and the Pennsylvania Fish and Boat Commission.



A Natural Heritage Inventory of Mifflin County, Pennsylvania
2007

Prepared by:
Pennsylvania Natural Heritage Program (PNHP)
Western Pennsylvania Conservancy (WPC)
208 Airport Drive
Middletown, PA 17057

Donna Bowers, Administration
Lucy Boyce, Seasonal Field Ecologist
Anthony F. Davis, Senior Ecologist
Jeremy Deeds, Aquatic Zoology Coordinator
Alice Doolittle, Conservation Assistant
Charlie Eichelberger, Herpetologist
Kathy Derge Gipe, Herpetologist
William (Rocky) Gleason, County Inventory Coordinator
Jim Hart, Mammalogist
Rita Hawrot, Terrestrial Zoology Coordinator
Denise Johnson, Assistant County Inventory Ecologist
Susan Klugman, Conservation Information Manager
John Kunsman, Senior Botanist
Betsy Ray Leppo, Invertebrate Zoologist
Trina Morris, County Inventory Ecologist
Betsy Nightingale, Aquatic Ecologist
Stephanie Perles, Ecologist
Greg Podniesinski, Inventory and Assessment Manager
Sally Ray, Seasonal Pools Ecologist
Erika Schoen, Conservation Information Assistant
Bud Sechler, County Inventory Ecologist
Stephanie Seymour, Seasonal Field Ecologist
Andrew Strassman, Ecologist
Chris Tracy, Ecologist
Amanda Treher, Seasonal Field Ecologist
Jeff Wagner, Director PNHP
Mary Walsh, Aquatic Ecologist

PREFACE

The Mifflin County Natural Heritage Inventory is a document compiled and written by the Pennsylvania Natural Heritage Program (PNHP) of the Western Pennsylvania Conservancy (WPC). It 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 the PNHP 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 federal, state, county and township lands are also provided on the maps where that information was available to us. 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.

Although an attempt was made through advertising, public meetings, research, and informal communications to locate the sites most important to the conservation of biodiversity within the county, it is likely that many things were missed. Anyone with information on sites that may have been overlooked should contact the Mifflin County Planning Commission (see address on following page) for inclusion into a future update of this report.

The results presented in this report represent a snapshot in time, highlighting the sensitive natural areas within Mifflin County. The sites in the Mifflin County Natural Heritage Inventory have been identified to help guide wise landuse and county planning. The Mifflin County Natural Heritage Inventory is a planning tool, but is *not* meant to be used as a substitute for environmental review, since information is constantly being updated as natural resources are both destroyed and discovered. Planning Commissions and applicants for building permits should 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 PNHP 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 special concern becomes available during environmental review, the review may be reconsidered by the jurisdictional agency.**

ACKNOWLEDGEMENTS

This project was funded in part by a state grant from the Department of Conservation and Natural Resources Wild Resource Conservation Program. Additional support was provided by the Department of Community & Economic Development. Additional funding was provided by the U.S. Fish and Wildlife Service through State Wildlife Grants program grant T-2, administered through the Pennsylvania Game Commission and the Pennsylvania Fish and Boat Commission. Thanks to everyone who provided financial and administrative support for the inventory. Without your help, this study would not have been possible.

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 survey would have been far less complete.

The report benefited from the help of local naturalists and conservationists who gave generously of their time. Thanks to all the help and support given by Karen Bange and Steve Shawver, for cave information; Steve Johnson for Lepidopteron identification, Dr. Larry Klotz, for botanical surveys; Dr. Carol Loeffler, pilot for aerial surveys; Aden Troyer, for avian expertise; Greg Turner, for cave surveys; and Jamie Zambo, for cave surveys and photos. The Mifflin County GIS office and the Mifflin County provided several useful data layers for mapping the county. The Mifflin County Conservation District provided information on the natural attributes of the county. Thanks to the many other private citizens who contacted our office with information on natural areas.

Many thanks to everyone who participated in the Technical Advisory Committee by reviewing the draft Natural Heritage Inventory Report and providing assistance. In particular, thanks for input on the report go to Bill Gomes, Mifflin County Director of Planning; Cadie Pruss and Dan Dunmire, Mifflin County Conservation District; Steve Bernardi, PA Game Commission; Chris Urban, PA Fish and Boat Commission; Mike Piaskowski and Diane Kripas, DCNR; Greg Grove; Amy Griffith, Bureau of Forestry; and Stephanie Rynders, Central Pennsylvania Conservancy.

Finally, we especially wish to thank the many landowners who granted us permission to conduct inventories on their lands. The task of inventorying the natural heritage of Mifflin County would have been far more difficult without the cooperation and welcome of the county and its inhabitants.

Katharine D. Gipe
Pennsylvania Natural Heritage Program

Copies of this document may be obtained from:

Mifflin County Planning Commission
20 North Wayne Street
Lewistown, PA 17044
Phone: (717) 248-6733
Toll Free: 1 (800) 248-CNTY
Fax (717) 248-3695

Or in electronic format from the Western Pennsylvania Conservancy at: www.paconserve.org
Or the Pennsylvania Natural Heritage Program website: www.naturalheritage.state.pa.us

This reference may be cited as:
Pennsylvania Natural Heritage Program. 2007. A Natural Heritage Inventory of Mifflin County. Western Pennsylvania Conservancy. Middletown, PA.

Mifflin County Natural Heritage Inventory Site Index

Pennsylvania Natural Heritage Program

1	PENNS CREEK FLOODPLAIN
2	PANTHER RUN--HIGH MOUNTAIN SLOPES
3	Little Weikert Run Wetlands
4	LITTLE WEIKERT RUN POOLS
5	TALL TIMBERS NATURAL AREA
6	PITCHPINE RIDGE
7	FLAT HOLLOW POOLS
8	THICK MOUNTAIN WETLANDS
9	LITTLE POE ROAD POOLS
10	BIG FLAT
11	HAVICE MOUNTAIN SEEPS
12	KISHACOQUILLAS and TREASTER VALLEY KARST
13	AITKINS GAP
14	HONEY CREEK SLOPES
15	JACKS MOUNTAIN--EAST
16	MUTTERSBAUGH GAP POOLS
17	Stone Creek Road Wetlands
18	SPRUCE GAP POOLS
19	Chestnut Springs Pools
20	LINGLE CREEK HEADWATERS at BEAR GAP
21	TEA CREEK
22	Reedsville Cave
23	Coffee Run Spring Cave
24	JACKS MOUNTAIN--WEST
25	JACKS MOUNTAIN SLOPES
26	Barrville Cave
27	BELLTOWN POOLS
28	PLEASANT VALLEY KARST
29	WAGNER RUN POOLS
30	WAGNER GAP
31	SHINDLE GAP
32	MOWRY RUN POOLS
33	Herblengths Cave
34	MAITLAND POOLS
35	MAITLAND CAVE
36	Dry Valley Pits
37	LEWISTOWN NARROWS NORTH
38	LEWISTOWN NARROWS SOUTH
39	Highland Park Cave
40	MOUNT ROCK CAVE
41	BUCK RUN GRASSLANDS
42	Big Ridge Pools
43	JUNIATA RIVER--MIFFLIN COUNTY
44	BLUE MOUNTAIN at HISSING ROCKS
45	BLUE MOUNTAIN at VINCENT TRAM ROAD
46	BLUE MOUNTAIN at WHITSEL TRAIL
47	East Licking Creek Wetlands
48	BLACKLOG MOUNTAIN at SPRUCE RUN
49	Kings Cave
50	Belleville Cave
51	KINGS HOLLOW
52	Allensville Cave
53	RUPERT CAVE
54	MIDDLE RIDGE POOLS
55	Big Ridge Cave
56	JOHNSON CAVES
57	Mcveytown Quarry Caves
58	Mcveytown Cave
59	Shanks Run Cave
60	BLUE MOUNTAIN at CARLISLE GAP
61	BLACKLOG MOUNTAIN at T328
62	WEST LICKING CREEK HEADWATERS
63	West Licking Creek Wetlands
64	BLUE MOUNTAIN at WEST LICKING CREEK
65	SUGAR RIDGE
66	JACKS NARROWS

Site Identification # and Significance

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

core habitat

supporting landscape

TOWNSHIP BOUNDARIES

USGS quadrangles

Miles
0 1.25 2.5 5 7.5 10

Scale 1:200,000

Centre County
Union County
Snyder County
Juniata County
Huntingdon County

ARMAGH
BROWN
DECATUR
DERRY
UNION
MENNO
GRANVILLE
OLIVER
BRATTON
WAYNE

CENTRE HALL
SPRING MILLS
COBURN
WEIKERT
MC ALEVYS FORT
BARRVILLE
BURNHAM
ALFARATA
MC CLURE
MOUNT UNION
ALLENSVILLE
BELLEVILLE
LEWISTOWN
MIFFLINTOWN
NEWTON HAMILTON
MC VEYTOWN
AUGHWICK
MC COYSVILLE

Site Index

Alphabetical Site Index Numbered Roughly East to West by Township. Notice that natural areas with species of concern are in capital letters while locally significant sites without species of concern are in title case letters throughout the document

EXECUTIVE SUMMARY

• 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. The first steps in ensuring protection of our natural environment are to recognize environmentally sensitive or ecologically important areas and to provide information regarding their sensitivities to various land use activities.

A County Natural Heritage Inventory (NHI) is designed to identify and map areas that support species of special concern, exemplary natural communities, and broad expanses of intact natural ecosystems that support important components of Pennsylvania's native species biodiversity. Its purpose is to provide information to municipal, county, and state governments, private individuals, and business interests so that they may plan development with the preservation of an ecologically healthy landscape for future generations in mind.

• Natural Heritage Inventory Classification

To provide the information necessary to plan for conservation of biodiversity at the species, community, and ecosystem levels, sites identified in the NHI were designated and ranked as to their ecological significance. These sites, as well as areas identified from the Important Mammal Area and Important Bird Area Projects, are mapped and described in this report.

A Natural Heritage site is an area containing plants and/or animals of special concern at state or federal levels, exemplary natural communities, or exceptional native diversity. Sites are mapped to include both the immediate habitat and surrounding lands important in the support of these special elements.

Conservation Planning Application: Sites are mapped according to their sensitivity to human activities. **"Core habitat"** areas delineate essential habitat that cannot absorb significant levels of activity without substantial impact to the elements of concern. "**Supporting Natural Landscape**" include areas necessary to maintain vital ecological processes or secondary habitat that may be able to accommodate some types of low-impact activities.

• Methods

Fifty-one out of sixty-seven county inventories have been completed in Pennsylvania to date. The Mifflin County NHI followed the same methodologies as previous inventories, which proceeded in the following stages:

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 Mifflin County. Knowledgeable individuals were consulted concerning the occurrence of rare plants and unique natural communities in the county. Geological maps, United States Geologic Survey (USGS) topographical maps, National Wetlands Inventory maps, United States Department of Agriculture (USDA) soil surveys, recent aerial photos, and published materials were also used to identify areas of potential ecological significance. Once preliminary site selection was completed, reconnaissance flights were conducted to assess these areas.

Field Work

Areas identified as potential inventory targets were scheduled for ground surveys. 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 community and local threats were among the most important data recorded for each site. Sites were not ground surveyed in cases where permission to visit a site was not granted, when enough information was available from other sources, or when time did not permit.

Data Analysis

Data obtained during the 2005, 2006, and winter 2007 field seasons were combined with prior existing data and summarized. All sites with species

or communities of statewide concern, as well as exceptional examples of more common natural communities were mapped and described. Spatial data on the elements of concern were then compiled in a geographic information system (GIS) format using ESRI ArcGIS 9 software.

The boundaries defining each site were based on physical and ecological factors, and specifications for species protection provided by government jurisdictional agencies. The sites were then assigned a significance rank based on size, condition, rarity of the unique feature, and quality of the surrounding landscape.

- **Results**

Sixty-six areas of ecological significance are recognized in the Mifflin County NHI (page vi), including caves as important geologic and ecological features in the county. Spatial distribution of Natural Heritage sites across the county is shown on the site index on page vi. Significance ranks (exceptional, high, notable, and local) of Natural Heritage sites in order of their contribution to the protection of the biological diversity and ecological integrity of the region are given in the table following the site index and in the results section of the report.

- **Conservation Recommendations**

Mifflin County has a number of groups pursuing the protection of natural areas within the county. The following are general recommendations for protecting the biological diversity of Mifflin County.

1. Consider conservation initiatives for natural areas on private land.
2. Prepare management plans that address species of special concern and natural communities.
3. Protect bodies of water.
4. Provide for buffers around natural areas.
5. Reduce fragmentation of surrounding landscape.
6. Encourage the formation of grassroots organizations.
7. Manage for invasive species.
8. Encourage community education.
9. Incorporate County NHI information into planning efforts.

- **Discussion and Recommendations**

Planning for Biodiversity and Ecological Health. Provisioning for the future health of ecological resources in Mifflin County will require a combination of efforts. These include the active stewardship of specific sites that host unique species and communities, broader-scale planning to maintain the unique contiguity of its forested regions, and restoration efforts to alleviate water pollution and restore ecological function to damaged landscapes and waterways.

o *Forest Communities*. In the forested landscapes, objectives for large-scale planning should include maintaining and increasing contiguity and connectivity of natural land. Contiguity relates to the nearness of adjacent forest blocks so they are essentially touching, forming a continuously forested area. This is important for the enhanced habitat values outlined above; however, for many species, it is equally critical that natural corridors are maintained that connect forests, wetlands and waterways. For example, many amphibians and dragonflies use an aquatic or wetland habitat in one phase of their life then migrate to an upland, forested habitat for their adult life. Either habitat alone cannot be utilized unless a corridor exists between them.

Municipal and regional land use plans can support maintenance of forest contiguity by encouraging residential or commercial projects to re-develop in existing town centers or re-use previously altered landscapes, rather than orienting new infrastructure through unfragmented natural landscapes.

o *Wetland/Aquatic Communities*. Mifflin County's waterways, ranging from headwater mountain streams to the Juniata River, include some of Pennsylvania's most scenic features. Objectives for large-scale planning should include restoration of water quality in the county's waterways through a reduction in the release of pollutants into runoff, including sediments, nutrients, and chemical contaminants.

Stewardship or restoration of native forest communities in riparian buffers will greatly improve water quality and enhance the habitat value for various aquatic and semi-aquatic species. Attending to the basic ecological functions of streams and wetlands will ensure the continued availability of

quality water for human communities, enabling the restoration of healthy fisheries, and enhancing the quality of life for which the region is known.

○ *Cave Features.* Caves and karst features are fragile resources that have unique recreational and ecological value, providing habitats for common, rare, and threatened and endangered species. These systems serve as direct conduits to the groundwater table, a serious issue for Mifflin County's rural communities that rely on well water. Conservation of cave and karst resources needs to be a concern for all who use or impact the cave environment as well as for communities in karst areas that rely on clean groundwater.

Most caves in Mifflin County do not occur within ecologically natural landscapes. The sites containing caves are within a disturbed matrix of agriculture, roads, residences, and industry. Thus the usual approach to protecting natural areas does not apply here. Conservation efforts should focus on buffering cave entrances, preventing contamination of the groundwater, and limiting access to caves that host hibernating bats.

○ *Evaluating Proposed Activity Within Natural Heritage Sites.* A very important part of encouraging conservation of the sites identified within the Mifflin County NHI is the careful review of proposed land use changes or development activities that overlap with Natural Heritage sites. The following overview should provide guidance in the review of these projects or activities.

- Always contact the Mifflin County Planning Commission.

The County Planning Commission should be aware of all activities that may occur within Natural Heritage sites in the county so that they may interact with the County Conservation District and other necessary organizations or agencies to better understand the implications of proposed activities. They can also provide guidance to the landowners, developers, or project managers as to possible conflicts and courses of action.

- Conduct free online preliminary environmental reviews.

Applicants for building permits should 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 PNHP 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 special concern becomes available during environmental review, the review may be reconsidered by the jurisdictional agency.

Depending upon the resources contained within the Natural Heritage site, the agencies/entities responsible for them will then be contacted. The points of contact and arrangements for that contact will be determined on a case-by-case basis by the county and PNHP. In general, the responsibility for reviewing natural resources is partitioned among agencies in the following manner:

- *U.S. Fish and Wildlife Service:* all federally listed plants or animals.
- *Pennsylvania Game Commission:* all birds and mammals.
- *Pennsylvania Fish and Boat Commission*: all reptiles, amphibians, fish, and aquatic invertebrates.
- *Pennsylvania Department of Conservation and Natural Resources*: all plants, all natural communities, and terrestrial invertebrates (with PNHP).

PNHP and agency biologists can provide more detailed information with regard to the location of natural resources of concern in a project area, the needs of the particular resources in question, and the potential impacts of the project to those resources.

- Plan ahead.

If a ground survey is necessary to determine whether significant natural resources are present in the area of the project, the agency biologist reviewing the project will recommend a survey be conducted. PNHP, through the Western Pennsylvania Conservancy (WPC), or other knowledgeable contractors can be retained for this

purpose. Early consideration of natural resource impacts is recommended to allow sufficient time for thorough evaluation. Given that some species are only observable or identifiable during certain phases of their life cycle (i.e., the flowering season of a plant or the flight period of a butterfly), a survey may need to be scheduled for a particular time of year.

- Work to minimize environmental degradation.

If the decision is made to move forward with a project in a sensitive area, PNHP can work with municipal officials and project personnel during the design process to develop strategies for minimizing the project's ecological impact while meeting the project's objectives. The resource agencies in the state may do likewise.

Finally, preliminary consultation with PNHP or another agency does not take the place of the environmental review. However, early consultation and planning as detailed above can provide for a more efficient and better integrated permit review, promoting a better understanding among the parties involved as to the scope of any needed project modifications.

- **Using the Natural Heritage Inventory in Mifflin County Planning Processes:**

The following are specific recommendations that will serve to incorporate the information in this report into planning and land conservation activities in Mifflin County.

1. Adopt the Mifflin County Natural Heritage Inventory report by resolution. The county should work to incorporate the NHI into the implementation of the comprehensive plan (in particular the Environmental Resources Plan, Chapter 15) and to use the NHI to guide future planning, subdivision review, acquisition, development and conservation initiatives.

2. Incorporate the NHI into the joint Mifflin/Juniata Greenway and Open Space Network Plan, in progress.

3. Revise the county future land use planning map by incorporating the NHI core sites into parameters used for designating the Natural Resource Protection Area and the Rural Development Area. At the time of the comprehensive planning process, the parameters for the Natural Resource Protection Area were limited to steep slopes, 100 Year Floodplain, wetlands, and public lands. Some of the Natural Heritage sites, such as pastoral features and karst resources, can be compatible with rural land uses, given that appropriate management practices are encouraged, and could be incorporated into the Rural Development Area. Others would be more consistent with the Natural Resource Protection Areas.

4. Make the NHI report available to all municipalities in the county. Copies of the final report were provided to each municipality. GIS layers resulting from the NHI will be available from the Mifflin County GIS Department.

5. Provide the NHI report to local watershed organizations, such as the Juniata Cleanwater Partnership, and conservation organizations, such as the Central Pennsylvania Conservancy for prioritizing conservation actions.

Table 1: Mifflin County Natural Heritage Sites Categorized by Significance

The sites of significance for the protection of biological diversity in Mifflin County categorized by significance. More in-depth information on each site including detailed site descriptions and management recommendation, where appropriate, can be found in the text of the report following the maps for each municipality. Quality ranks, legal status, and last observation dates for each species of special concern and natural communities are located in the table that precedes each map page. Notice that natural areas with species of concern are in capital letters while locally significant sites without species of concern are in title case letters throughout the document

Site #	Site Name Municipality *USGS quadrangle*	Description	Page #
Exceptional Significance			
10	**BIG FLAT** Armagh Township *Spring Mills quad*	One **Ephemeral/Fluctuating Natural Pool,** a community of concern, and one dug-out pond are located here. This site is occupied by a **species of concern** as well as a rare damselfly, the **Amber-winged Spreadwing (*Lestes eurinus*).**	71
7	**FLAT HOLLOW POOLS** Armagh Township *Coburn quad*	The saddle and watershed divide between Pitchpine Ridge and White Mountain are the site of a cluster of six **Ephemeral/Fluctuating Natural Pools,** a community of concern. These pools support a large population of a **species of concern.**	71
56	**JOHNSON CAVES** Oliver Township *Allensville, Belleville, McVeytown, Newton Hamilton quads*	An old quarry in a ridge at McVeytown provides two cave openings known as the Johnson Caves. Invertebrate species of concern known to this site include the **Refton Cave Planarian (*Sphalloplana pricei*)**, **Price's Cave Isopod (*Caecidotea pricei*),** and **Allegheny Cave Amphipod (*Stygobromus allegheniensis*)**.	132
12	**KISHACOQUILLAS and TREASTER VALLEY KARST** Armagh Township *Alfarata, Burnham, Coburn quads*	The Kishacoquillas Creek and Treaster Run Valleys contain more than 18 caves, several of which support species of concern. Invertebrate animal species of concern known to this site include the **Stellmack's Cave Amphipod (*Stygobromus stellmacki*)**, **Price's Cave Isopod (*Caecidotea pricei*),** and the **Allegheny Cave Amphipod (*Stygobromus allegheniensis*)**.	71
16	**MUTTERSBAUGH GAP POOLS** Armagh Township *Barrville quad*	The saddle formed south of Bald Mountain is the site of a complex of ten **Ephemeral/Fluctuating Natural Pools,** a community of concern. Many of the vernal pools support populations of a **species of concern**.	71
28	**PLEASANT VALLEY KARST** Decatur Township *Alfarata quad*	The Pleasant Valley contains 5 caves, several of which support **species of concern**.	102
53	**RUPERT CAVE** Oliver Township *Allensville quad*	The limestone Bald Ridge above the underground world of Rupert Cave provides habitat for several plants and animals unique to limestone-based openings. The sunny open ridge provides habitat for the **hoary puccoon (*Lithospermum canescens*),** as well as several rare butterfly and skipper species, including the **Silvery Checkerspot (*Chlosyne nycteis*), Baltimore Checkerspot (*Euphydryas phaeton*)**, **Northern Pearly-eye (*Enodia anthedon*),** and **Edward's Hairstreak (*Satyrium edwardsii*)**. The site additionally is host to several rare moths, a rare scorpionfly, and two other **species of concern**.	132
65	**SUGAR RIDGE** Wayne Township and Huntingdon Co. *Aughwick, Newton Hamilton quads*	The limestone-influenced slopes of Sugar Ridge above the Juniata River provide habitat for a diverse flora. Plant species of concern discovered at this site include **oblique milkvine (*Matelea obliqua*)**; **hoary puccoon (*Lithospermum canescens*)**; **Virginia mallow (*Sida hermaphrodita*); leaf-cup (*Polymnia uvedalia*)**; and **shale-barren evening-primrose (*Oenothera argillicola*)**. Additionally, the **Allegheny Woodrat (*Neotoma magister*)** occupies a cave and rocky slope at this location.	146

Site #	Site Name Municipality *USGS quadrangle*	Description	Page #
High Significance			
48	**BLACKLOG MOUNTAIN at SPRUCE RUN** Bratton Township and Juniata Co. *Lewistown, McCoysville, McVeytown quads*	Active signs of **Allegheny Woodrat (*Neotoma magister*)** were located in rock outcrops on Blacklog Mountain during surveys in 1992.	86
61	**BLACKLOG MOUNTAIN at T328** Bratton Township and Juniata Co. *McVeytown quad*	Sandstone talus fields are host to the **Allegheny Woodrat (*Neotoma magister*)**.	86
60	**BLUE MOUNTAIN at CARLISLE GAP** Bratton Township *McVeytown quad*	A power line right-of-way and surrounding slopes support a population of the **Allegheny Woodrat (*Neotoma magister*)**.	86
44	**BLUE MOUNTAIN at HISSING ROCKS** Granville Township and Juniata Co. *Lewistown quad*	A population of **Allegheny Woodrat (*Neotoma magister*)** occupies the crest of this mountain.	118
64	**BLUE MOUNTAIN at WEST LICKING CREEK** Wayne Township *Newton Hamilton quad*	This portion of Blue Mountain supports a population of **Allegheny Woodrat (*Neotoma magister*)**.	146
45	**BLUE MOUNTAIN at VINCENT TRAM ROAD** Granville Township *Lewistown quad*	Rock outcrops at this site support the **Allegheny Woodrat (*Neotoma magister*)**.	118
46	**BLUE MOUNTAIN at WHITSEL TRAIL** Bratton Township *Lewistown quad*	Rock outcrops along Blue Mountain provide habitat for the **Allegheny Woodrat (*Neotoma magister*)**.	86
14	**HONEY CREEK SLOPES** Armagh *Burnham quad*	The rich limestone and calcareous shale slopes above Honey Creek support a population of **hoary puccoon (*Lithospermum canescens*)**.	71
66	**JACKS NARROWS** Wayne Township and Huntingdon Co. *Mount Union quad*	This site along the slopes above the Juniata River supports several occurrences of the **Allegheny Woodrat (*Neotoma magister*)**.	146
43	**JUNIATA RIVER—MIFFLIN COUNTY** Bratton, Granville, Wayne Townships *Belleville, Lewistown, McVeytown, Newton Hamilton quad*	Several species of freshwater mussels inhabit suitable habitat in portions of the Juniata River. One of these is considered a species of concern due to declines in its global and state range and abundance: the **Yellow Lampmussel (*Lampsilis cariosa*)**.	86, 118, 146
51	**KINGS HOLLOW** Menno Township *Allensville quad*	Roughly 50 acres of older growth **Hemlock-Tuliptree-Birch Forest** occurs in a narrow ravine on Stone Mountain.	126
37	**LEWISTOWN NARROWS NORTH** Derry Township and Juniata Co. *Lewistown, Mifflintown quads*	Active signs of **Allegheny Woodrat (*Neotoma magister*)** were located along the talus slopes of the Lewistown Narrows. During surveys in 2001, a population of the **Northern Myotis (*Myotis septentrionalis*)** was found feeding along the Juniata River and open areas at this site. Additionally, the floodplain in the Narrows has been host to a population of **wild senna (*Senna marilandica*)**, a plant species of concern.	110
38	**LEWISTOWN NARROWS SOUTH** Granville Township and Juniata Co. *Lewistown, Mifflintown quads*	The talus slopes of the Lewistown Narrows support several populations of **Allegheny Woodrat (*Neotoma magister*)**.	118

Site #	Site Name Municipality *USGS quadrangle*	Description	Page #
High Significance (continued)			
35	**MAITLAND CAVE** Derry Township *Burnham quad*	In the Devonian limestone of Jacks Creek ridge lies a large cave known as Maitland Cave, which supports a **species of concern**.	110
54	**MIDDLE RIDGE POOLS** Oliver Township *Belleville quad*	A cluster of seasonal pools is located on a level area between Middle and Front Ridge, forming a complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern.	132
40	**MOUNT ROCK CAVE** Derry Township *Lewistown quad*	This cave is associated with two abandoned quarries in the Devonian Helderberg limestone and supports a **species of concern**.	110
32	**MOWRY RUN POOLS** Decatur Township *Alfarata quad*	Several seasonal and permanent pools are clustered on the northern slope of Shade Mountain in the Mowry Run drainage, forming a complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern.	102
2	**PANTHER RUN-HIGH MOUNTAIN SLOPES** Armagh Township *Coburn quad*	The north-facing slope of High Mountain above Panther Run contains **a Hemlock (White Pine) Northern Hardwood Forest** community potentially a remnant of old growth forest.	71
1	**PENNS CREEK FLOODPLAIN** Armagh Township; Centre Co.; Union Co. *Coburn quad*	This portion of Penns Creek flows from Centre to Union County and includes a large portion of level floodplain. Five invertebrate species of special concern occur here--**Appalachian Tiger Beetle (*Cicindela ancocisconensis*), River Jewelwing (*Calopteryx aequabilis*), Appalachian Jewelwing (*Calopteryx angustipennis*), Ski-tailed Emerald (*Somatochlora elongata*)**, and **Spine-crowned Clubtail (*Gomphus abbreviatus*).** An **species of concern** utilizes the surrounding forest habitat for summer foraging and breeding.	71
31	**SHINDLE GAP** Decatur Township *Alfarata quad*	The forests along Shindle Run provide refuge and summer foraging habitat for an **species of concern.**	102
18	**SPRUCE GAP POOLS** Brown Township *Barrville quad*	Several clusters of seasonal wetlands are located on steps in the slope of Brush Ridge, forming a complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern. These pools support a **species of concern.**	94
5	**TALL TIMBERS NATURAL AREA** Armagh Township and Snyder Co. *Weikert quad*	This site covers more than 660 acres of second growth **Hemlock (White Pine)-Northern Hardwood Forest**, primarily in Snyder County. While not virgin timber, Tall Timbers has all the components of a functioning old growth forest.	71
21	**TEA CREEK** Brown Township *Barrville quad*	The Tea Creek watershed is the home of the currently southernmost documented population of **Northern Water Shrew (*Sorex palustris albibarbis*)** in Pennsylvania.	94
30	**WAGNER GAP** Decatur Township and Juniata Co. *Alfarata quad*	Rocky habitats overlooking the water gap are host to the **Allegheny Woodrat (*Neotoma magister*)**.	102
29	**WAGNER RUN POOLS** Decatur Township *Alfarata quad*	Several seasonal and permanent pools are clustered on the northern slope of Shade Mountain in the Wagner Run drainage, together forming a complex of **Ephemeral/Fluctuating Natural Pools**, a community of concern. One or two of the pools contain **false hop sedge (*Carex lupuliformis*)**.	102
62	**WEST LICKING CREEK HEADWATERS** Bratton Township *McVeytown quad*	The headwaters of West Licking Creek are in an old beaver pond that remains as an open-canopy sphagnous wetland. Populations of **netted chainfern (*Woodwardia areolata*)** and **screw-stem (*Bartonia paniculata*)** are found in this wet meadow.	86

Site #	Site Name Municipality *USGS quadrangle*	Description	Page #
Notable Significance			
13	**AITKINS GAP** Armagh Township *Alfarata, Burnham quads*	This site consists of oak forest with large white pines on both sides of a narrow stream valley. This site supports a population of an **species of concern** that relies on the forested matrix found at the site.	71
27	**BELLTOWN POOLS** Decatur Township *Alfarata quad*	A small cluster of seasonal pools is located on the lower slope of Jacks Mountain near Belltown, forming a complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern.	102
41	**BUCK RUN GRASSLANDS** Derry, Granville Townships *Belleville, Burnham, Lewistown quads*	This site encompasses an area of pastoral landscape along Buck Run where a **species of concern** has been located.	110, 118
11	**HAVICE MOUNTAIN SEEPS** Armagh Township *Coburn quad*	This site contains numerous seeps and springs feeding into a small clear sand-bottomed stream flowing through hemlock-mixed hardwood forest. The site supports two small populations of **mountain starwort (*Stellaria borealis*)**.	71
25	**JACKS MOUNTAIN SLOPES** Brown Township *Barrville, Belleville quads*	The Jacks Mountain Slopes overlook the Kishacoquillas Creek. Nests of an **species of concern** were located at this site.	94
15 24	**JACKS MOUNTAIN-EAST & WEST** Armagh, Brown, Decatur, Derry, Granville, Menno, Oliver, Union, Wayne Townships; Huntingdon & Snyder Counties *Alfarata, Allensville, Barrville, Belleville, Burnham, McClure, Newton Hamilton, Weikert quads*	The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate **Timber Rattlesnake (*Crotalus horridus*)**. This mountain range also remains one of the largest continuous blocks of forested land in the central portion of the county.	
20	**LINGLE CREEK HEADWATERS at BEAR GAP** Brown Township *Barrville quad*	The headwaters of Lingle Creek at Bear Gap are a hemlock-white pine palustrine wetland with a boggy S*phagnum* moss substrate interwoven with rivulets and the stream. These seepy openings were found to support the **Gray Petaltail Dragonfly (*Tachopteryx thoreyi*)**. This site also supports a **species of concern** that relies on the forested matrix found at the site.	94
9	**LITTLE POE ROAD POOLS** Armagh Township *Coburn quad*	The saddle of Long Mountain used by Little Poe Road is occupied by a very small complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern.	71
4	**LITTLE WEIKERT RUN POOLS** Armagh Township *Coburn quad*	Several scattered vernal pools and wetlands, forming a complex of **Ephemeral/Fluctuating Natural Pools,** a community of concern, occupy a broad step in the slope of Treaster Mountain.	71
34	**MAITLAND POOLS** Derry Township *Alfarata quad*	**Ephemeral/Fluctuating Natural Pools,** a community of concern, are located on the lower slope of Shade Mountain near Maitland.	110
6	**PITCHPINE RIDGE** Armagh Township *Coburn quad*	The Pitchpine Ridge contains a small example of a **Scrub Oak Shrubland** mapped on this ridge.	71
8	**THICK MOUNTAIN WETLANDS** Armagh Township *Coburn quad*	Deep within the Bald Eagle State Forest is a complex of wetlands associated with the headwaters of a small stream on Thick Mountain. Some of these wetlands constitute **Ephemeral/Fluctuating Natural Pools,** a community of concern.	71
Local Significance			
52	**Allensville Cave** Menno Township *Allensville quad*	Four known entrances to this cave access underground channels flowing from Stone Mountain to the Kishacoquillas Creek.	126
26	**Barrville Cave** Union Township *Barrville quad*	This cave is formed at the end of a blind valley in Ordovician limestone.	140

Site #	Site Name Municipality *USGS quadrangle*	Description	Page #
Local Significance (continued)			
50	**Belleville Cave** Union Township *Belleville quad*	This cave is located in a small ridge and what may have been an abandoned quarry in Ordovician limestone.	140
55	**Big Ridge Cave** Oliver Township *Belleville quad*	This cave is formed on a wooded ridge in Devonian Helderberg limestone.	132
42	**Big Ridge Pools** Granville Township *Lewistown quad*	One or two natural seasonal pools as well as several dug-out ponds are located along the drainage of an unnamed intermittent stream below Big Ridge.	118
19	**Chestnut Springs Pools** Brown Township *Barrville quad*	One large pool and a small isolated pool are located in a saddle of Brush Ridge.	94
23	**Coffee Run Spring Cave** Brown Township *Barrville quad*	This cave is part of the extensive Ordovician limestone karst system in the Kishacoquillas Valley. The cave entrance at the base of a limestone bluff is the main source of Coffee Run.	94
36	**Dry Valley Pits** Derry Township *Burnham quad*	These caves are formed in Devonian Helderberg limestone in the ridge southeast of Dry Valley.	110
47	**East Licking Creek Wetlands** Bratton Township and Juniata Co. *McVeytown quad*	The upper parts of the East Licking Creek drainage are characterized by several wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain.	86
33	**Herblengths Cave** Decatur Township *Alfarata quad*	Herblengths Cave is part of the Devonian limestone karst system in the Jacks Creek Valley.	102
39	**Highland Park Cave** Derry Township *Burnham, Lewistown quads*	The Highland Park Cave is formed on a wooded ridge in Devonian Helderberg limestone.	110
49	**Kings Cave** Union Township *Belleville quad*	Kings Cave is formed in a farm field in Ordovician limestone.	140
3	**Little Weikert Run Wetlands** Armagh Township *Coburn, Weikert quads*	This headwater mountain stream generally is bordered by a well-drained forest, but in some areas a wet substrate opens up into hemlock-dominated swamps.	71
58	**McVeytown Cave** Oliver Township *McVeytown, Newton Hamilton quads*	This cave is formed on a wooded ridge above the Juniata River in Devonian Helderberg limestone.	132
57	**McVeytown Quarry Caves** Oliver Township *Newton Hamilton quad*	Several small caves occur in a quarry west of McVeytown, in Devonian Helderberg limestone.	132
22	**Reedsville Cave** Brown Township *Burnham quad*	This cave is part of the extensive Ordovician limestone karst system in the Kishacoquillas Valley.	94
59	**Shanks Run Cave** Bratton Township *McVeytown, Newton Hamilton quads*	The Juniata River valley contains a few cave entrances, such as Shanks Run Cave in Devonian limestone.	86
17	**Stone Creek Road Wetlands** Brown Township *Barrville quad*	A series of wetlands and vernal pools is located at the watershed divide between Laurel Creek and Standing Stone Creek as well as along the headwaters of each drainage.	94
63	**West Licking Creek Wetlands** Bratton, Wayne Townships *McVeytown, Newton Hamilton quads*	The upper parts of the West Licking Creek drainage are characterized by several wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain. A few scattered seasonal pools are found within the floodplain.	86, 146

TABLE OF CONTENTS

List of Figures

List of Tables

.

INTRODUCTION

Mifflin County, named in honor of Governor Thomas Mifflin, was formed in 1789 from parts of Cumberland and Northumberland Counties. Its shape reflects the patterns created by the mountains of the Valley and Ridge geographic province, a pattern continued to the south in Juniata County. Bordering to the east are Snyder and Union Counties; and Centre and Huntingdon Counties to the north and west, respectively. The County has an area of 431 square miles, or 275,840 acres.

The Kishacoquillas Valley in Mifflin County
Photo source: PNHP

Mifflin County's population has remained stable in recent decades, growing only slightly from 46,197 in 1990 to 46,486 in 2000. Despite the stable population, there remains increased development pressure on some of the sensitive natural areas of the county. Ongoing transportation improvements in the county, in particular the large road projects associated with State Routes 22, 522, and 322, can be expected to alter land uses and encourage economic growth within the transportation corridors. Economically unsustainable farms could be sold to developers for residential and commercial uses. Farms represent many generations of cultural heritage and some farms contain a natural component or are adjacent to a natural area. In response to a quality of life survey conducted by Mifflin County for the 2000 Comprehensive Plan, the majority of respondents rated farmland and open space preservation (39.28%) and protecting natural resources (49.3%) among the highest priorities in the county (Mifflin County 2000).

In 1997 the Mifflin County Board of Commissioners initiated an update of the county's comprehensive plan with the support of all 16 municipalities. This plan provides a blueprint to direct future development and land use in the county. One outcome of this planning process was to identify the need to prepare a Natural Heritage Inventory of rare, threatened, and endangered ecological resources in the county (Mifflin County 2000).

The natural areas that comprise the natural heritage of Mifflin County can be easily lost without careful planning of growth and development. Ironically, the scenic and remote 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, rare and otherwise. Planning for long-term sustainability can maintain open space that is inclusive of natural environments and the plants and animals associated with them. Using a 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 county and municipal government, the public, developers, and planners know the location of such environmentally sensitive areas in order to maintain a balance and protection of these areas. Knowing where these areas are located can help prevent potential land-use conflicts, and help focus conservation efforts and limited funds to the most vulnerable areas. The Pennsylvania Natural Heritage Program (PNHP), under contract with the Mifflin County Planning Commission, has undertaken this project to provide a document and maps that will aid in the identification of these important areas.

This Natural Heritage Inventory (NHI) report presents the known outstanding natural features—floral, faunal, and geologic—in Mifflin County. The Inventory provides maps of the best natural communities (habitats) and the locations of animal and plant species of special concern (rare, threatened, or endangered) in Mifflin County. Due to budget and time constraints, some high-quality areas in the county are likely to have been overlooked. The maps

do not pinpoint the site of the species of concern but rather represent a zone of species occurrence within the site's watershed. A written description and a summary table of the sites, including quality, degree of rarity, and last-observed date, accompany each map.

Potential threats and some suggestions for protection of the rare plants or animals at the site are included in many of the individual site descriptions. Selected geologic features of statewide significance are also noted. In addition, the inventory describes some areas that are significant, but have not been ranked in this inventory because no species of concern were documented at these sites. These "locally significant" sites are representative of habitats that are relatively rare in the county, support an uncommon diversity of plant species, and/or provide valuable wildlife habitat. Locally significant sites without documented species of concern are referenced in lower case lettering throughout this report.

Particular species names, common and scientific, are provided in coordination with the appropriate jurisdictional agency. Plants, natural communities, and terrestrial invertebrates are under the jurisdiction of the PA Department of Conservation and Natural Resources (DCNR). Mammals and birds are under the jurisdiction of the PA Game Commission (PGC). Aquatic animals, reptiles, and amphibians are under the jurisdiction of the PA Fish and Boat Commission (PFBC). Species governed by the PGC and the PFBC are often subject to unauthorized collection and are therefore sometimes not identified in the text of this report, at the request of the agencies, in order to provide some measure of protection.

The information and maps presented in this report provide a useful guide for planning commercial and residential developments, for sighting recreational parks, 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 NHI will be provided to each municipality through the Mifflin County Planning Commission. The NHI 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. Mifflin County, its municipalities, land trusts, and other organizations can also use the NHI to identify potential protection projects that may be eligible for funding through state or community grant programs such as the Growing Greener II fund.

Landowners too may 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 DCNR's Bureau of Forestry, assists landowners in creating management plans. This plan incorporates landowner objectives (e.g., wildlife or timber management) as well as enhances habitats for natural resources. Other programs include the USDA's Forest Legacy Program, the Pennsylvania Department of Agriculture's Agricultural Land Preservation Program, and landowner assistance programs within PGC and PFBC. Land managers may wish to consult with this report and the PNHP in an effort to avoid potential conflicts in areas with species of special concern and/or identify ways of enhancing or protecting this resource. Users of this document are encouraged to contact the Middletown office of the PNHP (717-948-3962) for additional information.

Questions regarding potential conflicts between proposed projects and species of concern mentioned in this report should be directed to the Environmental Review Specialist at the PNHP office in Harrisburg (717) 772-0258. (http://www.naturalheritage.state.pa.us/)

NATURAL HISTORY OVERVIEW OF MIFFLIN COUNTY

The climate, topography, geology, and soils have been particularly important in development of ecosystems (forests, fields, wetlands) and physical features (streams, rivers, mountains) that occur in Mifflin County. Many disturbances, both natural and human, have been influential in forming and altering many of Mifflin Counties' ecosystems, causing extinction of some species and the introduction of others. These combined factors provide the framework for locating and identifying exemplary natural communities and species of special concern in the county. The following sections provide a brief overview of the physiography, geology, soils, surface water, and vegetation of Mifflin County.

Physiography and Geology

Characteristic landscapes and distinctive geological formations classify a Physiographic Province. 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. Physiographic and geologic information was obtained from many sources including Ground Water in Northeastern Pennsylvania (Lohman 1957), The Geology of Pennsylvania (PA Geological Survey and Pittsburgh Geological Survey 1999), Soil Survey of Juniata and Mifflin Counties, Pennsylvania (USDA 1981), and Physiographic Provinces of Pennsylvania (Sevan 2000).

Mifflin County lies entirely within the Ridge and Valley physiographic province (Cuff et al. 1989). The Ridge and Valley province is a distinguished belt of long, narrow wooded ridges and broad agricultural valleys that sweep diagonally through central Pennsylvania. The ridges of this province are similar in structure and elevation, typically rising between 800-1200 feet above sea level, but occasionally to 2000 feet. The ridges of Mifflin County are primarily sandstone and include Stone Mountain and the Seven Mountains complex on the northern boundary, Jacks Mountain bisecting the county, and Blue Mountain and Shade Mountain along the southeastern border. Meanwhile, the valleys that dominate in this region are variable depending on the type of rock that underlies them. Mifflin County valleys typically have Ordovician limestone bedrock, which are the flattest and the most fertile of valley types. Shale soils are also present in Mifflin County, which are characteristic of a more hilly land and relatively poor soil; for example in the Juniata River Valley (Cuff et al. 1989). Land use patterns in the county follow the Ridge and Valley geology, with streams, roads, farms, parks, etc. all following the lines of the mountains along a southwest to northeast distribution.

Mifflin County is characterized by thickly forested ridges divided by agricultural valleys, exemplified by this view of the Juniata River valley near McVeytown.

Photo source: PNHP

Most of the valley lowlands are underlain by rocks dominated by carbonates, displaying a karst topography with sinkholes, pinnacles, and caves (Shultz 1999). Mifflin County contains a significant portion of the state's caves, numbering 59 known cave entrances in 1999 (Dayton et al. 1981, White and White 1999). See page 8 for more details on the significance of the area's karst features. Caves are primarily located along the northeastern margin and the northwestern end of the Kishacoquillas Valley and in a more scattered pattern in the valley between

Jacks and Shade Mountains (Dayton et al. 1981). This smaller valley includes the Big Ridge Cave, which is recorded to have the deepest drop in Pennsylvania (Dayton et al. 1981). Maps of Mifflin County surface geology that highlight the karst areas can be found in the 2000 Comprehensive Plan (Figures 8-5 and 8-6; Mifflin County 2000).

Watersheds

Mifflin County is completely within the Susquehanna River drainage basin. Major watersheds in the county include the Kishacoquillas Creek, Jacks Creek, and the Juniata River. The Kishacoquillas Creek watershed alone drains 44.3% of Mifflin County. These watersheds are discussed more extensively in the Aquatic Community Classification section (p.39). Additional resources for information about the Kishacoquillas Creek, Lower Kishacoquillas Creek, and Tea Creek watersheds can be found in watershed assessments by the Mifflin County Conservation District (2003, 2005, 2007). Additionally, a conservation plan has been prepared for the Juniata River watershed and includes many resources of information for the watershed and the county (Juniata Clean Water Partnership 2000).

The Juniata River in Mifflin County remains quite scenic with little development along the banks.
Photo source: PNHP

.

Soils

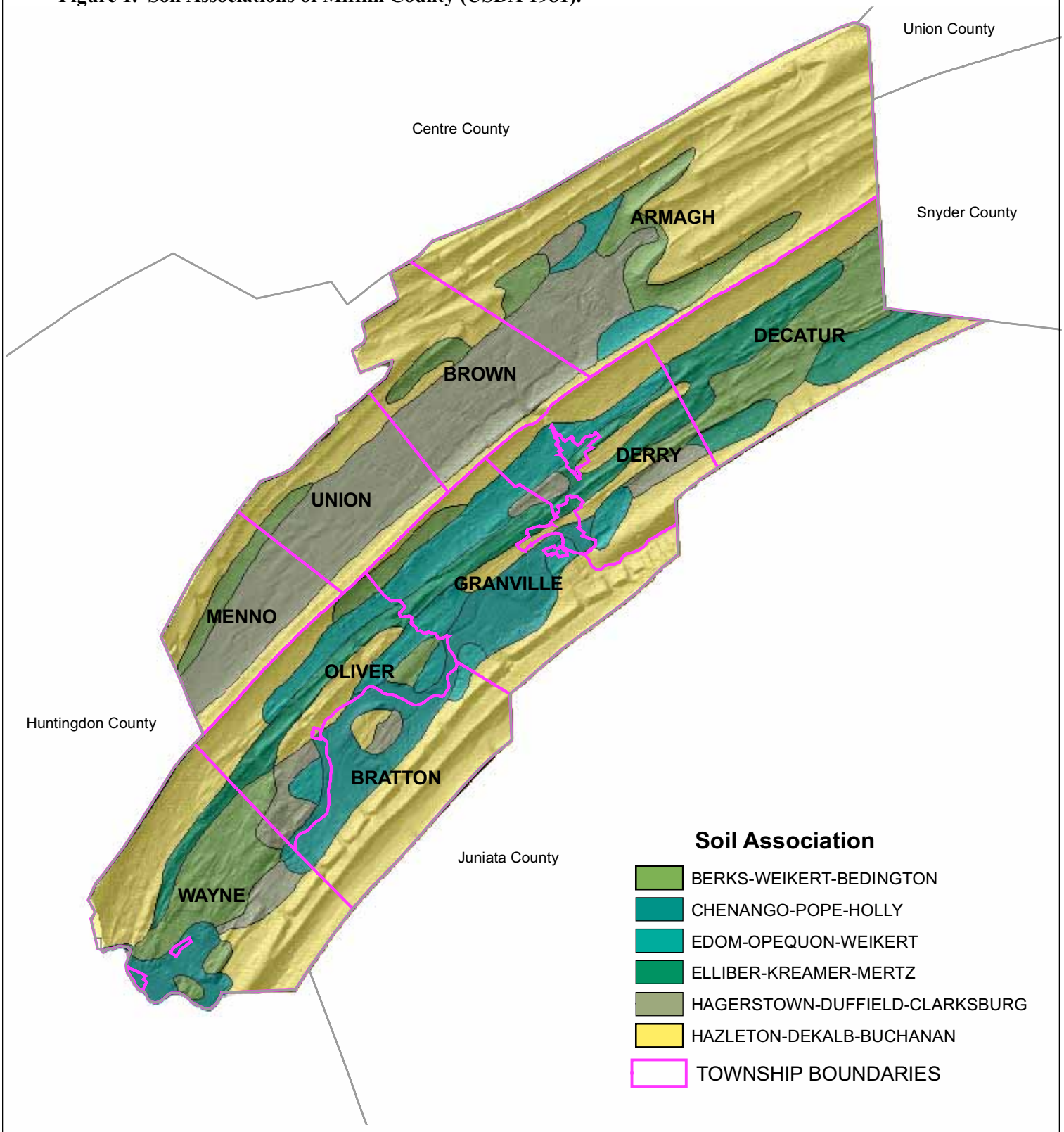
A soil association is a group of soils with a distinctive, proportional pattern of occurrence in the landscape. This description of the soils of Mifflin County comes from The Soil Survey of Juniata and Mifflin Counties (USDA, 1981) and more recent information provided by the Mifflin County Conservation District. There have been six soil associations mapped for Mifflin County.

Farming continues to be the most prevalent land use in the county, and most of the soils in the county have fair to good potential for farming. Few areas have soils and landscapes unfavorable to urban development, with the exception of floodplain portions of the Chenango-Pope-Holly association and steep portions of the Hazleton-Dekalb-Buchanan association.

Table 2. Soil associations described for Mifflin County, adapted from The Soil Survey of Juniata and Mifflin Counties (USDA, 1981).

Soil Association	Description	County Coverage	Land Use
Hazleton-Dekalb-Buchanan	Deep, well drained and moderately well drained, nearly level to very steep soils on primary ridges and on benches and foot slopes. It is on the top, side, and foot slopes of the higher ridges. The landscape consists of narrow to moderately broad, nearly smooth to rolling ridgetops and steep side slopes. Broad benches and undulating foot slopes are near the bases of the ridges.	46%	This association is mainly wooded because it is too stony for cultivated crops. Some areas are used for crops and pasture. The nonstony areas are suited to most farm uses if adequately managed to control erosion and conserve moisture.
Berks-Weikert-Bedington	Moderately deep and shallow, well drained, nearly level to steep soils on secondary ridges and hills. It is on secondary ridges and hilly uplands in both counties. The landscape consists of gently rolling to steep ridges and rounded oblong hills.	22%	This association is mainly used for cultivated crops. Some areas are used for woodland and pasture. A few small areas are quarried for shale.
Hagerstown-Duffield-Clarksburg	Deep and shallow, well drained, nearly level to moderately steep soils in upland valleys. It is mostly in the Kishacoquillas and Ferguson Valleys in Mifflin County. The landscape consists of gently sloping to rolling and hilly valley floors and foot slopes and some low ridge protrusions.	10%	This association is mainly used for crops. Some areas are used for pasture and woodland, and a few small areas are the sites of towns and villages. A few limestone quarries are in the association.
Edom-Opequon-Weikert	Deep and shallow, well drained, nearly level to very steep soils on ridges and in valleys on uplands. It is on ridges and valley floors in both counties. The landscape consists of gently undulating valleys to hilly ridges that have some steep and very steep side slopes.	7%	Most of this association is used for cultivated crops. Some areas are wooded. If management practices are adequate to control erosion and conserve moisture, this association is suited to most farm uses.
Elliber-Kreamer-Mertz	Deep, well drained and moderately well drained, nearly level to very steep soils on secondary ridges. It is on upland ridges in both counties. The landscape consists of gently undulating to very steep rounded ridges that have long side slopes and foot slopes.	7%	Most of this association is used for cultivated crops. Some areas are used for woodland and pasture. If management practices are adequate to control erosion and conserve moisture, this association is suited to most farm uses.
Chenango-Pope-Holly	Deep, poorly drained, moderately well drained, and well drained, nearly level to gently sloping alluvial soils on flood plains and terraces. It is along rivers and major streams in both counties. The landscape consists of nearly flat flood plains and nearly smooth to gently rolling terraces.	5%	Most of this association is used for crops and pasture. A few areas are used for woodland, and a few areas are the sites of towns and villages. Flooding and wetness are the major limitations for most land uses.

Figure 1. Soil Associations of Mifflin County (USDA 1981).



Vegetation

Upland Forest Communities

The American chestnut once dominated many of the Eastern North American Hardwood Forests from Maine to Alabama to the Mississippi River. However, around 1904, a chestnut blight (*Cryphonectria parasitica*) was introduced to North America from Asia. The blight spread from the Bronx Zoo northward and southward, and by 1960, there were basically no mature chestnuts left standing. Today, some young sprouts and shoots still remain, but very few will ever reach maturity due to the blight. The loss of the chestnut from the canopy left huge breaks all across the eastern United States. These holes have since filled with many of the chestnut's associated species, including species of oak and hickory. These oak species comprise the Appalachian Oak Forest, which is the dominant vegetation type in the uplands of Mifflin County (Cuff et al. 1989). White oak (*Quercus alba*), northern red oak (*Q. rubra*), and chestnut oak (*Q. montana*) dominate the upland forest communities along with an array of other hardwood species.

a pre and post chestnut blight forest

Characteristic species of the Appalachian Oak Forest

Trees:	
white oak	*Quercus alba*
northern red oak	*Quercus rubra*
chestnut oak	*Quercus montana*
black birch	*Betula lenta*
pignut hickory	*Carya glabra*
American beech	*Fagus grandifolia*
tulip poplar	*Liriodendron tulipifera*
eastern white pine	*Pinus strobus*
scarlet oak	*Quercus coccinea*
scrub oak	*Quercus ilicifolia*
black oak	*Quercus velutina*
Shrubs:	
mountain-laurel	*Kalmia latifolia*
low sweet blueberry	*Vaccinium angustifolium*
lowbush blueberry	*Vaccinium pallidum*
black huckleberry	*Gaylussacia baccata*
witch hazel	*Hamamelis virginiana*
Herbaceous Vegetation:	
Canada mayflower	*Maianthemum canadense*
Pennsylvania sedge	*Carex pensylvanica*
Teaberry	*Gaultheria procumbens*
Bracken fern	*Pteridium aquilinum*
False Solomon's seal	*Smilacina racemosa*
Wild sarsaparilla	*Aralia nudicaulis*
May apple	*Podophyllum peltatum*
Wood ferns	*Dryopteris* spp.

Wetlands

Wetlands are the key to the survival of many species of plants and animals considered rare in the state. Even though wetlands account for only two percent of Pennsylvania's total area, they are home to a diverse array of rare plants and animals and are an extremely productive part of the landscape as a whole (Cuff et al. 1989). Wetlands differ in size, structure, and species diversity. Wetlands also differ according to their placement on the landscape – at stream headwaters, dips in valleys, or on slopes where ground water discharges; and whether the water contained is flowing or stagnant. These different scenarios result in peatlands, marshes, swamps, floodplain forests, forested wetlands, wet meadows, and seeps. Wetlands differ also in vegetative species cover.

- Forested swamps are usually dominated by tree species such as red maple, yellow birch (*Betula alleghaniensis*), eastern hemlock (*Tsuga canadensis*) and ash species (*Fraxinus* spp.). The understory typically consists of shrub species such as highbush blueberry (*Vaccinium corymbosum*), rhododendron and azaleas (*Rhododendron* spp.), winterberry holly (*Ilex verticillata*), alders (*Alnus* spp.), swamp rose (*Rosa palustris*) and many others.

- Graminoid marshes, also known as emergent marshes, are wetlands dominated by grass-like

(graminoid) plants such as cattails, sedges, rushes, and grasses. This type of wetland may be found in association with slow streams or in areas with ground water seepages. Emergent marshes in the county are usually formed as successional communities following beaver dams or other impoundments.

• Shrub swamps are wetlands occurring on mineral soils usually with a thick accumulation of peat moss (*Sphagnum* spp.) and other organic matter with water near or above the surface most of the year (Cuff et al 1989). Shrubs under 20 feet tall dominate this type of wetland. Shrub swamps in the county frequently include highbush blueberry, chokeberry (*Aronia* spp.), mountain holly (*Nemopanthus mucronatus*), alder, swamp rose, meadowsweet and steeplebush (*Spiraea* spp.), and sedges (*Carex* spp.).

Due to the rarity of undisturbed examples of wetlands in Mifflin County and Pennsylvania, all good examples of these habitats should be preserved whenever possible. Wetlands provide valuable habitat for breeding and migrating birds, mammals, reptiles, amphibians and insects. Wetlands also provide a refuge for many species of wetland dependent rare plants. These systems also provide critical roles in maintenance of water quality.

Unique Natural Communities in Mifflin County

Different regions of the state have characteristic landforms that contain the regions' most biologically interesting habitats. Southeastern PA has tidal estuaries and serpentine barrens, northeastern PA has extensive wetland systems formed by glacial activity, and north-central PA has some old growth forests. Central PA, including Mifflin County, has extensive cave systems and vernal pools as well as some remnant forest communities described here.

Limestone Solutional Cave

Pennsylvania's karst landscapes with solutional caves are renowned nation-wide. Solutional caves are formed in limestone or dolomite by the dissolving action of groundwater. Water has formed all of the caves in this region, eroding limestone both physically and chemically. The caves that have formed in Ordovician limestone, such as those found in the Kishacoquillas Valley, tend to occur in long, parallel bands along the base of ridges and often still contain underground streams that connect to the surface through sinking streams and large springs (White and White 1999). Caves formed in Helderberg limestone, such as those in the Jacks Creek Valley, are capped with resistant sandstone and few have natural entrances or contain active groundwater systems (White and White 1999). Mifflin County contains a significant portion of the state's caves, numbering 59 known cave entrances in 1999 (Dayton et al. 1981, White and White 1999).

Caves and karst features are fragile resources that have unique recreational and ecological value, providing habitats for common, rare, and threatened and endangered species. Cave systems also serve as direct conduits to the groundwater table, a serious issue for Mifflin County's rural communities that rely on well water. Conservation of cave and karst resources needs to be a concern for all who use or impact the cave environment as well as for communities in karst areas that rely on clean groundwater.

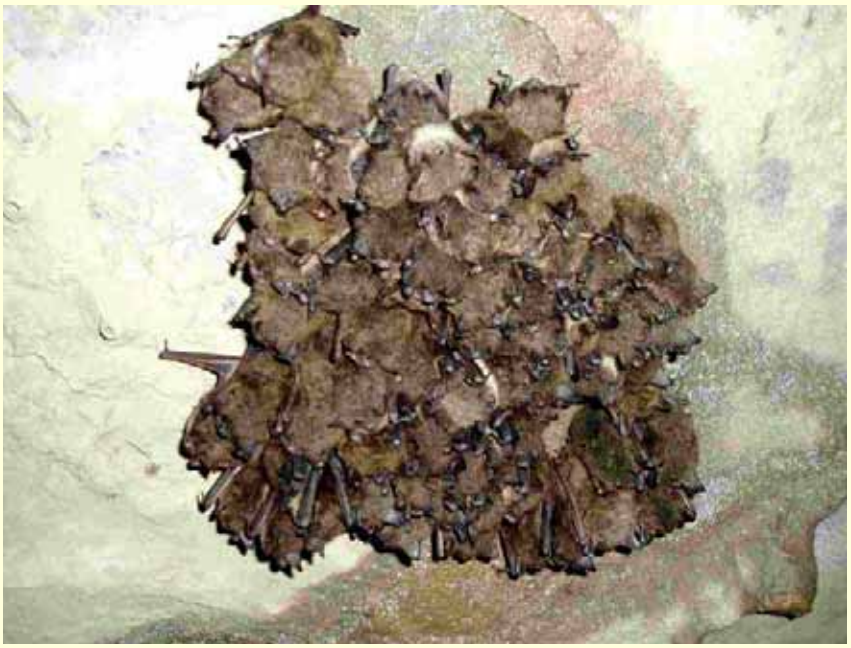
A cave entrance

Photo source: PNHP

Many human activities threaten caves and the fauna that depend on them. Terrestrial pollution in karst terrains results in a very real subterranean threat. Because water moves readily from the earth's surface down through solution cavities and fractures and undergoes very little filtration, groundwater in karst limestone is easily polluted. Contamination of groundwater can come from industrial sources as

well as sewage, fertilizers, herbicides, and pesticides from municipal, agricultural, and household sources. Even stormwater may be considered a polluting substance as overland runoff transfers surface material, including pollutants and excessive nutrients, into the fragile underground environment.

Identification of cave resources in this report is provided as a highlight of geologic and natural resources of the county and should not be considered a guide to cave exploration. Individual landowners control the access to caves on their property and should be contacted prior to visiting a cave. Caves that support overwintering bats should not be visited from October 1 to May 1 in order to avoid disturbing the bats. When bats are disturbed in hibernation, they use up much of their fat reserves and may not survive through the winter. While bats have been unjustly feared and persecuted in the past, we are continuing to realize the critical ecological role and benefits to humans that these species provide in the form of insect control. More information about cave exploration in central Pennsylvania is available through the local cave clubs, such as Nittany Grotto, Pennsylvania Cave Conservancy, and the Mid-Atlantic Cave Conservancy. For more information on cave environments and the animals found within, see the Cave Environment fact sheet in Appendix X.



This cluster of hibernating bats serves a vital ecological role as well as being beneficial to humans. In the warmer months of the year, these bats will forage along wooded creeks and streams, eating insects as they hatch from the waters. A common myth is that bats swarm and often entangle themselves in people's hair. In reality, Pennsylvania's bats are incredibly agile and will never strike a human. Bats do often fly around humans, but are usually busy plucking mosquitoes and other insects from the air.
Photo source: PNHP

Ephemeral/fluctuating Natural Pool

Also known as vernal pools or seasonal pools, these wetlands fill with water on an intermittent basis due to annual precipitation, rising groundwater, or surface water runoff (Kenney and Burne 2000). These pools become almost completely dry in most years, losing water through transpiration and evaporation. Because these pools are ephemeral and virtually free of fish, they attract many species of breeding salamanders, frogs, and toads. Some species, like the Jefferson Salamander (*Ambystoma jeffersonianum*) are vernal pool indicator species. This species and other ambystomatid salamanders lay eggs almost exclusively in vernal pools. Plants typically associated with vernal pools include woolgrass (*Scirpus* spp.), three-way sedge (*Dulichium arundinacea*), pin oak (*Quercus palustris*), highbush blueberry, red maple, and the federally endangered northeastern bulrush (*Scirpus ancistrochaetus*).

Communities of vernal pools have historically received negative attention because they have been thought of as mosquito breeding waste grounds, with few benefits to humans. In recent years, we have begun to understand and appreciate the intricate ecology of these rare and isolated communities. Many of the misconceptions of these pool communities have been corrected through more recent vigorous scientific research.

For example, we now realize that vernal pool communities do not produce mass numbers of mosquitoes as was once thought. The species of mosquitoes known to transmit West Nile Virus are more likely to thrive in disturbed sites with no natural predators, such as old tires, buckets, and stagnant puddles (Mitchell et al. 2006). While mosquito eggs are laid in vernal pools, few of them survive to adulthood because a group of highly specialized amphibians and insects have adapted to the unique growing conditions provided by vernal pools

and eat the majority of the mosquito larvae before they hatch.

Pennsylvania's vernal pool origins are most commonly rooted in the glacial advances of the Illinoian and Wisconsin glaciations. In fact, these pools can allow glimpses into the past using Paleobotany, in which historic plant species are identified by examining pollens housed in anoxic soils where they are in a preserved state due to a lack of decomposition. Paleobotany studies from some pools in Pennsylvania have identified tamarack pollens from a few feet down, indicating that a portion of the Commonwealth was covered by a boreal forest about 30,000 years ago when this particular pool was formed. Today, this tamarack forest is common to the boreal regions of northern Canada.

Pennsylvania's vernal pool communities certainly provide windows into the makeup of the landscape from eons ago, and represent a diverse suite of organisms specially adapted to vernal pool communities, including several plant and animal species of concern. Many vernal pool species have evolved some of the most interesting life histories of any North American animals. More information on the ecology of vernal pool animals can be found in the Ephemeral/fluctuating natural pool factsheet found in Appendix X.

Hemlock (White Pine) forest
photo source: Andrew Strassman PNHP

Vernal pool
photo source: PNHP

The Pennsylvania Seasonal Pools Registry is a citizen-based program to document locations of seasonal pools. The registry is an important step toward understanding Pennsylvania's ephemeral wetland habitats. Anyone interested in submitting information on seasonal pools should visit http://paconserve.org/rc/sp/.

Old Growth Hemlock (White Pine) Forest
In 1681, when William Penn chartered the enormous tract of land in the new world now known as "Pennsylvania", the vast forests of the territory became the symbol of "Penn's Woods". At that time, Pennsylvania was known for seemingly endless forests, filled with majestic giant trees. Forests of eastern hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*) in Pennsylvania were once widespread throughout the state, with stands of giant trees that towered over 200 feet tall. Today, only tiny fragments of this once great forest remain.

Patches of old-growth forest are not merely composed of large old trees; the nature of true old-growth forest depends on the functioning of the system. The USDA Forest Service has set up the following criteria for identifying old-growth forests. True stands of old growth forest contain: (1) large trees for species and site, (2) wide variation in tree

size and spacing, (3) accumulation of large, dead trees (snags, logs), (4) tree decadence (a process of deterioration), and (5) diverse tree canopy structure (layers, gaps).

Characteristic species of the Hemlock (white pine) forest	
Trees:	
eastern hemlock	*Tsuga canadensis*
eastern white pine	*Pinus strobus*
black birch	*Betula lenta*
yellow birch	*Betula alleghaniensis*
sugar maple	*Acer saccharum*
red maple	*Acer rubrum*
red oak	*Quercus rubra*
black oak	*Quercus velutina*
American beech	*Fagus grandifolia*
tuliptree	*Liriodendron tulipifera*
Shrubs:	
rosebay	*Rhododendron maximum*
witch hobble	*Viburnum lantanoides*
maple leafed viburnum	*Viburnum acerifolium*
witch hazel	*Hamamelis virginiana*
Herbaceous Vegetation	
partridge-berry	*Mitchella repens*
Canada mayflower	*Maianthemum canadense*
ground pine	*Lycopodium* spp.
teaberry	*Gaultheria procumbens*
New York fern	*Thelypteris noveboracensis*
Indian cucumber root	*Medeola virginiana*
Christmas fern	*Polystichum acrostichoides*

Most of these old-growth criteria are characters of a process known as gap formation. Gap formation occurs when an old tree dies and falls over, creating an opening in the canopy. Smaller shaded trees that have been waiting in the undergrowth (sometimes for centuries) are suddenly able to take advantage of the newly opened gap and shoot towards the canopy. Gap formation implies the presence of large trees, some of which have died and fallen over, creating a mixed layer of dead woody material on the forest floor (Coarse Woody Debris), and the naturally spaced sub-canopy trees filling the gap and growing skyward into the canopy.

In addition to creating an incredibly scenic landscape, old growth forests are also known to be extremely rich in biodiversity. Certain species of animals prefer old growth forests. Many songbirds, raptors, weasels, rodents, shrews, bats, and amphibians thrive in old growth stands. Some studies of old growth have noted that the invertebrate biomass is more than five times that found in younger timber stands. Aside from being representatives of Pennsylvania's past landscape, the remaining patches of old growth forests in the state offer tremendous biological significance and are incredibly unique natural communities that shape the character of the Commonwealth.

Disturbance

Disturbances, whether natural or human-induced, have played a key role in shaping many of the natural communities and the associated species. The frequency and scale of these disturbances have played a large part in the appearance of natural communities today.

Natural disturbances such as fire and flooding can actually benefit certain natural communities and species. For example, periodic fires are needed to maintain pitch pine and scrub oak barren areas in order to facilitate new growth of these species and prevent succession. Floodplain forests benefit from the periodic scouring and deposition of sediments as streams overtop their banks. At the same time, streamside wetlands hold excess water, thus reducing the scale of flooding downstream.

Another disturbance, over-browsing by deer, can have detrimental effects on natural communities and species (Rhoads and Klein, 1993). Excessive deer browse can decrease the understory of some forests, and halt regeneration of new growth of the canopy and understory. Deer feeding preferences can have a direct effect on rare plants and severely decrease essential habitat for other animal species including birds, mammals, reptiles, amphibians and insects. Private landowners should be encouraged to control deer populations by allowing hunting on their lands.

Disturbances caused by beaver can be either beneficial or detrimental to wetland habitats within the county. On one hand, thinning the canopy and flooding by beavers can eventually create open wetland meadows upon which many unique species rely. On the other hand, damming by beavers can alter habitats to a degree that render the sites no longer suitable for some of the rare species of the county. 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 unique bog adapted species. Beaver activity in the long term is critical to the cyclic pattern of wetland disturbance, but in the short term it can threaten the integrity of 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.

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, especially to species that require an early successional habitat. However, what may be beneficial to a few species is often detrimental to other species. Many rare species have become rare because they cannot adapt to disturbance of their particular habitat, which is often a specialized niche. 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. Early farms in the county were centered around floodplains and later expanded into the hills. Agriculture has more recently declined in the area and many of the old farmsteads have been converted to small-scale development, or houses and vacation cabins for people from other regions of the state or elsewhere (USDA 1981).

In many cases, human disturbances have directly affected natural communities and animal and plant species in certain areas. In Mifflin County, farming and urbanization have created biological "islands" where small natural areas are surrounded by agriculture or development. This isolates gene pools of wildlife and/or plant species, inhibiting the gene flow between populations. In addition, logging and mining can affect forest age and natural community structure. For example, old-growth forest has virtually disappeared despite the fact that some scattered old trees remain. Additionally, many wetlands have been intentionally flooded or drained resulting in severe losses of biodiversity at a given site. As farming remains an important industry in Mifflin County, some farm practices and abandoned farmland make conditions favorable for some grassland birds. Birds such as Short-eared Owl, Eastern Meadowlark, Bobolink, Henslow's Sparrow and Vesper Sparrow have benefited from human created and managed early successional habitats, including reclaimed strip mines in western Pennsylvania.

This photograph showcases the destruction possible from an overpopulation of deer. While many people are attracted to the park-like atmosphere in a forest like this, there is very limited habitat in this type of forest, and it is representative of an unhealthy ecosystem. Allowing hunting on lands could eventually allow this forest to recover, but this particular stand may require hands-on management to remove some of the hay scented fern that carpets the forest floor, shading out sprouting trees and shrubs.
photo source: PNHP

Agriculture, residences, road building, industry, mining and 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 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 potential sources of water impairment within Mifflin County. Much information on the water and geological resources of the county can be found on the PA DEP eMap web page: http://www.emappa.dep.state.pa.us/emappa/

Dams

Pennsylvania has thousands of dams on its rivers, creeks and streams. 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. 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).

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 our rivers and streams, we can re-establish 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. To address the impacts to resources under their management, the PA Fish & Boat Commission has authority (PA Code Chapter 57, Section 22) to request that dam owners install fish passage structures on dams to benefit migratory or resident fish species.

Pennsylvania currently leads the nation in dam removal and Governor Rendell received a National Award of Merit from the Association of State Dam Safety Officials in 2004 for his commitment to dam safety in Pennsylvania. 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.

Invasive Species

Natural habitats within Mifflin County are threatened by the invasion of exotic (non-native) plant and animal species. These invasive species are plants, animals, or other organisms that do not naturally occur in the area and which are likely to cause harm to the natural environment, the economy or to human health. In 2000 the year economic cost in the US of non-native invasive species was estimated at $137 billion (Pimentel et al. 2000). Because they have no natural enemies to limit their reproduction, they usually spread rampantly. Once they are established, it is extremely difficult to control their spread. Invasive species are recognized as one of the leading threats to biodiversity and impose enormous costs to agriculture, forestry, fisheries, and other enterprises, as well as to human health (www.invasivespeciesinfo.gov).

Mile-a-minute vine

Photo source: PNHP

The introduction of non-native species into Pennsylvania first began with initial settlement in the 17th century (Thompson 2002) and continues to this day. Plants and animals have been deliberately introduced for a variety of reasons 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 are ones that reproduce rapidly, spread quickly over the landscape, and have few, if any, natural controls such as herbivores and diseases to keep them in check. 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.

Invasive plants are capable of displacing native plants from natural communities, especially those with rare, vulnerable, or limited populations (Swearingen et al. 2002). This initial impact is worsened by the tendency for native wildlife to prefer native species to invasive species for food. (Swearingen et al. 2002). In some cases, a switch to the invasive plant food supply may affect the physiology of the prey species. For example, many invasive shrubs, including bush honeysuckle, 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 (Swearingen et al. 2002). 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 Weed Wrench and the Honeysuckle Popper). Herbicide control 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 each 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 these species can be found at: www.invasive.org/eastern/. A list of the most prevalent invasive plants in Mifflin County is provided in Table 2.

Invasive Animal Species

In addition to invasive plants, Pennsylvania is now home to several exotic species of animals including mammals, birds, fish, and reptiles (Table 3). 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*) and House Mouse (*Mus muscula*) are all too common encounters in our homes and built areas.

Hemlock Woolly Adelgid infestation along a hemlock branch
Photo source: Connecticut Agricultural Experiment Station Archives

Arguably, the most significant threat from an invasive animal species to the biodiversity of Mifflin County 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

Table 3. Significant invasive plant species potentially found in Mifflin County.

Species	Description and Threat
Tree-of-heaven (*Ailanthus altissima*)	Introduced to Philadelphia from China in the early 1800s, it is present along roadsides, old fields and timber cuts throughout the county. This fast growing tree is a prolific seeder and can also proliferate through vegetative means, outcompeting native vegetation.
Norway maple (*Acer platanoides*)	Research has recently shown that forests that have been invaded by Norway maple suffer losses in diversity of native forest wildflowers compared with forests in which the canopy is dominated by native species such as sugar maple.
Japanese stiltgrass (*Microstegium vimineum*)	A fast-spreading grass that is typically found along forest roads, streambanks, and other cool moist habitats. Outcompetes native vegetation and may have an effect on animal species that use streamside microhabitats.
Japanese knotweed (*Polygonum cuspidatum*) Giant knotweed (*Polygonum sachalinense)*	These large fast-growing exotics displace natural vegetation and greatly alters natural ecosystems. Typically found along stream banks and other low-lying areas, as well as old home sites and waste areas.
Mile-a-minute (*Polygonum perfoliatum*)	A vine that invades open and disturbed areas and scrambles over native vegetation in open and disturbed areas, limiting their photosynthesis. This species is listed as a noxious weed in Pennsylvania.
Purple loosestrife (*Lythrum salicaria*)	A herbaceous wetland invasive that is present at scattered sites throughout the county. Once established in a wetland this species is difficult to eradicate and will displace native species.
Garlic mustard (*Alliaria petiolata*)	An increasingly common invasive biennial herb spreading through natural areas throughout the region. Recent scientific evidence has shown that this species can disrupt microrhizyl relationships that trees depend on for their growth.
Japanese honeysuckle (*Lonicera japonica*) Oriental Bittersweet (*Celastrus orbiculatus*)	These species of vines cover and outcompete native vegetation as well as girdle trees by twining up them.
Bush honeysuckles (*Lonicera tatarica, L. morrowii, and L. maackii*)	Found in a variety of environments from wetlands to uplands. Competes with native plants for moisture, nutrients, and pollinators. Fruits do not provide high energy food for migrating birds.
Canada, Bull, and Nodding (Musk) thistle (*Cirsium arvense, C. vulgare, Carduus nutans*)	Pennsylvania listed noxious weeds. Invades a variety of dry to moist habitats displacing native plants and disrupting community processes.
Spotted knapweed (*Centaurea stoebe* spp. *micranthus*)	Competes with native species by capturing moisture and nutrients. Poses a high threat to shale barrens and other dry habitats.
Autumn olive (*Elaeagnus umbellata*)	A drought-tolerant species that thrives in many soil conditions. Threatens native ecosystems through competition and alteration of natural succession patterns and nutrient cycling.
Japanese barberry (*Berberis thunbergii*)	Commonly planted ornamental that escapes and forms dense stands in a variety of habitats, including forests and wetlands, displacing native vegetation.
Winged burning bush (*Euonymus alatus*)	A shrub that can form dense thickets that displace native woody and herbaceous plants.
Multiflora rose (*Rosa multiflora*)	Widely planted shrub that invades a variety of habitats excluding most native shrubs and herbs. May be detrimental to the nest of native birds.
Jetbead (*Rhodotypos scandens*)	A shrub that forms dense thickets that displace native woody plants and shades out herbaceous groundcover.
Privet (*Ligustrum* spp.)	These shrubs can form dense thickets in floodplains, forests, wetlands, and fields that can outcompete native vegetation.
Reed canary grass (*Phalaris arundinacea)*	This grass, though native to PA, forms dense, monospecific stands in open wetlands, wet meadows and riparian areas. It effectively excludes all other plant species, causing greatly decreased biological diversity in wetland communities.

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, provide habitat for about 90 species of birds and mammals, and are an essential element of eastern forests. Several control options are currently being tested. This species originates from Japan and China and was introduced accidentally to North America around 1924 (McClure 2001). It is currently distributed from Maine to Georgia and can be found in most of the counties in Pennsylvania with infection of the entire state expected in the near future (PA DCNR 2007).

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. American 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 oak and hickory.

Table 4. Significant invasive animal species potentially found in Mifflin County.

Species	Description and Threat
Hemlock Woolly Adelgid (*Adelges tsugae*)	This species is causing severe damage to eastern hemlock (*Tsuga canadensis*) killing up to 90% of infected trees, thus greatly modifying ecosystems.
Gypsy Moth (*Lymantria dispar*)	Feeding preferentially on oak trees (*Quercus* spp.) and their relatives this species will eat almost any plant when in need and can cause severe environmental and economic damage.
Common Pine Shoot Beetle (*Tomicus piniperda*)	A pest of pine trees (*Pinus* spp.) this species damages terminal shoots stunting the growth of trees thus weakening the trees and increasing their susceptibility to other pests.
Sirex Woodwasp (*Sirex noctilio*)	A recent invader, this species attacks living pines and is likely to cause great amounts of damage to pine plantations throughout the nation.
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.
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.
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.
Grass Carp (*Ctnopharyngodon 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.
Common Carp (*Cyprinis carpio*)	Introduced as a food fish, this species is now found anywhere with warm, slow-moving water. As a bottom feeder it greatly increase turbidity and mobilizes large amounts of sediment.
Snakehead (*Channa spp.*)	Prized as a food species in Asia, this species was recently introduced to the East Coast and has quickly taken root. Currently not found in Mifflin County, it should be monitored for.
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.
European Starling (*Sturnus vulgaris*)	Competing directly with native cavity-nesting birds, this species also cause severe crop damage.
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.
Mute Swan (*Cygus 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.
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.
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.
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.

The Gypsy Moth (*Lymantria dispar L.*) 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, in particular oak species. This defoliation results in a reduction in the rate of a tree's growth and seed production and possibly the eventual death of the tree.

The European Starling (*Sturnus vulgaris*) was introduced to North America in the late 1890s as part of a plan to introduce all of the birds mentioned in the works of Shakespeare to Central Park in New York City. It has since spread throughout the US. In addition to competing with native bird species for food and space (specifically smaller cavity nesting birds), large flocks of this species can destroy fields of crops.

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 (*Driessena polymorpha*) was accidentally introduced to the Great Lakes in the 1980's and has been spreading in Pennsylvania's waters. Not currently known to Mifflin County, 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 Juniata River. Of greatest concern to biodiversity is the capacity of the clam to alter the ecology of an aquatic system, making it less hospitable to the native assemblage of freshwater mussels, fish, invertebrates, and plants. Another aquatic species, the Rusty Crayfish (*Orconectes rusticus*), has been introduced from its native range in the midwestern US to many of Pennsylvania's watersheds. 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 keeps 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 on the young of these species. Rusty Crayfish have been found in much of the Juniata River watershed in Mifflin County.

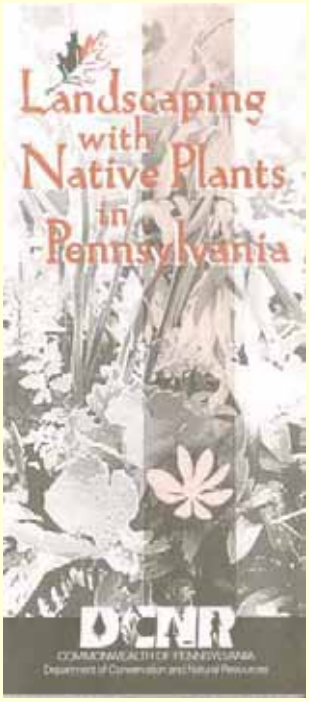
Overall Invasive Recommendations

Although Mifflin County has many sites that are free from non-native species, invasive species are an increasing threat to biodiversity harbored within Mifflin County. Successful control of invasive plant species is a time, labor, and resource-intensive process. Prevention or control during the early stages of invasion is the best strategy. In areas where invasive plants are well established, multiple control strategies and follow-up treatments may be necessary. 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:

- CNHI sites identified in this report can serve as useful high conservation value "focus areas" for the control of invasive species.
- Cooperative Weed Management Areas (CWMAs), once largely confined to the western states, are increasingly forming in the east. A CWMA is a partnership of landowners, including federal, state, and local government agencies, individuals, and various interested groups that work together to manage noxious weeds and invasive plants in a defined geographic area. An overview of CWMAs can be found online at: http://www.weedcenter.org/weed_mgmt_areas/wma_overview.html.
- It is far more cost effective to prevent invasive species introductions and to control introductions while they are still small, than to control invasive species populations after they have become established. Some nurseries in Pennsylvania now carry a selection of tree, shrub, and herbaceous species that are native to Pennsylvania, and these are recommended where plantings are necessary in, or adjacent to, natural areas. Additionally, when grown from local seed stock, these native plants are often hardier than non-native cultivars because they are already adapted to Pennsylvania's climate. The Vascular Flora of Pennsylvania (Rhoads and Klein 1993) is a helpful reference for determining whether a plant species is native to the state or not. Additional references include two PA Department of Conservation and Natural Resources

publications: *Invasive Plants in Pennsylvania* and *Landscaping with Native Plants in Pennsylvania* .



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

- Many education resources exist regarding invasive exotic species. Regional groups such as the Mid-Atlantic Exotic Pest Plant Council (MA-EPPC) can help with funding opportunities and educational outreach on invasive species. A membership brochure is available as a pdf file at: http://www.ma-eppc.org .
- Several excellent web sites 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, as well as an evaluation of possible control techniques:
  - Invasive Plant Tutorial http://intraforestry/invasivetutorial/index.htm
  - The Nature Conservancy's Weeds on the Web http://tncweeds.ucdavis.edu/
  - The Virginia Natural Heritage Program's invasive plant page http://www.dcr.state.va.us/dnh/invinfo.htm
  - The Missouri Department of Conservation's Missouri Vegetation Management Manual http://www.conservation.state.mo.us/nathis/exotic/vegman/
  - National invasive species information clearinghouse http://www.invasivespecies.gov/

Pennsylvania has a Noxious Weed law that prevents the propagation, sale, or transport of several weed species within the Commonwealth (Appendix I). This list includes several plants, such as Purple Loosestrife, Mile-a-minute, Canadian thistle and Multiflora rose, that are known to invade natural areas. 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 (PA Code 58.71.6). This list includes the Zebra Mussel and the Rusty Crayfish among others. (Appendix I)

After intensive removal of invasive species, restoration of natural habitats through replanting with native species is often needed. Nurseries 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 that can be routinely maintained. Control of invasive plants is critical to the long-term protection of Pennsylvania's natural areas and rare species.

Invasive Plant Species

Among the most aggressive introduced plant species in Pennsylvania include the following top offenders of natural areas. These species are not kept in check by natural predators and out-compete native species. Once established, they can be very difficult and time consuming to remove. Natural Heritage sites should be monitored regularly for pioneer populations of these species. Small populations, once encountered, should be eradicated to help ensure the continued viability of the sites. Photos: PA Department of Agriculture & PNHP

Garlic mustard (*Alliaria petiolata*)

Multiflora rose (*Rosa multiflora*)

Tree of Heaven (*Ailanthus altissima*)

Purple loosestrife (*Lythrum salicaria*)

Below: Edge habitat that has been invaded by aggressive species of plants including tree-of-heaven, Japanese honeysuckle, multiflora rose, and Oriental bittersweet becomes a snarled, poor quality forest.

Japanese Knotweed (*Polygonum cuspidatum*)

Japanese honeysuckle (*Lonicera japonica*)

.

.

A Review of Mifflin County's Animal Biodiversity

MAMMALS AND MAMMALIAN HABITATS IN MIFFLIN COUNTY

While the mountainous areas of Mifflin County are very important to the hunting economy of the county, the mixture of topography has created many types of habitats important to a large number of mammal species, some of which are very rare in the state or even endangered at the federal level. Future development along the Route 322 corridor and increased housing development due to the proximity of the county to State College could have significant impacts on these mammalian habitats in the very near future.

White-tailed Deer
photo source: Charlie Eichelberger

Hunting of White-tailed Deer (*Odocoileus virginianus*) remains one of the county's important non-agricultural industries. Three major state forests: Rothrock, Tuscarora and Bald Eagle, provide some of the best opportunities for success during the various deer seasons. Additionally, the mixture of forested and openland on State Game Lands (SGL) provides the hunter with both large and small game opportunities. In terms of harvest numbers, Mifflin County generally produces around 3,000 deer annually. The Black Bear (*Ursus americanus*) harvest showed a low of 10 in 1999 and a high of 37 during 2001. Most of this fluctuation is likely due to weather that can make the remote areas of the county hard to access. The number of bear sighted throughout the county continues to rise, increasing the chances of higher harvest numbers in the future. These two species will continue to contribute significantly to the economy of Mifflin County well into the future.

While deer and bear appear to be the most significant game mammal species within the county, other important mammal species occur in the county and are also important to local economies during the various hunting seasons. These include the Eastern Gray and Fox Squirrels (*Sciurus carolinensis, S. niger*), Eastern Cottontail Rabbit (*Sylvilagus floridanus*), and fur-bearer species, such as the Mink (*Mustela vison*), Red Fox (*Vulpes vulpes*), Gray Fox (*Urocyon cinereoargenteus*), Raccoon (*Procyon lotor*), Striped Skunk (*Mephitis mephitis*), and Coyote (*Canis latrans*).

Many of the species occurring throughout the county are well represented throughout Pennsylvania and possess abilities that ensure their survival in a wide range of habitat types. These species are termed "generalists" and include the Northern Short-tailed Shrew (*Blarina brevicauda*) and several other shrew and mole species, White-footed Mouse **(***Peromyscus leucopus***)** and several other rodent species, as well as Virginia Opossum (*Didelphis virginiana*) and the ubiquitous Eastern Chipmunk (*Tamias striatus*). All of these species occur throughout the many habitats within Mifflin County and are in no jeopardy of disappearing from the landscape.

White-footed Mouse
photo source: Dick Cooper

Other species have fairly restricted habitat needs and are termed "habitat specialists". They may be restricted to grassland- and meadow-type habitats, the forest interior, upper elevation ridgelines, wetlands, and streams or, during part of their life cycle, to specific habitats such as caves and mines. Examples of these species include the Meadow Vole (*Microtus pennsylvanicus*; grasslands and meadows), Allegheny Woodrat (*Neotoma magister*; upper elevation ridges), Muskrat (*Ondatra zibethicus*) and Beaver (*Castor canadensis*; wetlands and streams) and most, if not all, of the bat species (caves and mines).

Habitat availability is just one of a number of factors that determine whether a species of mammal is going to persist within certain areas. Food resources are an extremely important factor as reproductive females and dispersing individuals require consistent and substantial amounts in order to bear young, nurse and travel between nesting and foraging areas or to find new nest sites. Species such as the Allegheny Woodrat have most likely declined due to a possible lack of food resources; their primary foodstuff of historic times, the American chestnut (*Castanea dentata*), was lost to the chestnut blight during the early to mid-1900's. Forced now to rely on more ephemeral food resources like acorns and a diverse array of greens in the form of the leaves of many shrubs, they become energy-stressed during times when food resources become limited or food caches created during the fall decay in mild and damp winter periods. Competition for these resources with other, more numerous mammal species also reduces the survival chances for these populations, especially when they are isolated from others of their own kind. There are more than 20 active woodrat sites located along the Juniata – Mifflin County border. These ridges thus provide a substantial portion of the species' global habitat and connectivity between the populations should be maintained.

Allegheny Woodrat

photo source: John Hall

Wetlands and streams play a major role in providing habitat for mammals as well as serving as corridors for dispersal throughout the county. Whenever biologists research mammals, one of the first environs investigated are marshes, bogs and streams as they are often sites where the number of species of mammals, or diversity, is highest. It is not uncommon to find 6 species of shrews, 9-10 species of rodents, 4-5 species of weasels, 7-8 species of bats as well as sign of various medium-sized carnivores, squirrels, bear and deer along these habitats. One species found around small streams in northern Mifflin County is the Northern Water Shrew (*Sorex palustris albibarbis*), a species rarely observed in Pennsylvania. This species was once thought to be extremely rare but recent evidence seems to indicate that it is much more widespread in the northern tier counties of Pennsylvania than previously thought. One of the larger shrew species, the Northern Water Shrew swims and dives in pools along the smaller tributaries that empty into moderate to larger sized streams. The Northern Water Shrew depends on macroinvertebrates found in clean streams and wetlands and may serve in the future as an "indicator species", a species that may alert us to arising environmental problems such as acid mine drainage or acid rain. The southern limit of this species' distribution runs through Mifflin County in the Woodland/Milroy area along the streams of Stone and Front Mountains.

Northern Water Shrew

photo source: PNHP

.

Openland in the form of meadows and reverting grasslands are habitat types occasionally found along the valleys of Mifflin County. The most well known mammal occurring in these openlands is the Meadow Vole. The runways formed by this medium-sized rodent can be spotted under dense vegetation during the summer months and under the icy crust forming on snow during the winter months. Meadow Voles are so successful at dispersing throughout the county that they are sometimes found in grassy forest clearings within large tracts of forest having made their way there along the forest roads, pipelines, and power right-of-ways. Several other species of mammal are known to occur within openlands including the Eastern Cottontail Rabbit (*Sylvilagus floridanus*), Woodchuck (*Marmota monax*) and Red Fox.

Bats are a common component of the forests of Mifflin County, most often encountered during the summer months along the streams and open bodies of water that occur throughout the county. During the summer, rocky ridges may provide roost sites for the Eastern Small-footed Bat (*Myotis leibii*) as it raises its young. The Silver-haired Bat (*Lasionycteris noctivagans*), a rarely encountered bat species in Pennsylvania, may occur within Mifflin County during the early spring or late fall months as it migrates through the state on its way to and from its summer habitat in the northern portion of the United States and Canada. During the winter months, however, most bats disappear into the many caves and mines in Mifflin County for hibernation. Hibernating bat species such as the Little Brown Bat (*Myotis lucifugus*) and Big Brown Bat (*Eptesicus fuscus*) are common bats found throughout the caves of the county. The Indiana Bat (*Myotis sodalis*), a federally endangered bat species, has also been found overwintering in some of the caves in Mifflin County. Several species such as the Hoary Bat (*Lasiurus cinereus*) and Red Bat (*Lasiurus borealis*) don't overwinter in the state at all but migrate further south to states like the Carolinas and Florida. They are thought to spend their winter months in hibernation under deep patches of leaf and forest floor litter.

Indiana Bat

Photo source: John Chenger

Fisher

photo source: Massachusetts Dept Fisheries & Wildlife

Historically, several species have either disappeared from Mifflin County or their populations had become so low that they were thought to be gone from the county. Two of these species, the Fisher (*Martes pennanti***)** and the River Otter (*Lontra canadensis*) have been re-introduced by the Pennsylvania Game Commission in portions of their range in Pennsylvania where habitat necessary to their existence still occurs. These populations have expanded into other portions of the state and these species may occur in Mifflin County, although no known populations exist at present. It is likely that they will be spotted in the future by hunters and fishermen along the many watercourses throughout the county as well as interior portions of the existing forests. Sightings of both have been reported in recent years along the Juniata River in Mifflin County.

As outlined here, Mifflin County is very diverse in terms of the habitats available to the mammal fauna of Pennsylvania. In many portions of the state, most

habitats are fragmented and the ecosystems necessary for the survival of many species have become small, occupied blocks within a matrix of inhospitable habitat. 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 very localized populations. These isolated populations become limited in their ability to survive any major change in food resources, availability of nesting 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. Large blocks of forestland and vegetated stream and river corridors serve as avenues of dispersal to the diverse list of mammals noted to occur in the county. 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 for viewing the state's mammalian wildlife. This, in turn, will enhance the county's wealth as the ecotourist industry begins to flourish in Pennsylvania.

Important Mammal Areas in Mifflin County

The Important Mammal Areas Project (IMAP) is being carried out by a broad based alliance of sportsmen, conservation organizations, wildlife professionals, and scientists. Nominated sites are reviewed by IMAP personnel and local scientists, with final site selection managed by the Mammal Technical Committee of the Pennsylvania Biological Survey. The primary concern of the project is to help ensure the future of Pennsylvania's wild mammals, both game and non-game species. Precedence is given to sites with species of special concern but the project is also interested in habitats that have high mammalian diversity or those that offer exceptional educational value.

Mifflin County includes portions of three Important Mammal Areas (IMAs): Central Mountains; Blacklog Mountain; and 1000 Steps (Figure 2). These IMAs extend beyond Mifflin County, and features described below pertain to the entire IMA. Descriptions are adapted from Important Mammal Areas Assessment Reports, 2005.

Central Mountains IMA
This IMA includes a large area in central Pennsylvania, including a series of ridges between Nittany Mountain to the north and part of Shade Mountain to the south. Habitats vary from mature forests to old fields, and include seeps and wetlands of various types. Sections contain large expanses of unfragmented forest habitat, as well as virgin old growth (white pine, eastern hemlock, pitch pine). Located within the IMA are seven caves of great significance to mammals and groundwater. The area encompassed by this IMA is under continual assault from development in the valleys, as well as from road construction through higher elevations (e.g. I-99 corridor). Portions of the area are State Forest Lands (Bald Eagle, Tuscarora, Rothrock). Of the cave sites, some are protected or gated, while others are commercially exploited (Woodward Cave).

Blacklog Mountain IMA
This large IMA extends over five counties in central PA , with approximately 65% located in SGL 81 and SGL 107. It is bisected by SR 522 at Shade Gap. Dominated by deciduous forest, it includes coniferous and mixed woodlands, as well as some grasslands. Although this large site is home to an array of mammal species, its designation is due to the recognition that it represents a stronghold for Allegheny Woodrats. Populations at Blue Springs Cave and Lewistown Narrows have been monitored since 1986 and 1987, respectively. The multiplicity of public and private owners suggests that this long ridge is protected to some degree, but is likely to be under continual threat from development based in the surrounding valleys.

1000 Steps IMA
Located east of Huntingdon along SR 22, this IMA borders the Juniata River and represents a portion of SGL 112. Dominated by mixed woodlands, there are extensive rock outcroppings. A trail up the face of Jacks Mountain (the "1000 steps" formerly used by quarry workers) provides access to the area. A dense population of Allegheny Woodrat occupies the site, which provides ideal habitat for this species. Although the hiking trail is popular, human impacts are minimal, as the site is no longer quarried. Any plans to widen SR 22 would pose a critical threat.

.

Figure 2. Important Mammal Areas in Mifflin County

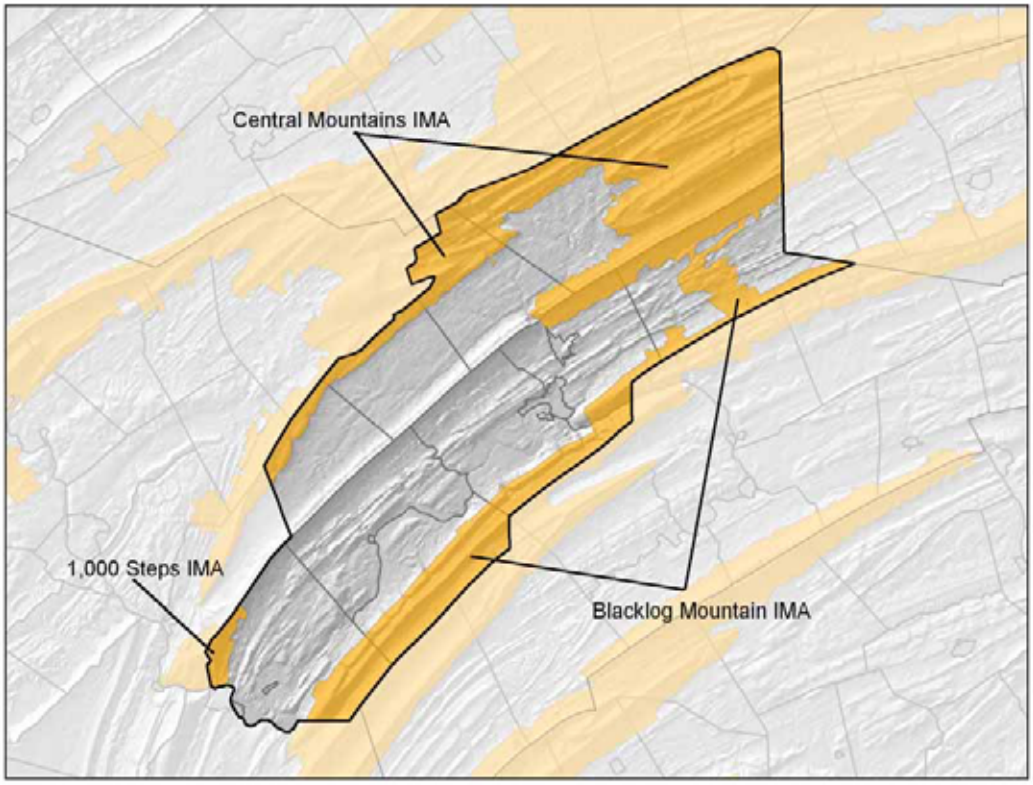
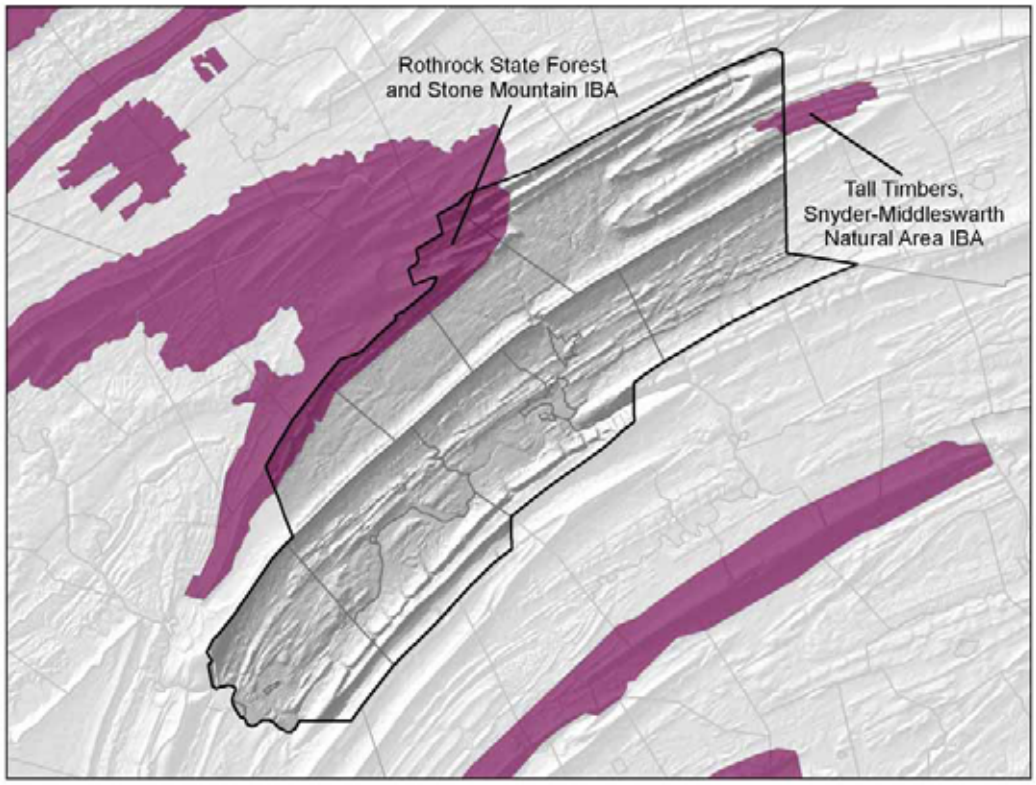


Figure 3. Important Bird Areas in Mifflin County



BIRDS OF MIFFLIN COUNTY

Pennsylvania is an important state for breeding, migrating, and wintering birds (Brauning 1992). Mifflin County, with its varied landscape, presents a wide range of habitats for birds. The habitat types include large, contiguous forest blocks, marsh and wetland areas, riparian corridors and floodplains, and the pastoral landscape. Several important habitat types for bird conservation are negatively affected by increasingly rapid land use change. Protection and responsible management of these ecosystems is necessary for the maintenance of healthy bird populations.

The Ridge and Valley province of Pennsylvania, in which Mifflin County resides, is a significant ornithological region as a result of the distinctive geology and topography. The forested ridges of the Allegheny Front rise 2,000 feet above sea level, providing habitat for northern bird species while the ridges drop into riverine valleys that southern species frequent. This region, part of the Appalachian flyway, is also an important area for migrating birds (Brauning 1992). On fall days observers often count thousands of migrating birds passing overhead. Protected natural areas such as the Snyder-Middleswarth Natural Area, state and national parks, forests, and nature preserves provide habitat for all wildlife including birds.

Forest Interior Species

Large contiguous tracts of forests, necessary for forest interior species, are declining in most regions. Forest interior, or core forest, is defined as contiguous forest that is 300 feet and greater from a road or edge (Whitcomb et al. 1981). This critical habitat is declining with seventy percent of Pennsylvania's core forest land found in patches of 5,000 acres or *less*; this indicates a highly fragmented landscape. As an example a square, unbroken 40-acre patch of forest contains only 12

Scarlet Tanager
photo source: Ron Austing

Cerulean Warbler
photo source: Ron Austing

Common Forest Interior Bird Species	
Broad-winged Hawk	*Buteo platypterus*
Black-throated Green Warbler	*Dendroica virens*
Pileated Woodpecker	*Dryocopus pileatus*
Acadian Flycatcher	*Empidonax virescens*
Black and White Warbler	*Mniotilta varia*
Scarlet Tanager	*Piranga olivacea*
Hairy Woodpecker	*Picoides villosus*
Ovenbird	*Seiurus aurocapillus*
Barred Owl	*Strix varia*
Partners In Flight (PIF) Priority Forest Interior Birds	
Olive-sided Flycatcher	*Contopus cooperi*
Cerulean Warbler	*Dendroica caerulea*
Worm-eating Warbler	*Helmitheros vermivorus*
Wood Thrush	*Hylocichla mustelina*
Kentucky Warbler	*Oporornis formosus*
Louisiana Waterthrush	*Seiurus motacilla*
Golden-winged Warbler	*Vermivora chrysoptera*
Canada Warbler	*Wilsonia canadensis*
Pennsylvania State Listed Forest Interior Specialist Birds	
Northern Goshawk	*Accipiter gentilis*
Northern Saw-whet Owl	*Aegolius acadicus*
Long-eared Owl	*Asio otus*
Swainson's Thrush	*Catharus ustulatus*
Yellow-bellied Flycatcher	*Empidonax flavescens*
Prothonotary Warbler	*Protonotaria citrea*

acres of forest interior while a similar 640-acre square contains 503 acres of interior. Fragmentation and smaller interior area negatively affects the nesting success of these bird species (Whitcomb et al. 1981). Increased forest edges, created by forest management practices such as logging and utility development, exposes nesting birds to greater dangers such as brood parasitism and nest predation (Robinson 1994). Forest 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 owner's expense.

The ridge top forests of the Ridge and Valley region retain the greatest amount of core forests in Mifflin County. Forest interiors have high bird diversity. These communities include a variety of warblers, tanagers, vireos, owls, woodpeckers, and hawks. Additionally, there is a high concentration of high-priority species in the Northern Ridge and Valley region, as identified by the multi-agency avian conservation program, Partners In Flight (PIF). In addition to conservation efforts for rare species, maintaining viable populations of common birds is increasingly important as formerly common forest interior species have shown a persistent population decline over time (Sauer et al. 2000).

To sustain viable populations, the forest structure must remain intact. The structural diversity of the forest, such as natural openings (not caused by tree removal or management) and complex vertical layering of trees provides more types of feeding, perching, and nesting habitats. Maintaining structural diversity is accomplished by maximizing the size of contiguous forest tracks, keeping larger forest patches closely grouped, harvesting around forest edges, and establishing corridors between contiguous blocks (Pashley et al. 2000).

Marsh, Wetland and Riparian Dependent Birds

Wetlands and riparian zones are an imperiled habitat across the state (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.

Wetlands are transitional lands between terrestrial and aquatic systems and have high species diversity

Common Wetland Dependent Birds in Mifflin County

Great Blue Heron	*Ardea herodias*
Red-winged Blackbird	*Agelaius phoeniceus*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*
Great Egret	*Ardea alba*
Red-shouldered Hawk	*Buteo lineatus*
PNHP bird species of special concern found in wetlands	
Osprey	*Pandion haliaetus*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*)
Virginia Rail	*Rallus limicola*
King Rail	*Rallus elegans*
Sora	*Porzana carolina*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Bald Eagle	*Haliaeetus leucocephalus*

Least Bittern

photo source: Ron Austing

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 bird species include waterfowl, shorebirds, herons, rails, bitterns, swallows, and sparrows. Many of these birds are secretive, cryptic, and hard to flush, making marshes difficult areas to survey. Many of 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 Eagles, prefer nesting on top of tall trees with a good view

of the surrounding land. The Red-shouldered Hawk (*Buteo lineatus*) forages and nests almost exclusively in wooded wetlands and along streams, a feature common in Mifflin County. Wading birds, such as Great Blue Herons, prefer clumps of dead, water-surrounded trees in which to place their rookeries.

Conservation and management programs for marsh birds are critical to sustain 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.

Grassland Birds

Grasslands, open fields, and old farm fields create a unique habitat for a variety of bird species of special concern. Historically, grasslands were not a dominant part of the northeastern United States landscape, but were present and extensive in some areas. Mifflin County would have had several grasslands present on certain ridge and hill tops along with many wet meadow grasslands. Although more grassland has been created in this historically forested area, a large number of grassland birds appear to be declining throughout the East as documented in the American Breeding Bird Survey (BBS). Most grassland birds, including common species, show a decline of around 40 to 60 percent (Sauer et al. 2000). Their decline has resulted from changes in agricultural practices, habitat fragmentation, pesticide application, natural fire suppression, and human development.

Eastern Meadowlark
photo source: Ron Austing

Grassland birds are often found in the rich valleys of Mifflin County with their mix of agricultural fields, pastures, old fields, and lands enrolled in conservation programs. These species include the Eastern Meadowlark (*Sturnella magna*), various sparrows including the Grasshopper and Savannah Sparrows (*Ammodramus savannarum* and *Passerculus sandwichensis*), Killdeer (*Charadrius vociferous*), American Kestrel (*Falco sparverius*), and swallows (family *Hirundinidae*). Though none of the following are known to breed in Mifflin County, it is important to note that there are a number of grassland bird species that are facing extirpation in the state; these include Northern Harrier (*Circus cyanus*), Dicksissel (*Spiza americana*), Upland Sandpiper (*Bartramia longicauda*), Short-eared Owl (*Asio flammeus*), and Loggerhead Shrike (*Lanius ludovicianus*).

A species of special concern found in Mifflin County's agricultural areas is the Barn Owl (*Tyto alba*). Historically nesting in large tree cavities and small caves, the Barn Own now nests almost exclusively in man-made structures such as old barns and silos. Hunting at night over open fields and wet meadows, the Barn Owl is rarely seen except by the lucky individuals who house them on their land. Specific threats to the Barn Owl include the development and conversion of open fields to row crops, demolition of old farm structures, and

Barn Owl
photo source: Jamie Zambo

vehicular collision during nocturnal hunting (Marti et al. 2005). For more information about the Barn Owl, see Appendix X.

Grassland maintenance is difficult due to the natural succession of forests, the timing of agricultural practices, and conflicting views of land managers. Programs like the Conservation Reserve Enhancement Program (CREP) through the US Department of Agriculture provide incentives to farmers to restore habitats to healthy conditions. Additional practices, such as restricting mowing fields until late July, can allow most young birds to fledge. For more information about incentive programs for grassland management, contact the Mifflin County Farm Service Agency in Mifflintown (717-436-8953).

Important Bird Areas in Mifflin 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 81 areas within the state that they consider 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 Mifflin County: the Tall Timber and Snyder-Middleswarth Natural Areas in the Bald Eagle State Forest and Rothrock State Forest and Stone Mountain (Figure 3). The IBAs extend beyond Mifflin County; therefore, features described below pertain to the entire IBA and are not necessarily confined to the county. The descriptions below are adapted from site reports provided by the Audubon Society of Pennsylvania. More information about the Important Bird Area Program can be found at Audubon PA's website (http://pa.audubon.org/).

Tall Timber and Snyder-Middleswarth Natural Areas
These two contiguous State Forest Natural Areas are in a deep valley drained by Swift Run. Snyder-Middleswarth is a virgin old-growth forest dominated by White Pine and Eastern Hemlock. Tall Timbers is a mixed forest of second-growth oak, White Pine, and Eastern Hemlock. A large diversity of bird species depend on this site as a stopover during spring migration, including high densities of thrushes and wood warblers. The old-growth conifer forest also provides significant habitat for forest interior birds such as Louisiana Waterthrush, Magnolia Warbler, Winter Wren, Brown Creeper, and Barred Owl in the breeding season.

Major threats to this area are forest insect pests, most notably the Hemlock Woolly Adelgid, which is threatening the hemlocks on the site. The site is protected as a State Forest Natural Area and will continue to benefit from management that allows natural succession to continue and buffers the site from invasive plant species.

Rothrock State Forest and Stone Mountain
This 51,000-hectare IBA includes Thickhead Wild Area and Alan Seeger Natural Area in the heart of Rothrock State Forest, as well as the Stone Mountain ridgeline. These areas contain some of the best remaining stands of old growth in Pennsylvania and large sections of unfragmented forest important for forest-interior bird species. Areas of old-growth and relic habitats such as the conifer bog at Bear Meadows Natural Area increase the diversity of the site, allowing greater numbers of bird species to inhabit the area. This site is of primary importance to area-sensitive, forest-interior bird species. Approximately 50 breeding bird species utilizing forest-interior habitat have been recorded breeding on the site. The Stone Mountain ridgeline, situated in the middle of the Eastern Flyway, is important for migrating raptors in autumn. In addition, the site provides habitat for songbirds during migration.

Several issues have been identified that may affect the quality of the IBA. These include: the invasion of exotic insects and plant species; decline of species diversity in a unique bog community; human use impacts and white-tailed deer overabundance. The IBA is largely protected as State Forest Natural and Wild Areas and will continue to benefit from management that allows natural succession to continue and buffers the site from invasive plant species.

REPTILES AND AMPHIBIANS IN MIFFLIN COUNTY

Pennsylvania's mixed landscapes create a great diversity of habitats for a wide range of reptile and amphibian species. Pennsylvania's reptile and amphibian makeup, known as the herpetofauna, is quite unique. 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 within the region. Today, the Commonwealth is home to 72 native herptile species, including those common 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 the coastal plain.

Common Snapping Turtle
photo source: Charlie Eichelberger

Mifflin County is home to many common, generalist species, such as the Eastern Garter Snake (*Thamnophis sirtalis*), the Red-spotted Newt (*Notophthalmus viridescens*), the Bull and Green Frogs (*Rana catesbeiana*, *R. clamitans*), 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, Mifflin County includes several less common species of reptiles and amphibians. Many of these species have restricted ranges or are considered specialists, meaning their life histories have more specific habitat requirements.

Much of Pennsylvania has succumbed to a large amount of habitat degradation, destruction, and fragmentation due to land development. However, a number of large forested tracts remain in Mifflin County, providing a good amount of contiguous habitat for the reptiles and amphibians of the state. The array of habitats within these large forested blocks serves both the generalist and specialist species.

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. The Red-backed, Slimy, and Valley and Ridge Salamanders (*Plethodon cinereus*, *P. glutinosis*, *and P. hoffmani*) are the most common woodland species throughout Mifflin County's forests.

The numerous woodland waterways and small mountain streams of Mifflin County provide habitat for the brook salamanders, including the Northern and Mountain Dusky Salamanders (*Desmognathus fuscus*, *D. ochrophaeus*), the Northern Two-lined and Long-tailed Salamanders (*Eurycea bislineata*, *E. longicauda*) and the Northern Spring Salamander (*Gyrinophilus porphyriticus*). In the cold-water drainages of the county, the brilliant Northern Red Salamander (*Pseudotriton ruber*) can be found under the litter and rocks in seeps and spring heads. All of the streamside salamanders require high water quality and forested stream edges.

Northern Green Frog
photo source: Charlie Eichelberger

The largest salamander on the continent, the Hellbender (*Cryptobranchus alleganiensis*), may still be found in the moderately sized creeks where

suitable habitat exists. Able to reach over two feet in length, this bizarre-looking harmless salamander is rarely seen, as it spends the majority of the time under large flat rocks in swift moving, high quality waters. Hellbender populations have been declining very rapidly due to decreases in water quality and introductions of aggressive non-native crayfish. Amphibians as a whole are particularly sensitive to toxins. Consequently, acid mine drainage is detrimental to the salamanders that inhabit affected streams. While there have been no directed Hellbender surveys in Mifflin County in recent years, reports of their continued presence in the Juniata drainage are few.

Portions of the county support complexes of Ephemeral/Fluctuating Natural Pools, more commonly known as vernal pools. These 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. The Wood Frog (*Rana sylvatica*), and the Jefferson, Marbled and Spotted Salamanders (*Ambystoma jeffersonianum*, *A. opacum*, and *A. maculatum*), all of which are vernal pool indicator species, are known from Mifflin County. These species rely on vernal pools for successful reproduction. Therefore, the health of these species' populations relies upon the integrity of vernal pools in the county.

Jefferson salamander migrating over snow to a vernal pool
photo source: Charlie Eichelberger

The Four-toed Salamander (*Hemidactylium scutatum*) is not a vernal pool obligate but is often found in association with these habitats. This diminutive salamander lays its eggs in peat mosses (*Sphagnum* spp.) and can be found in the margins of seeps, springs and streamsides where *Sphagnum* moss is found above cool, clear water. The Four-toed Salamander tends its clutch, which is laid in vertical mats of *Sphagnum* moss, until the young hatch. In addition to the Four-toed Salamander, many frogs and toads that are not vernal pool obligates can also be found using these habitats. The American Toad (*Bufo americanus*), Spring Peeper (*Pseudacris crucifer*), Grey Tree Frog (*Hyla versicolor*), and the Northern Cricket Frog (*Acris crepitans*) are regular visitors to vernal pools and may use these wetlands to breed and forage. Though the Northern Cricket Frog was once widespread across southeastern Pennsylvania, numbers have dropped off rapidly, and there are currently only two sites in the state where cricket frogs are still known to breed.

The Fowler's Toad (*Bufo fowleri*) is generally less common than the related American Toad, with the former typically inhabiting areas of sandy soils and the latter being far more general in its habitat requirements. The Upland Chorus Frog (*Pseudacris feriarum*) can be found using 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 for unknown reasons. Likewise, the Pickerel Frog (*Rana palustris*) and Northern Leopard Frog (*Rana pipiens*) require heavily vegetated streams and creeks. Once one of North America's most common species of frog, the Northern Leopard Frog has rapidly disappeared from much of its range for mysterious reasons. Many herpetologists are now concerned with the future of this species.

The Stinkpot Turtle (*Sternotherus odoratus*) inhabits most moderate-to-large wetlands, though it is infrequently encountered because of its secretive nature. The Map Turtle (*Graptemys geographica*) is common in the Juniata River. In Pennsylvania, this species is restricted to the larger tributaries of the

Four-toed Salamander tending her clutch of eggs
photo source: Charlie Eichelberger

Eastern Box Turtle
photo source: Charlie Eichelberger

Susquehanna River. The semi-aquatic Wood Turtle (*Glyptemys insculpta*) relies on wooded creeks and rivers, and can be locally common in areas. Riverine turtle nests are generally laid in suitable substrates along waterways. These sites are frequently used by many nesting females and are easily targeted by overpopulations of raccoons, skunks, and opossums. The Eastern Box Turtle (*Terrapene carolina*) is an easily recognized, generalist species found throughout the 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. 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.

The Northern Fence Lizard (*Sceloporus undulatus*), and the Five-lined Skink (*Eumeces fasciatus*) are the only lizard species known from Mifflin County. Both of these species occur in relatively small, isolated populations in dry habitats with an abundance of cover objects and basking areas. These habitats often include many sun-exposed rocks and dead woody debris. These species are particularly susceptible to localized extinction because of their populations' small sizes and isolation from other lizard populations.

The Northern Black Racer (*Coluber constrictor*) and the Black Rat Snake (*Elaphe allegheniensis*), two fairly common species in the state, can be found in many different habitats across the county. These two species prey upon small mammals including mice and squirrels. The brilliantly patterned Milk Snake (*Lampropeltis triangulum*) 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 Mifflin County. This species hunts along open waterways, searching for amphibians and small fish. The Eastern Hognose Snake (*Heterodon platirhinos*) is known from a few locales in the county. This harmless, toad-eating snake is known to flare its neck into a hood, and strike at predators while hissing loudly. If the performance doesn't work, this snake will feign death and roll on its back while becoming limp and gaping its mouth.

Black Rat Snake
photo source: Charlie Eichelberger

The Smooth Green Snake (*Liochlorophis vernalis*) is likely common in grassy areas but is difficult to locate because its camouflage allows it to virtually disappear into vegetation. Though this snake is rarely seen, the species is thought to be secure in the state. The Eastern Ribbon Snake (*Thamnophis sauritus*) depends on the sedge and grass covered edges of wetlands. This species is thought to be declining due to wetland destruction. Several small and secretive snake species in the county include the Red-bellied Snake (*Storeria occipitomaculata*), the Northern Brown Snake (*Storeria dekayi*), the Ring-necked Snake (*Diadophis punctatus*), and the Eastern Worm Snake (*Carphophis amoenus*). With the exception of the Worm Snake, these species are fairly common residents and can be found beneath rocks and decaying wood and bark. Worm Snakes are exclusively fossorial, meaning they spend their lives underground. Consequently, little is known about the Worm Snake in Pennsylvania.

The Timber Rattlesnake (*Crotalus horridus*) and Northern Copperhead (*Agkistrodon contortrix*) have

black and yellow color phases of the Timber Rattlesnake
photo source: Charlie Eichelberger

long been persecuted due to their venomous nature. Although these snakes may deliver a serious bite if threatened, the danger they pose has been drastically over-exaggerated. In fact, there has never been a documented human fatality in Pennsylvania from a Rattlesnake or Copperhead bite. The forested ridges of Mifflin County provide wonderful habitat for these species and there are records of both of these species in the county. Rattlesnakes and Copperheads are able to use a wide range of habitats and may be encountered throughout the forested regions of the county. Rattlesnakes primarily occur on rocky slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Copperheads can be found from mountaintops to valley floors in dry settings as well as wetland edges. Both species forage in a variety of habitats, but favor forested areas with healthy small mammal populations. Hibernacula, or dens, often are found under canopy cover but are usually located within several hundred meters of an open basking site. Persistence of these sites relies on forestry practices that maintain a diversity of open areas adjacent to forested foraging habitat.

Timber Rattlesnakes are still considered a game species by the Pennsylvania Fish and Boat Commission (PFBC) and can be collected with an appropriate PFBC permit. Despite the allowance of rattlesnake hunting, the Timber Rattlesnake is considered a species of special concern because it is declining from human persecution. The American Society of Ichthyologists and Herpetologists (2006) has stated that rattlesnake roundups and hunts cannot co-exist with rattlesnake conservation and should be ended if we are to maintain Timber Rattlesnake populations in the Commonwealth. Timber Rattlesnakes are a protected species in every surrounding state where the snake occurs and are considered during environmental review in Pennsylvania. The wooded habitats along the ridges of Mifflin County provide a tempting location for housing development; however, housing locations at these sites are not recommended based on the risk of human-snake encounters.

Mifflin County is a significant spot in the state for the Commonwealth's reptiles and amphibians. The large, unfragmented forested tracts with numerous waterways provide critical habitat for the reptiles and amphibians. Of utmost importance to the conservation of the county's herpetofauna is the protection of the region's forests and wetlands, including the communities of seasonal pools. The rich and diverse herpetofauna of Mifflin County is unique to Pennsylvania and should be considered in the long-term plan of the region.

This text has been created by examining the range maps for Pennsylvania herptile species and examining records found in museums, databases, and various monographs. While this information has been based on decades of scientific research and inventories, the secretive nature of herptiles make them difficult to survey. Therefore, there could be other herptile species that occur in the county that have not yet been recorded.

PA Fish and Boat Commission Regulations
In Pennsylvania, the PFBC has jurisdiction over the reptiles and amphibians. Recently, regulations concerning the herptiles were revised, with considerable changes in 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 PFBC website at sites.state.pa.us/PA_Exec/Fish_Boat/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.

DRAGONFLIES AND DAMSELFLIES: THE ODONATES

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 Habitats

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.

A damselfly

photo source: PNHP

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 5-15 molts 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 (Westfall and May 1996).

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 now feed on the emerged adults of the community of insects with whom they shared an underwater life as larvae. They also add to their diet additional insects they encounter for the first time as adults, such as butterflies.

A dragonfly

photo source: PNHP

Adult odonates are closely associated with the larval habitat during mating and subsequent oviposition when 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 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 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

.

An adult dragonfly, newly emerged from its nymphal exoskeleton
photo source: PNHP

that strengthens populations by diversifying the gene pool.

Species Diversity 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, we currently have 121 species of dragonflies and 55 species of damselflies (PNHP, 2006). Several of these species are tracked as rare in the state because of their sensitivity to habitat loss or poor water quality in wetlands and rivers. For a list of species of odonates documented in Mifflin County, see Appendix II.

Families of Damselflies (Order Odonata, Suborder Zygoptera) in Pennsylvania:
Calopterygidae – Broad-winged Damselflies
Coenagrionidae – Pond Damsels
Lestidae - Spreadwings

Families of Dragonflies (Order Odonata, Suborder Anisoptera) in Pennsylvania:
Aeshnidae - Darners
Cordulegastridae - Spiketails
Corduliidae - Emeralds
Gomphidae - Clubtails
Libellulidae - Skimmers
Macromiidae - Cruisers
Petaluridae – Petaltails

BUTTERFLIES AND MOTHS: THE LEPIDOPTERA

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.

American Copper
Photo source: PNHP

Life History And Habitats
The Lepidoptera cycle of life starts with an egg laid on a specific plant called a host 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 (instars), typically 4-6, 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 occurs. After a period of time that varies from species to species, climate, and location, 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.

Butterfly eggs hatching on the leaf of a foodplant
Photo source: PNHP

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. Additionally, some moth adults lose their mouthparts and do not feed as adults. 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

Common Least Skipper (*Ancyloxypha numitor*)
photo source: Sally Ray

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 species of Lepidoptera (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 (Wright 2007; Appendix II), as well as an unmeasured number of species of moths. No state agency is directly responsible for managing Lepidoptera, and scientists suspect the population trends for many species are headed down. This group is understudied, but the PNHP tracks several species of butterflies, skippers, and moths as rare in Pennsylvania and targets them in surveys during the county inventory projects. For a list of Lepidoptera found in Mifflin County surveys, see Appendix II.

CONSERVATION RECOMMENDATIONS FOR INSECTS

The specific habitat requirements of many odonates and Lepidoptera and other 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 foodplants. 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.

Great Spangled Fritillaries nectaring on milkweed.
Photo source: PNHP

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 homes 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 this still affects predators such as fish and insects, which experience a decrease in food availability when their formerly abundant prey items are eliminated.

Indirect effects of pest control can also severely reduce populations of lepidoptera. These species are vulnerable to changes in the distribution and abundance of the foodplants. 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. Applications of insecticides can have non-target effects as well. 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. 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.

photo source: PNHP

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.

AQUATIC COMMUNITY CLASSIFICATION

A statewide project of the PA 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 (Walsh et al. 2007a, 2007b). The most common community type per watershed was chosen to represent typical watershed organisms and habitats (Table 5). Although other community types may exist in a particular watershed, the major community type is described.

What is an aquatic community?
An aquatic community represents a group of organisms that occur together in a particular habitat. The organisms require similar habitat features, may be dependent on each other for food or other resources, and/or may be dependent on similar processes in their environment.

The aquatic communities in this report refer to three types of organisms: fish, macroinvertebrates, and mussels. Aquatic communities for each type of organism can be used to describe the aquatic resources, habitat types, and stream quality.

Where do aquatic communities occur?
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 are identified within watersheds (Table 5). The term watershed describes an area of land that drains down slope to the lowest point. 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 on downstream, eventually reaching an estuary and the ocean. 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 this report, relatively small watersheds (hydrologic unit code 12 – huc12) are described by their community types. (For more information on huc 12: http://water.usgs.gov/GIS/huc.html)

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. For example, sediment from erosion at mismanaged construction site near a stream may cover gravel and cobble habitats where brook trout lay the eggs. Developing fish will be smothered by layers of fine particles.

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 and aquatic communities reflect their environment. 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 discharges from sewage treatment plants, mines, and industrial sources.

Table 5. Pennsylvania aquatic life uses, special protection water designations and their occurrence with fish assemblages.

(EV = Exceptional Value Waters, HQ = High Quality waters, CWF= Cold Water Fishes, WWF= Warm Water Fishes, TSF= Trout Stocked Fishes, MF= Migratory Fishes)

Increasing watershed area	Aquatic Community Classification-Fish	EV	HQ	CWF	WWF	TSF	MF
	Coldwater	x	x	x			
	Coolwater 1, Coolwater 2		x	x	x	x	x
	Warmwater 1, Warmwater 2			x	x	x	x
	River & Impoundment				x		x

How does this Classification relate to the DEP stream designations?

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. The similar nomenclature of both classifications may be confusing, but 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 PA stream designations broadly encompass habitats occupied by several Aquatic Community Classification fish assemblages and are used in water quality regulation (Table 4).

How are communities described?

Fact sheets are provided for each Aquatic Community classified in Mifflin County. The fish and macroinvertebrate communities are named by descriptive community habitat names and mussel communities are named by the commonly occurring animals in the community type. Other organisms that may be found in the community are also 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.

1) Community Description and Habitat - the environment of the stream where the community occurs is described by watershed and stream characteristics. Average values of the community characteristics across their entire range from a large dataset are presented, including size of the stream and watershed, gradient (slope), and elevation. Local conditions are also mentioned. Some water chemistry variables are also valuable in understanding the conditions of the community, including:

- pH – is the measure of the concentration of hydrogen ions in a solution. The concentration of hydrogen ions determines the alkalinity (pH > 7) or acidity (pH < 7) of stream water.

- Water temperature - is important to stream organisms because it influences metabolism and growth of stream organisms. Each aquatic animal species has a tolerance for specific temperature ranges and cannot survive at extremely high or low temperatures.

- Conductivity – is defined as the ability of water to conduct an electrical current. It is expressed in microsiemens (µS) per centimeter at 25 °C. Conductivity is determined by the types and quantity of dissolved substances in water. In streams, conductivity can be elevated because of pollution or natural causes.

- Alkalinity – is a measure of how well a waterbody resists or does not resist changes in acidity. If a stream has high alkalinity and can neutralize acids sufficiently, then it is subject to little change in pH. A low alkalinity stream is less resistant to changes in acidity and may be naturally acidic or may become acidic due to acid precipitation or other causes.

2) Stream quality rating- Communities locations are generally ranked as low, medium, or high quality based on habitat, water chemistry, and sensitivity of organisms to pollution.

3) Threats and Disturbances - potential pollution sources or other threats that may alter the natural state of the community are listed, where known.

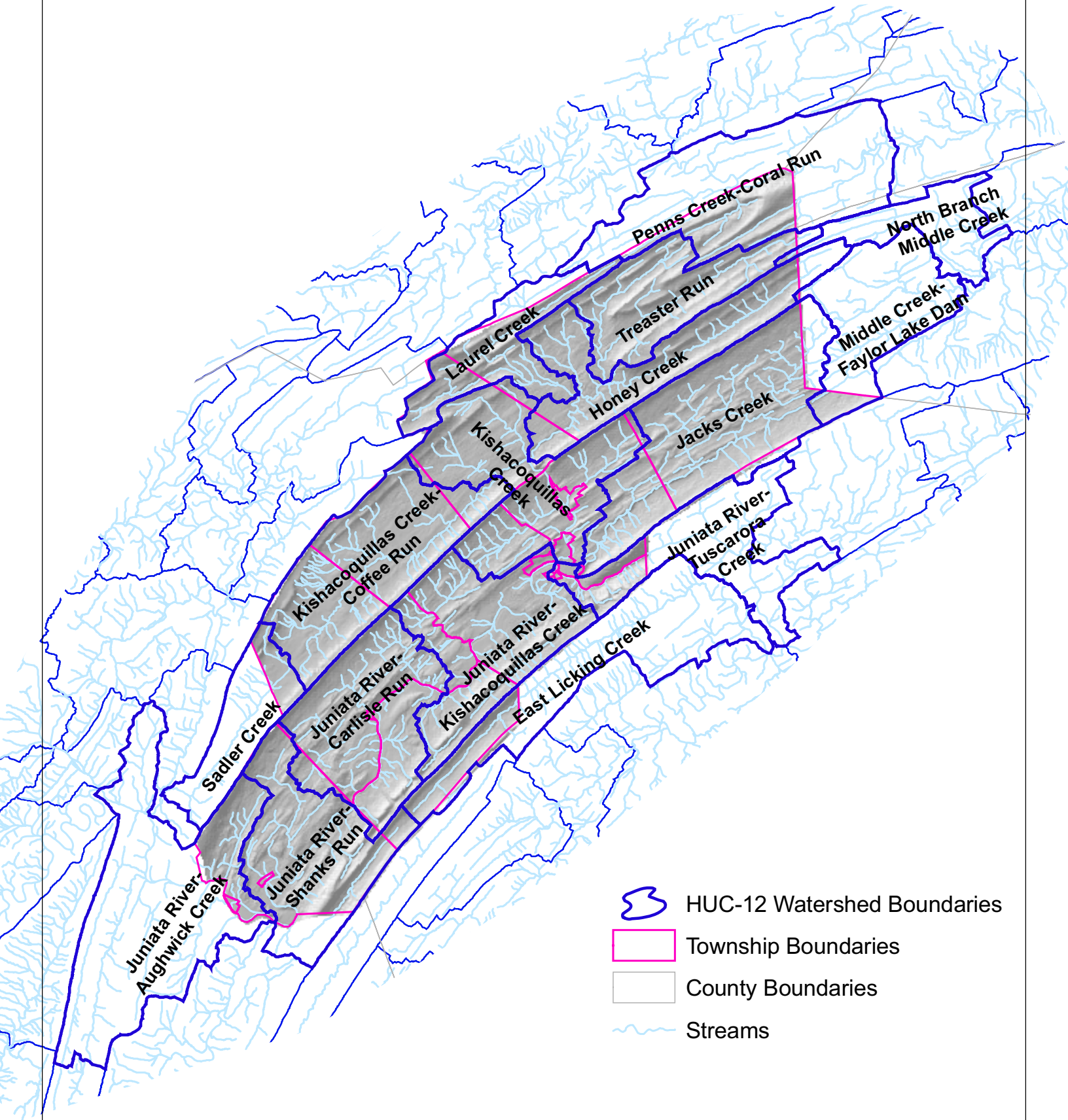
4) Conservation recommendations – for the county natural resource managers and land planners to consider in protection and management of the watersheds and communities are described.

Table 6. Hydrologic unit code 12 (HUC12) watersheds in Mifflin County and the results of the Aquatic Community Classification Project for fish, macroinvertebrate, and mussel community types identified within each. Fact sheets describing each community type can be found on the following pages.

Watershed Name	Stocked Trout Present*	Fish Community	Macroinvertebrate Community	Mussel Community
East Licking Creek	Y	Atlantic River and Impoundment Community	High Quality Small Stream Community	Eastern Elliptio Community
Honey Creek	Y	Coolwater Community 2	not assessed	not assessed
Jack's Creek	Y	Warmwater Community 1	Low Gradient Valley Stream Community	not assessed
Juniata River—Aughwick Creek	Y	Warmwater Community 1	High Quality Small Stream Community	not assessed
Juniata River—Carlisle Run	Y	Warmwater Community 1	High Quality Small Stream Community	not assessed
Juniata River—Kishacoquillas Creek	Y	Coolwater Community 1	High Quality Small Stream Community	Eastern Elliptio Community
Juniata River—Shanks Run	Y	Coldwater Community	not assessed	Eastern Elliptio Community
Juniata River—Tuscarora Creek	Y	Atlantic River and Impoundment Community	High Quality Small Stream Community	Yellow Lampmussel Community
Kishacoquillas Creek	Y	Warmwater Community 1	High Quality Small Stream Community	not assessed
Kishacoquillas Creek—Coffee Run	Y	Warmwater Community 1	Low Gradient Valley Stream Community	not assessed
Laurel Creek	Y	Coldwater Community	Common Large Stream Community	not assessed
Middle Creek – Faylor Lake Dam	Y	Warmwater Community 1	not assessed	not assessed
North Branch Middle Creek	Y	Warmwater Community 2	not assessed	not assessed
Penn's Creek – Coral Run	Y	Coldwater Community	not assessed	not assessed
Sadler Creek	Y	Coolwater Community 2	not assessed	not assessed
Treaster Run	Y	Coolwater Community 1	not assessed	not assessed

* Surveys by the Pennsylvania Fish and Boat Commission found one or more fish (trout or warmwater gamefish) present of hatchery origin. This suggests that this watershed or a nearby watershed is stocked. While prized by anglers, the introduction of non-native fish species disrupts the natural balance of the aquatic community and can overall decrease the quality of the waterway.

Figure 4. Watersheds of Mifflin County (hydrologic unit code 12 – huc12)



Atlantic Coldwater Community

typified by: Brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*)

Community Description and Habitat This headwater stream community occurs in small swift streams running off ridges. Water temperatures are the coldest among the fish communities. The Coldwater Community represents small, swift streams with brook trout and slightly larger streams with both brook trout and brown trout or with brown trout only. The Coldwater Community occurs in West Licking Creek (Juniata River-Shanks Run huc), Laurel Creek (Laurel Creek huc), Lingle Creek (Laurel Creek huc), and Weikert Run (Penn's Creek – Coral Run huc) and is commonly found in streams designated as High Quality (HQ) and Cold Water Fishery (CWF) by PA DEP.

Brook Trout
photo source: http://www.cnr.vt.edu/efish

The small streams that support the Coldwater Community tend to have fewer disturbances than larger waters flowing through valleys. These systems often flow from sandstone or shale ridges and have a unique water chemistry signature with few dissolved cations and low buffering capacity.

Average Water Chemistry		
alkalinity	-	27 mg/l
conductivity	-	140 µS/cm
pH	-	6.7
H_20 temp.	-	cold

A natural landscape often surrounds the streams where the Coldwater Community is found and supports the stream habitat. Forested riparian buffers and watersheds preserve the cold and well oxygenated waters and maintain high quality stream habitats and water quality. Natural cover, like logs and woody debris from the forest, and loose gravels required for spawning habitat should be abundant to support the fish community. Forage fish and invertebrates serve as a food supply for the brook and brown trout.

Stream quality rating: High

Threats and Disturbances: Streams may be acidic from two major pollution sources: coal mining and acid deposition. Mining may occur near Coldwater Community, but is not common in Mifflin County. Acidic precipitation that falls on these watersheds can leach away the watershed's natural acid buffering capacity. Acid precipitation eventually reduces stream pH values to stressfully low levels for aquatic organisms. Some headwater streams flowing from ridges in Mifflin County are relatively acidic, due to natural and human influenced conditions, and may threaten the Coldwater Community habitat.

Conservation Recommendations: Addressing water pollution from acidic sources is critical for headwater, cold-water streams. One instance of an acidic stream is the headwaters of Laurel Creek, which was listed as "Impaired" by PA DEP due to poor water quality from acid deposition.

Streams in these watersheds may have wild-reproducing populations of brook and brown trout and may be a fishery resource. Because cold, headwater streams often occur in terrain unsuitable for most types of human developments, they are not usually subject to the same types of water pollution issues as valley streams.

Small, high gradient streams with forested watersheds are typical of the Atlantic Coldwater Community habitat.
photo source: PNHP

Trout streams in Pennsylvania are highly valued by fisherman, but have been greatly altered by the transplantation of European brown trout and rainbow trout from western North America. Habitats for native brook trout have been restricted by competition with other trout species.

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 streams high in the watershed, but may also be found in valley streams. In contrast to the Coldwater Community, 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 to a lesser extent by human settlements.

Fathead Minnow
photo source: http://www.cnr.vt.edu/efish

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. Examples of the Coolwater Community 1 habitats are the lower reaches of Strodes Run (Juniata-Kishacoquillas Creek huc) and lower reaches of Treaster Run (Treaster Run huc).

Average Water Chemistry		
alkalinity	-	54 mg/l
conductivity	-	225 µS/cm
pH	-	7.0
H_20 temp.	-	cool

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 is pollution from poorly managed agricultural areas. 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. Both the Juniata-Kishacoquillas Creek huc and Treaster Run huc have agriculture in the valley lowlands that may negatively influence water quality and habitat if not properly managed. Some streams in the Treaster Run huc were listed as "Impaired" by DEP as a result of siltation.

Medium size streams are typical of Cool water Community 1.
photo source: PNHP

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.

Atlantic Coolwater Community 2

typified by: Blacknose dace (*Rhinichthys atratulus*), white sucker (*Cato-stomus 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 Honey Creek (Honey Creek huc) and Sadler Creek (Sadler Creek huc).

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 Cold Water Fishery streams, like in Sadler Creek. Some species like the blacknose dace and white sucker are also found with brown trout. Some Cold Water Fishery streams may also be seasonally warm and can still support relatively tolerant brown trout, in some locations.

Blacknose Dace
photo source: http://www.ohiodnr.com/dnap

Stream quality rating: Low

Threats and Disturbances: Poorly managed agriculture is the most pressing threat to Atlantic Coolwater Community 2. Excess siltation and nutrients contributed from crop fields and livestock grazing lead to degraded stream conditions. In the Honey Creek huc and Sadler Creek huc, streams are designated as "Impaired" by PA DEP due to excessive nutrients and siltation from crop agriculture and livestock grazing.

Average Water Chemistry		
alkalinity	-	55.6 mg/l
conductivity	-	213 µS/cm
pH	-	7.2
H_20 temp.	-	cool

Point sources from industry and municipal sources, like sewage treatment plants, may also occur in watersheds supporting the Atlantic Coolwater Community 2.

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 runoff from crops and livestock pastures will reduce sedimentation and nutrient loading. Upgrades or enhancements in treatment systems for hazardous effluents from industrial and municipal point sources can vastly improve water quality.

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.
photo source: PNHP

Atlantic Warmwater Community 1

typified by: Central stoneroller (*Campostoma anomalum*), northern hogsucker (*Hypentelium nigricans*), river chub (*Nocomis micropogon*), longnose dace (*Rhinichthys cataractae*), cutlips minnow (*Exoglossum maxilingua*), mottled sculpin (*Cottus bairdii*), margined madtom (*Noturus insignis*), creek chub (*Semotilus atromaculatus*), rosyface shiner (*Notropis rubellus*), fantail darter (*Etheostoma fabellare*), greenside darter (*Etheostoma blenniodes*)

Community Description and Habitat: The Atlantic Warmwater Community 1 usually occurs in small to medium size watersheds) in valley streams. Streams have warmer waters and are slower moving than headwater, high gradient streams.

Northern Hogsucker
photo Source: http://www.ohiodnr.com/dnap

Thermal tolerances of fish in the community group are higher than fish from the cold and cool-water communities. Habitat preferences of indicator taxa suggest this community occurs in warm-water streams with moderate to high gradients and currents and little silt.

The habitats for Warmwater Community 1 are typically associated with some human disturbance in the surrounding landscape. Agriculture and other valley land uses likely occur in the watershed with Warmwater 1 Communities. Many larger streams in the valleys of Mifflin County are classified as Warmwater 1 Community habitats. Large and small tributaries to the Juniata River are likely to have Warmwater 1 Communities, like Jack's Creek (Jack's Creek huc), Hares Valley Creek (Juniata River-Aughwick Creek huc), Musser Run (Juniata River-Carlisle Run huc), and Kishacoquillas Creek (in the Kishacoquillas Creek huc and the Kishacoquillas Creek-Coffee Run huc). The fish assemblages, in reaches flowing into the Juniata River, have many overlapping fish species with the warm-waters of the Juniata. Some valley streams with Warmwater 1 Communities may also be classified by PA DEP as Cold Water Fisheries or Trout Stocked Fisheries. Seasonally warm valley streams may have stocked or wild brown trout during some periods, but are primarily characterized by fish preferring warmer temperatures.

Average Water Chemistry		
alkalinity	-	50 mg/l
conductivity	-	175 µS/cm
pH	-	7.2
H_20 temp.	-	warm

Stream quality rating: Medium

Threats and Disturbances: Water quality and habitat may be influenced by non-point source pollution from agriculture and urban land uses. Poorly managed agriculture can be a threat to this community. Nutrient enrichment and excess sedimentation of streams from mismanaged agricultural practices impair many streams in watersheds with this community type. In several watersheds with Warmwater 1 Communities, aquatic life is designated as "Impaired" by PA DEP due to excess nutrients and siltation from agricultural (e.g., streams in the Kishacoquillas Creek- Coffee Run huc, Kishacoquillas Creek huc, and the Juniata River- Carlisle Run huc).

Conservation Recommendations: This community is a high conservation priority. Warmwater streams in good condition are not common. The fish associates of this community type are not especially rare individually; however, the community group occupies habitats in need of restoration in Pennsylvania.

Since warmwater streams mainly occur in valleys downstream of human influences, they are often subject to pollution from non-point sources, such as agriculture and urban runoff. Storm water management, restoration of riparian buffer zones, and exclusion of livestock from streams are some mitigation techniques for non-point source pollution.

Medium-sized streams without many groundwater inputs are typical of Atlantic Warmwater Community 1 streams. Stream sequences of pools (slow-moving habitats), riffles (swift current habitats), and runs (intermediate current habitats) provide a variety of habitats and support warmwater fish communities.
photo source: PNHP

Atlantic Warmwater Community 2

typified by: Redbreast sunfish (*Lepomis auritus*), rock bass (*Ambloplites rupestris*), spotfin shiner (*Cyprinella spiloptera*), smallmouth bass (*Micropterus dolomieu*), spottail shiner (*Notropis hudsonius*), common shiner (*Luxilus cornutus*), tessellated darter (*Etheostoma olmstedi*), pumpkinseed (*Lepomis gibbosus*), bluntnose minnow (*Pimephales notatus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), satinfin shiner (*Cyprinella analostana*), swallowtail shiner (*Notropis procne*), shield darter (*Percina peltata*), American eel (*Anguilla rostrata*), largemouth bass (*Micropterus salmoides*), common carp (*Cyprinus carpio*)

Community Description and Habitat: The Atlantic Warmwater Community 2 is found in many larger waterways. The common habitat for the Warmwater 2 Community is low-gradient, medium-to-large sized valley streams. Some examples of Warmwater Community 2 habitat are in the North Branch Middle Creek huc, like Middle Creek and the South Branch of Middle Creek. Stream communities in the huc are likely influenced by assemblages in local impoundments, like Faylor Lake.

Community fish prefer pools in warm streams, ponds, and impoundments. Some indicator fish are tolerant of low dissolved oxygen or turbid waters. Many community fish are habitat generalists. The community group also includes game fish, like smallmouth bass and bluegill, which were stocked in many locations and have since become naturalized.

Redbreast Sunfish
photo source: http://www.ohiodnr.com/dnap

Stream quality rating: Medium

Average Water Chemistry		
alkalinity	-	47 mg/l
conductivity	-	237 µS/cm
pH	-	neutral
H_20 temp.	-	warm

Threats and Disturbances: Non-point source pollution is a threat for Atlantic Warmwater Community 2. Much of the watershed is in agricultural land cover where this community group occurs. Threats to this community group are similar to the Warmwater Community 1.

Many fish in the community were not originally present in the Susquehanna River watersheds that cover the eastern and central regions on Pennsylvania. For instance, rock bass and smallmouth bass have been transplanted into the Susquehanna River basin.

This community occurs in large streams and rivers with warmwaters. A variety of habitats supports a diverse fish community.
Photo source: PNHP

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. Management of combined sewer overflows, residential and road runoff, and stream habitat improvements in urban streams would improve community quality. Alternatively, the restoration of riparian buffer zones and exclusion of livestock from streams are some mitigation techniques to control non-point source pollution in agricultural streams.

Atlantic River and Impoundment Community

typified by: Walleye (*Stizostedion vitreus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), goldfish (*Carassius auratus*)

Yellow Perch
Photo Source: http://www.cnr.vt.edu/ef

Community Description and Habitat: : The River and Impoundment Community habitat is relatively low gradient large streams and rivers and their tributaries in Pennsylvania's river valleys. Dam impoundments along rivers create deep pools with soft-sediment stream bottoms that are tolerated by this community. The community fish prefer the large stream and rivers that are warm, relative to other waters, and provide a variety of habitats. The Juniata River (Juniata River-Tuscarora Creek huc) and parts of the Juniata River tributary, East Licking Creek (East Licking Creek huc) are classified as the River and Impoundment Community. Fish from the Juniata River assemblage may also find habitat in the smaller tributaries, like East Licking Creek. Agricultural valleys surround the Juniata River, as often occurs with the waters where the River and Impoundment Community is found. Residential communities and roads are also common in valleys surrounding large rivers.

Average Water Chemistry		
alkalinity	-	60 mg/l
conductivity	-	256 µS/cm
pH	-	7.4
H_20 temp.	-	18.6°C

Stream quality rating: Medium

Threats and Disturbances: Large streams and rivers, downstream of many human settlements, are subject to many types of pollution. Large rivers receive effluents from industrial, sewage treatment plants, and storm water overflow sources. Non-point source pollution from agricultural contributes excessive silt and nutrients to the rivers. In urban areas, runoff from impervious surfaces reaches the rivers and carrying along road contaminants. Lastly, the presence of dams on the Susquehanna River fundamentally alters the river habitat and change natural flow patterns.

In watersheds where the River and Impoundment Community occurs streams are degraded by agriculture. Streams in the Juniata River-Tuscarora Creek huc and East Licking Creek huc are classified as "Impaired" by PA DEP for excessive nutrients and siltation from agricultural sources.

This community is primarily composed of fish that are not native to the Susquehanna River watershed. Walleye, black crappie, and goldfish are introduced species to the Atlantic basins in eastern and central Pennsylvania. Many game fish, like walleye and yellow perch, have been introduced and may be actively stocked around Pennsylvania. Fish may have naturalized in many locations.

Conservation Recommendations: Large stream and river habitats in good quality condition are rare. Most large rivers have flood-control, navigational, or recreational dams. Special consideration to dam removal where possible because they alter river ecosystem functions, like stream flows, habitats, and connectivity. Damming of rivers has many wide-reaching ecological effects, including disruption of migration and dispersal of aquatic species.

The potential sources of pollution to the large stream and river habitats are many, but solutions to pollution problems are possible by treating non-point and point source pollution in the contributing watershed. In Mifflin County, addressing runoff from roads and agriculture is important to the health of the River and Impoundment Community. Re-vegetation of stream banks and restoration of in-stream habitats along the Juniata River and its tributaries will help to restore conditions for the River and Impoundment Community. Mitigating runoff from crops and livestock pastures will reduce sedimentation and nutrient loading.

Rivers, like the Susquehanna River, and impoundments are common habitats of this community type. Photo source: PNHP

High Quality Small Stream Community

typified by: Brushlegged mayfly (Isonychiidae), fingernet caddisfly (Philopotam-idae), dobsonfly (Corydalidae), saddlecase maker (Glossosomatidae), watersnipe fly (Ather-icidae), common burrower (Ephemeridae), snail-case maker caddisfly (Helicopsychidae)

Community Description and Habitat: This community is found in small streams that are fast flowing. The watershed surrounding the community has much natural land cover, but may also have substantial agriculture.

Brushlegged Mayfly
photo source: www.dec.state.ny.us

The High Quality Small Stream Community is typically found in streams with mainly sandy bottoms, mixed with larger cobble and boulders. This community type is indicative of high quality streams. The organisms associated with this community are generally intolerant of pollution. There are many examples of the High Quality Small Stream Community habitats in the sloped, fast streams in Mifflin County. Markee Creek (East Licking Creek huc), Smith Creek (Juniata River-Aughwick Creek huc), Wakefield Run (Juniata River- Carlisle Run huc), headwaters of Strokes Run (Juniata River-Kishacoquillas Creek huc), Horning Run (Juniata River-Tuscarora Creek huc), and the headwaters of Kishacoquillas Creek (Kishacoquillas Creek huc).

Stream quality rating: High

Average Water Chemistry		
alkalinity	-	53 mg/l
conductivity	-	203 µS/cm
pH	-	neutral

Threats and Disturbances: Organisms in this community type are sensitive to organic pollution and habitat degradation. Low levels of water quality degradation may occur in watersheds where the community is present.

This community occurs in watersheds with moderate amounts of agricultural land cover, which may alter the in-stream habitat. Impairments resulting from poorly buffered agricultural land may include excess nutrient and sediment input from cropland or livestock pastures. In some locations, municipal point sources (e.g. sewage treatment plants and urban runoff) may affect water quality.

Typical community habitats are small to medium-sized streams with diverse stream-bottom habitats and high water quality. photo source: PNHP

Conservation Recommendations: : Inputs of silt and nutrients from agricultural sources in some watersheds where the High Quality Small Stream Community occurs may degrade water quality and habitat. Once pollution and habitat alteration become severe, the macroinvertebrate community will shift to other organisms that can tolerate poor conditions. Some watersheds with High Quality Small Stream Communities where streams are listed as "Impaired" by DEP include: Kishacoquillas Creek huc, Juniata River-Kishacoquillas Creek huc, Juniata River- Carlisle Run huc, and the Juniata River- Tuscarora Creek huc. In areas where non-point source agricultural pollution is occurring, 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. Stream habitats will improve with the addition of riparian buffers.

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 with a diverse assemblage of organisms. Medium- to large -size stream community habitats are often relatively high quality. Watersheds supporting the community habitat may be buffered by geology and stream waters are ion-rich. The community may occur in agricultural valleys where the water quality is relatively good. This community type is indicative of larger streams that are of good quality, despite being affected by watershed disturbances that alter the habitats of most streams of this size. There were not many instances of the Common Large Stream Community in the Mifflin County hucs. It was found in Laurel Creek (Laurel Creek huc) below the reservoir.

Nemourid broadback stonefly
photo source: www.dec.state.ny.us

Stream quality rating: Medium

Average Water Chemistry		
alkalinity	-	58 mg/l
conductivity	-	320 µS/cm
pH	-	neutral

Threats and Disturbances: Excess siltation from agricultural runoff may occur some habitats where this community is found. In Laurel Creek, a primarily forested headwaters stream is classified as "Impaired" by DEP because of low pH due to acid deposition. The valley streams in the Laurel Creek huc are "Impaired" according to DEP for excessive siltation, related to agriculture. Storm sewers and road runoff from Route 322 also contribute to the "Impaired" status due to flow alteration. In addition, the Laurel Creek Reservoir has altered the stream habitat.

Conservation Recommendations: Mitigating siltation from crops and live-stock grazing can be achieved with riparian buffers, stream bank fencing, and soil conservation practices. Watershed managers should work to prevent additional volume of storm water from storm sewers and runoff from entering valley streams and to find solutions for ameliorating impairment due to storm water.

Large to medium 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.
Photo source: PNHP

Low Gradient Valley Stream Community

typified by: Riffle beetle (Elmidae), waterpenny beetle (Psephenidae) netspinning caddis-fly (Hydropsychidae), Asian clam (*Corbicula fluminea*), narrow-winged damselfly (Coenagrion-idae), rusty dun mayfly (Caenidae), fingernail clam (Sphaeriidae), freshwater limpet (Ancylidae), broad-winged damselfly (Calopterygidae)

Riffle Beetle

Photo source: www.epa.gov

Community Description and Habitat: This community generally occurs in small- to medium-sized valley streams. Streams have moderate to low slopes and may be slow moving. Valley streams having watersheds with agriculture and some residential land uses commonly have the Low Gradient Valley Stream Community. Example habitats for this community are the slow moving sections of Kishacoquillas Creek (Kishacoquillas Creek-Coffee Run huc) and Jack's Creek (Jack's Creek huc).

Stream quality rating:
Intermediate

Average Water Chemistry		
alkalinity	-	76 mg/l
conductivity	-	318 µS/cm
pH	-	neutral

Threats and Disturbances: The exotic Asian clam (*Corbicula fluminea*) commonly occurs with this community type. The Asian clam is a threat to other bivalves due to competition for food resources and habitat For more information, see the Asian Clam factsheet in Appendix X.

The habitat for this community type may receive pollution from a variety of sources. In streams where this community is found, water quality may be degraded from excess nutrients, habitat modification and siltation due to poorly maintained agricultural practices. Streams in the Jack's Creek huc and the Kishacoquillas Creek- Coffee Run huc were determined to be "Impaired" by DEP for agriculturally related siltation and nutrients. Like other valley stream habitats, streams associated with this community type in the Kishacoquillas Creek- Coffee Run huc are also influenced by storm water and are classified as "Impaired" by DEP for flow alteration.

Conservation Recommendations: Where this community is common, non-point source pollution from the surrounding watershed may be contributing to moderately degraded water quality and habitat conditions. Although this community type does not always signify extremely poor stream quality, some stresses to stream condition are indicated.

Areas with large amounts of agriculture and roads have the potential for non-point source pollution. In agricultural environments, 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. Stream habitats will improve over time with the addition of riparian buffers.

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.

This community is typically found in low gradient valley streams with some influence from agricultural practices in the watershed.

Photo source: PNHP

Eastern Elliptio Community

typified by: Eastern Elliptio (*Elliptio complanata*)
The Rainbow Mussel (*Villosa iris*), Yellow Lampmussel (*Lampsilis cariosa*)* and Eastern Lampmussel (*Lampsilis radiata*)* are not consistent community members, but are often associated with this community.

Community Description and Habitat: The Eastern Elliptio Community is widely distributed across the study area and is found in a variety of environments. The most common community member, Eastern Elliptio, tolerates variable habitats. The community is usually found in large streams and small rivers in Mifflin County. Stream bottom habitats can be variable, but this community requires some sand and silt mixed with larger cobble and gravel. Shale, sandstone, and calcareous bedrock is found in watersheds supporting this community.

Water chemistry parameters may be influenced by non-point source pollution from agriculture and resource extraction. Agriculture in the watershed may contribute to non-point source pollution. An example of the Eastern Elliptio Community habitat is the Juniata River (Juniata River-Kishacoquillas Creek huc and Juniata River-Shanks Run huc) and East Licking Creek (East Licking Creek huc).

Eastern Elliptio
Photo source: PNHP

Stream quality rating: Medium

Average Water Chemistry		
alkalinity	-	63.6 mg/l
conductivity	-	199 µS/cm

Threats and Disturbances: Watershed disturbances including improperly managed agriculture may be detrimental to the Eastern Elliptio Community. Watershed non-point source pollution from agriculture and road runoff may result in excess nutrients and silt contributed to streams. Habitat alteration from stream bank vegetation removal and sedimentation, from alteration of the stream channel, and from any water quality impairments may reduce the distribution and health of the Eastern Elliptio Community.

The Eastern Elliptio Community can occupy diverse habitats from small, slow-moving rivers to large rivers like the Susquehanna.
Photo source: PNHP

Conservation Recommendations: Although the Eastern Elliptio is not a rare species in Pennsylvania, some of the associated species that may occur with this community are species of concern. Protection of current mussel habitats and high water quality will mean that communities will endure and potentially be reintroduced where they have been lost. Mitigating habitat and water quality threats in the agricultural valleys in Mifflin County is important for conserving this community type.

Zebra mussels have been reported in the most of major drainage basins in Pennsylvania: Delaware River, Susquehanna River, Genesee River, Ohio River and Lake Erie basins. Monitoring of zebra mussel infestation will document the spread and effects of the non-native species on native mussel populations.

* Recognized as a species of special concern in Pennsylvania by the Pennsylvania Natural Heritage Program.

Yellow Lampmussel Community

typified by: Yellow Lampmussel (*Lampsilis cariosa*)*
Additionally, the Eastern Floater (*Pyganadon cataracta*), Eastern Lampmussel (*Lampsilis radiata*)* and Triangle Floater (*Alasmidonta undulata*)* are all commonly associated with this community.

Yellow Lampmussel (*Lampsilis cariosa*)
Photo source: Andrew Strassman (PNHP)

Community Description and Habitat: This community type is found in large river systems in the Juniata River watershed. Large streams and rivers with slow moving reaches and appropriate stream bottom habitats are good habitats for this community. The main indicator species, Yellow Lampmussel, is a habitat generalist and occurs in a variety of substrate types including sand, silt, cobble, and gravel (Connecticut DEP 2003, NatureServe www.natureserve.org/explorer).

Sandstone and shale bedrock geology is common in watersheds containing this community. As is typical of larger rivers, watersheds of this community type may be influenced by much human disturbance. Much of the watershed is agriculture land cover in the valleys surrounding the Juniata River. The Juniata River is one example of this community's habitat.

Stream quality rating: Medium

Threats and Disturbances: Watershed disturbances including coal mining and improperly managed agriculture may be detrimental to the Yellow Lampmussel Community. Upstream non-point source pollution from agriculture results in excess nutrients and silt contributed to streams. Habitat alteration from stream bank vegetation removal and sedimentation and any water quality impairments may reduce the range and health of the Yellow Lampmussel Community.

Conservation Recommendations: Large river habitat conservation is a daunting task since river watersheds are very expansive and contain many potential pollution sources and habitat alteration problems. At the minimum, maintaining habitats where communities are currently residing and preventing further water pollution will ensure that current communities will continue to exist. However, restoring habitats and improving water quality may pave the way for mussel species in decline to rebound.

* Recognized as a species of special concern in Pennsylvania by the Pennsylvania Natural Heritage Program.

The Juniata River is an example of habitat that is typical for this community.
Photo source: Andrew Strassman (PNHP)

Threats and Conservation of Freshwater Mussels

Freshwater mussel populations are rapidly declining in North America. For mussel species in the United States, nearly 25% have a Federal endangered or threatened status and 75% are listed as threatened, endangered, or special concern by individual states (Nedeau et al. 2005).

Mussel communities are generally indicative of habitat types that are rare in the Commonwealth and becoming increasingly rarer. Mussel species are generally found in watersheds at least 75 sq. km. in size that have medium or large size streams. Mussel species richness tends to increase with increasing watershed size (Strayer and Jirka 1997), so the largest rivers in Pennsylvania, like the Ohio, Allegheny, Susquehanna, and Delaware Rivers tend to have the most diverse mussel communities.

Yellow Lampmussel
Photo source: PNHP

Water quality threats to mussels include toxic and organic compounds released from industrial and municipal point sources. Non-point source pollution contributed from large areas, like farms and cities, can also threaten water quality for mussels. Agricultural practices can vary greatly, as can their influences on mussel communities. In many instances, mussels are seemingly undisturbed, compared to other aquatic organisms, by agricultural pollution. But excessive sedimentation and habitat alteration from agricultural practices can also be detrimental to mussel communities. Runoff from urban and suburban developments appears to be more damaging to mussels, most likely due to combined effects of altered hydrology, excess sediment and nutrients, and warm water temperatures. In recent decades, regulations of gross point source discharges have sufficiently improved water quality and allowed mussels to recolonize some streams and rivers (Strayer and Jirka 1997).

Hydrologic alteration, disrupted connectivity, habitat alteration, and changes in thermal properties are ways in which dams negatively influence mussel communities. Fish hosts have restricted movement from dams and parasitic mussels carried by their hosts are similarly restricted in the distribution. Alterations of the stream channel above and below the dam will potentially alter available habitat for mussel communities. Water quality and temperature can be largely altered in a reservoir. Impoundment management and drawdown plans can be important for maintaining mussel communities.

Invasive mussel species like the Zebra Mussel (*Dreissena polymorpha*) and the Asian Clam (*Corbicula fluminea*) may be damaging to populations of native mollusks. Non-native mussels may alter food resources and habitat (Hakenkamp et al. 2001) and may also smother endemic mussel populations, as is the case with the Zebra Mussel.

Mussel habitat requirements are not well known. Protecting habitats where mussels are currently occurring is a first step to ensuring the long-term mussel resource. Protection from major channel alteration by bridges, dams, dredging is important for maintaining habitat. Preventing excessive amounts of sediments, nutrients, and toxins in streams and rivers will maintain good water quality to support healthy mussel communities. Adopting zoning, stormwater detention ordinances, and natural resource protection ordinances will help protect mussel resources. Reducing the effects of urbanization through control of quantity and quality of stormwater will also help protect these habitats.

PNHP staff surveying for freshwater mussels in the Susquehanna River using clear-bottomed buckets.
Photo source: PNHP

Pennsylvania is fortunate to harbor many inland freshwater mussel taxa that are globally rare. By conserving the processes that support these species, we are better able to conserve the species. Thus, we believe that it is important to protect examples of each mussel community and protect watersheds that contain diverse mussel populations to effectively protect the biodiversity of the state, and the nation.

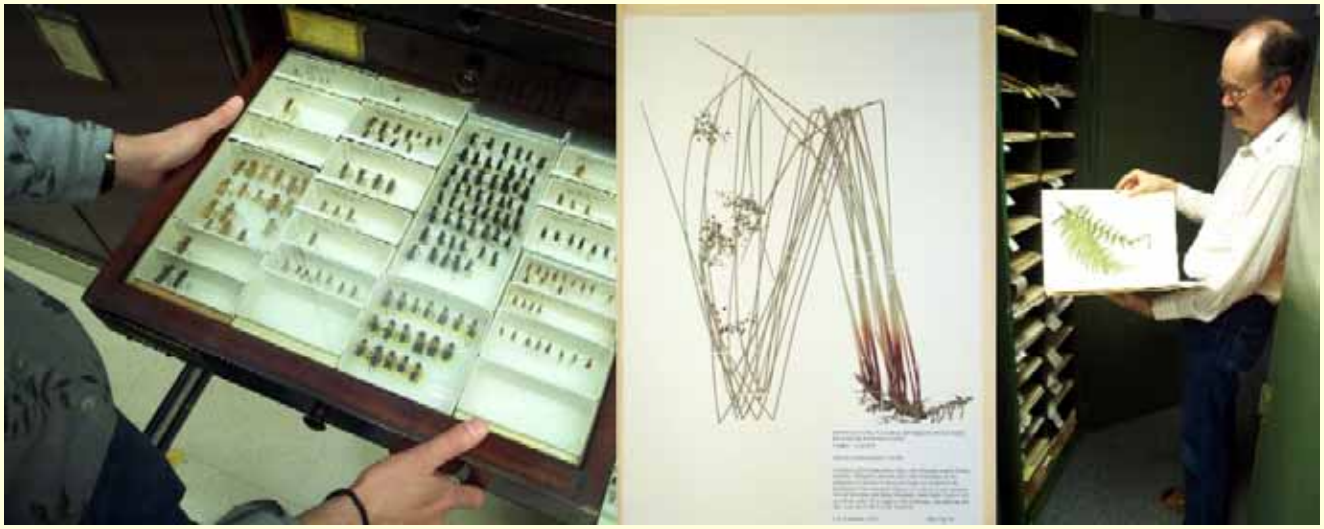
PENNSYLVANIA NATURAL HERITAGE PROGRAM DATA SYSTEM

The Pennsylvania Natural Heritage Program (PNHP) was established in 1982 as a joint venture between the PA Department of Environmental Resources, The Nature Conservancy, and the Western Pennsylvania Conservancy (WPC). Today this partnership continues under the leadership of WPC, the Department of Conservation and Natural Resources (DCNR), the Pennsylvania Game Commission (PGC), and the Pennsylvania Fish and Boat Commission (PFBC). The PNHP database has become Pennsylvania's chief storehouse of information on outstanding natural habitat types (natural communities) and sensitive plant and animal species of special concern. Several other noteworthy natural features are also stored in the database, including 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 existing data on occurrences of species and communities of special 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.

As of January 2007, PNHP has recorded nearly 18,000 detailed occurrences of species and communities of special concern, largely the result of field surveys. These are stored in computer and manual files and denoted on topographic maps. Additional data are stored in extensive manual and digital files set up for over 200 natural community types, 1,400 animals, and 3,500 plants. These files are organized by each of Pennsylvania's 881 7½ USGS topographic quadrangle maps using a geographic information system (GIS).

In order to conduct an inventory of significant flora, fauna, and natural communities in the county, biologists from the Middletown office first consulted the database maintained by the PNHP. They then used this systematic inventory approach to identify the areas of highest natural integrity in Mifflin County. The natural community and sensitive species data are the basis for judging the biological values of sites within the county. Protecting the sites with the best occurrences of the county's natural communities, and viable populations of sensitive plant and animal species can help to insure that a full range of biological diversity in Mifflin County is preserved for the future.



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

NATURAL HERITAGE INVENTORY METHODS

Methods used in the Mifflin County Natural Heritage Inventory followed Pennsylvania Natural Heritage Program (PNHP) procedures, and those developed in Illinois (White 1978) and Indiana. The inventory proceeds in three stages: 1) information is gathered from the PNHP database files, local experts, and map and air photo interpretation; 2) ground surveys conducted (preceded by one low-altitude flight over the county); and 3) data are analyzed and mapped.

Information Gathering

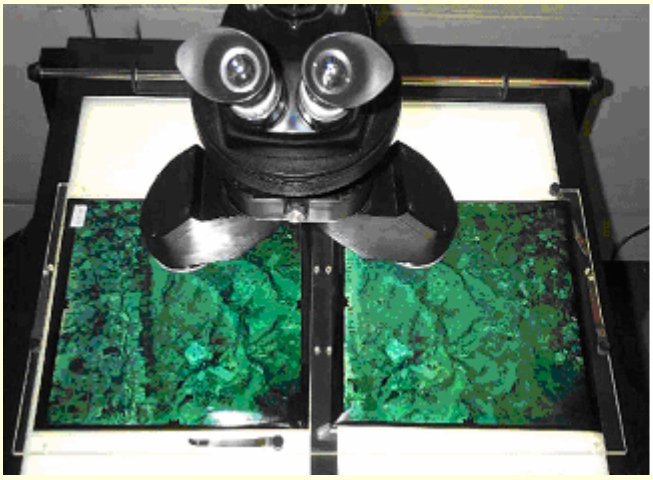
A list of natural features found in the county was prepared from the PNHP database and supplemented with information volunteered by local individuals and organizations familiar with Mifflin County. In October of 2004 a public meeting was held and recommended Natural Heritage Survey Forms (Appendix III) were distributed to facilitate public input. PNHP staff solicited information about potential natural communities, plant species of special concern and important wildlife breeding areas from knowledgeable individuals and local conservation groups. A number of potential natural heritage sites were identified by audience members and scheduled for field surveys.

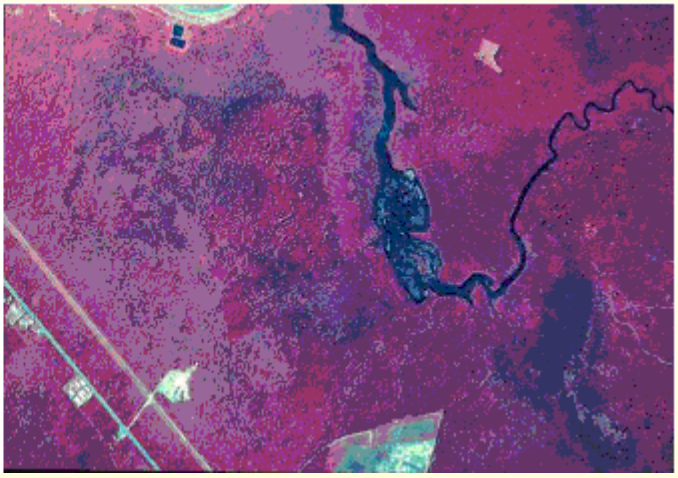
Map and Air Photo Interpretation

PNHP ecologists familiarized themselves with the air photo characteristics of high quality natural communities already documented (Appendix IV). Additional data from vegetation maps, soil survey maps, field survey records and other sources were consulted to gain familiarity with Mifflin County's natural systems. 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.

Work progressed systematically within the area encompassed by each USGS topographic map. The natural area potential of all parcels of land was assessed using aerial photographs. Areas continuing into adjacent counties were examined in their entirety. Topographic maps used during field surveys were marked to indicate locations and types of potential natural heritage sites 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 species. Baseline information on sites appearing to have good quality communities or potential for rare species was compiled to help prioritize fieldwork.

After an initial round of photo interpretation, field





Using aerial photography, skilled PNHP staff are able to identify areas with characteristic signatures that potentially indicate areas with high biological significance. Aerial photography interpretation can give a quick overview of the condition of particular areas in the county and is a first stop for identifying areas that will be targeted for field surveys.

surveys were conducted to evaluate the potential targets. In March of 2005, two low altitude reconnaissance flights were flown over the county to provide a more accurate overview of the current condition and extent of known natural heritage sites and to assess the potential of any additional areas. Locations with minimally disturbed natural communities or with species of special concern were outlined on topographic quadrangle 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

Experienced PNHP biologists and contractors conducted numerous field surveys throughout Mifflin County during 2005, 2006, and winter 2007. Biologists evaluated the degree of naturalness of habitats (including assessment of percent of native vs. non-native plant species, degree of human disturbance, age of trees, etc.) and searched for plant and animal species of special concern. Workers also categorized the vegetation of each potential site visited. An evaluation of quality was made for each potential natural community element, with care being taken to give reasons for the quality rank. Boundaries of the community types were redrawn, if needed, based on new field information. Community information recorded included the dominant, common, and other species, as well as disturbances to the community. Field forms were completed for all occurrences of plant and animal species of special concern and natural communities (see sample Field Survey Form, Appendix V), the quality of each population or community was assessed, and locations were marked on USGS topographic quadrangle maps.

Data Analysis

To organize the natural features data and set conservation priorities, each natural community or species (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 VI). Each location of a species (an element occurrence) 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 VII. The element-ranking and element occurrence-ranking systems help PNHP personnel to simultaneously gauge the singular importance of each occurrence of, for example, an Ephemeral/Fluctuating Pool Natural Community or yellow-fringed orchid occurrence in Mifflin 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.

Field data for natural communities of D-rank or better, and for all plant and animal species of concern found, were combined with existing data and summarized on PNHP Element Occurrence Records for mapping and computerization. Mapped locations of natural features, including approximate watershed or subwatershed boundaries, were then created and added electronically to PNHP's Geographical Information System (GIS) layer.

Small Mammal Surveys

Invertebrate Surveys

Experienced PNHP staff conduct botanical surveys and habitat assessments for species of special concern. All sites are evaluated for their natural condition. Associated disturbances and threats are noted and recommendations are made to minimize negative impacts.

Information on the needs of the rare species in this report has come from a variety of sources, including field guides and research publications. For reptiles and amphibians, the major sources are Hulse et al. (2001) and DeGraaf and Rudis (1981); for birds, Brauning (1992) McWilliams and Brauning (2000); for moths, Covell (1984); for butterflies, Opler and Krizek (1984) and Opler and Malikul (1992); Schweitzer (1981) provided much of the information on rare moth and butterfly species in Pennsylvania. A list of Plant and Animals of Special Concern in Mifflin County is provided in Appendix VIII.

Landscape Analysis

Background: Fragmentation of the landscape by roads, utility lines, and other human disturbances can impact the surrounding landscape significantly. A road or utility line cut through a forested block cleaves the large block into two smaller blocks and significantly increases the amount of edge habitat within the forest. When a forest with a closed canopy is disturbed by road building activities, the newly disturbed soil and open canopy favor the establishment of invasive species of plants and animals. Many of these will out-compete and displace native species in this disturbed habitat. These smaller forest fragments will have significantly more edge habitat and less forest interior than the original forest block. Furthermore, fragmentation of large forest blocks decreases the ability of many species to migrate across manmade barriers such as roads. Migration corridors, once severed, isolate populations of species one from another, limit the gene flow between populations and create islands of suitable habitat surrounded by human activity. Much of the native biological diversity of an area can be preserved by avoiding further fragmentation of these large forested areas. Historically, edge habitat was created to provide habitat for organisms, namely game species, which often thrive in disturbed areas. Today, we realize that by fragmenting forests we are eliminating habitats for the forest interior species. Those species that utilize edge habitats are typically considered generalists, capable of utilizing many

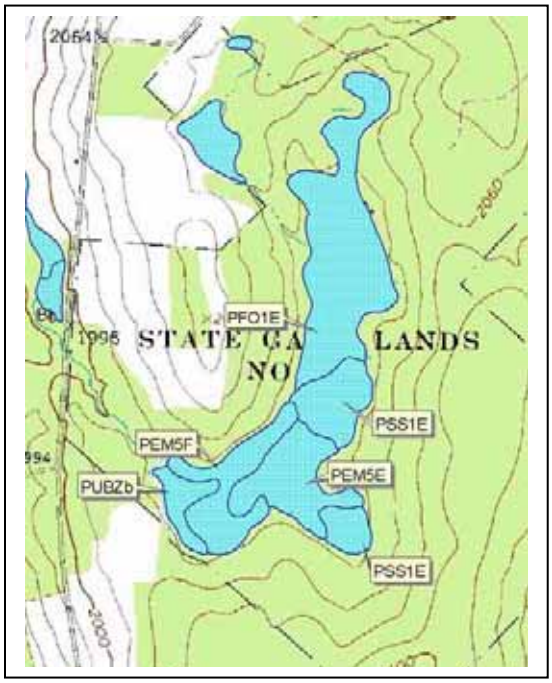
different habitats and are usually not of immediate conservation concern.

The larger forested blocks in the county (those of at least 250 acres in area) have been highlighted in an effort to draw attention to the significance of large forested blocks within the county. Besides being habitat suitable for many native species, large unfragmented forest blocks in close proximity to each other become natural corridors for species movement within and through the county. In many cases, by highlighting the larger forested blocks, the most natural landscape corridors become evident.

GIS Methodology: Creating NHI Forest Block Layers

Forested areas in Mifflin County were identified though a classification of 2000 Penn State Land Cover Data, compiled from Landsat TM (thematic mapping) satellite imagery with a resolution of 30 meters (~100 feet) and downloaded from Pennsylvania Spatial Data Access (http://pasda.psu.edu/).

Land cover types used in the creation of forest blocks were transitional, deciduous, coniferous, and mixed forest; woody wetlands, and emergent herbaceous wetlands. Interstates, U.S. and state highways, state, county and township roads, active railroads, and utility right-of-way locations digitized from aerial photos were considered fragmenting features. The forest block layer was overlain by the Penn DOT road layer to identify forest blocks fragmented by roads. The Penn DOT right-of-way (ROW) distance was applied as a buffer to roads: interstates have a 500-foot ROW, PA and US designated roads have a 150-foot ROW, and local roads have a 100-foot ROW. Analysis to identify contiguous blocks of forest was conducted using the map calculator function of the Spatial Analyst Extension in ArcView 3.2. The results were then compared against aerial photos and any apparent non-forested areas were removed. Forest blocks less than 1 acre were then removed and the remaining blocks were grouped into four size classes: 0-250 acres; 250-1,000 acres; 1,000-5,000 acres; and greater than 5,000 acres. A detailed description of the GIS analysis is available upon request.



Wetlands are frequently a combination of several types of natural communities. National Wetland Inventory (NWI) maps provide distinctions among these types. The lines that occur within wetlands on the township maps in this report represent these distinctions. A wetland is represented in the aerial photo and the topographic map above. Distinct zones of open water and types of vegetation are clearly visible in the aerial photo and roughly correspond to the lines on the topographic map. This helps illustrate the complex diversity of habitats found in many wetlands. For a definition of wetland codes visit the National Wetland Inventory web site at: http://wetlandsfws.er.usgs.gov/tips.html

Species Ranking

Each year biologists representing various taxonomic groups of the Pennsylvania Biological Survey meet to discuss and rank the most important species for the protection of biodiversity in Pennsylvania. The various Biological Technical Committees include the Bryophyte and Lichen Technical Committee, the Fish Technical Committee, the Fungi Technical Committee, the Herpetological Technical Committee, the Invertebrate Technical Committee (with subcommittees of aquatic, terrestrial, arachnid and mollusk), the Mammal Technical Committee, the Ornithological Technical Committee, and the Vascular Plant Technical Committee. 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.

Site Mapping and Ranking

Boundaries defining core habitat and supporting natural landscape for each site were delineated based upon PNHP conservation planning specifications for the elements of concern. These specifications are based on scientific literature and professional judgment for individual species or animal assemblages and may incorporate physical factors (e.g., slope, aspect, hydrology), ecological factors (e.g., species composition, disturbance regime), and input provided by government agencies with jurisdiction over the species. 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 buffers if one receives mostly ground water and the other mostly surface water, or if one supports migratory waterfowl and the other does not.

Sites were then assigned a significance rank to help prioritize future conservation efforts. The PNHP considers several criteria when ranking NHI sites to ensure that all sites, regardless of ecological differences, are evaluated systematically. Each criterion is considered independently and then all are examined collectively to ensure that no one criterion receives more emphasis than another. First, the commonness/rareness of the species at a site, defined by the global and state ranks (G & S ranks Appendix VI), is considered in the site ranking process. Those sites that include rarer species with higher ranks (i.e. G3 or S1) are given precedence over sites with more common, lower ranked species (i.e. G5 or S3). Next, the number of different species occurring at a site is also considered in the ranking process. Sites with multiple tracked species 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. By considering these criteria, the conservation priorities within Mifflin County are highlighted to promote appropriate use of conservation dollars and efforts.

The four significance ranks are: **Exceptional**, **High**, **Notable**, and **Local significance**. These ranks have been used to prioritize all identified sites and suggest the relative attention that sites should receive for protection.

Exceptional: 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 special concern or a rare natural community type that are of a good size and extent and are in a relatively undisturbed condition. Sites of exceptional significance merit quick, strong and complete protection.

High: Sites that are of high importance for the biological diversity and ecological integrity of

the county or region. These sites contain species of special concern or natural communities that are highly ranked, and because of their size or extent, relatively undisturbed setting, or a combination of these factors, rate as areas with high potential for protecting ecological resources in the county. Sites of high significance merit strong protection in the future.

Notable: 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 special concern or natural communities that are either of lower 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: Sites that have great potential for protecting biodiversity in the county but are not, as yet, known to contain species of special concern or state significant natural communities. Often recognized because of their size, undisturbed character, or proximity to areas of known significance, these sites invite further survey and investigation. In some cases, these sites could be revealed as high or exceptional sites.

Northeastern Mifflin County looking into the Big Valley.

Photo source: PNHP

RESULTS AND DISCUSSION

Forest Block Analysis--Landscape-scale Conservation

Forest blocks were identified in Mifflin County and grouped into four size classes: 0-250 acres; 250-1,000 acres; 1,000-5,000 acres; and greater than 5,000 acres (Figure 5). The largest blocks were concentrated in the Bald Eagle State Forest of Armagh Township in the northeast corner of the county, the length of Jacks Mountain across the county, and the Blue Mountain corridor along the southeast edge of the county. A discussion of the importance of considering these large remaining forested areas in conservation follows.

Prior to European settlement, forest covered more than 90% of Pennsylvania (Goodrich et al. 2003). Today, 62% of the state is forested, comprising an area of over 17 million acres (Goodrich et al. 2003, Myers et al. 2000). However, much of this forest exists as relatively small islands isolated by surrounding linear features such as roads, utility right-of-ways, all-terrain vehicle and snowmobile trails, and railroads, as well as non-forest lands. Figure 6 shows forested areas greater than 250 acres that remain after fragmentation by interstate, US, and state highways; state and local roads; public forest roads; utility right-of ways; and active railroads. The forest blocks represent potential contiguous habitat for animals sensitive to all scales of fragmenting features, such as amphibians and interior forest birds. The acreage size classes shown in this figure roughly correspond to area-sensitive species requirements.

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 species; (6) alteration of the chemical environment.

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 migration between wetland and upland habitats, and individuals are inconspicuous. One study conducted in southeastern Pennsylvania documented over 100 road-killed salamanders and frogs in one rainy night on a one-mile stretch of road in 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, Allegheny County, Pennsylvania, over the last four years, white-tailed deer (*Odocoileus virginianus*) mortality due to road-kills was approximately four times higher than mortality due to hunting (Upper St. Clair Township Department of Deer Management). Six hundred thirty seven bobcats (*Lynx rufus*) were reported as road-kills in Pennsylvania from 1985 to 2000 (Goodrich et al. 2003). A 10-year study of road mortality in New Jersey recorded 250 raptors representing 12 species along a 90-mile section of road (Loos and Kerlinger 1993, cited in Goodrich et al. 2003).

Animals may alter their behavior in the presence of a road. One study found that small forest mammals (e.g., eastern chipmunk, eastern gray squirrel, and deer mouse) were reluctant to venture onto road surfaces where the distance between forest margins exceeded 20 m. 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 fresh water twice as wide (Oxley et al. 1974). 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 thus affecting their territorial behavior and mating success (Seiler 2001). Roads, wide trails, and grassy corridors can also function as barriers restricting the movement of invertebrates and amphibians. Populations of microhabitat-specific species like land snails and salamanders, that generally require moist habitats, may be isolated by inhospitable, xeric corridors (Williams 1995, Blaustein et al. 1994). Some forest butterflies, like the West Virginia white (*Pieris virginiensis*), will not cross open habitats and 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 low recruitment rates that can, in turn, result in local extinctions (Seiler 2001).

Figure 5. Forested blocks in Mifflin County greater than 250 acres.

These large forested blocks are critical habitat for plants and animals that are dependent of forest interior conditions such as many migrating bird species, fishers, bobcats, Northern Goshawks and Barred Owls. These forest blocks and their adjacent streams 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.

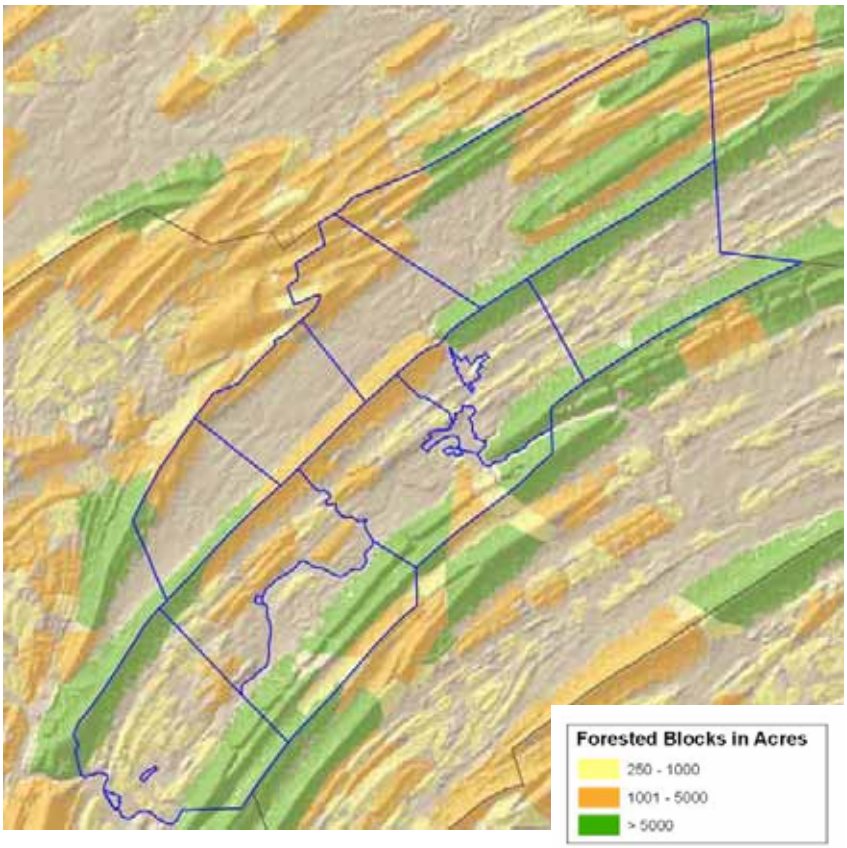
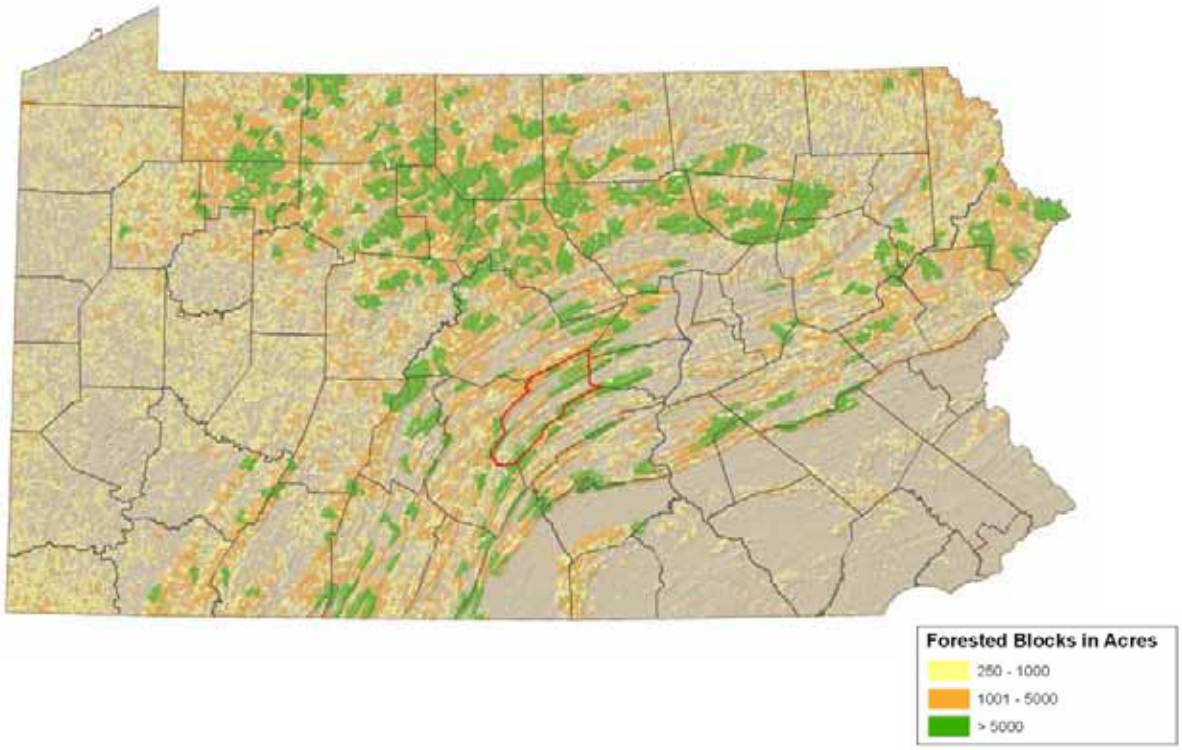


Figure 6. Forested blocks greater than 250 acres statewide in Pennsylvania.



Fragmentation of contiguous forested landscapes into smaller, isolated tracts has an effect on plant and animal distribution and community composition. When an extensive forest tract is fragmented, the resulting forest islands may lack the full range of microhabitats 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 (*Seirus 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 1995). Area-sensitive species such as 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 (Squires and Reynolds 1997, Mazur and James 2000, Ciszek 2002, NatureServe 2005).

Along with a reduction in total forested area, forest fragmentation creates a suite of "edge effects" which can extend more than 300 meters into the remaining fragment (Forman and Deblinger 2000). Edge forest is composed of a zone of altered microclimate and contrasting community structure distinct from the interior, or core forest (Matlack 1993). Edges experience increased light intensity, altered insect and plant abundance, a depressed abundance and species richness in macroinvertebrate soil fauna, and a reduced depth of the leaf-litter layer (Yahner 1995, Haskell 2000, Watkins et al. 2003). The macroinvertebrate fauna of the leaf litter is significant for the pivotal role it plays in energy and nutrient cycling; these macroinvertebrates also provide prey for salamanders and ground-feeding birds. A number of studies have shown that the nesting success of forest-interior songbirds is lower near forest edges than in the interior because of increased densities of nest predators and brood parasites (reviewed in Murcia 1995).

Roads can act as corridors for plant dispersal, and exotic species increase their range by spreading along roadsides (Watkins et al. 2003). Vehicles and road-fill operations transport exotic plant seeds into uninfested areas, and road construction and maintenance operations provide safe sites for seed germination and seedling establishment (Schmidt 1989; Greenberg et al. 1997; Trombulak and Frissell 2000). Road traffic and maintenance of right-of-ways contribute at least six different classes 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 and iron contaminate soils, plants, and invertebrates up to 200 meters from roads, as well as vertebrate fauna foraging within the affected zone (Trombulak and Frissell 2000). Deicing salts contribute ions to the soil, altering pH and soil chemical composition, which affects plant growth (Forman and Alexander 1998, Trombulak and Frissell 2000). Airborne sodium chloride from road salt may cause leaf injury to trees up to 120 meters 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 (Trombulak and Frissell 2000). Storm runoff from roads, particularly where roads abut or cross water bodies, results in the transport of nutrients and sediments into aquatic ecosystems (Trombulak and Frissell 2000). Drifting or misapplied herbicides applied to roadsides and utility right-of-ways to control woody plant growth may damage forest edge and interior plant species (Williams 1995).

Even a moderately sized gravel road can act as a fragmenting feature in a large tract of forest.
Photo source: PNHP

Humans are an integral part of natural history, where we function as ecosystem engineers, altering the landscape around us to suit our needs. Some species benefit from human-induced changes, such as birds that inhabit the early successional and edge

habitats provided by utility corridors or disturbance-adapted plants that colonize roadsides. But as is more often the case, species with specific habitat requirements tend to suffer declining numbers 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 overstated. Not only are they potential habitat for a number of area-sensitive species, they are also important for the maintenance of vital ecosystem processes such as nutrient cycling, pollination, predator-prey interactions, and natural disturbance regimes (Heilman et al. 2002). In addition, large forested areas also serve to filter and regulate the flows of streams within watersheds and store large quantities of carbon as biomass.

Recommendations for all Forest Blocks

A significant portion of the land encompassed by these forest blocks is under public ownership, which presents land managers with the opportunity to coordinate sustainable management as well as biodiversity conservation. The Bureau of Forestry, responsible for managing a significant portion of land within these forest blocks, recognizes sustainability as the overarching goal of the management of state forests. The Pennsylvania Game Commission, which manages a small portion of the lands contained within these forest blocks, focuses on management practices aimed at enhancing habitat for wildlife. It is recommended that both of these agencies take into consideration the uniqueness of the contiguous forest contained within these areas, managing for older forests through longer rotations and silvicultural practices that enhance structure.

A number of resources, listed in Appendix IX, are available to private landowners interested in sustainably managing their forestlands for biodiversity conservation, forest health, and forest products including timber, mushrooms, and high-value medicinal herbs. A good place to start is the Forest Stewardship Program, which assists landowners in developing a forest management plan based on their envisioned goals for their land. Landowners interested in bringing deer numbers back into balance with their habitat may want to consider enrolling in the Pennsylvania Game Commission's Deer Management Program.

Forest fragmentation can be minimized by utilizing existing disturbed areas for new projects (e.g., wind farms) rather than clearing additional forest, by consolidating roads and right-of-ways where multiple routes exist, and by restoring unused cleared areas such as abandoned roads or railroad tracks to forest. When planning development, it is preferable to avoid complete division of the forest block to minimize impacts. Contiguity could be improved by establishing forested corridors at least 300 meters (1000 feet) wide between forest blocks that are separate. The impact of individual features such as wells, roads, right-of-ways, or other clearings can also be minimized by the use of ecologically informed best management practices in construction and maintenance.

Riparian Buffer Recommendations

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. An undisturbed (no-cut) riparian buffer of 100 meters is recommended adjacent to all streams. The riparian buffers recommended in this report also include wetlands, while artificially created farm ponds have been excluded from this riparian buffer.

The literature varies with regard to buffer distances. From a strictly water quality standpoint, wetland buffers of 35-100 feet are thought to be sufficient for water quality maintenance (Wenger 1999). However, many of these buffer recommendations do not take wildlife habitat into account. Unfortunately, many states still refer to older literature with regard to wetland buffers and many of these studies are now considered to be rather obsolete. Newer scientific techniques have allowed researchers to conduct better studies with regard to habitat buffers. For example, wetland buffers of 15-30 meters were once thought to be sufficient to protect vernal pool amphibians. A series of papers from Conservation Biology (Semlitsch and Brodie 2003 - Buffer Zones for Wetlands and Riparian Habitats) conclude that buffers of this size are inadequate to protect terrestrial habitats for amphibians and reptiles. As the size of a buffer increases, the functions of that buffer for water quality, flow, and wildlife habitat expand (Wenger 1999, Palone and Todd 1997). Many species of

mammals and birds require much larger forested buffers to persist.

Based on studies of the values of variously-sized riparian buffers, PNHP recommends minimum buffers of 100 meters (328 feet) to maintain the water quality of the wetland as well as to support many of the species of wildlife found in these sites. These buffers were not created for any one particular species but are thought to overlap the habitats used by both common and rare species found at these sites. Certainly, expanding these buffers will still provide water quality protection while increasing habitat for species that require larger blocks of contiguous forest, such as the Fisher and Northern Goshawk. It is our scientific judgment that a minimum buffer of 100 meters should be implemented and maintained around the wetland and riparian areas identified in the report to continue to support the species, both common and rare found at these locations.

The township maps graphically symbolize these recommended riparian buffers in a green shade. Where these buffers coincide with large forested blocks (yellow, orange or green) the riparian buffer is a priority for conservation. Where the buffers are outside of large forested blocks (gray areas) these are riparian buffers that should be considered priorities for restoration. In an assessment of the Kishacoquillas watershed, the Mifflin County Conservation District determined that the lack of an adequate riparian buffer was the factor having the greatest negative impact on the quality of the streams (2003). Specific examples and recommendations for riparian buffer creation can be found in their report.

Riparian buffers through large forest blocks, such as West Licking Creek in Wayne Township (above), should be considered a priority for conservation

Riparian buffers through non-forested areas should be considered a priority for restoration (left).

Priorities for Protection—Inventory Results

Sixty-six Natural Heritage Sites were identified in the Mifflin County Natural Heritage Inventory (see the fold-out Site Index that follows). Detailed maps and description of each site follows, organized by township. For each township, a map, summary table, and full report are provided. Townships are arranged alphabetically; boroughs are included with the appropriate township due to their small size. Township sections include:

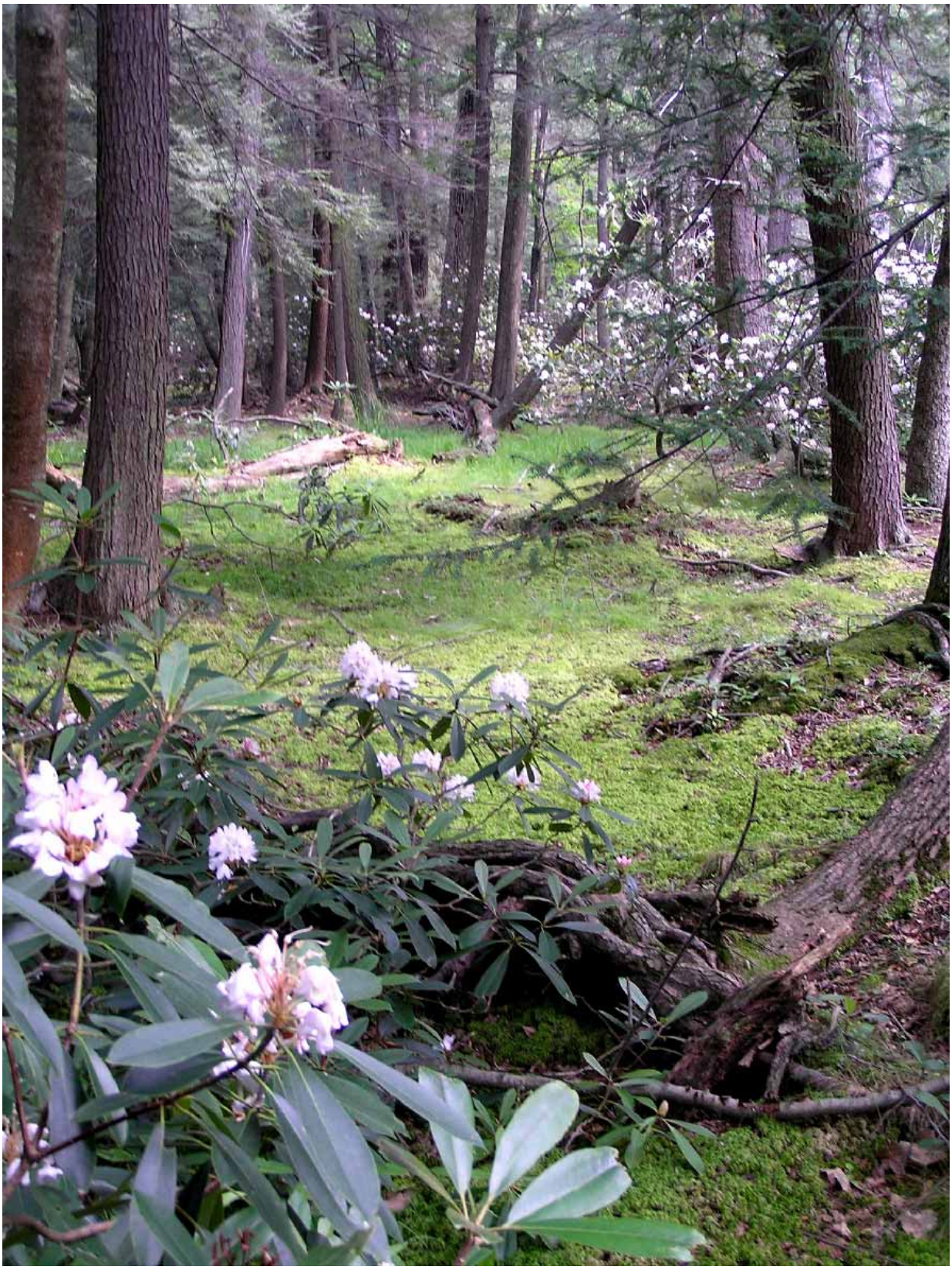
- A categorical designation of a site's relative significance is listed after the site name. Table 1 (pg. xvi) has a summary of sites by significance category. Definitions of the significance categories are outlined in the Methods section (pg.60).
- Listed under each site name are any state-significant natural communities and species of special concern that have been documented within the area.
  - See Appendix IV (pg. 175) for a list of Natural Communities recognized in Pennsylvania.
  - Some species perceived to be highly vulnerable to intentional disturbance are referred to as "species of concern" rather than by their species name, and no ranks are revealed.
  - The PNHP rarity ranks and current legal status (detailed in Appendix VI, pg.179) 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.

Table 1 prioritizes sites with natural communities and species of concern documented in Mifflin County. These sites are displayed in UPPER CASE letters throughout the report. This table ranks sites from the most important and threatened to the least, with "Exceptional" representing the higher priority sites and "Notable" representing the lower priority sites for the conservation of biodiversity in the county. Table 1 lists the site name, local jurisdiction, and pertinent information about the site. A more detailed description for each site is included in the text for each township in which it occurs.

Sites of "Local" significance are indicated in Title Case letters throughout the document, and are briefly discussed in the text accompanying each map. These are sites at which species of special concern or high-quality natural communities could not be documented during the survey period. These areas are not exemplary at the state level, but may be important at the county level. Examples would include relatively intact forested areas, caves, large wetlands, and other areas significant for maintaining local biodiversity.

Each of the primary sites identified in this report has associated with it areas mapped as Core Habitat and Supporting Natural Landscape. Core Habitat areas are 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. The 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.

Natural Heritage Sites of Mifflin County by Township



Havice Mountian Seeps, Armagh Township Photo source: PNHP

Armagh Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
AITKINS GAP		*Notable Significance*			
Species of concern[3]				5/21/2003	E
BIG FLAT		*Exceptional Significance*			
Amber-winged Spreadwing Damselfly (*Lestes eurinus*)	G4	S3	-	6/26/2006	E
Species of concern[3]				6/29/2006	C
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	6/29/2006	C
FLAT HOLLOW POOLS		*Exceptional Significance*			
Species of concern[3]				6/29/2006	BC
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	6/29/2006	C
HAVICE MOUNTAIN SEEPS		*Notable Significance*			
Plant: mountain starwort (*Stellaria borealis*)	G5	S1S2		7/19/2006	E
HONEY CREEK SLOPES		*High Significance*			
Plant: hoary puccoon (*Lithospermum canescens*)	G5	S2	-	9/7/2006	C
JACKS MOUNTAIN—EAST		*Notable Significance*			
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
KISHACOQUILLAS AND TREASTER VALLEY KARST		*Exceptional Significance*			
Species of concern[3]				10/28/2000	BC
Species of concern[3]				10/28/2000	BC
Species of concern[3]				2/4/1999	E
Stellmack's Cave Amphipod (*Stygobromus stellmacki*)	G1G2	S1	-	3/11/1993	AB
Price's Cave Isopod (*Caecidotea pricei*)	G5	S2S3	-	8/29/1995	AB
Allegheny Cave Amphipod (*Stygobromus allegheniensis*)	G5	S2S3	-	3/14/1994	BC
LITTLE POE ROAD POOLS		*Notable Significance*			
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	8/23/2006	C
LITTLE WEIKERT RUN POOLS		*Notable Significance*			
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	4/10/2006	C
MUTTERSBAUGH GAP POOLS		*Exceptional Significance*			
Species of concern[3]				6/28/2006	BC
Community: Ephemeral/Fluctuating Natural Pools	GNR	S3	-	6/28/2006	B

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.

	PNHP Rank[1]		State	Last Seen	Quality[2]
	Global	State	Status[1]	(m/d/y)	
PANTHER RUN-HIGH MOUNTAIN SLOPES		*High Significance*			
Community: Hemlock (White Pine)–Northern Hardwood Forest	GNR	S3S4	-	11/7/2006	B
PENNS CREEK FLOODPLAIN		*High Significance*			
Species of concern[3]				1/19/1999	E
Appalachian Tiger Beetle (*Cicindela ancocisconensis*)	G3	S1	-	6/1/1983	E
River Jewelwing Damselfly (*Calopteryx aequabilis*)	G5	S2	-	7/8/1972	E
Appalachian Jewelwing Damselfly (*Calopteryx angustipennis*)	G4	S1S2	-	7/9/1972	E
Ski-tailed Emerald Dragonfly (*Somatochlora elongata*)	G5	S2	-	5/12/1956	H
Spine-crowned Clubtail Dragonfly (*Gomphus abbreviatus*)	G3G4	S2	-	4/9/1961	H
PITCHPINE RIDGE		*Notable Significance*			
Community: Scrub Oak Shrubland	GNR	S3	-	4/5/2005	E
TALL TIMBERS NATURAL AREA		*High Significance*			
Community: Hemlock (White Pine)–Northern Hardwood Forest	GNR	S3S4	-	10/13/2006	AB
THICK MOUNTAIN WETLANDS		*Notable Significance*			
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	4/10/2006	C
Little Weikert Run Wetlands		*Local Significance*			

PUBLICLY MANAGED LANDS: Bald Eagle State Forest, White Mountain Wild Area, Reeds Gap State Park, Rowland Preserve (The Nature Conservancy)

OTHER CONSERVATION AREAS: Rothrock State Forest and Stone Mountain Important Bird Area; Tall Timbers, Snyders-Middleswarth Natural Areas Important Bird Area; Central Mountains Important Mammal Area

HIGH QUALITY STREAMS: Greens Valley Stream, Havice Creek, Honey Creek, Laurel Creek, Lingle Creek, Little Weikert Run, Panther Run, Penns Creek, Rock Run, Swift Run, Treaster Run, Weikert Run

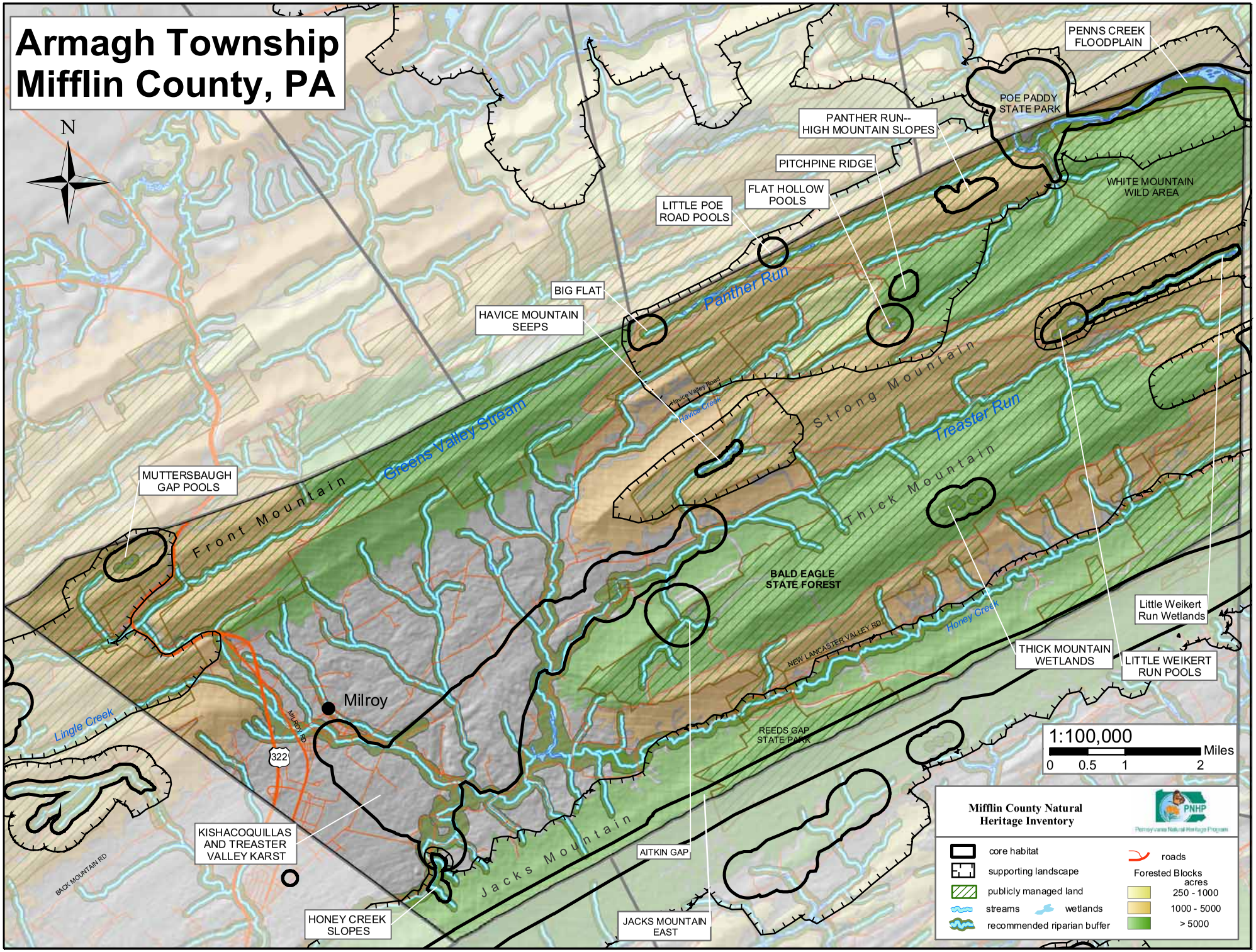
AQUATIC COMMUNITY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Honey Creek - Coolwater Community 2
- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Laurel Creek - Coldwater Community; Common Large Stream Community
- North Branch Middle Creek - Warmwater Community 2; High Quality Small Stream Community
- Penns Creek-Coral Run - Coldwater Community
- Treaster Run - Coolwater Community 1

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.


Armagh Township
Mifflin County, PA
N
PENNS CREEK FLOODPLAIN
POE PADDY STATE PARK
PANTHER RUN-- HIGH MOUNTAIN SLOPES
PITCHPINE RIDGE
FLAT HOLLOW POOLS
WHITE MOUNTAIN WILD AREA
LITTLE POE ROAD POOLS
BIG FLAT
HAVICE MOUNTAIN SEEPS
Panther Run
Havice Valley Road
Havice Creek
Strong Mountain
Treaster Run
Thick Mountain
Greens Valley Stream
MUTTERSBAUGH GAP POOLS
Front Mountain
BALD EAGLE STATE FOREST
Honey Creek
NEW LANCASTER VALLEY RD
Little Weikert Run Wetlands
THICK MOUNTAIN WETLANDS
LITTLE WEIKERT RUN POOLS
Milroy
Lingle Creek
MILROY RD
322
REEDS GAP STATE PARK
1:100,000
Miles
0 0.5 1 2
KISHACOQUILLAS AND TREASTER VALLEY KARST
BACK MOUNTAIN RD
AITKIN GAP
Jacks Mountain
HONEY CREEK SLOPES
JACKS MOUNTAIN EAST
Mifflin County Natural Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks acres
250 - 1000
1000 - 5000
> 5000

Armagh Township, located in the northeast corner of Mifflin County, is the largest township in the county and includes the largest portion of contiguous forest in the county, with more than three-quarters (78%) of the township covered by forested ridges and valleys. Bald Eagle State Forest, including the White Mountain Wild Area, makes up most of this land, but it also includes Rothrock State Forest, Reeds Gap State Park, and Rowland Preserve, owned by The Nature Conservancy. The township is bordered by Centre County to the north and Snyder County to the east. Much of Armagh Township has bedrock geology of sandstone on the ridgetops and limestone, shale, and slate in the valleys. Front Mountain runs along the northern border, and Jacks Mountain is located along the southern border of the township, with Strong Mountain and Thick Mountain in between. At 19%, Armagh Township also has the least amount of land use by agriculture in the county. Agriculture is concentrated in the western part of the township in the Kishacoquillas Valley, locally known as "Big Valley." This valley is host to a high concentration of caves and associated sinkholes, sinking streams, and groundwater resources. Treaster Run and Honey Creek are the major streams flowing through the township.

Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

This portion of the forested ridges provides connectivity to neighboring counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them. Most of the streams flow through the forested areas, which provide an excellent buffer for sediments and chemicals, but some streams flow through the agricultural and residential areas in the western part of the township.

Conservation efforts within the township should concentrate on replanting riparian buffers along the Honey Creek watershed in the valley. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains Important Mammal Area (IMA) is located in the eastern part of the township where there are large forest blocks. Two Important Bird Areas (IBA) cross into Armagh Township. The largest, the Rothrock State Forest/ Stone Mountain IBA, is in the northwestern corner of the township. This site was chosen due to the presence of old growth forests that are important for interior forest species and the ridgeline that provides a raptor migration route in the fall.

Numerous high quality headwater streams originate in the forested portion of Armagh Township.

Photo source: PNHP

AITKINS GAP (Armagh Township)
This site consists of oak forest with large white pines on both sides of a narrow stream valley (an unnamed tributary to Treaster Run). The site supports a nesting population of a globally secure, state vulnerable **species of concern** that relies on the forested matrix found at the site. The majority of the site is within Bald Eagle State Forest, but it includes private lands as well. Dominant plants at the site include pitch pine (*Pinus rigida*), white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*), chestnut oak (*Quercus montana*), witch hazel (*Hamamelis virginiana*), black birch (*Betula lenta*), mountain laurel (*Kalmia latifolia*), and lowbush blueberry (*Vaccinium angustifolium*).

Threats and Disturbances:
The Bureau of Forestry land is protected, and because of the steep slopes of the site, it is unlikely that the private land would be developed. Currently the habitat for the species of concern appears to be stable but should be monitored so that any threats that may arise could be swiftly addressed. The site could be susceptible to future forest management operations that would remove the nesting habitat.

Conservation Recommendations:
The site would be best protected by the establishment of a 100-meter (328-foot) no-cut forested buffer. The site should be monitored for persistence of the species of concern as well as habitat availability. A conservation easement should be pursued with the private landowner in order to protect the site from future development or forest mismanagement.

In the early months of spring, seasonal pools such as this one at Big Flat serve a critical ecological role for vernal pool-breeding amphibians.
Photo source: PNHP

BIG FLAT (Armagh Township)
The headwaters of Panther Run are formed in a wide saddle known as Big Flat. One **Ephemeral/ Fluctuating Natural Pool,** a GNR S3 community of concern and one dug-out pond are located here. This site is occupied by a **species of concern** as well as a rare damselfly, the G4S3 **Amber-winged Spreadwing (*Lestes eurinus*).** Associated species include wool-grass (*Scirpus cyperinus*), rattlesnake mannagrass (*Glyceria canadensis*), the sedge *Carex canescens*, and *Sphagnum* moss. The surrounding forest has an open aspect of oak-hardwoods with heath understory. The supporting natural landscape for this site is designed to maintain landscape-level connectivity between nearby vernal pool systems.

Amber-winged Spreadwing (*Lestes eurinus)*
Photo source: Ann Johnson

Threats and Disturbances:
The site is within the Bald Eagle State Forest and is bordered by the Mid-State trail. This trail is for foot traffic only and does not appear to pose a threat to the wetland but should be monitored as a potential corridor for invasive species colonization.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools

rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant, damselfly, and other species that occur here.

FLAT HOLLOW POOLS (Armagh Township)
The saddle and watershed divide between Pitchpine Ridge and White Mountain are the site of a cluster of six **Ephemeral/Fluctuating Natural Pools, a** GNR S3 community of concern. The surrounding forest is well-drained mixed hardwood forest with heath understory. These pools support a large population of a **species of concern.** The pools contain a mixture of open water and emergent vegetation, including three-way sedge (*Dulichium arundinaceum*), mannagrass (*Glyceria acutiflora*), a sedge (*Carex lupulina*), wool-grass (*Scirpus cyperinus*), and *Sphagnum* moss. The supporting natural landscape for this site is designed to maintain landscape-level connectivity between nearby vernal pool systems.

Sediment runoff from a forest road fills a pool at Flat Hollow, covering amphibian and invertebrate eggs.
Photo source: PNHP

Threats and Disturbances:
The site is within the Bald Eagle State Forest and is bisected by the Flat Hollow Road. This road is severely degraded at the low point between the ponds, causing pooling of rainwater, increased disturbance to the roadbed from vehicles, and silted runoff directly into the ponds. This silt has been observed covering salamander egg masses, a potentially fatal impediment to their development.

Conservation Recommendations:
The road should be repaired in order to prevent siltation of surrounding areas, but care should be taken during repairs to retain the existing hydrology of this wetland complex. Re-routing the road around the site would be best for long-term maintenance of this wetland complex, particularly if future uses of the surrounding forest increase traffic on the road. The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant and other species that occur here.

HAVICE MOUNTAIN SEEPS (Armagh Township)
This site contains numerous seeps and springs feeding into a small, clear, sand-bottomed stream flowing through hemlock-mixed hardwood forest. The site supports two small populations of G5 S1S2 **mountain starwort (*Stellaria borealis*)**. Tree species at the site are white oak (*Quercus alba*), northern red oak (*Q. rubra*), chestnut oak (*Q. montana*), black gum (*Nyssa sylvatica*), white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), black birch (*Betula lenta*), yellow birch (*B. alleghaniensis*), and tulip poplar (*Liriodendron tulipifera*). The understory is thick with rosebay (*Rhododendron maximum*), as well as mountain laurel (*Kalmia latifolia*), witchhazel (*Hamamelis virginiana*), dangleberry (*Gaylussacia frondosa*), and lowbush blueberry (*Vaccinium pallidum*).

Threats and Disturbances:
The site is within Bald Eagle State Forest and is in close proximity to logging operations and planted Norway spruce (*Picea abies*). While not as rapidly spreading as some of the more aggressive invasive

Mountain starwort (*Stellaria borealis*)
Photo source: PNHP

plant species, the Norway spruce does show up frequently outside the plantations. Logging without an adequate buffer to the seeps could alter the hydrology of this area and reduce the quality of the habitat for the species of concern.

Conservation Recommendations:
A 100-meter (328-foot) no-cut buffer should be established around the complex of seeps and springs. Monitoring efforts should include removal of invasive species of plants as they are detected. Conifer plantations should be harvested, non-native seedlings should be removed, and the sites should be allowed to regenerate with native species.

HONEY CREEK SLOPES (Armagh Township)
The rich limestone and calcareous shale slopes above Honey Creek support a population of the G5 S2 **hoary puccoon (*Lithospermum canescens*)**. The surrounding land use is agricultural and residential. The scrubby woods characterizing this site are dominated by eastern red-cedar (*Juniperus virginiana*), hop-hornbeam (*Ostrya virginiana*), chinquapin oak (*Quercus muhlenbergii*), sugar maple (*Acer saccharum*), basswood (*Tilia americana*), and hackberry (*Celtis occidentalis*).

Threats and Disturbances:
The plant species of concern is limited to a narrow slope above Honey Creek that is threatened by encroachment of weedy invasive species introduced by the presence of nearby disturbed and open areas.

Conservation Recommendations:
Further surveys to determine the extent of the hoary puccoon on Honey Creek will aid in preparing a plan to control encroachment by invasive species.

JACKS MOUNTAIN—EAST (Armagh, Brown, Decatur, and Derry Townships, and Snyder County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—West at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential

future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

KISHACOQUILLAS and TREASTER VALLEY KARST (Armagh Township)
The Kishacoquillas Creek and Treaster Run Valleys are karst valleys in Ordovician limestone with abundant cave openings, dry valleys, and sinking streams in an agricultural setting. The valley around Milroy and the Treaster Run Valley contain more than 18 caves, several of which support species of concern. Invertebrate animal species of concern known to this site include the G1G2 S1 **Stellmack's Cave Amphipod (*Stygobromus stellmacki*)**, G5 S2S3 **Price's Cave Isopod (*Caecidotea pricei*),** and the G5 S2S3 **Allegheny Cave Amphipod (*Stygobromus allegheniensis*)**. These crustaceans have only been found in a handful of caves in Pennsylvania. These animals are dependent on the quality of the groundwater in caves and on the influx of organic material for food. The drainage patterns in the Treaster Valley are complex and not completely understood.

Caves known to support hibernating bats should be gated in winter months to prevent disturbance to bats.
Photo source: PNHP

Treaster Run begins to lose water when the stream flows out onto the limestone. Only under very high runoff conditions does the surface channel contain water all the way to Havice Creek (Dayton et al. 1981). The site includes Mammoth Spring, the second largest spring in the state at 14,000 gallons per minute (Patrick 2004). The subterranean linkages between the karst systems of the Treaster and Kishacoquillas Valleys are poorly understood, but studies have shown that there is a hydrologic connection between the two areas (Dayton et al. 1981).

Threats and Disturbances:
The species of concern in this valley are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Much of the Milroy area is within "high growth areas" designated by the Mifflin County Comprehensive Plan (2000). Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity. Alexander Caverns was once commercially open to the public, but has since been closed with limited access.

Conservation Recommendations:
Growth in the Milroy area should be planned with protection of caves and groundwater resources as a high priority. Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater within this core polygon is critical to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Water quality can be improved by limiting livestock access to sinking streams. Protection of these groundwater resources is critical to the water quality of the groundwater in the township. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

LITTLE POE ROAD POOLS (Armagh Township)
The saddle of Long Mountain used by Little Poe Road is occupied by a very small complex of **Ephemeral/Fluctuating Natural Pools,** a GNR S3 community of concern**.** The surrounding forest is composed of white pine (*Pinus strobus*), chestnut oak (*Quercus montana*), black gum (*Nyssa sylvatica)*, red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), and black birch (*Betula lenta*) in the canopy, with a thick mountain laurel (*Kalmia latifolia*) understory. Though the pools are small and few, their condition is good and they lie in an undisturbed setting, thus providing quality habitat for amphibians and other pool-dependent species. The supporting natural landscape for this site is designed to maintain landscape-level connectivity between nearby vernal pool systems.

Threats and Disturbances:
The site is within the Bald Eagle State Forest. The Little Poe Road jeep trail passes within 30 meters (98 feet) of the wetlands but appears to receive little use.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here.

LITTLE WEIKERT RUN POOLS (Armagh Township)
Several scattered vernal pools and wetlands, forming a complex of **Ephemeral/Fluctuating Natural Pools**, a GNR S3 community of concern, occupy a broad step in the slope of Treaster Mountain. Five to six wetland areas were located in 2006 that support vernal pool indicator species. Dominant species of the surrounding forest are black gum (*Nyssa sylvatica*), northern red oak (*Quercus rubra*), red maple (*Acer rubrum*), white oak (*Q. alba*), mountain laurel (*Kalmia latifolia*), and rosebay (*Rhododendron maximum*). The upper pools were primarily ephemeral and unvegetated. Two of the lower wetlands were part of seepages that form the headwaters to Little Weikert Run, and they were vegetated by *Sphagnum* moss and graminoids. The supporting natural landscape for this site illustrates the importance of the watershed to the water quality and sources for Little Weikert Run.

Threats and Disturbances:
The site is within the Bald Eagle State Forest and has been subjected to various past management treatments, including a wildlife food plot, selective logging, and a larger timber sale. Tire ruts in some of the pools are indicative of potential misuse of the area by ATV-users.

Conservation Recommendations:
Access roads should be gated to prevent further disturbance of the wetlands by vehicular traffic. The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here.

MUTTERSBAUGH GAP POOLS (Armagh Township)
The saddle formed south of Bald Mountain is the site of a complex of ten **Ephemeral/Fluctuating Natural Pools**, a GNR S3 community of concern. Many of the vernal pools support populations of a **species of concern**. The surrounding forest is typical upland hardwood, with oaks (*Quercus* spp.), red maple (*Acer rubrum*), black gum (*Nyssa*

One of many seasonal pools at Muttersbaugh Gap
Photo source: PNHP

sylvatica), black birch (*Betula lenta*), and a heath shrub layer. Some of the pools are entirely vegetated with emergent herbaceous vegetation, while others are primarily open water. Wetland plants observed include three-way sedge (*Dulichium arundinaceum*), mannagrass (*Glyceria acutiflora*), wool-grass (*Scirpus cyperinus*), and soft rush (*Juncus effusus*). Many of the pools are likely to retain water year-round. The supporting natural landscape for this site is designed to maintain landscape-level connectivity between nearby vernal pool systems.

Threats and Disturbances:
The site is within the Rothrock State Forest. The Ben Jacobs Trail, an ungated jeep road, borders the pool complex and is being colonized by invasive plant species, such as Japanese stiltgrass (*Microstegium vimineum)*. However, there is little evidence that overuse of the jeep trail extends into the wetlands.

Conservation Recommendations:
Limiting use of the Ben Jacobs Trail could benefit the site by reducing the spread of invasive plant species as well as avoiding potential disturbance of the site by off-trail ATV use. The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant and other species that occur here.

PANTHER RUN-HIGH MOUNTAIN SLOPES
(Armagh Township)
The north-facing slope of High Mountain above Panther Run contains an area of potentially virgin remnant of **Hemlock (White Pine)–Northern Hardwood Forest**, a GNR S3S4 natural community, encompassing roughly 140 acres. This tract is dominated by eastern hemlock (*Tsuga canadensis*) reaching far above the rest of the canopy, with black birch (*Betula lenta*) and eastern white pine (*Pinus strobus*) associated in the lower canopy. At the edges of the hemlock stands are old chestnut oak (*Quercus montana*), northern red oak

Panther Run High Mountain Slopes: Note the large woody debris and the hemlock saplings filling this gap in the canopy.
Photo credit: PNHP

(*Q. rubra*) and red maple (*Acer rubrum*). While old trees are a required component of old growth forest, the community is classified by having quality forest structure. This includes much large woody debris on the forest floor, and many slow-growing subcanopy hemlock trees awaiting the death of one of its ancient neighbors to take advantage of the newly opened hole in the forest canopy.

Threats and Disturbances:
Hemlock Woolly Adelgid (*Adelges tsugae*) presents the greatest threat to this unique natural community. The adelgid is an exotic pest that was first detected in Pennsylvania in 1967. Hemlock woolly adelgid feeds on the fluids found in hemlock needles and injects toxins into the remaining living tissue of the tree. Some trees are able to survive adelgid infestations for years, while others die off quickly. Other pathogens that could threaten this stand include the elongate hemlock scale (*Fiorinia externa*), spruce spider mite (*Oligonychus ununguis*), hemlock rust mite (*Nalepella tsugifolia*), and cryptomeria scale (*Aspidiotus cryptomeriae*).

Conservation Recommendations:
Unfortunately, there is not yet a cost effective measure to control hemlock woolly adelgid. It remains to be seen what the lasting effects of this exotic pest are. The site should be buffered from forestry practices in order to isolate it from invasion by pathogens and invasive plant species that are quick to colonize gaps in the forest from large tree falls.

PENNS CREEK FLOODPLAIN (Armagh Township, Centre County, Union County)
This portion of Penns Creek flows from Centre County to Union County and includes a large portion of level floodplain in the Mifflin County section. The site includes habitats utilized by five invertebrate species of special concern in Pennsylvania. A **species of concern** overwinters at the site and utilizes the surrounding forest habitat for summer foraging and breeding. The G3 S1 **Appalachian Tiger Beetle (*Cicindela ancocisconensis*)**, G5 S2 **River Jewelwing (*Calopteryx aequabilis*),** G4 S1S2 **Appalachian Jewelwing (*Calopteryx angustipennis*),** G5 S2 **Ski-tailed Emerald (*Somatochlora elongata*)**, and G3G4 S2 **Spine-crowned Clubtail (*Gomphus abbreviatus*)** have been documented at the creek prior to the 1980s but not since. However, no comprehensive insect surveys have been done in this vicinity recently, and the insects are still likely to occur at this site. The habitat for these species is the streams and the forested areas along their banks. They live part of their lives in the water, and during this phase they require fairly high water quality. In another part of their life cycle they inhabit the stream banks, and utilize vegetation that naturally occurs there.

The floodplain forest is dominated strongly by tulip tree (*Liriodendron tulipifera*) and American basswood (*Tilia americana*). The community is well developed and mature. This forest type has little understory, even in places where there has not been mechanical clearing, and is surprisingly free of weedy species given the various disturbances in the area. The floodplain is naturally restricted by the sides of Penns Creek gorge to a narrow strip of land, which probably floods periodically.

Penns Creek at Poe Paddy State Park.
Photo source: PNHP

Threats and Disturbances:
The contiguity of the forest community has been disturbed somewhat by the construction of many cabins, an old railroad grade and a powerline cut. In some areas, the vegetation of the forest floor is mechanically removed, preventing tree and shrub regeneration and also damaging the herbaceous community. Continued disturbance of this nature may result in local elimination of some species. Cabins are very prevalent in these forests.

Although the open nature of the forest canopy allows cabins to be built without cutting many surrounding trees, it would nevertheless be beneficial to restrict further construction in unaffected areas. The mechanical removal of underbrush limits natural regeneration.

The floodplain habitat currently appears to be in good condition for the animal species that utilize it. The damselflies and tiger beetle require fairly high water quality to survive, and thus would be sensitive to increased nutrient or sediment pollution, as well as to chemical contaminants from the upstream watershed. As they utilize streambank vegetation, the streambank areas where native vegetation is removed will be unsuitable for them as habitat.

Conservation Recommendations:
Large-scale removal of forest cover should be avoided in this area, especially along the stream banks. Encouraging current land use that is consistent with maintaining high water quality is recommended; this includes keeping and encouraging unmowed buffers along the stream, with fields, pastures and lawns set back from the stream edge. Habitat for the invertebrates can be enhanced through long-term landscape planning for the establishment of a corridor of natural vegetation along the stream, and for improvement of water quality in the stream.

PITCHPINE RIDGE (Armagh Township)
The Pitchpine Ridge contains a dwarf ridgetop tree forest with a mix of stunted oak-hardwoods/pitch pine and a relatively small area of dense scrub oak with scattered pitch pine. Dominant species are scrub oak (*Quercus ilicifolia*), pitch pine (*Pinus rigida*), red maple (*Acer rubrum*), chestnut oak (*Quercus montana*), northern red oak (*Quercus rubra*) and scarlet oak (*Quercus coccinea*). In 2005 a small example of a GNR S3 **Scrub Oak Shrubland** was mapped on this ridge. Tall shrubs in the community are scrub oak and mountain laurel (*Kalmia latifolia*). Short shrubs are black huckleberry (*Gaylussacia baccata*), teaberry (*Gaultheria procumbens*) and lowbush blueberry (*Vaccinium angustifolium*).

Threats and Disturbances:
Though protected in the Bald Eagle State Forest, the long-term persistence of barrens vegetation is threatened by forest succession, fire suppression, logging, and nearby introduced pine plantations.

Conservation Recommendations:
This site would benefit from a prescribed burn to become more viable as a scrub oak natural community. Fire will open the canopy and assist in the regeneration of the small amount of pitch pine that remains. Control of red pine (*Pinus resinosa*) saplings invading from the pine plantation should be implemented. This pine is considered native only to the northcentral portion of Pennsylvania. The barrens should be within a no-cut buffer of at least 100 meters (328 feet).

TALL TIMBERS NATURAL AREA (Armagh Township and Snyder County)
This site covers more than 660 acres of second growth **Hemlock (white pine) – northern hardwood forest**, a G5 S3S4 tracked community in the state, adjacent to the Snyder Middleswarth Natural Area that lies to the east in Snyder County. Despite the name "Tall Timbers", this site actually has shorter trees than Snyder Middleswarth Natural Area because the area was cut centuries ago. While not virgin timber, Tall Timbers has all the components of a functioning old growth forest.

Threats and Disturbances
Hemlock woolly adelgid (*Adelges tsugae*) presents the greatest threat to this unique natural community. The adelgid is an exotic pest that was first detected in Pennsylvania in 1967. Hemlock woolly adelgid feeds on the fluids found in hemlock needles, and injects toxins into the remaining living tissue of the tree. Some trees are able to survive adelgid infestations for years, while others die off rather quickly. Other pathogens that may threaten the integrity of Tall Timbers Natural Area include the elongate hemlock scale (*Fiorinia externa*), spruce spider mite (*Oligonychus ununguis*), hemlock rust mite (*Nalepella tsugifolia*), and cryptomeria scale (*Aspidiotus cryptomeriae*). Over browsing by deer may also limit the number of young oaks in the system.

Conservation Recommendations
Unfortunately, there is not yet a cost effective measure to control hemlock woolly adelgid. It remains to be seen what the lasting effect of this exotic pest is. As a Bureau of Forestry Natural Area, the site is already afforded adequate

protection. Deer hunting at this site should be promoted by the Bureau of Forestry to help maintain a natural composition of trees in the forest.

THICK MOUNTAIN WETLANDS (Armagh Township)
Deep within the Bald Eagle State Forest is a complex of wetlands associated with the headwaters of a small stream on Thick Mountain. Some of these wetlands constitute seasonal pool habitats, forming a community of **Ephemeral/Fluctuating Natural Pools,** a GNR S3 community of concern. The stream meanders, braids and disappears underground intermittently and appears as a narrow swamp forest in some places. The canopy is dominated by black gum (*Nyssa sylvatica*), chestnut oak (*Quercus montana*), northern red oak (*Quercus rubra*), and red maple (*Acer rubrum*). A very thick understory is dominated by mountain laurel (*Kalmia latifolia*) with some black huckleberry (*Gaylussacia baccata*). Though the pools are small and few, their condition is good and they lie in an undisturbed setting, thus providing quality habitat for amphibians and other pool-dependent species.

Threats and Disturbances:
The site is within the Bald Eagle State Forest. The distance of the site from the nearest road or trail as well as the thick understory would be expected to protect the site from human disturbance.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this may be suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate for conservation of vernal pool amphibians. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here.

Wetland openings along Little Weikert Run in the Bald Eagle State Forest. Photo source: PNHP

A semi-permanent pond at Thick Mountain.
Photo source: PNHP

Little Weikert Run Wetlands (Armagh Township)
This headwater mountain stream, generally bordered by a well-drained forest, in some areas opens to wet substrate swamps characterized by various-sized eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), mixed hardwoods, and rosebay (*Rhododendron maximum*). There are also some wet shrub thickets along the stream with the trees and shrubs are on hummocks. Many of the trees lean at various angles or have tipped over. Interspersed among the trees and shrubs are sphagnum/bryophyte patches and colonies of graminoids (especially the sedge *Carex folliculata*). Overall, these wetlands are

picturesque and unique to the county even though the flora is not particularly diverse.

Threats and Disturbances:
The site is within Bald Eagle State Forest and is in close proximity to logging operations. Logging without an adequate buffer to the stream and wetlands could alter the hydrology of this area and reduce the quality of the wetland habitats.

Conservation Recommendations:
A 100-meter (328-foot) no-cut buffer should be established around the complex of stream and wetlands.

Seasonal pool at Big Flat

Armagh Township contains the largest contiguous forest blocks in the county, most of which are managed by the Bald Eagle State Forest. Photo source: PNHP

Vernal Pools

Vernal pools rely soley on precipitation, groundwater and runoff for sources of water input. These pools are void of fish species because of the cyclic pattern of alternating wet/dry periods. For this reason, vernal pools support a wide array of organisms that are specially adapted to the varying hydroperiod, particularly several species of amphibians.

a marbled salamander migrating to a vernal pool

Vernal ponds are essential breeding habitat for amphibians.

a gray treefrog calling at a vernal pool

Bratton Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
BLACKLOG MOUNTAIN at SPRUCE RUN			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/16/1992	E
BLACKLOG MOUNTAIN at T328			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/30/1992	E
BLUE MOUNTAIN at CARLISLE GAP			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/16/1992	E
BLUE MOUNTAIN at WHITSEL TRAIL			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/17/1992	E
JUNIATA RIVER—MIFFLIN COUNTY			*High Significance*		
Yellow Lampmussel (*Lampsilis cariosa*)	G3G4	S3S4	-	7/20/2006	C
WEST LICKING CREEK HEADWATERS			*High Significance*		
Plant: netted chainfern (*Woodwardia areolata*)	G5	S2	-	7/5/2006	BC
Plant: screw-stem (*Bartonia paniculata*)	G5	S3	-	8/22/2006	D
East Licking Creek Wetlands			*Local Significance*		
Shanks Run Cave			*Local Significance*		
West Licking Creek Wetlands			*Local Significance*		

PUBLICLY MANAGED LANDS: Tuscarora State Forest

OTHER CONSERVATION AREAS: Blacklog Mountain Important Mammal Area

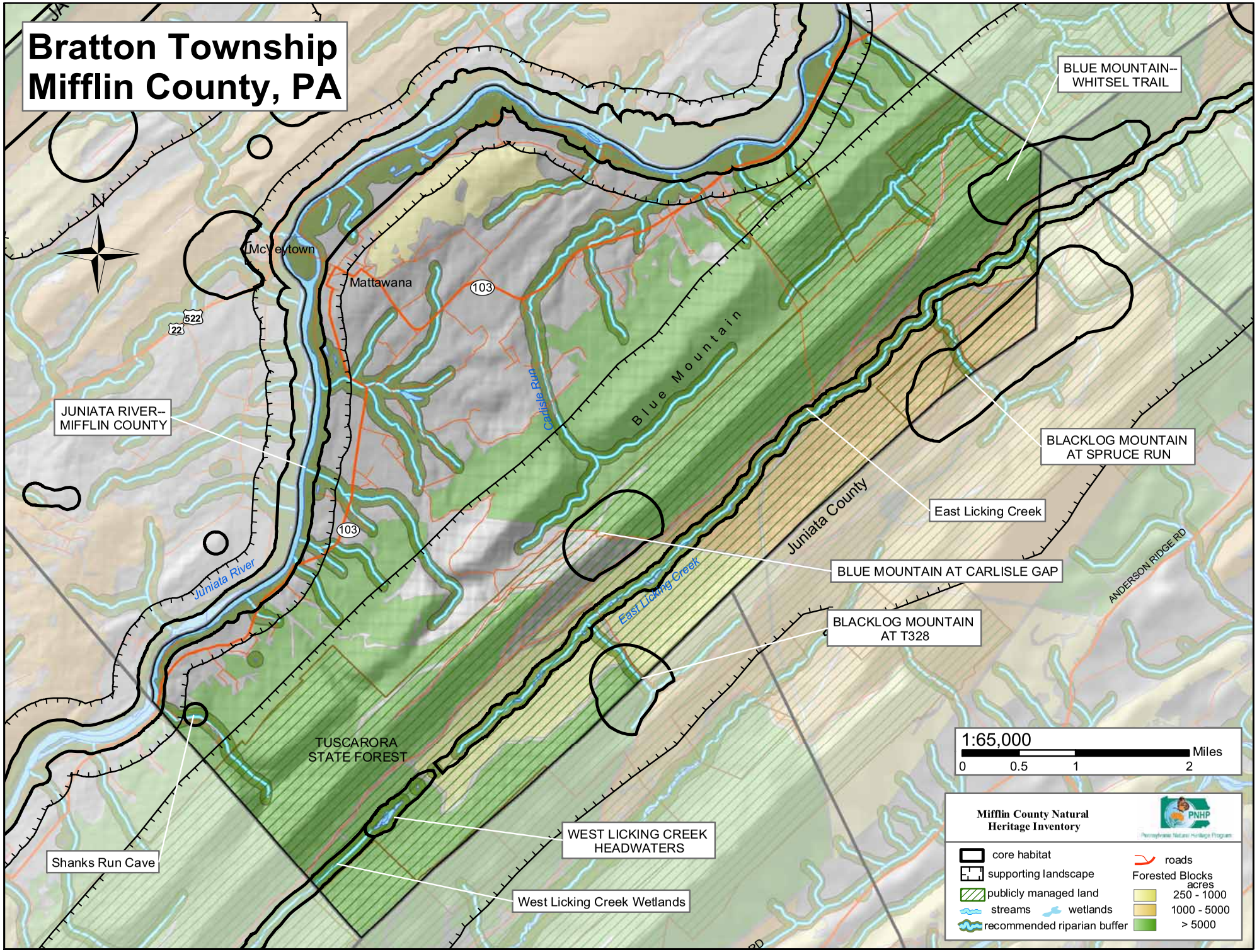
HIGH QUALITY STREAMS: East Licking Creek, West Licking Creek, Carlisle Run, Minehart Run, Shanks Run, Unnamed Tributaries to Juniata River

AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- East Licking Creek - Atlantic River and Impoundment Community; High Quality Small Stream Community; Eastern Elliptio Community
- Juniata River—Carlisle Run - Warmwater Community 1; High Quality Small Stream Community
- Juniata River—Kishacoquillas Creek - Coolwater Community 1; High Quality Small Stream Community; Eastern Elliptio Community
- Juniata River—Shanks Run - Coldwater Community; Eastern Elliptio Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.


Bratton Township
Mifflin County, PA
BLUE MOUNTAIN--
WHITSEL TRAIL
McVeytown
Mattawana
103
522
22
Blue Mountain
Carlisle Run
JUNIATA RIVER--
MIFFLIN COUNTY
BLACKLOG MOUNTAIN
AT SPRUCE RUN
East Licking Creek
Juniata County
BLUE MOUNTAIN AT CARLISLE GAP
ANDERSON RIDGE RD
Juniata River
East Licking Creek
BLACKLOG MOUNTAIN
AT T328
TUSCARORA
STATE FOREST
WEST LICKING CREEK
HEADWATERS
Shanks Run Cave
West Licking Creek Wetlands
1:65,000
Miles
0
0.5
1
2
Mifflin County Natural
Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks
acres
250 - 1000
1000 - 5000
> 5000

BRATTON TOWNSHIP

Bratton Township is located on the southern edge of Mifflin County, where it borders Juniata County to the south. Blacklog Mountain creates the border with Juniata County and the Juniata River creates the northern border. The bedrock geology is composed mainly of shale with some smaller areas of sandstone. Bratton Township has the second highest forested land use in the county, at 74%. The southeastern half of the township is part of the Blue Mountain ridgeline and is largely managed by the Tuscarora State Forest. Conservation efforts to buffer the edges of the state forest from development and disturbance are important to the long-term quality of the wildlife and land resources within this corridor. This portion of the forested ridges provides connectivity to neighboring townships and counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.

Much of the biodiversity of the township can be maintained by providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

Agriculture makes up 21% of the total land use in Bratton Township, the second lowest in Mifflin County. The Juniata River and East Licking Creek are the major waterways flowing through the township, including three high quality tributary streams. East Licking Creek and some other smaller streams flow through the large forested blocks in the southern portion of Bratton Township, providing an excellent buffer to filter out sediment and other pollutants before they enter into the stream. The Juniata River and the streams that run through the northern part of the township flow through open agricultural areas. Trees should be planted in these areas to buffer the stream and improve water quality. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Blacklog Mountain Important Mammal Area (IMA) is located in southern Bratton Township. This site was chosen due to the presence of habitat for a state threatened species, as well as other mammals.

Talus slopes are characteristic habitat for the Allegheny Woodrat and the Timber Rattlesnake.
Photo source: PNHP

BLACKLOG MOUNTAIN at SPRUCE RUN
(Bratton Township and Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located in rock outcrops on Blacklog Mountain during surveys in 1992. This species has been located at several locations along the Blacklog Mountain. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes, and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

BLACKLOG MOUNTAIN at T328 (Bratton Township and Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located in a sandstone talus field during surveys in 1992. The surrounding forest included black birch (*Betula lenta*), eastern hemlock (*Tsuga canadensis*), northern red oak (*Quercus rubra*), with a shrub layer of witch-hazel (*Hamamelis virginiana*). Porcupine signs were also observed at the site. The woodrat has been located at several sites along the Blacklog Mountain. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

BLUE MOUNTAIN at CARLISLE GAP
(Bratton Township)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located on the power line right-of-way during surveys in 1992. The power line lies on a talus slope and maintains an open canopy. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental

Though fragmenting the forest interior, this powerline maintains an open talus slope that can provide habitat for Allegheny Woodrats and Timber Rattlesnakes.
Photo source: PNHP

influences.

BLUE MOUNTAIN at WHITSEL TRAIL
(Bratton Township and Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located in rock outcrops on Blue Mountain during surveys in 1992. This species has been located at several locations along the Blue and Blacklog Mountains. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

JUNIATA RIVER—MIFFLIN COUNTY
(Bratton, Granville, and Wayne Townships)
Several species of freshwater mussels inhabit suitable habitat in portions of the Juniata River. One of these is considered a species of concern due to declines in its global and state range and abundance: the G3G4, S3S4 **Yellow Lampmussel (*Lampsilis cariosa*)**. The lampmussel is a species of larger rivers and is primarily found in sand and gravel with a good current. Pennsylvania is host to a large percentage of the Yellow Lampmussels in North America; therefore, preservation of the Commonwealth's populations is critical to the global conservation of the species. Associated species are the Common Elliptio (*Elliptio complanata*) and the Rainbow Mussel (*Villosa iris*), as well as the introduced Asian Clam (*Corbicula fluminea*) and Rusty Crayfish (*Orconectes rusticus*). Downstream portions of the river support a higher diversity of freshwater mussels, including several additional rare species. The entire length of the Juniata River should be considered suitable habitat for most of these freshwater mussel species. Additional surveys could be useful in estimating populations and distribution of the species of concern in the river. The G5 S4 Illinois pondweed (*Potamogeton illinoensis*), an aquatic plant that was recently removed from the list of species of concern, was found near Newton Hamilton in 1991. Surveys in 2006 failed to locate any populations of the plant, but its persistence cannot yet be ruled out.

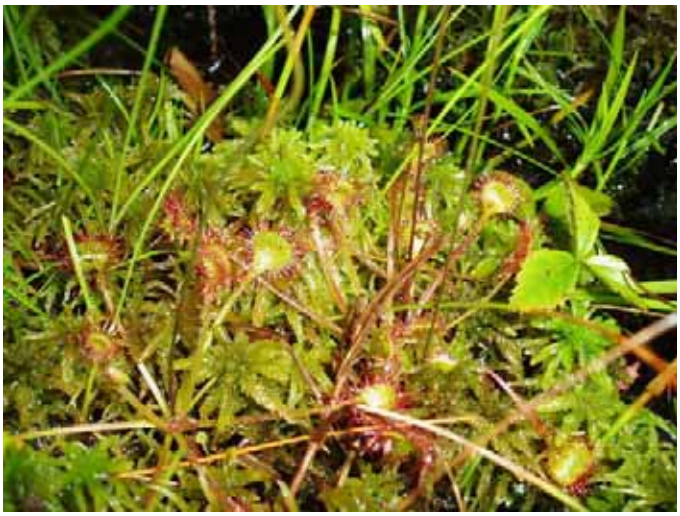
Threats and Disturbances:
There are numerous examples of disturbance along the Juniata River. Freshwater mussels are affected by non-point sources of pollution, including sedimentation from cultivated and developed land along the river, runoff from roadways, pesticide runoff from agricultural fields, discharge of chemical pollutants, and thermal pollution. There may also be a threat posed by competition from the Asian Clam and predation by the Rusty Crayfish, but the level of these threats is not fully understood.

Conservation Recommendations:
Any of the above types of disturbances should be minimized wherever possible. Also, monitoring of these populations should continue into the future. Water quality should be monitored and pollution sources should be identified and corrected. Forested buffers should be preserved where present

Impacts of non-point sources of pollution are felt far downstream in the Juniata River mainstem.

Photo source: PNHP

and created where absent along the length of the river, with logging operations refraining from cutting within 100 meters (328 feet) of the river edge. River bank forests help buffer the watershed from the effects of non-point sources of pollution, including runoff from agricultural, residential, and roadway settings. In addition, the river floodplain and corridor is usually an area of significantly higher biodiversity than the adjoining uplands. Maintaining or restoring an intact, forested floodplain along the river can preserve much of the area's important biodiversity. Local planning should discourage construction of new structures and roadways along the river, adjacent slopes, and floodplain. Additional information on riparian buffers can be found on page 66.



Sundews

Photo source: PNHP

WEST LICKING CREEK HEADWATERS
(Bratton Township)
The headwaters of West Licking Creek are in an old beaver pond that remains as an open-canopy sphagnous wetland. A thick herbaceous layer developed as the waters receded. Populations of the G5 S2 **Netted chainfern (*Woodwardia areolata*)** and the G5 S3 **Screw-stem (*Bartonia paniculata*)** are found in this wet meadow. These plants are restricted to acidic seep wetlands, which are uncommon in the state. The upper parts of the West Licking Creek drainage are characterized by several of these wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain. Dominant plants in the meadows include *Sphagnum* moss, tussock sedge (*Carex stricta*) and other sedges (*Carex* spp.), cinnamon fern (*Osmunda cinnamomea*), three-way sedge (*Dulichium arundinaceum*), tawny cotton-grass (*Eriophorum virginicum*), rushes (*Juncus* spp.), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), swamp dewberry (*Rubus hispidus*), black huckleberry (*Gaylussacia baccata*), and round-leaved sundew (*Drosera rotundifolia*). The seeps and wetlands also provide habitat for several reptile and amphibian species, such as the Wood Frog.

Netted chainfern (*Woodwardia areolata*)

Photo source: PNHP

Threats and Disturbances:
The site is within the Tuscarora State Forest and remains relatively undisturbed. Jeep trails and footpaths in the vicinity are providing disturbance pathways for invasive plant species such as Japanese stiltgrass (*Microstegium vimineum*) to establish, but few invasives were found in the wetland. Though the open wet meadows in this drainage were created by beavers, the limited distribution of the rare plants make their populations vulnerable to further alterations in hydrology such as flooding or draining.

Conservation Recommendations:
The wetland meadow of the West Licking Creek headwaters should be buffered by 100 meters (328 feet) from any logging operations in order to maintain the ecological integrity of the wetlands and the water quality of the groundwater seeps and surface water flowing to these wetlands. Populations of invasive plants should be monitored for encroachment into the more sensitive wetland systems. If beavers were to return to the area and

flood the headwater meadow, a trapping regime should be employed to sustain the rare plants.

East Licking Creek Wetlands (Bratton Township)
The upper parts of the East Licking Creek drainage are characterized by several wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain. Dominant plants in the meadows include *Sphagnum* moss, sedges (*Carex* spp.), cinnamon fern (*Osmunda cinnamomea*), marsh fern (*Thelypteris palustris*), sensitive fern (*Onoclea sensibilis*), smooth alder (*Alnus serrulata*), rushes (*Juncus* spp.), red maple (*Acer rubrum*), yellow birch (*Betula alleganiensis*), and swamp dewberry (*Rubus hispidus*). The seeps and wetlands also provide habitat for several reptile and amphibian species, such as the Red-spotted Newt. East Licking Creek is designated as a High Quality stream.

Seeps and braided streams create diverse habitats within forested swamps and floodplains of East Licking Creek.
Photo source: PNHP

Threats and Disturbances:
The site is within the Tuscarora State Forest and remains relatively undisturbed. Jeep trails and footpaths in the vicinity are providing disturbance pathways for invasive plant species such as Japanese stiltgrass (*Microstegium vimineum*) to establish, but few invasives were found in the wetlands.

Conservation Recommendations:
The East Licking Creek drainage should be buffered by 100 meters (328 feet) from any logging operations in order to maintain the ecological integrity of the wetlands and the water quality of the groundwater seeps and surface water flowing to these wetlands. Populations of invasive plants should be monitored for encroachment into the more sensitive wetland systems. Pioneer populations of invasive species should be removed when discovered to avoid major infestations in the future.

Shanks Run Cave (Bratton Township)
The Juniata River valley contains a few cave entrances, such as Shanks Run Cave in Devonian limestone occurring in the hillside above Shanks Run. The cave is a tight passage that does not extend far (Dayton et al. 1981). This cave is contained within the large forest block contiguous with the Tuscarora State Forest.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the cave environment. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats.

West Licking Creek Wetlands (Bratton and Wayne Townships)
The upper parts of the West Licking Creek drainage are characterized by several wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain. Dominant plants in the meadows include *Sphagnum* moss, sedges (*Carex* spp.), slender spike rush (*Eleocharis tenuis*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), three-way sedge (*Dulichium arundinaceum*), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), swamp dewberry (*Rubus hispidus*), and black huckleberry (*Gaylussacia baccata*). The seeps and wetlands also provide habitat for several reptile and amphibian species, such as the Eastern Garter Snake. A few scattered seasonal pools are found within the floodplain.

Threats and Disturbances:
The site is within the Tuscarora State Forest and remains relatively undisturbed. Jeep trails and footpaths in the vicinity are providing disturbance pathways for invasive plant species such as Japanese stiltgrass (*Microstegium vimineum*) to establish, but few invasives were found in the wetlands.

Conservation Recommendations:
The West Licking Creek drainage should be buffered by 100 meters (328 feet) from any logging operations in order to maintain the ecological integrity of the wetlands and the water quality of the groundwater seeps and surface water flowing to these wetlands. Populations of invasive plants should be monitored for encroachment into the more sensitive wetland systems.

Wetland openings interspersed along the banks of West Licking Creek

Photo source: PNHP

Brown Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
JACKS MOUNTAIN SLOPES			*Notable Significance*		
Species of concern[3]				5/1/2002	E
JACKS MOUNTAIN—EAST & WEST			*Notable Significance*		
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
LINGLE CREEK HEADWATERS AT BEAR GAP			*Notable Significance*		
Gray Petaltail Dragonfly (*Tachopteryx thoreyi*)	G4	S3	-	6/28/2006	E
Species of concern[3]				6/28/2006	D
SPRUCE GAP POOLS			*High Significance*		
Community: Ephemeral/fluctuating Natural Pool	GNR	S3	-	10/3/2006	C
Species of concern[3]				6/28/2006	E
TEA CREEK			*High Significance*		
Animal: Northern Water Shrew (*Sorex palustris albibarbis*)	G5T5	S3	-	8/22/1996	B
Chestnut Springs Pools			*Local Significance*		
Coffee Run Spring Cave			*Local Significance*		
Reedsville Cave			*Local Significance*		
Stone Creek Road Wetlands			*Local Significance*		

PUBLICLY MANAGED LANDS: Rothrock State Forest

OTHER CONSERVATION AREAS: Rothrock State Forest and Stone Mountain Important Bird Area; Central Mountain Important Mammal Area

HIGH QUALITY STREAMS: Honey Creek, Lingle Creek, Tea Creek

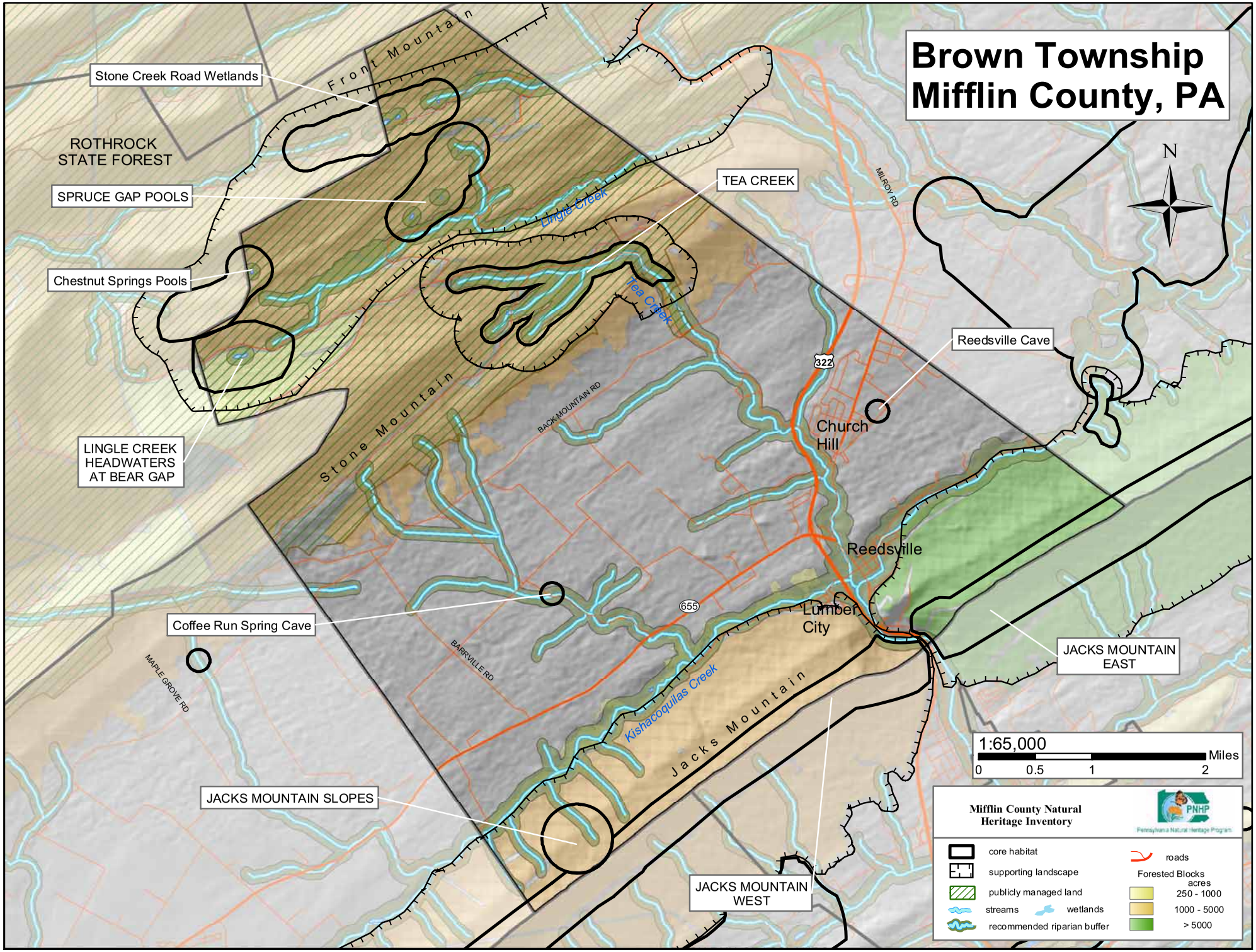
AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Honey Creek - Coolwater Community 2
- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Kishacoquillas Creek—Coffee Run - Warmwater Community 1; Low Gradient Valley Stream Community
- Laurel Creek - Coldwater Community; Common Large Stream Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.


Brown Township
Mifflin County, PA
N
Stone Creek Road Wetlands
ROTHROCK
STATE FOREST
SPRUCE GAP POOLS
Chestnut Springs Pools
LINGLE CREEK
HEADWATERS
AT BEAR GAP
Coffee Run Spring Cave
JACKS MOUNTAIN SLOPES
JACKS MOUNTAIN
WEST
JACKS MOUNTAIN
EAST
TEA CREEK
Reedsville Cave
Front Mountain
Stone Mountain
Jacks Mountain
Lingle Creek
Tea Creek
Kishacoquilas Creek
BACK MOUNTAIN RD
BARRVILLE RD
MAPLE GROVE RD
MILROY RD
322
655
Church
Hill
Reedsville
Lumber
City
1:65,000
Miles
0
0.5
1
2
Mifflin County Natural
Heritage Inventory
PNHP
Pennsylvania Natural Heritage Program
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks
acres
250 - 1000
1000 - 5000
> 5000

Brown Township is located along the northern edge of Mifflin County, where it borders Huntingdon County and Centre County. The bedrock is comprised of limestone in the southern portion of the township and shale, sandstone, and slate in the north. Stone Mountain and Front Mountain run along the northern part of Brown Township, and Jacks Mountain makes up the southern township border, with the Kishacoquillas Valley located in between. This valley is host to a high concentration of caves and associated sinkholes, sinking streams, and groundwater resources. Brown Township is 55% forested, which mostly occurs in large forested blocks in the north and south. The forests of Jacks Mountain have remained intact except for Rt. 322 cutting through.

Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

The northern slopes of Jacks Mountain rise above the Kishacoquillas Valley in Brown Township.
Photo source: PNHP

This portion of the forested ridges provides connectivity to neighboring counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.

Forty percent of the total land use in Brown Township is agriculture, located in the valley running through the middle of the township. Kishacoquillas Creek and Tea Creek are the major streams flowing through Brown Township. Most of the headwater streams originate from heavily forested areas, which provide a good buffer to filter out sediments and chemicals. Other streams flow through the agricultural areas, which provide little buffering capacity for water entering into the streams. Trees should be planted along streams to filter runoff. Conservation efforts within the township could concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the pass through Jacks Mountain. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains Important Mammal Area (IMA) is located in the northern forests and the southeastern portion of Jacks Mountain in Brown Township. The Rothrock State Forest/ Stone Mountain Important Bird Area (IBA) is also located in the large forest blocks in northern Brown Township. This area was chosen as an IBA because of the old growth forests remaining in this area, and the ridgeline that is used as a raptor migration route in the fall.

JACKS MOUNTAIN SLOPES (Brown Township)
The Jacks Mountain Slopes overlook the Kishacoquillas Creek. Nests of a globally secure, state vulnerable **species of concern** were located at this forested site in 2002.

Threats and Disturbances:
This site occurs on private land and could be threatened by future timbering operations. Because of the steep nature of the site, it is unlikely that the private land would be developed. The species of concern is dependent on the tall canopy trees and forest matrix at the site.

Conservation Recommendations:
The site would be best protected by the establishment of a 100-meter (328-foot) no-cut forested buffer. Conservation options such as an easement should be discussed with the landowner in order to protect the site from future development or forest mismanagement.

JACKS MOUNTAIN—EAST & WEST
(Armagh, Brown, Decatur, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; Huntingdon and Snyder Counties)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but the Jacks Mountain—East and West are disconnected from each other at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

LINGLE CREEK HEADWATERS AT BEAR GAP (Brown Township)
The headwaters of Lingle Creek at Bear Gap are a hemlock-white pine palustrine wetland with a boggy S*phagnum* moss substrate interwoven with rivulets and the stream. There are several large canopy eastern white pines (*Pinus strobus*) in a matrix of eastern hemlock (*Tsuga canadensis*) and rosebay (*Rhododendron maximum*) understory. The area is surrounded by mixed oak-hardwood upland forest. The canopy cover is partial and provides for several small meadow-like openings dominated by S*phagnum* moss, graminoids and ferns, including soft rush (*Juncus effusus*), marsh fern (*Thelypteris palustris*), and sedges such as *Carex baileyi, C. lurida, C. gynandra,* and *C. folliculata*. These seepy openings were found to support the G4 S3 **Gray Petaltail Dragonfly (*Tachopteryx thoreyi*)**. This large dragonfly breeds in spring-fed hillside seeps in forested habitats. Foraging adults usually perch in sunny openings on tree trunks or logs but are also known for perching on the occasional human observer. This site also supports a nesting population of a globally secure,

state vulnerable **species of concern** that relies on the forested matrix found at the site.

Threats and Disturbances:
Currently the habitat for the species of concern appears to be stable but should be monitored so that any threats that may arise could be swiftly addressed. A recent logging operation to the west may have an effect on the foraging habitat for these species of concern. The site is within Rothrock State Forest and could be included in future forest management operations. The site is not large and does not provide much habitat for expansion of the existing populations of species of concern.

Gray Petaltail Dragonfly (*Tachopteryx thoreyi*) lands on a surveyors shoulder. Photo source: PNHP

Conservation Recommendations:
The site would be best protected by the establishment of a 100-meter (328-foot) no-cut forested buffer around any wetlands and springs. Maintenance of water quality of the springs is dependent on best management practices on the nearby logging sites as well as the adjacent gravel road. The site should be monitored for persistence of the species of concern as well as habitat availability.

SPRUCE GAP POOLS (Brown Township)
Several clusters of seasonal wetlands are located on steps in the slope of Brush Ridge, together forming a complex of **Ephemeral/Fluctuating Natural Pools,** a GNR S3 community of concern. One cluster of pools is leaf litter bottom and does not hold water for long. Two additional clusters of pools are tied to seasonal spring sources and are partially vegetated with emergent Graminoid plants, including rice cutgrass (*Leersia oryzoides*), slender mannagrass (*Glyceria melicaria*), *Sphagnum* moss, and sedges (*Carex intumescens*, *Carex atlantica*, *Carex lupulina*). These pools support a small population of a **species of concern.** The surrounding forest is well-drained oak-mixed hardwood with heath understory.

Threats and Disturbances:
The site is within the Rothrock State Forest and has been influenced by nearby forestry operations and a wildlife food plot.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this is usually suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate if vernal pool amphibians are to be conserved. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and the plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant and other species that occur here.

TEA CREEK (Brown Township)
The Tea Creek watershed is the home of the currently southernmost documented population of G5T5 S3 **Northern Water Shrew (*Sorex palustris albibarbis*)** in Pennsylvania. Tea Creek is a high gradient clearwater mountain stream with lush understory along its margins, providing optimal habitat for this small mammal. The surrounding forest is northern red oak (*Quercus rubra*), black oak (*Q. velutina*), and chestnut oak (*Q. montana*) with black birch (*Betula lenta*) and mountain laurel (*Kalmia latifolia)*.

Tea Creek

Photo source: PNHP

Threats and Disturbances:
The drainage is within Rothrock State Forest and appears to be in good condition. The shrew eats aquatic macroinvertebrates that rely on high quality waters. An alteration of the water quality may in turn affect populations of the shrew or its food sources.

Conservation Recommendations:
Tea Creek should be buffered from disturbances such as logging or road maintenance by at least 100 meters (328 feet) in order to prevent siltation and damage to the riparian vegetation.

Chestnut Springs Pools (Brown Township, Huntingdon County)
One large pool and small isolated pools are located in a saddle of Brush Ridge. The larger pond is likely to hold water year-round and provide an important water resource for wildlife. Emergent vegetation is dominated by three-way sedge (*Dulichium arundinaceum*). The surrounding forest has an open aspect with typical oak-mixed hardwood with heath understory.

Threats and Disturbances:
The site is with the Rothrock State Forest and is bordered by the Brush Ridge trail. This trail gets little use and does not appear to pose a threat to the wetland.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this is usually suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate if vernal pool amphibians are to be conserved. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and the plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the amphibian species that occur here.

A small seasonal pool nestled amongst the heath at Chestnut Springs.

Photo source: PNHP

Coffee Run Spring Cave

Coffee Run Spring Cave (Brown Township)
Coffee Run Spring Cave is part of the extensive Ordovician limestone karst system in the Kishacoquillas Valley. The cave entrance, at the base of a limestone bluff, is the main source of Coffee Run. Connectivity with other underground systems in the valley is unknown. The presence of the spring head has limited exploration of this cave and its ability to support animal species of concern is unknown. Just upstream is the outlet for Yoder Spring, with a measured yield of 1,230 gallons per minute (Geyer and Bolles 1987).

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats. Additional surveys of the cave system, especially for invertebrates, are recommended.

Reedsville Cave (Brown Township)
Reedsville Cave is part of the extensive Ordovician limestone karst system in the Kishacoquillas Valley. The cave entrance has apparently become blocked by debris and it is little studied. An underground stream flows through a portion of the cavern. Connectivity with other underground systems in the valley is unknown.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and

Stone Creek Road Wetlands

Photo source: PNHP

structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats. Efforts to clear unnatural debris from the cave entrance zone could improve the cave environment of Reedsville Cave for animal inhabitants.

Stone Creek Road Wetlands (Brown Township, Huntingdon County)
A series of wetlands and vernal pools is located at the watershed divide between Laurel Creek and Standing Stone Creek as well as along the headwaters of each drainage. The wetlands are characterized by shallow but saturated sphagnous substrate, with scattered clumps of shrubs and trees growing on hummocks within the otherwise open canopied wetlands. Graminoids include three-way sedge (*Dulichium arundinaceum)*, wool-grass (*Scirpus cyperinus)*, rice cutgrass (*Leersia oryzoides*), cinnamon fern (*Osmunda cinnamomea*), and sedges (*Carex gynandra*, *Carex intumescens*, *Carex trisperma*, *Carex canescens*). Some isolated pools within this site are relatively unvegetated but provide habitat for amphibians and aquatic invertebrates.

Threats and Disturbances:
This site is within the Rothrock State Forest. Hunting camps border some of the wetlands.

Conservation Recommendations:
The Bureau of Forestry uses vernal pool buffers of 100 feet of no-cut, and 100 feet more of 50% cut. While this is usually suitable for maintaining aesthetic vernal pool characteristics, the 200-foot buffer is inadequate if vernal pool amphibians are to be conserved. A minimum 305-meter (1000-foot) no-cut forested buffer, as illustrated by the core habitat polygon, should be established around the pools at this site to protect the unique suite of vernal pool amphibians and the plants that inhabit this community. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here.

Decatur Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
BELLTOWN POOLS			*Notable Significance*		
Community: Ephemeral/Fluctuating Natural Pools	GNR	S3	-	8/15/2006	D
JACKS MOUNTAIN—EAST			*Notable Significance*		
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
MOWRY RUN POOLS			*High Significance*		
Community: Ephemeral/Fluctuating Natural Pools	GNR	S3	-	3/30/2006	C
PLEASANT VALLEY KARST			*Exceptional Significance*		
Species of concern[3]				10/7/2002	B
Species of concern[3]				2/14/1997	E
Species of concern[3]				2/14/1997	D
SHINDLE GAP			*High Significance*		
Species of concern[3]				1/27/2000	E
WAGNER GAP			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	10/10/1995	E
WAGNER RUN POOLS			*High Significance*		
Plant: false hop sedge (Carex lupuliformis)	G4	S1	-	7/26/2006	BC
Community: Ephemeral/Fluctuating Natural Pools	GNR	S3	-	3/30/2006	C
Herblengths Cave			*Local Significance*		

PUBLICLY MANAGED LANDS: Bald Eagle State Forest, State Game Lands #107

OTHER CONSERVATION AREAS: Central Mountains Important Mammal Area, Blacklog Mountain Important Mammal Area

EXCEPTIONAL VALUE/HIGH QUALITY STREAMS: None

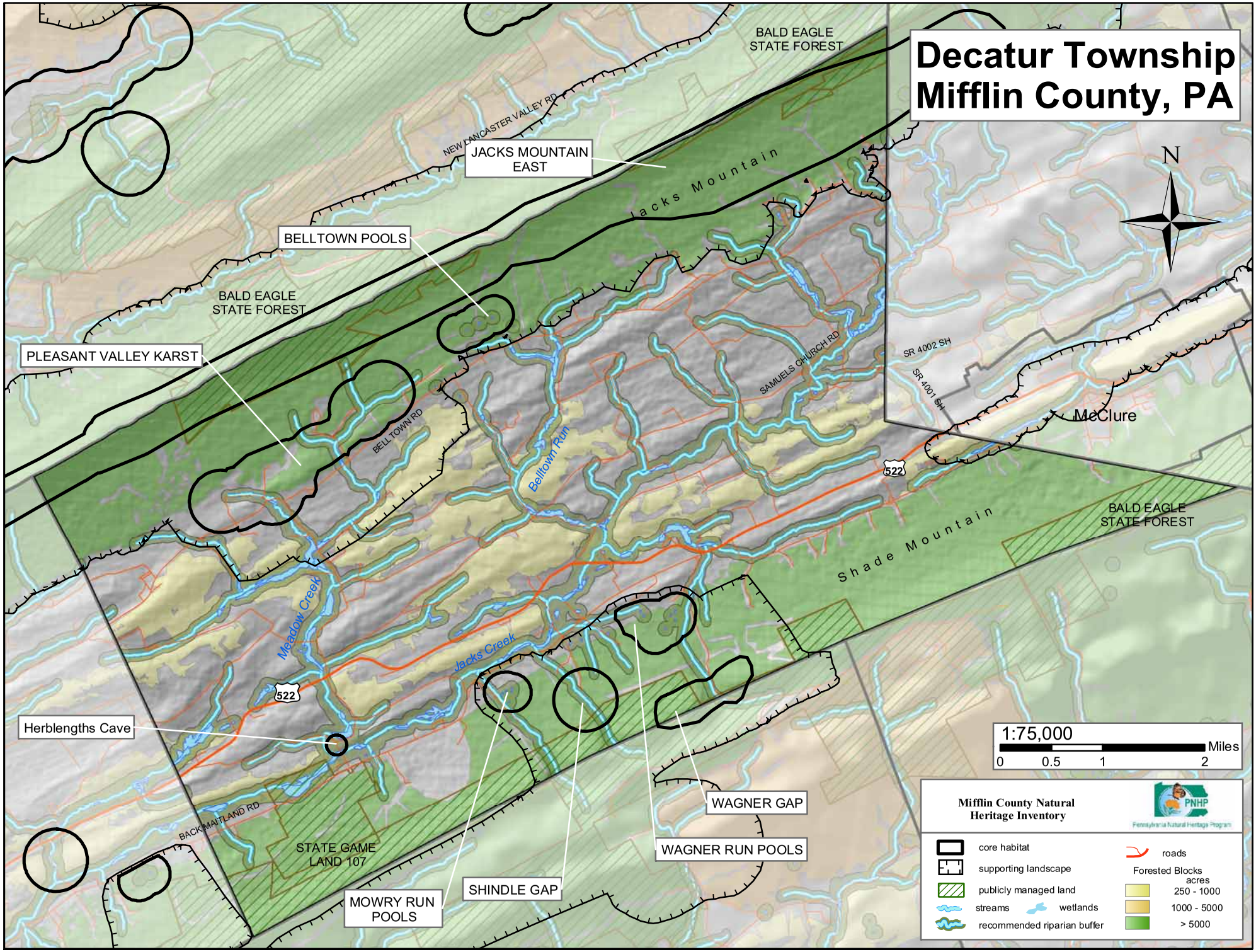
AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Jack's Creek - Warmwater Community 1; Low Gradient Valley Stream Community
- Middle Creek—Faylor Lake Dam - Warmwater Community 1

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.


Decatur Township
Mifflin County, PA
BALD EAGLE STATE FOREST
NEW LANCASTER VALLEY RD
JACKS MOUNTAIN EAST
Jacks Mountain
BELLTOWN POOLS
BALD EAGLE STATE FOREST
PLEASANT VALLEY KARST
BELLTOWN RD
Belltown Run
SAMUELS CHURCH RD
SR 4002 SH
SR 4001 SH
McClure
522
Shade Mountain
BALD EAGLE STATE FOREST
Meadow Creek
Jacks Creek
522
Herblengths Cave
BACK MAITLAND RD
STATE GAME LAND 107
MOWRY RUN POOLS
SHINDLE GAP
WAGNER GAP
WAGNER RUN POOLS
N
1:75,000
Miles
0 0.5 1 2
Mifflin County Natural Heritage Inventory
PNHP
Pennsylvania Natural Heritage Program
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks acres
250 - 1000
1000 - 5000
> 5000

Decatur Township is located in southeastern Mifflin County, bordered by Snyder County to the east and Juniata County to the south. Jacks Mountain forms the northern border and Shade Mountain forms the southern border. The bedrock geology is mostly comprised of shale with some areas of sandstone and limestone. Decatur Township is 65% forested, with most large forest blocks occurring in the northern and southern ends of the township. Other more fragmented forest blocks occur in the center of the township. There is the potential for these forest blocks to be connected by planting a corridor of trees between existing forests. Bald Eagle State Forest and State Game Lands 107 are partially located in Decatur Township, but they make up very little acreage.

Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

Agriculture makes up 31% of the total land use and is located in the center of the township. Jacks Creek is the major stream flowing through Decatur Township. Most of the streams in this township flow through the less forested areas in the center of the township. The open areas do not filter out the sediments and chemicals as well as forested areas do. Trees should be planted along the streams to provide a buffer and connect habitat. Conservation efforts within the township could concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested portions of the township. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains and the Blacklog Mountains Important Mammal Areas (IMA) are located in northern and southern Decatur Township, respectively. The Blacklog Mountain IMA was chosen due to the presence of habitat for a state threatened species, as well as other mammals.

Even narrow riparian buffers such as this one, provide benefits to improving water quality in the streams of the township. Wider buffers can provide additional benefits of improved water quality, wildlife habitat and wildlife corridors.
Photo source: PNHP

BELLTOWN POOLS (Decatur Township)
A small cluster of seasonal pools is located on the lower slope of Jacks Mountain near Belltown, together forming a complex of **Ephemeral/Fluctuating Natural Pools**, a GNR S3 community of concern. The ponds are interspersed among several new homes in a wooded development. One of the four is in a more continuous forest setting. The surrounding forest is well-drained oak-mixed hardwood with a moderate shrub layer. Though in a disturbed landscape, the pools support several vernal pool obligate species of amphibians, plants, and invertebrates.

Threats and Disturbances:
The lack of buffer between housing developments and roads and these pools will likely adversely influence the ponds over time. Invasive plant species are already encroaching on several of the pools. Additionally, the increased sunlight reaching the ponds may alter their vegetation and hydrology.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around the pools in this complex. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here. Landowners should be encouraged to buffer the pools from roads, mowing, dumping, and landscaping projects.

JACKS MOUNTAIN—EAST
(Armagh, Brown, Decatur, and Derry Townships, and Snyder County) The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—West at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:

The Timber Rattlesnake likely has small populations along the southeast-facing slopes of Jacks Mountain.

Photo source: Charlie Eichelberger

Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

MOWRY RUN POOLS (Decatur Township)
Several seasonal and permanent pools are clustered on the northern slope of Shade Mountain in the Mowry Run drainage, together forming a complex of **Ephemeral/Fluctuating Natural Pools,** a GNR S3 community of concern. Most of the ponds are small and dry very quickly after spring snowmelt and rains, though at least one appeared to be permanently filled. Dominant tree species at the site included white oak (*Quercus alba*), black gum (*Nyssa sylvatica*), eastern white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), and black birch (*Betula lenta*).

Threats and Disturbances:
The site is owned by multiple private landowners. Logging within proximity to the pools without adequate buffers could disturb the hydrology, vegetation, and wildlife value of these wetlands.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around the pools in this complex. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the amphibian and other species that occur here. Conservation options such as easements should be discussed with the private landowners in order to best protect the site from future development or forest mismanagement.

Aquatic invertebrates can inhabit underground water in caves if the water quality is high. Photo source: PNHP

Many of the pools at Mowry Run are subject to rapid drying
Photo source: PNHP

PLEASANT VALLEY KARST
(Decatur Township)
The Pleasant Valley is a karst valley in Devonian Helderberg limestone with abundant cave openings and sinking streams in an agricultural setting. The valley contains 5 caves, several of which support animal species of concern. The subterranean linkages between the karst systems of this site are poorly understood, but the geology indicates that hydrologic connection between the individual caves is likely.
Threats and Disturbances:
The species of concern in this valley are sensitive to even minor disturbance to the water quality and cave environment. Streams and

surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity. Formerly open as a commercial cave, at least one of the caves in this system is now gated, allowing limited access.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is important for human uses and critical to maintaining the aquatic life in the caves. Water quality can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

SHINDLE GAP (Decatur Township)
The forested gap of Shindle Run provides a refuge and summer foraging habitat for a **species of concern**. The site is characterized by a hemlock (white pine)-northern hardwood forest dominated by eastern hemlock (*Tsuga canadensis*), yellow birch (*Betula alleganiensis*), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and oak (*Quercus* spp.) with hemlock saplings in the understory.

Threats and Disturbances:
Many properties near Shindle are being developed for housing or vacation cabins. Extensive development and fragmentation of this site would diminish the value of the forested habitat for the species of concern as well as expose the area to additional human disturbance.

Conservation Recommendations:
Maintenance of the continuity of the large forest block enclosing this site is important to the persistence of this species here, as well as minimizing human disturbances to the site. A conservation easement or forest stewardship plan could be developed with the landowner.

WAGNER GAP (Decatur Township, Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located in rocky habitats overlooking the water gap during surveys in 1995. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

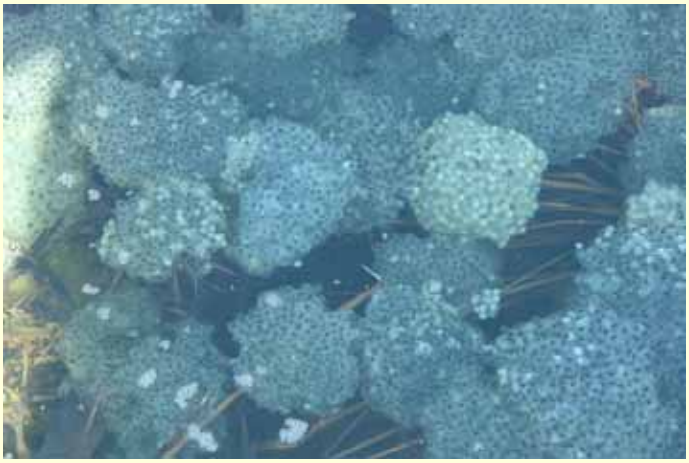
Threats and Disturbances:
The site is partially within State Game Lands 107 and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

WAGNER RUN POOLS (Decatur Township)
Several seasonal and permanent pools are clustered on the northern slope of Shade Mountain in the Wagner Run drainage, together forming a complex of **Ephemeral/Fluctuating Natural Pools**, a GNR S3 community of concern. The largest pool is man-

false hop sedge (*Carex lupuliformis*)
Photo source: John Kunsman

made, but others are natural with a leaf-litter bottom. One or two of the pools contain emergent wetland vegetation and support a population of G4 S1 **False hop sedge (*Carex lupuliformis*)**. Dominant tree species at the site include white oak (*Quercus alba*), chestnut oak (*Quercus montana*), eastern white pine (*Pinus strobus*), eastern hemlock (*Tsuga canadensis*), red maple (*Acer rubrum*), black birch (*Betula lenta*), and black gum (*Nyssa sylvatica*). Portions of the surrounding forest have been logged and are thick with white pine saplings.



Seasonal pools are critical habitat for wood frogs, as shown in this photo of wood frog eggs in a pool.
Photo source: PNHP

Threats and Disturbances:
The site is owned by multiple private landowners. The primary landuses currently are agriculture and recreational uses of the forest. Logging within proximity to the pools without adequate buffers could disturb the hydrology, vegetation, and wildlife value of these wetlands. Invasive plant species can be found within this site taking advantage of logging trails and other disturbances.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around the pools in this complex. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant and other species that occur here. Conservation options such as easements should be discussed with the private landowners in order to best protect the site from future development or forest mismanagement.

Herblengths Cave (Decatur Township)
Herblengths Cave is part of the Devonian limestone karst system in the Jacks Creek Valley. Connectivity with other underground systems in the valley is unknown.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

Small woodland pools can be easily overlooked.

Woodrat Habitat

Rock scree outcrops, typical of the ridges of Mifflin County, are the primary habitat of Allegheny woodrats (*Neotoma magister*).

Allegheny Woodrat (*Neotoma magister*)
Photo source: Calvin Butchkoski

Survey techniques for Allegheny woodrats include searching for dens (right), scat (above) and food caches. Photos: PNHP

Derry Township and Burnham Borough

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
BUCK RUN GRASSLANDS			*Notable Significance*		
Species of concern[3]				6/30/2005	E
JACKS MOUNTAIN—EAST & WEST			*Notable Significance*		
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
LEWISTOWN NARROWS NORTH			*High Significance*		
Allegheny woodrat (*Neotoma magister*)	G3G4	S3	PT	11/11/2002	B
Northern Myotis bat (*Myotis septentrionalis*)	G4	S3B, S3N	-	6/4/2001	E
Plant: wild senna (*Senna marilandica*)	G5	S1	-	10/10/2001	BC
MAITLAND CAVE			*High Significance*		
Species of concern[3]				2/20/1996	E
MAITLAND POOLS			*Notable Significance*		
Community:Ephemeral/Fluctuating Natural Pools	GNR	S3	-	4/10/2006	C
MOUNT ROCK CAVE			*High Significance*		
Species of concern[3]				1/29/1996	E
Dry Valley Pits			*Local Significance*		
Highland Park Cave			*Local Significance*		

PUBLICLY MANAGED LANDS: State Game Lands #107

OTHER CONSERVATION AREAS: Central Mountains Important Mammal Area, Blacklog Mountain Important Mammal Area

HIGH QUALITY STREAMS: Kishacoquillas Creek: Main Stem, Yeagertown/Burnham Railroad Bridge to SR 2005 (Mill Road) Bridge at Mount Rock

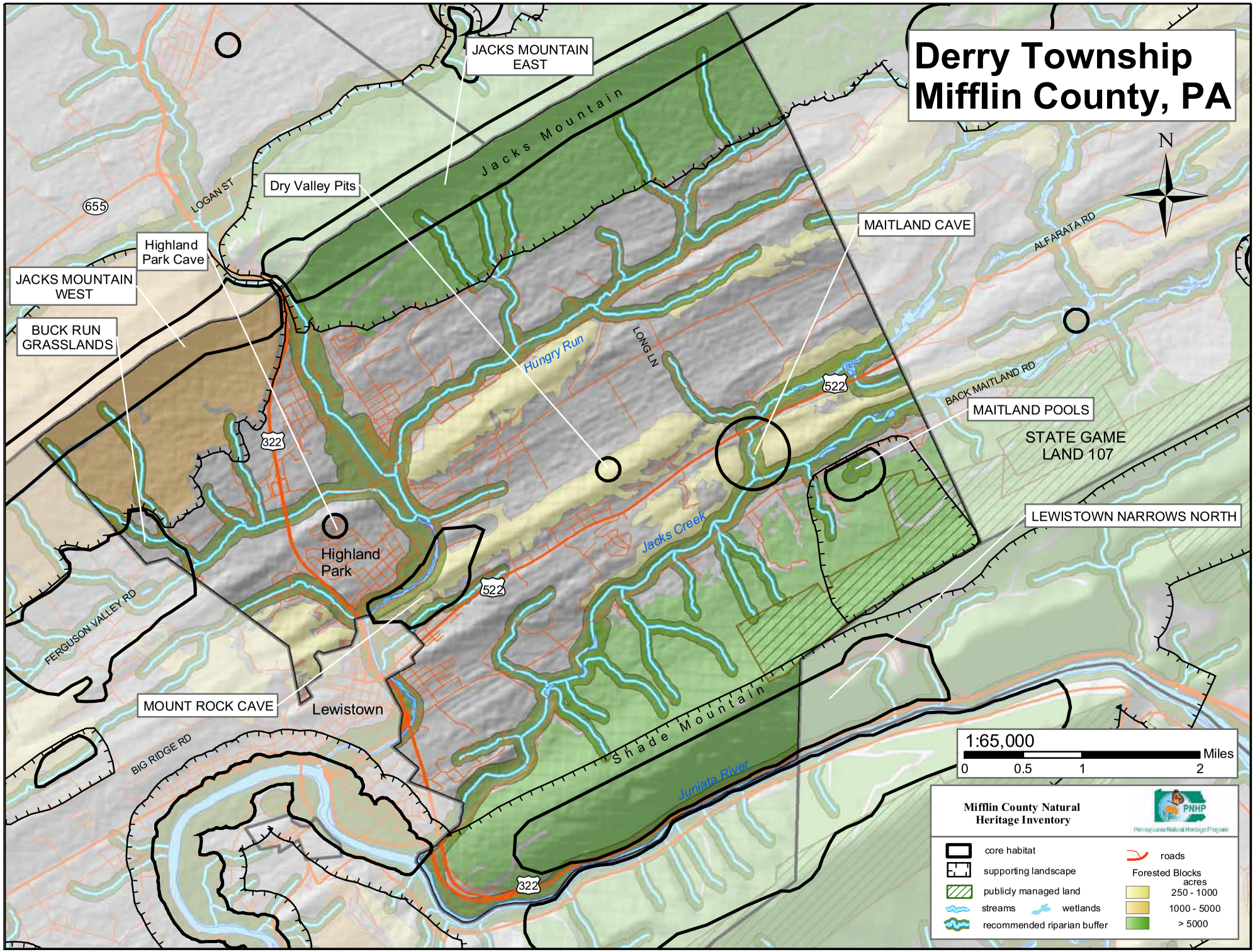
AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Jack's Creek - Warmwater Community 1; Low Gradient Valley Stream Community
- Juniata River—Tuscarora Creek - Atlantic River and Impoundment Community; High Quality Small Stream Community; Yellow Lampmussel Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.


Derry Township
Mifflin County, PA
JACKS MOUNTAIN EAST
Dry Valley Pits
Highland Park Cave
JACKS MOUNTAIN WEST
BUCK RUN GRASSLANDS
MAITLAND CAVE
MAITLAND POOLS
STATE GAME LAND 107
LEWISTOWN NARROWS NORTH
MOUNT ROCK CAVE
Jacks Mountain
Shade Mountain
Hungry Run
Jacks Creek
Juniata River
LONG LN
LOGAN ST
ALFARATA RD
BACK MAITLAND RD
FERGUSON VALLEY RD
BIG RIDGE RD
Highland Park
Lewistown
655
322
522
N
1:65,000
Miles
0 0.5 1 2
Mifflin County Natural Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks acres
250 - 1000
1000 - 5000
> 5000

Derry Township is located in southern Mifflin County and is the second smallest township in the county. Jacks Mountain creates the northern border, while Shade Mountain creates the southern border with Juniata County. The Juniata River also creates part of the southern border. The bedrock geology is mostly made up of shale with some smaller areas of sandstone and limestone. Derry Township is 58% forested, with most of the forested areas occurring in Jacks Mountain and Blue Mountain. Smaller fragmented forest blocks occur in the center of the township. State Game Land 107 is located in the large forest blocks in the Blue Mountain.

Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations. This portion of the forested ridges provides connectivity to neighboring townships for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.

Agriculture makes up 30% of the total land use in the township, located in the center of the township. The Juniata River, Jacks Creek, and Hungry Run are the major waterways flowing through the township. The headwaters of many of the streams begin in the large forest blocks in the northern and southern portions of Derry Township. The streams later flow through the agricultural areas with little or no buffer to filter out sediments and chemicals. Trees should be planted along the streams in the open areas to create a forested buffer. Conservation efforts within the township could concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the valleys. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains and Blacklog Mountain Important Mammals Areas (IMA) are located in the mountains of northern and southern Derry Township, respectively. The Blacklog Mountain IMA was chosen due to the presence of habitat for a state threatened species, as well as other mammals.

Burnham Borough is located within Derry Township. Seventy percent of the total land use in the borough is high intensity residential

An example of a well-buffered stream in an otherwise open landscape.

Photo source: PNHP

BUCK RUN GRASSLANDS (Derry and Granville Townships)
This site encompasses an area of pastoral landscape along Buck Run that supports a **species of concern**. The core area includes the necessary foraging habitat within the agricultural setting. The site is primarily composed of a matrix of agricultural fields, pastureland, and interspersed woodland edge. The prey of this species includes various small mammals, some of which are considered agricultural pests. With changes in agricultural practices and suburban development, grasslands and agricultural lands are rapidly being converted to other land uses.

Threats and Disturbances:
The major threat to this site is the potential loss of pastures and grasslands to commercial development and intensive row-crop farming. These land use practices decrease habitat for prey populations by reducing cover or by completely eliminating habitats. Additionally, the conversion to high-intensity agriculture or development has decreased the number of old farm structures that provide suitable or stable habitat. Other stresses include pesticide poisoning through chronic exposure, accidental poisoning with rodenticide, and vehicle related mortality.

Conservation Recommendations:
Land use practices that adversely affect prey species, such as the conversion to development or high-intensity agriculture, should be avoided within the core habitat. Mowing or light grazing is recommended to maintain grass cover and keep a layer of ground litter, which encourages a healthy prey population (NatureServe 2006). Prescribed burning (*when done correctly and safely*) is another potential management technique to maintain the open fields.

JACKS MOUNTAIN—EAST & WEST
(Armagh, Brown, Decatur, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; Huntingdon and Snyder Counties)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but the Jacks Mountain—East and West are disconnected from each other at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

The Mann Narrows in Jacks Mountain is seen in the distance, creating an impassible break in habitat for the Timber Rattlesnake and other wildlife.

Photo source: PNHP

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

LEWISTOWN NARROWS NORTH (Derry and Granville Townships, Juniata County)
Long recognized as an exceptionally interesting geological, topographic, and scenic feature of Juniata and Mifflin counties, the Lewistown Narrows is also a core thoroughfare for travel through the region (historic and current). At its steepest point the Narrows drops over 1600 feet in around one-half mile to the Juniata River. Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located along the talus slopes of the north side of the Lewistown Narrows during regular surveys over the past three decades. The sandstone and talus outcrops where the woodrats have been found extend along much of the ridgeline above the Juniata River. The surrounding forest is characterized by black birch (*Betula lenta*), basswood (*Tilia americana*), sassafras (*Sassafras albidum*), hickory (*Carya* spp.), white oak (*Quercus alba*), red oak (*Q. rubra*), and chestnut oak (*Q. montana*). The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes, and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

During surveys in 2001, a population of the G4 S3B, S3N **Northern Myotis (*Myotis septentrionalis*)** was found feeding along the Juniata River and open areas at this site. While the relationship of this location to a maternity site or overwintering site is unknown, the multiple individuals captured here show that this population uses this site for foraging. Additionally, the floodplain in the Narrows has been host to a

The Lewistown Narrows is impacted by its role as a major transportation corridor, as illustrated here by the widening of SR 322/22.
Photo source: PADOT

population of G5 S1 **wild senna (*Senna marilandica*)**, a plant species of concern.

Threats and Disturbances:
Targeted monitoring stations for these species have been recently established at this site in association with planned and ongoing expansion of Route 322. While the habitat for the woodrat is generally high on the slope above the road construction, it is unknown what effect nearby disturbance, blasting, and earthmoving will have on the species of concern. The wild senna was in the direct path of road construction and has been artificially moved to a similar habitat out of harm's way. The success of this transplant needs to be assessed.

wild senna (*Senna marilandica*)
photo source: Larry Klotz

Conservation Recommendations:
Continued monitoring of the populations will be needed to determine the impacts of the highway construction and potential loss of habitat. The chances for success of the plant relocation are low, but additional populations could be found in similar habitats along this stretch of river. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

MAITLAND CAVE (Derry Township)
In the Devonian limestone of Jacks Creek ridge lies a large cave entrance known as Maitland Cave. Passage through the cave has been altered over time by excavations and other human influence. The cave supports a **species of concern**. The subterranean linkages between this cave and others in the Jacks Creek geology are not known.

Threats and Disturbances:
The species of concern in this site are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

MAITLAND POOLS (Derry Township)
One or two seasonal pools are located on the lower slope of Shade Mountain near Maitland. The surrounding forest is well-drained oak-mixed hardwood with a moderate shrub layer. Though in a disturbed landscape, the pools support several vernal pool obligate species of amphibians, plants, and invertebrates.

Threats and Disturbances:
The lack of buffer between these pools and agriculture, forestry, and roads will likely adversely influence the ponds over time. Invasive plant species may be brought in along access trails and roads. The available foraging habitat for amphibians that breed in these ponds is limited in scope and may be further fragmented in the future.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around vernal pools in order to maintain habitat needed by the amphibians that use the pool. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here. Landowners should be encouraged to buffer the pools from roads, mowing, dumping, and landscaping projects.

MOUNT ROCK CAVE (Derry Township)
This cave is associated with two abandoned quarries in the Devonian Helderberg limestone. The cave supports a **species of concern**. The cave is a series of long narrow rooms and includes a stream channel.

Threats and Disturbances:
The species of concern in this valley are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect

climatic conditions in the cave, including airflow, temperature, and humidity. This cave has been gated to restrict access.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

Dry Valley Pits (Derry Township)
The Dry Valley Pits are formed in Devonian Helderberg limestone in the ridge southeast of Dry Valley. The pits have not been explored extensively, but may expand into larger passages that could support animal species of concern.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats if they are present.

Highland Park Cave (Derry Township)
The Highland Park Cave is formed on a wooded ridge in Devonian Helderberg limestone. The cave has not been explored extensively, but may support animal species of concern.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

A typical cave entrance in a limestone bluff.
Photo source: PNHP

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats if they are present.

Lewistown Narrows

The rock-talus outcrops on both sides of the Lewistown Narrows provide excellent habitat for Allegheny Woodrats
Photos: PNHP

Granville Township and Juniata Terrace and Lewistown Boroughs

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
BLUE MOUNTAIN at HISSING ROCKS			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	11/13/1992	E
BLUE MOUNTAIN at VINCENT TRAM ROAD			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/16/1993	E
BUCK RUN GRASSLANDS			*Notable Significance*		
Species of concern[3]				6/30/2005	E
JACKS MOUNTAIN—WEST			*Notable Significance*		
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
JUNIATA RIVER—MIFFLIN COUNTY			*High Significance*		
Yellow Lampmussel (*Lampsilis cariosa*)	G3G4	S3S4	-	7/20/2006	C
LEWISTOWN NARROWS SOUTH			*High Significance*		
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	11/11/2002	B
Big Ridge Pools			*Local Significance*		

PUBLICLY MANAGED LANDS: Tuscarora State Forest, State Game Lands #113

OTHER CONSERVATION AREAS: Blacklog Mountain Important Mammal Area

HIGH QUALITY STREAMS: Granville Run, Minehart Run, Strodes Run, Unnamed Tributaries to Juniata River

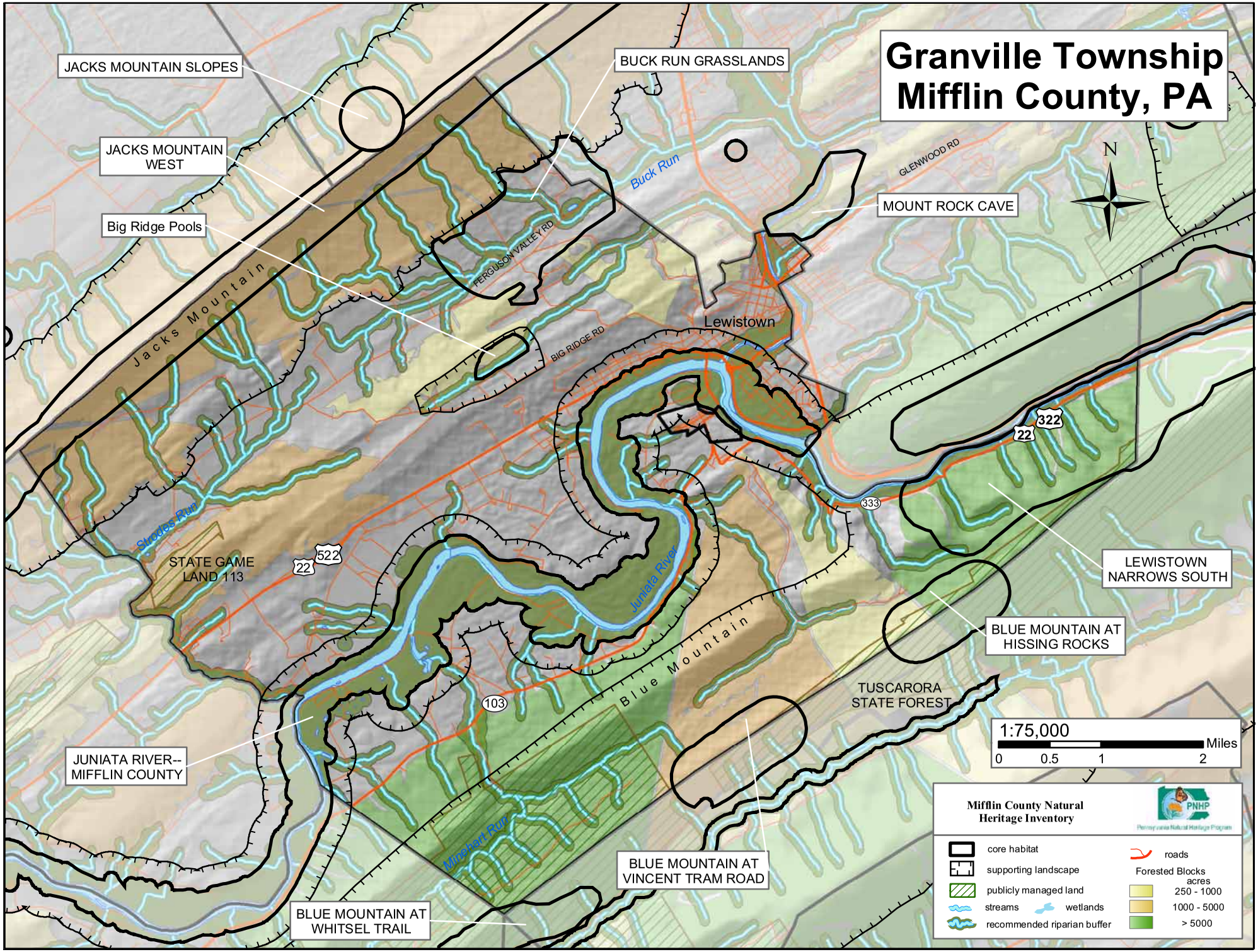
AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Juniata River—Kishacoquillas Creek - Coolwater Community 1; High Quality Small Stream Community; Eastern Elliptio Community
- Juniata River—Tuscarora Creek - Atlantic River and Impoundment Community; High Quality Small Stream Community; Yellow Lampmussel Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection.


Granville Township
Mifflin County, PA
JACKS MOUNTAIN SLOPES
JACKS MOUNTAIN WEST
Big Ridge Pools
BUCK RUN GRASSLANDS
MOUNT ROCK CAVE
LEWISTOWN NARROWS SOUTH
BLUE MOUNTAIN AT HISSING ROCKS
TUSCARORA STATE FOREST
BLUE MOUNTAIN AT VINCENT TRAM ROAD
BLUE MOUNTAIN AT WHITSEL TRAIL
JUNIATA RIVER--MIFFLIN COUNTY
STATE GAME LAND 113
Jacks Mountain
Blue Mountain
Buck Run
Juniata River
Strodes Run
Minehart Run
FERGUSON VALLEY RD
BIG RIDGE RD
GLENWOOD RD
Lewistown
N
1:75,000
Miles
0 0.5 1 2
Mifflin County Natural Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks
acres
250 - 1000
1000 - 5000
> 5000

GRANVILLE TOWNSHIP

Granville Township is located in southern Mifflin County. Blue Mountain creates the southern border with Juniata County, and Jacks Mountain creates the northern border. Strodes Run flows along the western border and the Juniata River creates part of the eastern border of Granville Township. The bedrock geology is composed mainly of shale with some areas of sandstone and limestone. Granville Township is 63% forested, most of which is located in Jacks Mountain and Blue Mountain. Tuscarora State Forest and State Game Lands 113 are located in Granville Township, which should help to prevent further fragmentation of the larger forest blocks. Conservation efforts to buffer the edges of the state forest from development and disturbance are important to the long-term quality of the wildlife and land resources within this corridor.

Much of the biodiversity of the township can be maintained by providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations. This portion of the forested ridges provides connectivity to neighboring townships and counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.

Agriculture makes up 28% of the total land use in the township, which occurs in the center of the township. The Juniata River and Buck Run are the major waterways flowing through Granville Township. The headwaters of many of the streams originate in the large forest blocks, which provide a good buffer to filter out the sediments and chemicals. Most of the streams later flow through the agricultural areas, which do not filter out the pollutants as well as the forested areas. Conservation efforts within the township should concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the valley. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Blacklog Mountain Important Mammal Area (IMA) is located in southern Granville Township. This site was chosen due to the presence of habitat for a state threatened species, as well as other mammals.

Juniata Terrace Borough is located with in Granville Township. High intensity residential areas make up 32% of the total land use in the borough, but 42% remains as forest. Lewistown Borough is located between Granville Township and Derry Township. Most of the borough (68%) is in high intensity residential areas.

Jacks Mountain spans the length of Mifflin County at the northern border of Granville Township, forming an extensive forested corridor broken only by occasional utility lines and small roads and the Mann Narrows, seen in the distance. Photo source: PNHP

BLUE MOUNTAIN at HISSING ROCKS
(Granville Township, Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny woodrat (*Neotoma magister*)** were located at the crest of this mountain during surveys in 1992. This species has been located at several locations along the Blue Mountain. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

The nest of an Allegheny Woodrat, tucked into the rocks on a talus slope in Mifflin County.
Photo source: PNHP

BLUE MOUNTAIN at VINCENT TRAM ROAD
(Granville Township and Juniata County)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located on rock outcrops at this site during surveys in 1993. This species has been located at several locations along the Blue Mountain. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

BUCK RUN GRASSLANDS (Granville and Derry Townships)
This site encompasses an area of pastoral landscape along Buck Run that supports a **species of concern**. The core habitat includes the necessary foraging habitat within the agricultural setting. The site is primarily composed of a matrix of agricultural fields, pastureland, and interspersed woodland edge. The prey of this species includes various small mammals, some of which are considered agricultural pests. With changes in agricultural practices and suburban development, grasslands and agricultural lands are rapidly being converted to other land uses.

Threats and Disturbances:
The major threat to this site is the potential loss of pastures and grasslands to commercial development and intensive row-crop farming. These land use practices decrease habitat for prey populations by reducing cover or by completely eliminating habitats. Additionally, the conversion to high-intensity agriculture or development has decreased the number of old farm structures that provide suitable or stable habitat. Other stresses include pesticide poisoning through chronic exposure, accidental poisoning with rodenticide, and vehicle related mortality.

Conservation Recommendations:
Land use practices that adversely affect prey species, such as the conversion to development or high-

intensity agriculture, should be avoided within the core habitat. Mowing or light grazing is recommended to maintain grass cover and keep a layer of ground litter, which encourages a healthy prey population (NatureServe 2006). Prescribed burning (*when done correctly and safely*) is another potential management technique to maintain the open fields.

JACKS MOUNTAIN—WEST (Brown, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; and Huntingdon County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—East at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

JUNIATA RIVER—MIFFLIN COUNTY
(Bratton, Granville, and Wayne Townships)
Several species of freshwater mussels inhabit suitable habitat in portions of the Juniata River. One of these is considered a species of concern due to declines in its global and state range and abundance: the G3G4, S3S4 **Yellow Lampmussel (*Lampsilis cariosa*)**. The lampmussel is a species of larger rivers and is primarily found in sand and gravel with a good current. Pennsylvania is host to a large percentage of the Yellow Lampmussels in North America; therefore, preservation of the Commonwealth's populations is critical to the overall conservation of the species. Associated species are the Common Elliptio (*Elliptio complanata*) and the Rainbow Mussel (*Villosa iris*), as well as the introduced Asian Clam (*Corbicula fluminea*) and Rusty Crayfish (*Orconectes rusticus*).

Shallow riffles with gravelly substrate provide excellent habitat for freshwater mussels in the Juniata River.
Photo source: PNHP

Downstream portions of the river support a higher diversity of freshwater mussels, including several additional rare species. The entire length of the

Juniata River should be considered suitable habitat for most of these freshwater mussel species. Additional surveys could be useful in estimating populations and distribution of the species of concern in the river. Illinois pondweed (*Potamogeton illinoensis*), an aquatic plant that was once considered a species of concern, was found near Newton Hamilton in 1991. Surveys in 2006 failed to locate any populations of the plant, but its persistence cannot yet be ruled out.

Threats and Disturbances:
There are numerous examples of disturbance along the Juniata River. Freshwater mussels are affected by non-point sources of pollution, including sedimentation from cultivated and developed land along the river, runoff from roadways, pesticide runoff from agricultural fields, discharge of chemical pollutants, and thermal pollution. There may also be a threat posed by competition from the Asian Clam and predation by the Rusty Crayfish, but the level of these threats is not fully understood.

Conservation Recommendations:
Any of the above types of disturbances should be minimized wherever possible. Also, monitoring of these populations should continue into the future. Water quality should be monitored and pollution sources should be identified and corrected. Forested buffers should be maintained and created where absent along the length of the river, with logging operations refraining from cutting within 100 meters (328 feet) of the river edge. River bank forests help buffer the watershed from the effects of non-point sources of pollution, including runoff from agricultural, residential, and roadway settings. In addition, the river floodplain and corridor is usually an area of significantly higher biodiversity than the adjoining uplands. Maintaining an intact, forested floodplain along the river can preserve much of the area's important biodiversity. Local planning should discourage construction of new structures and roadways along the river, adjacent slopes, and floodplain. Additional information on riparian buffers can be found on page 66.

A Yellow Lampmussel in the Juniata River.
photo source: Andrew Strassman (PNHP)

Juniata River in Mifflin County

LEWISTOWN NARROWS SOUTH (Derry and Granville Townships; and Juniata County)
Long recognized as an exceptionally interesting geological, topographic, and scenic feature of Juniata and Mifflin counties, the Lewistown Narrows is also a core thoroughfare for travel through the region (historic and current). At its steepest point the Narrows drops over 1600 feet in around one-half mile to the Juniata River. An excellent location to view the Narrows from is Hawstone Overlook situated just south of 333 on Blue Mountain. Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** have been located along the talus slopes of the Lewistown Narrows during regular surveys over the past three decades. The sandstone and talus outcrops where the woodrats have been found extend along much of the ridgeline in the Narrows. The surrounding forest is characterized by black birch (*Betula lenta*), basswood (*Tilia americana*), sassafras (*Sassafras albidum*), Hickory (*Carya* sp.), white oak (*Quercus*

alba), red oak (*Quercus rubra*), and chestnut oak (*Quercus montana*). The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes, and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation. Rare plants formerly found on the north bank are likely to occur in similar habitat within this site. This site may additionally provide foraging habitat for bats as seen on the north bank.

Threats and Disturbances:
Targeted monitoring stations for these species have been recently established on the north side of the River in association with planned and ongoing expansion of Route 322. While the habitat for the woodrat on the south side of the River is not threatened by road construction, it is unknown what effect nearby disturbance, blasting, and earthmoving will have on the species of concern.

Conservation Recommendations:
Continued monitoring of the population will be needed to determine the impacts of the highway construction and potential loss of habitat. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences. Surveys for floodplain plants should be conducted.

Big Ridge Pools (Granville Township)
One or two natural seasonal pools as well as several dug-out ponds are located along the drainage of an intermittent stream below Big Ridge. The surrounding forest is well-drained oak-mixed hardwood with a moderate shrub layer. Though in a disturbed landscape, the pools support several vernal pool obligate species of amphibians, plants, and invertebrates.

Threats and Disturbances:
The lack of buffer between these pools and grazing, agriculture, forestry, and roads will likely adversely influence the ponds over time. Invasive plant species are encroaching from past logging operations. The available foraging habitat for amphibians that breed in these ponds is limited in scope and may be further fragmented in the future.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around vernal pools in order to maintain habitat needed by the amphibians that use the pool. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the species that occur here. Landowners should be encouraged to buffer the pools from roads, mowing, dumping, and landscaping projects.

Acorns, or “mast” of oak trees have become the primary food source for the Allegheny Woodrat since the decline of the American chestnut. Mast productivity experiences many fluctuations, which may put stresses on the Allegheny Woodrat populations.

Photo source: Jerry Hassinger

Hibernating Bat Surveys

Surveys of winter hibernating bats are conducted periodically by PA Game Commission wildlife biologists. Minute anatomical differences help differentiate between several species of bats.

Photos PNHP

Menno Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
JACKS MOUNTAIN—WEST			*Notable Significance*		
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
KINGS HOLLOW			*High Significance*		
Community: Hemlock-Tuliptree-Birch Forest	GNR	S4	-	10/13/2006	C
Allensville Cave			*Local Significance*		

PUBLICLY MANAGED LANDS: Rothrock State Forest

OTHER CONSERVATION AREAS: Rothrock State Forest and Stone Mountain Important Bird Area, Central Mountains Important Mammal Area

HIGH QUALITY STREAMS: none

AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

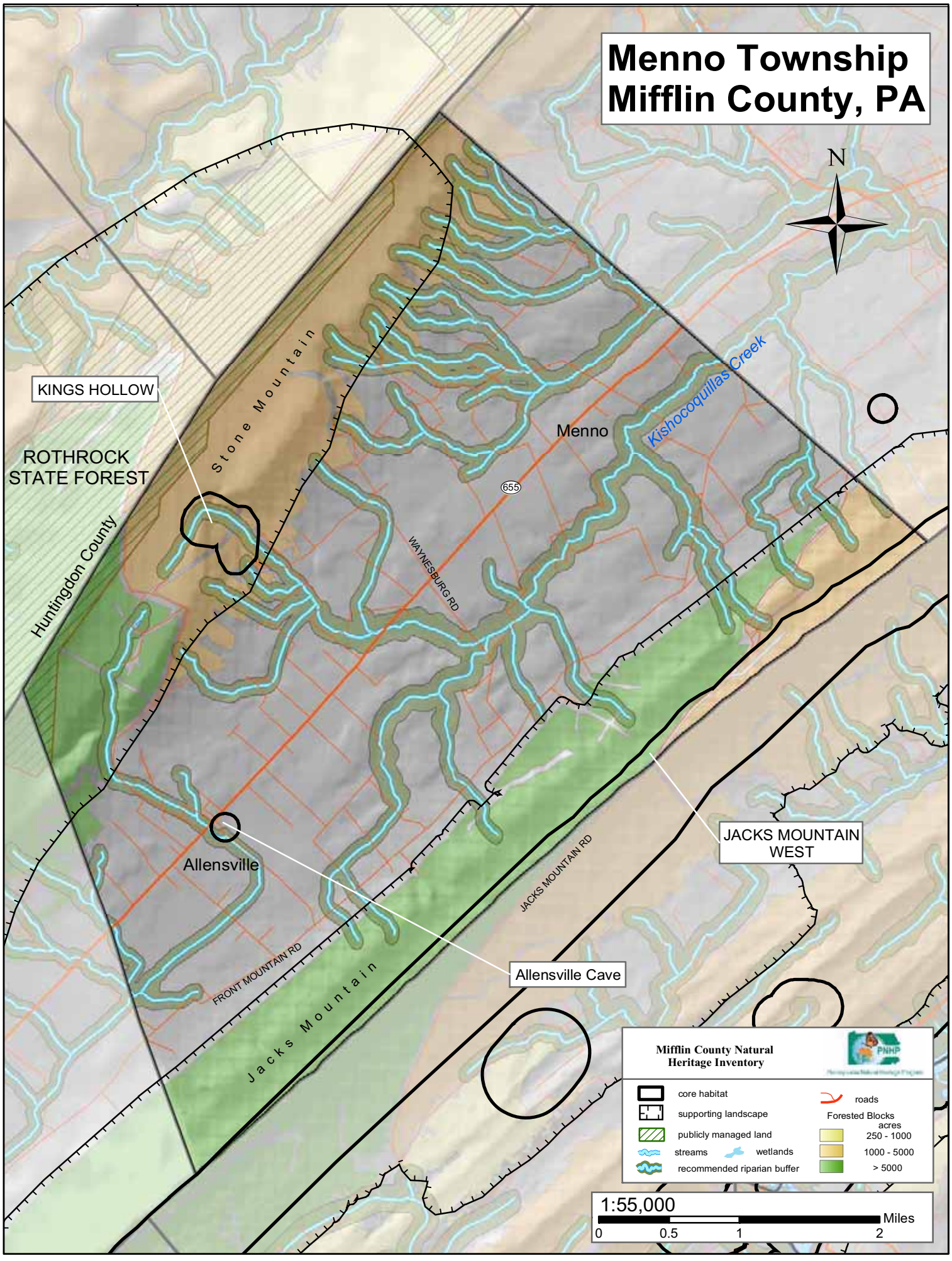
- Kishacoquillas Creek—Coffee Run - Warmwater Community 1; Low Gradient Valley Stream Community
- Sadler Creek - Coolwater Community 2

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

Menno Township is the smallest township in Mifflin County and is bordered by Huntingdon County to the north. The bedrock geology is made up of limestone in the Kishacoquillas Valley and shale and sandstone in the mountains in the north and south. Stone Mountain runs along the northern border of Menno Township, and Jacks Mountain runs along the southern border.

Only 40% of the township is forested, the second lowest amount in Mifflin County, but the forested areas that remain have stayed intact in large forest blocks beneficial for interior forest species. Rothrock State Forest is located along Stone Mountain and crosses into northern Menno Township. Conservation efforts to buffer the edges of the state forest from development and disturbance are important to the long-term quality of the wildlife and land resources within this corridor. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations. This portion of the forested ridges provides connectivity to neighboring counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.


Menno Township
Mifflin County, PA
N
KINGS HOLLOW
ROTHROCK
STATE FOREST
Stone Mountain
Huntingdon County
Menno
Kishocoquillas Creek
655
WAYNESBURG RD
Allensville
JACKS MOUNTAIN RD
JACKS MOUNTAIN
WEST
FRONT MOUNTAIN RD
Allensville Cave
Jacks Mountain
Mifflin County Natural
Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks
acres
250 - 1000
1000 - 5000
> 5000
1:55,000
Miles
0
0.5
1
2

Agriculture makes up 57% of the total land use in the township, the second highest in Mifflin County. Kishacoquillas Creek is the major stream flowing through the township, where it runs through the agricultural valley. This valley is host to a high concentration of caves and associated sinkholes, sinking streams, and groundwater resources. Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. The headwaters of many of the small tributaries begin in the forested mountains to the north and south, but soon flow down into the open agricultural areas. Conservation efforts within the township should concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the pass through Jacks Mountain. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains Important Mammal Area (IMA) is located along Stone Mountain in the northern part of Menno Township. The Rothrock State Forest/ Stone Mountain Important Bird Area (IBA) is also located along Stone Mountain in northern Menno Township. This area was chosen as an IBA because of the old growth forests still found in this area that provide habitat for warblers and other mature forest species and for the ridge line that is used as a raptor migration route in the fall.

A view of the agricultural valley of Menno Township from the slopes of Stone Mountain.
Photo source: PNHP

KINGS HOLLOW (Menno Township)
Roughly 50 acres of old growth GNR, S4 **Hemlock-Tuliptree-Birch Forest** occurs in a narrow ravine on Stone Mountain. Eastern hemlock (*Tsuga canadensis*) and white pine (*Pinus strobus*) dominate the super canopy while hemlock, white pine, and several hardwoods including northern red oak (*Quercus rubra*), yellow and black birch (*Betula alleganiensis* and *B. lenta*), and tulip poplar (*Liriodendron tulipifera*) are common in the canopy. A sparse understory includes witch hazel (*Hamamelis virginiana*), mountain laurel (*Kalmia latifolia*), and elderberry (*Sambucus canadensis*). While old trees are a required component of old growth forest, the community is classified by having quality forest structure. This includes much large woody debris on the forest floor, and many slow-growing subcanopy hemlock trees awaiting the death of one of their ancient neighbors to take advantage of the newly opened hole in the forest canopy.

The steep slope of Kings Hollow
Photo source: PNHP

Threats and Disturbances:
Hemlock woolly adelgid (*Adelges tsugae*) presents the greatest threat to this unique natural community. The adelgid is an exotic pest that was first detected in Pennsylvania in 1967. Hemlock woolly adelgid feeds on the fluids found in hemlock needles and injects toxins into the remaining living tissue of the tree. Some trees are able to survive adelgid infestations for years, while others die off quickly. Other pathogens that could threaten this stand include the elongate hemlock scale (*Fiorinia externa*), spruce spider mite (*Oligonychus ununguis*), hemlock rust mite (*Nalepella tsugifolia*), and cryptomeria scale (*Aspidiotus cryptomeriae*). A few invasive plant species are found within the stand and could compete with the native trees for colonization of newly opened canopy gaps.

Conservation Recommendations:
Unfortunately, there is not yet a cost effective measure to control hemlock woolly adelgid. It remains to be seen what the lasting effects of this exotic pest are. The site should be buffered from forestry practices in order to isolate it from invasion by pathogens and invasive plant species that are quick to colonize gaps in the forest from large tree falls. Invasive plants such as tree of heaven (*Ailanthus altissima*) and Japanese barberry (*Berberis thunbergii*) should be removed and monitored.

JACKS MOUNTAIN—WEST (Brown, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; Huntingdon County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend

to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—East at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

Allensville Cave (Menno Township)
In southwestern Mifflin County many streams descend Stone Mountain and follow underground channels on their way toward Kishacoquillas Creek. Only one of these subterranean stream courses is known to be accessible. This is the cave at Allensville, with four known entrances. Groundwater flowing deep in the cave is likely to harbor communities of rare cave invertebrates, but it has not been sampled due to the challenges of exploring this cave.

Threats and Disturbances:
Any groundwater invertebrates potentially inhabiting this subsurface region are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats if they are present.

Caves with underground watercourses and pools are likely to support small invertebrates, such as this cave-adapted amphipod. Many of these species are considered rare because their populations have become isolated over geologic time.

Photo source: PNHP

Oliver Township and McVeytown Borough

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
JACKS MOUNTAIN—WEST		*Notable Significance*			
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
JOHNSON CAVES		*Exceptional Significance*			
Species of concern[3]				3/9/1988	E
Species of concern[3]				3/9/1988	E
Refton Cave Planarian (*Sphalloplana pricei*)	G2G3	S1	-	2/17/95	E
Price's Cave Isopod (*Caecidotea pricei*)	G5	S2S3	-	8/25/95	B
Allegheny Cave Amphipod (*Stygobromus allegheniensis*)	G5	S2S3	-	2/17/95	C
MIDDLE RIDGE POOLS		*High Significance*			
Community: Ephemeral/Fluctuating Natural Pools	GNR	S3	-	5/16/06	BC
RUPERT CAVE		*Exceptional Significance*			
Species of concern[3]				2/1/1997	E
Species of concern[3]				7/14/06	BD
Baltimore Checkerspot Butterfly (*Euphydryas phaeton*)	G4	S2S4	-	7/14/06	BD
Edward's Hairstreak Butterfly (*Satyrium edwardsii*)	G4	S3S4	-	7/12/2005	E
Henry's Elfin Butterfly (*Callophrys henrici*)	G5	S1S3	-	5/4/2007	E
Northern Pearly-eye Butterfly (*Enodia anthedon*)	G5	S3S4	-	7/14/06	E
Silvery Checkerspot Butterfly (*Chlosyne nycteis*)	G5	S3S4	-	6/15/06	BC
A Borer Moth (*Papaipema marginidens*)	G4	SU	-	9/19/2006	E
A Tolype Moth (*Tolype notialis*)	G4G5	S1	-	7/12/2005	E
Promiscuous Angle Moth (*Macaria promiscuata*)	G4	S1	-	7/12/2005	E
Earwig Scorpionfly (*Merope tuber*)	G3G5	SU	-	7/12/2005	E
Plant: hoary puccoon (*Lithospermum canescens*)	G5	S2	-	6/15/06	B
Big Ridge Cave		*Local Significance*			
McVeytown Cave		*Local Significance*			
McVeytown Quarry Caves		*Local Significance*			

PUBLICLY MANAGED LANDS: State Game Lands #113

OTHER CONSERVATION AREAS: None

HIGH QUALITY STREAMS: Musser Run, Strodes Run, Town Run, Wakefield Run, Unnamed Tributaries to Juniata

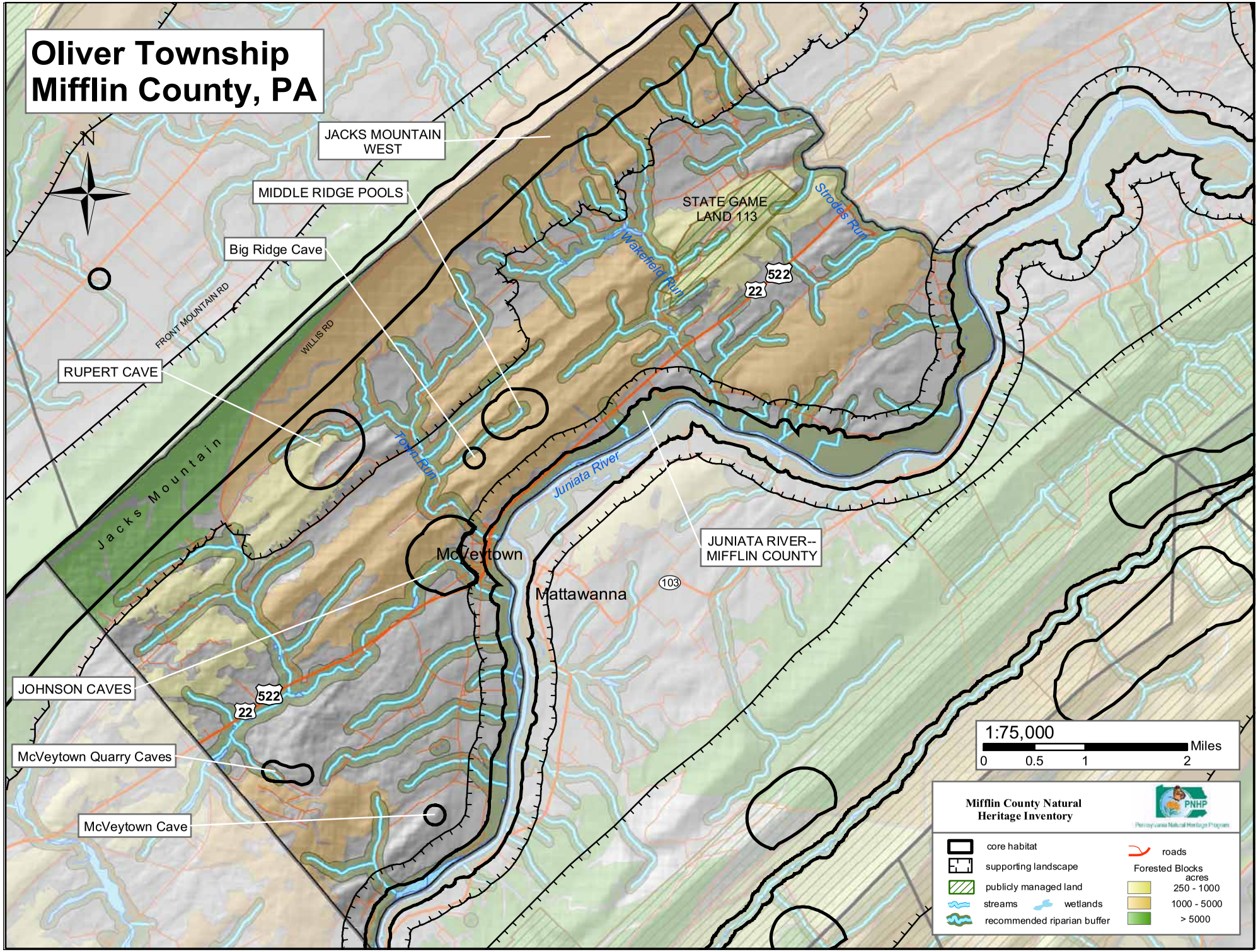
AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Juniata River—Carlisle Run - Warmwater Community 1; High Quality Small Stream Community
- Juniata River—Kishacoquillas Creek - Coolwater Community 1; High Quality Small Stream Community; Eastern Elliptio Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.

[3] This species is not named at the request of the agency overseeing its protection


Oliver Township
Mifflin County, PA
N
JACKS MOUNTAIN WEST
MIDDLE RIDGE POOLS
Big Ridge Cave
RUPERT CAVE
JOHNSON CAVES
McVeytown Quarry Caves
McVeytown Cave
JUNIATA RIVER--MIFFLIN COUNTY
STATE GAME LAND 113
FRONT MOUNTAIN RD
WILLIS RD
Jacks Mountain
Town Run
Wakefield Run
Strodes Run
Juniata River
McVeytown
Mattawanna
522
22
103
1:75,000
Miles
0 0.5 1 2
Mifflin County Natural Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks acres
250 - 1000
1000 - 5000
> 5000

OLIVER TOWNSHIP

Oliver Township is located in the center of Mifflin County, and only a small portion in the northwestern corner of the township borders Huntingdon County. Oliver Township is bordered by Jacks Mountain to the north, the Juniata River to the south, and Strodes Run to the east. The bedrock geology is primarily composed of sandstone and shale, with smaller areas of limestone.

Forests make up 56% of the total land use in Oliver Township. Most of the forested area is located in the northern part of the township, including Jacks Mountain. The Ferguson Valley is located in between the forested areas and is generally not forested. The only managed land in Oliver Township is State Game Lands 113, which covers a small area. This leaves the other privately owned forests open to further fragmentation. In areas with fragmented forests, nearby forested blocks should be connected whenever possible in order to create contiguous habitat for forest species.

Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

Agriculture makes up 36% of the total land use in Oliver Township. The Juniata River, Wakefield Run, and Strodes Run are the major waterways flowing through the township, including several high quality streams. Most of the streams are flowing through the open areas, which do not filter out the sediments and chemicals in runoff before they enter into the stream. Conservation efforts within the township should concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the pass through Jacks Mountain. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

McVeytown Borough is located within Oliver Township along the Juniata River. Almost all of the land use in the borough is low intensity residential areas.

A small residential development at the base of Jacks Mountain illustrates the potential for future fragmentation of this forested ridge and the wildlife habitat it supports.
Photo source: PNHP

JACKS MOUNTAIN—WEST (Brown, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; and Huntingdon County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—East at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories.
Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

JOHNSON CAVES (Oliver Township)
An old quarry in a ridge at McVeytown provides two cave openings known as the Johnson Caves. Invertebrate species of concern known to this site include the G2G3 S1 **Refton Cave Planarian (*Sphalloplana pricei*)**, the G5 S2S3 **Price's Cave Isopod (*Caecidotea pricei*),** and the G5 S2S3 **Allegheny Cave Amphipod (*Stygobromus allegheniensis*)**. These animals have only been found in a handful of caves in Pennsylvania. They are dependent on the quality of the groundwater in caves and on the influx of organic material for food. The drainage patterns in this karst system are complex and not completely understood. The water level in the caves occasionally fluctuates, but sources and connectivity of the groundwater to other systems has not been investigated (Dayton et al. 1981).

Threats and Disturbances:
The species of concern are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats.

MIDDLE RIDGE VERNAL POOLS (Oliver Township)
A cluster of seasonal pools is located on a level area between Middle and Front Ridge, together forming a complex of **Ephemeral/Fluctuating Natural Pools**, a GNR S3 community of concern. The pools vary in their substrate from heavily vegetated with emergent

One of the vegetated pools at Middle Ridge.
Photo source: PNHP

plants to leaf litter only. The surrounding forest is well-drained oak-mixed hardwood with an understory of mountain laurel (*Kalmia latifolia*), sassafras (*Sassafras albidum*), spicebush (*Lindera benzoin*), witch-hazel (*Hamamelis virginiana*), and rosebay (*Rhododendron maximum*). Surrounding land use is forested; recreational, hunting, and selective logging.

Threats and Disturbances:
The site is primarily under one private landowner. The primary landuse is recreational uses of the forest. Logging within proximity to the pools without adequate buffers could disturb the hydrology, vegetation, and wildlife value of these wetlands.

Conservation Recommendations:
At the very least, a 305-meter (1000-foot) no-cut buffer should be established around the pools in this complex. Though vernal pools are often thought of as isolated wetlands, the species within the pools rely on the linkages between the wetlands as well as the surrounding forest for year-round foraging habitat. The preservation of an intact forest canopy around this site will help maintain habitat for the rare plant and other species that occur here. Conservation options such as easements should be discussed with the landowner in order to best protect the site from future development or forest mismanagement.

RUPERT CAVE (Oliver Township)
The limestone Bald Ridge above the underground world of Rupert Cave provides habitat for several plants and animals unique to limestone-based openings. The G5 S2 **hoary puccoon (*Lithospermum canescens*)** occurs along this ridge. The ridge has a partial canopy closure of sugar maple (*Acer saccharum*), tulip poplar (*Liriodendron tulipifera*), slippery elm (*Ulmus rubra*), basswood (*Tilia americana*), and black cherry (*Prunus serotina*). Dominant understory species include Virginia pine (*Pinus virginiana*), eastern white pine *(P. strobus*), and redbud *(Cercis canadensis*). The sunny open ridge also provides habitat for several rare butterfly and skipper species, including the G5 S1S3 **Henry's Elfin (*Callophrys henrici*)**, G5 S3S4 **Silvery Checkerspot (*Chlosyne nycteis*),** G4 S2S4 **Baltimore Checkerspot (*Euphydryas phaeton*)**, G5 S3S4 **Northern Pearly-eye (*Enodia anthedon*),** and G4 S3S4 **Edward's Hairstreak (*Satyrium edwardsii*)**. These species are dependent on healthy populations of their larval hostplant—redbud, false foxglove (*Aureolaria flava*), sunflower (*Helianthus* spp.), scrub oak (*Quercus ilicifolia*), and others—as well as ample nectar sources for the adult butterflies. The diversity of Lepidoptera supported at this site extends to the nocturnal insects, the moths. Inventories of moth species at the site documented three rare species: a G4 SU **Borer Moth (*Papaipema marginidens*),** a G4G5 S1 **Tolype Moth (*Tolype notialis*),** and a G4 S1 **Promiscuous Angle Moth (*Macaria promiscuata*)**, as well as a rare G3G5 SU **Earwig Scorpionfly (*Merope tuber*).** The site additionally provides refuge for two other **species of concern**.

Threats and Disturbances:
Threats include mowing in the spring and summer when ground birds have low-lying nests and certain butterfly and moth caterpillars are feeding on low-lying vegetation. The species of concern associated with the cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration

Lepidoptera Of Rupert Cave

Baltimore Checkerspot larvae

Baltimore Checkerspot (*Chlosyne nycteis*) emerging from its chrysalis

Henry's Elfin (*Callophrys henrici*)

Northern Pearly-eye (*Enodia anthedon)*

Promiscuous Angle Moth
(*Macaria promiscuata*)
Photo source: Henderson State University

Photo sources: PNHP

A Borer Moth (*Papaipema marginidens*)

through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Flowering redbud at Rupert Cave serve as a foodplant for the caterpillars of two rare butterflies.
Photo source: PNHP

Conservation Recommendations:
Open habitats on the limestone ridge should be maintained in order to prevent forest succession; however, care should be taken to coordinate mowing schedules with the requirements of the butterfly and plant species of concern (after the first frost would be ideal). Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats. The supporting natural landscape for Rupert Cave represents an area of similar geology that has potential to offer habitat for the same host of species supported at the site if the habitats were restored in the future.

Big Ridge Cave (Oliver Township)
The Big Ridge Cave is formed on a wooded ridge in Devonian Helderberg limestone. The cave has not been explored extensively for the presence of animals, but it may support animal species of concern, particularly in the water pools and stream found within the cave.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity. This cave has been gated to restrict access.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human life and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes

and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats if they are present.

Mcveytown Cave (Oliver Township)
The McVeytown Cave is formed on a wooded ridge above the Juniata River in Devonian Helderberg limestone. The cave has not been explored extensively, but may support animal species of concern.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats if they are present.

Mcveytown Quarry Caves (Oliver Township)
Several small caves occur in a quarry west of McVeytown, in Devonian Helderberg limestone. As of 1980 the caves were very limited in extent and nearly destroyed by quarry operation (Dayton et al. 1981). They appear unlikely to support animal species of concern.

Threats and Disturbances:
The cave entrances and extent have been altered over the years by quarry operations.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). Even though these caves are in a disturbed situation, they may provide underground conduits to runoff and thus be important to the water quality of the groundwater in this valley.

Union Township

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
JACKS MOUNTAIN—WEST		*Notable Significance*			
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
Barrville Cave		*Local Significance*			
Belleville Cave		*Local Significance*			
Kings Cave		*Local Significance*			

PUBLICLY MANAGED LANDS: Rothrock State Forest

OTHER CONSERVATION AREAS: Rothrock State Forest and Stone Mountain Important Bird Area, Central Mountains Important Mammal Area

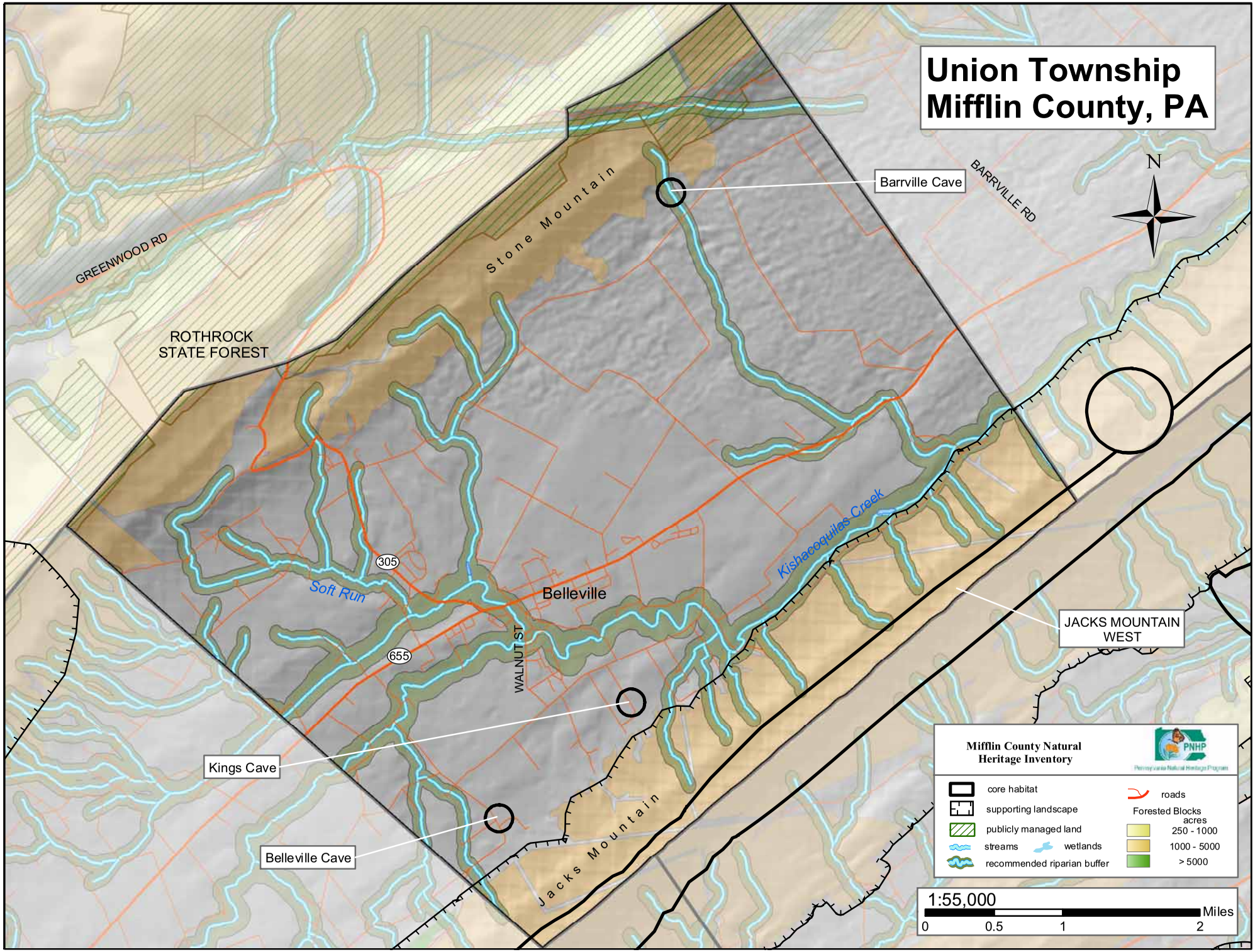
HIGH QUALITY STREAMS: Frog Hollow

AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Kishacoquillas Creek - Atlantic Warmwater Community 1; High Quality Small Stream Community
- Kishacoquillas Creek—Coffee Run - Warmwater Community 1; Low Gradient Valley Stream Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.


Union Township
Mifflin County, PA
N
Barrville Cave
BARRVILLE RD
GREENWOOD RD
Stone Mountain
ROTHROCK
STATE FOREST
Soft Run
305
655
Belleville
WALNUT ST
Kishacoquillas Creek
JACKS MOUNTAIN
WEST
Kings Cave
Belleville Cave
Jacks Mountain
Mifflin County Natural
Heritage Inventory
PNHP
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks
acres
250 - 1000
1000 - 5000
> 5000
1:55,000
Miles
0
0.5
1
2

Union Township is the second smallest township in the county and is located along the northern edge of Mifflin County, where it borders Huntingdon County. The bedrock geology is mostly limestone, which is located in the Kishacoquillas Valley. This valley is host to a high concentration of caves and associated sinkholes, sinking streams, and groundwater resources. Sandstone and shale are found in the more mountainous areas in the northern and southern portions of the township. Stone Mountain and Jacks Mountain run along the northern and southern border of the township, respectively.

Union Township is the least forested in Mifflin County, making up 36% of the total land use. The forests that are present, however, are mostly made up of large forest blocks, which make them beneficial for interior forest species. Small portions of Rothrock State Forest cross into northern Union Township. Conservation efforts to buffer the edges of the state forest from development and disturbance are important to the long-term quality of the wildlife and land resources within this corridor.

At 58%, much of the rest of the land use in the township is agriculture, which occurs in the valley. Kishacoquillas Creek is the major stream flowing through the township. Even though the headwaters of many of the smaller streams are located in the forested areas, all of the streams flow down into the agricultural valley. This does not provide a good buffer to filter out the sediments, fertilizers, and other chemicals before they enter into the stream. Much of the biodiversity of the township can be maintained by protecting cave entrances, providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Conservation efforts within the township should concentrate on replanting riparian buffers along creeks in the valley, thus providing connectivity between the forested headwaters and the pass through Jacks Mountain. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Central Mountains Important Mammal Area (IMA) is located along Stone Mountain in the northern part of Union Township. The Rothrock State Forest/ Stone Mountain Important Bird Area (IBA) is also located along Stone Mountain in northern Union Township. This area was chosen as an IBA because of the old growth forests still found in this area that provide habitat for warblers and other mature forest species and for the ridge line that is used as a raptor migration route in the fall.

Water quality in the Kishacoquillas watershed could be improved by planting riparian buffers and reducing erosion of streambanks. Photo source: PNHP

JACKS MOUNTAIN—WEST (Brown, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; and Huntingdon County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—East at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

Barrville Cave (Union Township)
The Barrville Cave is formed at the end of a blind valley in Ordovician limestone. The cave has not been explored extensively for the presence of animals, but it may support animal species of concern such as bats or aquatic invertebrates.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats if they are present.

Belleville Cave (Union Township)
The Belleville Cave is located in a small ridge and what may have been an abandoned quarry in Ordovician limestone. The cave has not been explored extensively for the presence of animals and is limited in extent.

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface

runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats if they are present.

A cave entrance at the base of a limestone bluff in Union Township.
Photo source: PNHP

Kings Cave (Union Township)
Kings Cave is formed in a farm field in Ordovician limestone. The cave has not been explored extensively for the presence of animals, but it may support animal species of concern, particularly in the water pools and stream found within the cave. Anecdotal evidence from landowners in the valley indicate the presence of a long subsurface drainage system within which this cave lies (Dayton et al. 1981)

Threats and Disturbances:
Species of animals that may inhabit this cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity. It appears that the entrance to this cave was blocked or altered shortly after its discovery in 1978 (Dayton et al. 1981).

Conservation Recommendations:
If an entrance to this cave is still available, then it should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of hibernating bats if they are present. The mapped opening to this cave was formed shortly before being closed, so it is unknown what effect this closure may have had on the cave environment.

Wayne Township and Kisler and Newton Hamilton Boroughs

NATURAL HERITAGE SITES	PNHP Rank[1] Global	PNHP Rank[1] State	State Status[1]	Last Seen (m/d/y)	Quality[2]
BLUE MOUNTAIN at WEST LICKING CREEK		*High Significance*			
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	3/18/1992	E
JACKS MOUNTAIN—WEST		*Notable Significance*			
Timber Rattlesnake (*Crotalus horridus*)	G4	S3S4	PC	9/7/2006	E
JACKS NARROWS		*High Significance*			
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	6/03/1997	E
JUNIATA RIVER—MIFFLIN COUNTY		*High Significance*			
Yellow Lampmussel (*Lampsilis cariosa*)	G3G4	S3S4	-	7/20/2006	C
SUGAR RIDGE		*Exceptional Significance*			
Plant: oblique milkvine (*Matelea obliqua)*	G4?	S1	-	8/16/2006	CD
Plant: hoary puccoon (*Lithospermum canescens*)	G5	S2	-	5/19/2005	BC
Plant: Virginia mallow (*Sida hermaphrodita*)	G3	S2	-	8/16/2006	BC
Plant: shale-barren evening-primrose (*Oenothera argillicola)*	G3G4	S2	-	8/16/2006	B
Plant: leaf-cup (*Polymnia uvedalia)*	G4G5	SNR	-	8/16/2006	CD
Allegheny Woodrat (*Neotoma magister*)	G3G4	S3	PT	1980	E
West Licking Creek Wetlands		*Local Significance*			

PUBLICLY MANAGED LANDS: Rothrock State Forest, Tuscarora State Forest

OTHER CONSERVATION AREAS: Blacklog Mountain Important Mammal Area, 1000 Steps Important Mammal Area

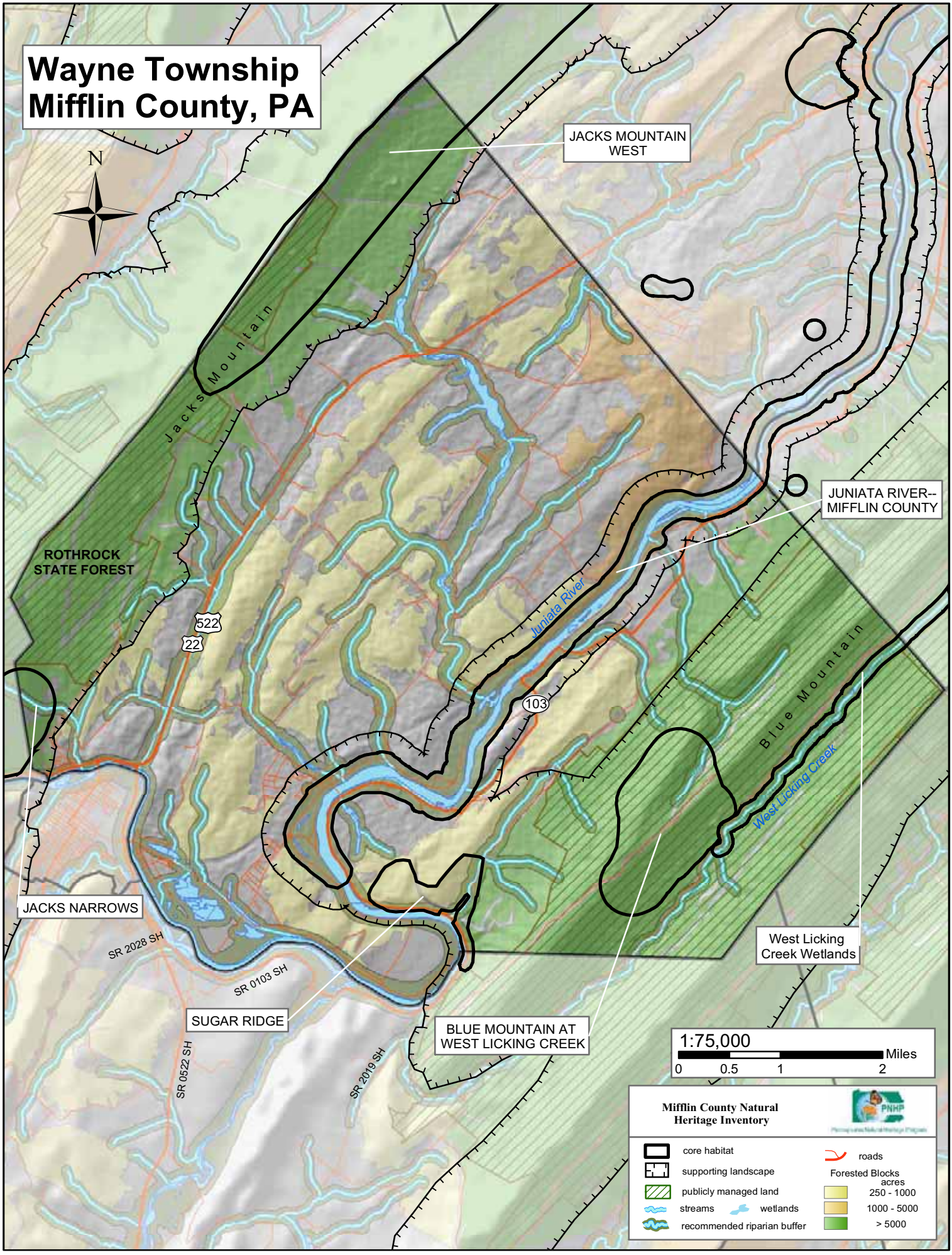
HIGH QUALITY STREAMS: Beaverdam Run, Furnace Hollow, Long Hollow Run, West Licking Creek, Wharton Run, Unnamed Tributaries to Juniata River

AQUATIC COMMUNTIY CLASSIFICATION PROJECT RESULTS (see p.39 for explanation)*:*

- Juniata River—Aughwick Creek - Warmwater Community 1; High Quality Small Stream Community
- Juniata River—Carlisle Run - Warmwater Community 1; High Quality Small Stream Community
- Juniata River—Shanks Run - Coldwater Community; Eastern Elliptio Community

[1] Please refer to Appendix VI for an explanation of PNHP ranks and legal status.

[2] Please refer to Appendix VII for an explanation of quality ranks.


Wayne Township
Mifflin County, PA
N
JACKS MOUNTAIN WEST
Jacks Mountain
ROTHROCK STATE FOREST
JUNIATA RIVER--MIFFLIN COUNTY
Juniata River
522
22
103
Blue Mountain
West Licking Creek
JACKS NARROWS
SR 2028 SH
SR 0103 SH
SUGAR RIDGE
SR 0522 SH
SR 2019 SH
BLUE MOUNTAIN AT WEST LICKING CREEK
West Licking Creek Wetlands
1:75,000
Miles
0 0.5 1 2
Mifflin County Natural Heritage Inventory
core habitat
supporting landscape
publicly managed land
streams
wetlands
recommended riparian buffer
roads
Forested Blocks acres
250 - 1000
1000 - 5000
> 5000

Wayne Township, the second largest township in the county, is located in southwestern Mifflin County, bordered by Huntingdon County to the west and Juniata County to the south. Jacks Mountain forms the northern border, Blacklog Mountain forms the southern border, and the Juniata River forms the western border of Wayne Township. The bedrock geology is made up of mostly sandstone and shale with small areas of limestone.

Sixty eight percent of the township is forested, much of which occurs is the large forested blocks in Jacks Mountain and Blue Mountain, including portions of Rothrock State Forest and Tuscarora State Forest. More fragmented forest blocks occur in the center of Wayne Township. Some of these forest blocks have the potential to be connected, and trees should be planted wherever possible to create larger tracts of intact forest. Conservation efforts to buffer the edges of the state forest from development and disturbance are important to the long-term quality of the wildlife and land resources within this corridor. This portion of the forested ridges provides connectivity to neighboring townships and counties for movement of wildlife and integrity of natural plant communities. Protection of these forest blocks will additionally protect the water quality of the many headwater streams originating within them.

Much of the biodiversity of the township can be maintained by providing forested buffers along streams, and avoiding fragmentation of the largest forest blocks with additional roads. Care should be taken during logging operations to avoid introducing invasive species of plants into the largely unfragmented forest blocks. Machinery should be thoroughly rinsed to avoid transferring invasive plant seeds and other exotic pests and pathogens from other locations. The spread of invasive species of plants could severely degrade the forest quality of the township. Removal of invasive species as they first appear is easier and more cost effective than removal of established populations.

Agriculture makes up 26% of the total land use for Wayne Township. The Juniata River and Beaverdam Run are the major waterways flowing through the township. Most of the streams run through open agricultural and residential areas, which provide a poor buffer to filter out sediments and chemicals. Trees should be planted in these areas to buffer the stream and improve water quality. Forested buffers help filter surface water runoff, preventing many non-point sources of pollution from entering waterways, protecting water quality in the township and the Susquehanna River basin. In addition, reforestation of creek and stream banks can help link larger forested blocks together, contributing to their utility as a natural wildlife corridor.

The Blacklog Mountain and 1000 Steps Important Mammal Areas (IMA) are located in Wayne Township. The Blacklog Mountain IMA is located in southern Wayne Township and was chosen because of the available habitat for a state threatened species as well as other mammals.

Newton Hamilton Borough is located within Wayne Township along the Juniata River, and much of the borough is in low intensity residential areas. Kisler Borough is also located within Wayne Township along the Juniata River. Twenty three percent of the borough is low intensity residential, and agriculture makes up another 35% of the total land use.

Intact natural areas such as meadows along West Licking Creek in Wayne Township provide important habitats for a variety of plant and animal species, for example the caterpillar of a monarch butterfly. Photo source: PNHP

BLUE MOUNTAIN AT WEST LICKING CREEK (Wayne Township)
Active signs of G3G4, S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)** were located at the crest of this mountain during surveys in 1992. This species has been located at several locations along the Blue Mountain. The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation.

Threats and Disturbances:
The site is within the Tuscarora State Forest and appears relatively undisturbed.

Conservation Recommendations:
Additional surveys for this species along the ridge are recommended to better understand the extent of the population. Avoid further fragmentation of the forested matrix surrounding this site with additional roads and utility rights-of-way. This will help the buffer the woodrat population from external disturbances and negative environmental influences.

JACKS MOUNTAIN—WEST (Brown, Derry, Granville, Menno, Oliver, Union, and Wayne Townships; and Huntingdon County)
The open scree woodlands and south-facing slopes of Jacks Mountain provide excellent habitat for the PA-candidate G4 S3S4 **Timber Rattlesnake (*Crotalus horridus*)**. Rattlesnakes primarily occur on rocky talus slopes where they can find refuge in spaces between the boulders as well as thermoregulate in the sunny openings. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid (pregnant) females, which will give live birth in late summer, are far less mobile and tend to stay within a short distance of the den. Specific locations of dens (hibernacula) and summer birthing sites have not been well inventoried along this ridge, but many landowners report encountering rattlesnakes on the mountain. The majority of the ridge consists of typical dry oak woodlands, broken by openings created by bedrock outcrops and scree. The length of Jacks Mountain in Mifflin County is host to one of the largest blocks of contiguous forest in the county and provides an important corridor for wildlife, including raptor and songbird migrations, connectivity and dispersal of populations of forest inhabitants. The habitat is broken only occasionally by utility lines and small roads, but is disconnected from Jacks Mountain—East at the Mann Narrows by State Route 322 and the Kishacoquillas Creek.

Threats and Disturbances:
The most immediate threats to Timber Rattlesnakes throughout their range in Pennsylvania are habitat loss and hunting. Though hunting of Timber Rattlesnakes is legal in the Commonwealth with proper permits, some populations cannot sustain any removal. The majority of Jacks Mountain is in private ownership, and is thus subject to potential future alterations of habitat through forest clearing or development, such as large-scale wind farms.

Rocky habitats ideal for Timber Rattlesnakes can be found along the length of Jacks Mountain.
Photo source: PNHP

Conservation Recommendations:
Further surveys to determine specific concentrations of rattlesnakes could improve protection of these sites. A statewide den inventory project coordinated by the PA Fish and Boat Commission should include Jacks Mountain in upcoming inventories. Cooperation with landowners is critical to protection of the rattlesnake. Programs to encourage best management practices in forestry, limiting fragmentation of the forest block, and educating landowners about rattlesnakes are all needed.

JACKS NARROWS (Wayne Township and Huntingdon County)
This site lies along the slopes above the Juniata River on the border of Huntingdon and Mifflin Counties and extends north into oak-dominated forest uplands underlain by sandstone. The 1,000 Steps Natural Area was extensively quarried between 1900 and 1952 for gannister, a Tuscarora sandstone, used in the production of heat-resistant silica bricks for steel, glass, iron, and other industries. Thousand Steps and the surrounding area are now managed by the Pennsylvania Game Commission. This site supports several occurrences of the G3G4 S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*)**. The uplands in this site provide prime habitat for the woodrat: oak-forested talus slopes that offer both nesting areas and a supply of acorns that comprise a large part of its diet.

Threats and Disturbances:
The site is partially within State Game Lands 112 and appears relatively undisturbed.

Conservation Recommendations
Forest cover is important in maintaining the microhabitat conditions and the food sources utilized by woodrats. Oak trees are especially important because of the mast they provide and should not be removed in proximity to talus slopes. Fragmentation and disturbance within the area should be avoided.

JUNIATA RIVER—MIFFLIN COUNTY (Bratton, Granville, and Wayne Townships)
Several species of freshwater mussels inhabit suitable habitat in portions of the Juniata River. One of these is considered a species of concern due to declines in its global and state range and abundance: the G3G4, S3S4 **Yellow Lampmussel (*Lampsilis cariosa*)**. The lampmussel is a species of larger rivers and is primarily found in sand and gravel with a good current. Pennsylvania is host to a large percentage of the Yellow Lampmussels in North America; therefore, preservation of the Commonwealth's populations is critical to the global conservation of the species. Associated species are the Common Elliptio (*Elliptio complanata*) and the Rainbow Mussel (*Villosa iris*), as well as the introduced Asian Clam (*Corbicula fluminea*) and Rusty Crayfish (*Orconectes rusticus*). Downstream portions of the river support a higher diversity of freshwater mussels, including several additional rare species. The entire length of the Juniata River should be considered suitable habitat for most of these freshwater mussel species. Additional surveys could be useful in estimating populations and distribution of the species of concern in the river. Illinois pondweed (*Potamogeton illinoensis*), an aquatic plant that was formerly considered a species of concern, was found near Newton Hamilton in 1991. Surveys in 2006 failed to locate any populations of the plant, but its persistence cannot yet be ruled out.

The Juniata River near Newton Hamilton. Purple loosestrife, an invasive plant species, can be seen blooming in the foreground.
Photo source: PNHP

Threats and Disturbances:
There are numerous examples of disturbance along the Juniata River. Freshwater mussels are affected by non-point sources of pollution, including sedimentation from cultivated and developed land along the river, runoff from roadways, pesticide runoff from agricultural fields, discharge of chemical pollutants, and thermal pollution. There may also be a threat posed by competition from the Asian Clam and predation by the Rusty Crayfish, but the level of these threats is not fully understood.

Conservation Recommendations:
Any of the above types of disturbances should be minimized wherever possible. Also, monitoring of these populations should continue into the future. Water quality should be monitored and pollution sources should be identified and eliminated. Forested buffers should be maintained and created where absent along the length of the river, with logging operations refraining from cutting within 100 meters (328 feet) of the river edge. River bank forests help buffer the watershed from the effects of non-point sources of pollution, including runoff from agricultural, residential, and roadway settings. In addition, the river floodplain and corridor is usually an area of significantly higher biodiversity than the adjoining uplands. Maintaining an intact, forested floodplain along the river can preserve much of the area's important biodiversity. Local planning should discourage construction of new structures and roadways along the river, adjacent slopes, and floodplain. Additional information on riparian buffers can be found on page 66.

SUGAR RIDGE (Wayne Township)
The limestone-influenced slopes of Sugar Ridge above the Juniata River provide habitat for a diverse flora. In 2005 and 2006 four plant species of concern were discovered at this site, including a small population of G4? S1 **oblique milkvine (*Matelea obliqua*)**; a population of G5 S2 **hoary puccoon (*Lithospermum canescens*)**; G3 S2 **Virginia mallow (*Sida hermaphrodita*);** and G4G5 SNR **leaf-cup (*Polymnia uvedalia*)**. Portions of the site have many representative limestone plant species with some exposed limestone outcrops overlooking the river. The surrounding land is wooded, with sugar maple (*Acer saccharum*), redbud (*Cercis canadensis*), hackberry (*Celtis occidentalis*), eastern red cedar (*Juniperus virginiana*), chinquapin oak (*Quercus muhlenbergii*), hop-hornbeam (*Ostrya virginiana*), and hickory (*Carya* spp.). Another portion of the site contains a shale cliff on the edge of a road where the G3G4 S2 **shale-barren evening-primrose (*Oenothera argillicola*)** is growing. The cliff habitat is probably part natural and probably partly enhanced by the building of the road.

Also located at the base of Sugar Ridge is the Blue Springs Cave, a limestone solutional geologic feature in Helderberg limestone. This cave has been known to support a population of the G3G4 S3 PA-threatened **Allegheny Woodrat (*Neotoma magister*).** The woodrat typically inhabits the deep crevices of rocky outcrops, boulder-strewn talus slopes and caves. Populations of this species throughout the state have experienced rapid decline in recent decades due to a variety of possible causes, including fluctuating food supplies and habitat fragmentation. Additional surveys for this species at this site are recommended.

Hoary puccoon
Photo source: PNHP

Threats and Disturbances:
Selective logging practices in the past and jeep trails have encouraged growth of invasive plant species at the site. Many are well established, including Japanese stiltgrass (*Microstegium vimineum)*, Japanese honeysuckle (*Lonicera japonica*), and tree of heaven (*Ailanthus altissima*). The evening primrose is dependent on the openings created by road cuts and would be threatened by maintenance or herbicide spraying of the roadside. Species of animals that may inhabit the cave are sensitive to even minor disturbance to the water quality and cave environment. Streams and surface

runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. In addition, the porous carbonate bedrock typical of karst topography allows solid and liquid wastes to seep into caves and groundwater. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, can affect climatic conditions in the cave, including airflow, temperature, and humidity.

Conservation Recommendations:
Careful management of the invasive plants at this location will benefit the populations of rare plants. Invasive species removal should not be done without consulting PNHP regarding the location and sensitivity of the rare plants. Cave entrances should be buffered from disturbance by at least 160 meters (525 feet). The water quality of the groundwater in this valley is critical to human uses and to maintaining the aquatic life in the caves and can be protected with restoration and maintenance of vegetated riparian buffers along streams, springs, around sinkholes and cave openings. Access to caves should be limited in winter months in order to avoid disturbance of potentially hibernating bats if they are present.

West Licking Creek Wetlands (Bratton and Wayne Townships)
The upper parts of the West Licking Creek drainage are characterized by several of these wet meadow openings interspersed throughout the drainage in an otherwise hemlock-dominated floodplain. Dominant plants in the meadows include *Sphagnum* moss, tussock sedge (*Carex stricta*) and other sedges (*Carex* spp.), cinnamon fern (*Osmunda cinnamomea*), three-way sedge (*Dulichium arundinaceum*), tawny cotton-grass (*Eriophorum virginicum*), rushes (*Juncus* spp.), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), swamp dewberry (*Rubus hispidus*), black huckleberry (*Gaylussacia baccata*), and round-leaved sundew (*Drosera rotundifolia*). The seeps and wetlands also provide habitat for several reptile and amphibian species, such as the Eastern Garter Snake and Wood Frog.

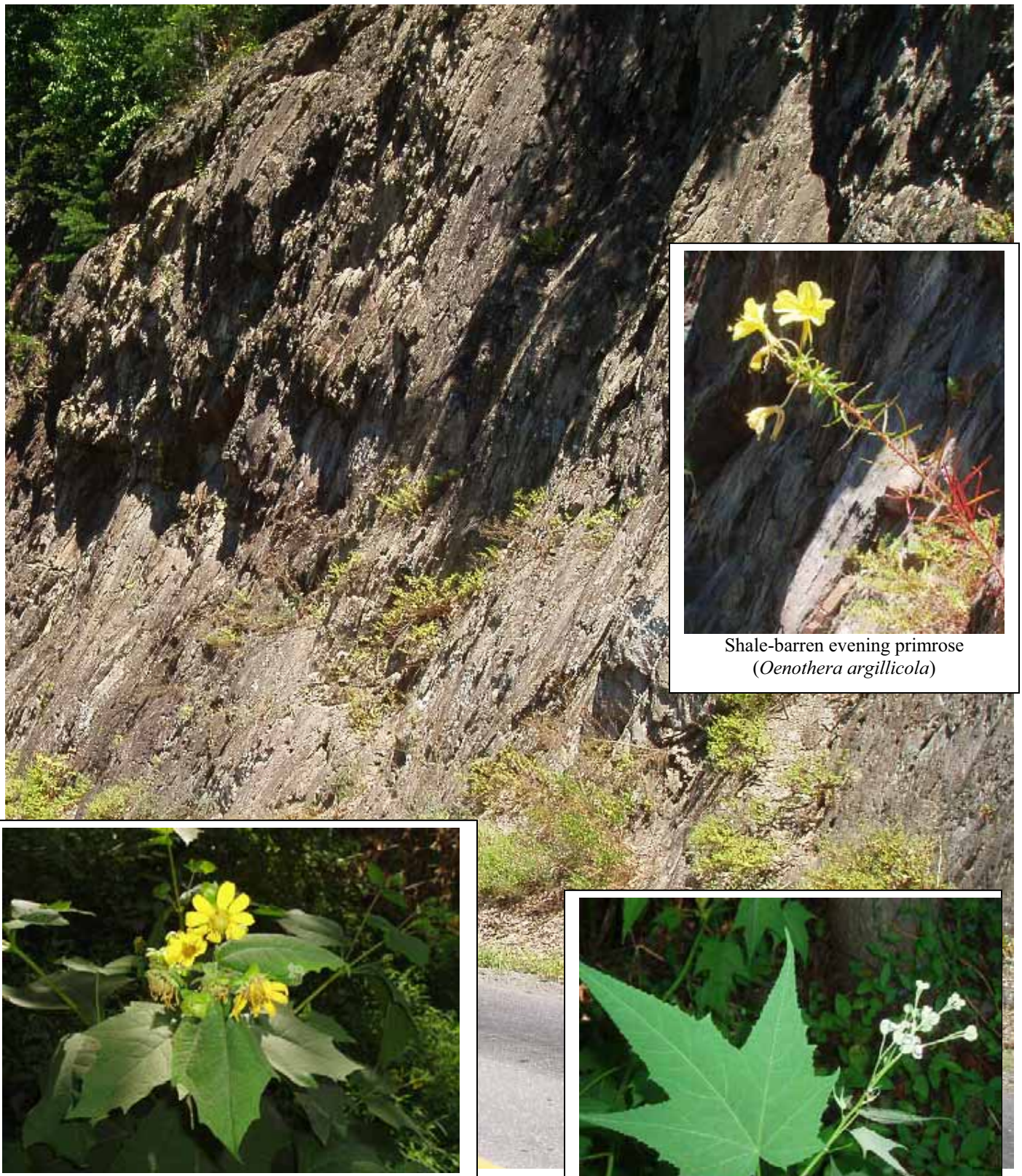
Threats and Disturbances:
The site is within the Tuscarora State Forest and remains relatively undisturbed. Jeep trails and footpaths in the vicinity are providing disturbance pathways for invasive plant species such as Japanese stiltgrass (*Microstegium vimineum*) to establish, but few invasives were found in the wetland.

Conservation Recommendations:
The West Licking Creek drainage should be buffered by 100 meters (328 feet) from any logging operations in order to maintain the ecological integrity of the wetlands and the water quality of the groundwater seeps and surface water flowing to these wetlands. Populations of invasive plants should be monitored for encroachment into the more sensitive wetland systems.

A wet meadow opening on West Licking Creek

Photo source: PNHP

Sugar Ridge Outcrop



Shale-barren evening primrose (*Oenothera argillicola*)

Leaf cup (*Polymnia uvedalia*)

Virginia mallow (*Sida hermaphrodita*)

Photos: Pennsylvania Natural Heritage Program

CONSERVATION RECOMMENDATIONS

Mifflin County has a number of groups pursuing the protection of natural heritage sites within the county. The following are general recommendations for protecting the biological diversity of Mifflin County.

Approaches to protecting a natural heritage site are wide-ranging and factors such as land ownership, time constraints, and tools/resources available should be considered when prioritizing protection of these sites. Prioritization works best within a planning situation, however, 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 our program or staff from state natural resource agencies are available to discuss more specific options as needed.

1. Consider conservation initiatives for natural heritage sites on private land.

•*Conservation easements* protect land while leaving it in private ownership. A conservation 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 landowner and conservation organization. Tax incentives apply to conservation easements. In Mifflin County the organization most likely to hold conservation easements on private lands is the Central Pennsylvania Conservancy (www.centralpaconservancy.org).
•*Leases, management agreements, and mutual covenants* also allow the landowner to retain ownership and ensure permanent protection of land, though in a much more limited way. There are no tax deductions 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 landowner and land trust to work together to develop a plan for managing resources such as plant or animal habitat, or protecting a watershed. Mutual covenants can be appropriate where land protection is important to several landowners but not of sufficient benefit to the general public to warrant a conservation easement.
•*Land acquisition* can be at fair market value, as a last resort by conservation organization, or as a bargain sale in which a sale is negotiated for a purchase price below fair market value with tax benefits that reduce or eliminate the disparity. The NHI will help to pinpoint 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 would be particularly ideal. Private lands adjacent to public should be examined for acquisition when a priority site is present on either property and there is a need of additional land to complete protection of the associated natural features.
•*Fee simple acquisition* gives landowner 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.
•*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.

2. Prepare management plans that address species of special concern and natural communities.

Many of the already-protected natural heritage sites are in need of additional management recommendations to ensure the continued existence of the associated natural elements. We hope that managers will incorporate specific recommendations into existing plans or prepare new plans. These may include: removal of exotic 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, agriculture and certain forestry practices.

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 species of special concern and their habitat needs and agreements should be worked out to minimize encroachments that may threaten native flora and fauna.

3. Protect bodies of water.

Protection of reservoirs, wetlands, rivers, and creeks is vital; especially those that protect biodiversity, supply drinking water, and are attractive recreational resources. Many sites that include rare species, unique natural communities or locally significant habitats are associated with water. Protection of high quality watersheds is the only way to ensure the viability of natural habitats and water quality. Land managers and township officials should 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. The Juniata Clean Water Partnership (www.jcwp.org) is dedicated to building and sustaining local capacity to enhance, restore, and protect the natural resources of the Juniata watershed.

The Pennsylvania Seasonal Pools Registry is a citizen-based program to document locations of seasonal pools. The registry is an important step toward understanding Pennsylvania's ephemeral wetland habitats. Anyone interested in submitting information on seasonal pools should visit http://paconserve.org/rc/sp/.

4. Provide for buffers around natural heritage sites.

Development plans should provide for natural buffers between disturbances and natural heritage sites, be it a barrens community, wetland, water body, or forest. Disturbances may include construction of new roads and utility corridors, non-conservation timber harvesting, and disruption of large pieces of land. County and township officials can encourage landowners to maintain vegetated buffer zones within riparian zones. Vegetated buffers (preferably of PA-native plant species) help reduce erosion and sedimentation and shade/cool the water. This benefits aquatic animal life, provides habitat for other wildlife species, and creates a diversity of habitats along the creek or stream.

Watersheds or subwatersheds where natural communities and species of special concern occur (outlined on the Township maps in this report) should be viewed as areas of sensitivity, although all portions of the watershed may not be zones of potential impact. As an example, conserving natural landscapes around municipal water supply watersheds provides an additional protective buffer around the water supply, habitat for wildlife, and may also provide low-impact recreation opportunities.

5. Reduce fragmentation of surrounding landscape.

Residents and township officials should encourage development in sites that have already seen past disturbances. Care should be taken to ensure that protected sites do not become "islands" surrounded by development. In these situations, the site is effectively isolated and its value for wildlife is reduced. Careful planning can maintain natural environments and 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, or brownfields development, for commercial and industrial projects presents one way to encourage economic growth while allowing ecologically sensitive areas to remain undisturbed. Cluster development could be used to allow the same amount of development on much less land and leave much of the remaining land intact for wildlife and native plants. By compressing development into already disturbed areas with existing infrastructure (villages, roads, existing ROW's), large pieces of the landscape can be maintained intact. If possible, networks or corridors of woodlands or greenspace should be preserved linking sensitive natural areas to each other.

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 heritage sites identified in this report. However, grassroots organizations are needed to assist with obtaining funding, identifying landowners who wish to protect their land, providing information about easements, land acquisition, and

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 disrupting the integrity of the ecosystems they occupy. Management for invasives depends upon the extent of establishment of the species. Small infestations may be easily controlled or eliminated but more well established populations might present difficult management challenges. For more information on invasive species, go to page 13.

8. Promote community education.

Educating the public about the environment and its protection is key to meeting the recommendations in this section. Without a sense of involvement and investment in environmental programs, public support will be hard to earn. By making educational resources readily available to the public, sponsoring booths and outreach activities during local community events, and promoting public programs and events about the environment, active public application of these recommendations is promoted.

9. Incorporate CNHI information into planning efforts.

Through internal planning, decision-making related to land-use development, and participation in regional planning initiatives, counties and municipalities could profoundly shape the land and landscapes of Pennsylvania. Natural Heritage Areas can be readily included in comprehensive plans, greenway and open space plans, parks and recreation plans, and regional planning initiatives. DCNR-funded greenway and open space plans, Heritage Region plans, and River Conservation Plans are good examples of planning efforts that reach beyond county boundaries

Glossary

Abandoned Mine Drainage (AMD) – drainage flowing from or caused by surface mining, deep mining, or coal refuse piles that are typically highly acidic or basic with elevated levels of dissolved metals (DEP).

Acidophilic – a plant that requires or prefers acidic soil conditions.

Alluvium – material such as sand, silt, or clay that is deposited on land by streams.

Anthracite - Dense, shiny coal that has a high carbon content and little volatile matter and burns with a clean flame. Also called hard coal.

Anthropogenic – human caused.

ATV – all-terrain-vehicle.

Bedrock - The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Bt (Bacillus thuringiensis) – an insecticide, which is produced by the fermentation of a bacterium (Bt), used to control many caterpillar-type pests (e.g., gypsy moth).

Bog – a nutrient poor, acidic peatland that receives water primarily from direct rainfall with little or no input from groundwater or runoff; vegetation consists primarily of peat moss and ericaceous shrubs.

Calcareous- composed of, containing, or characteristic of calcium carbonate, calcium, or limestone; chalky.

Canopy – the layer formed by the tallest vegetation.

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.

DBH – the diameter of a tree at 4.5 feet above the ground (breast height).

DCNR – Pennsylvania Department of Conservation and Natural Resources.

DEP – Pennsylvania Department of Environmental Protection.

Diabase – a dark gray igneous rock. The chemical composition of diabase may support unusual plant communities.

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.

Ericaceous – members of the heath family including blueberries, huckleberries, rhododendrons, and azaleas; these plants are adapted to living in acidic soils.

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.

Extirpated – loss of a species from part of its natural range; also referred to as "localized extinction".

Fen - open-canopy peatland that has developed under the influence of basic-rich waters

Floodplain – low-lying land generally along streams or rivers that receives periodic flooding.

Forb – non-grass herbaceous plant such as goldenrod.

Fragipan - a very dense soil layer that prevents water from draining quickly through the soil.

Graminoid – grass or grass-like plant such as a sedge or a rush.

Ground cover – low shrubs, herbs, and mosses that are found at or close to the ground surface.

Hemic – an organic soil in which the plant remains show a good degree of decomposition (between 1/3 and 2/3 of the fibers are still visible after rubbing the material between the fingers).

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.

Invasives – 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 invasives can often cause the breakdown of the natural community.

Karst—a landscape of characteristic landforms (sinkholes) and subsurface features (caves, sinking streams, limestone springs) produced primarily as a result of solution of the underlying bedrock

Lacustrine – any species living in or process involving lakes.

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.

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 Area – State Forest Natural Areas, which are specific management units designated by DCNR Bureau of Forestry.

Natural Heritage site – as used in this study, a site with either an exemplary natural community or species of special concern

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 storm water runoff contaminated with oil or pesticides.

Obligate species - able to exist or survive only in a particular environment or by assuming a particular role

Odonates – dragonflies and 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

POSCIP – Plant of Special Concern in Pennsylvania.

Potential Natural Area – used by Western Pennsylvania Conservancy to denote an area that may have desirable environmental characteristics to support rare species or exemplary natural communities, but which needs a field survey to confirm; a preliminary category given to sites prior to field survey (see METHODS section).

Prescribed burning – burning under controlled conditions; needed to maintain communities such as limestone glades and pitch pine barrens.

Riparian – streamside.

Rookery - the breeding ground of certain birds or animals, such as herons, penguins, and seals.

ROW – right-of-way: 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 - grasslike 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.

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).

Talus – slope formed of loose rock and gravel that accumulates at the base of mountains or cliffs.

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

The American Society of Ichthyologists and Herpetologists. 2006. Conservation Committee Position Paper - Position of The American Society of Ichthyologists and Herpetologists Concerning Rattlesnake Conservation and Roundups. Joint Meeting of Ichthyologists and Herpetologists New Orleans, LA.

Angermeier, P.L., and I.J. Schlosser. 1995. Conserving aquatic biodiversity: Beyond species and populations. American Fisheries Society Symposium 17: 402-414.

Audubon Society of Pennsylvania. Important Bird Areas Project. (2002). Retrieved from http://pa.audubon.org/Ibamain.htm on May 5, 2004.

Berg, T.M., J.H. Barnes, W.D. Sevon, V.W. Skema, J.P. Wilshusen, and D.S. Yannacci. 1989. Physiographic Map of Pennsylvania. Map #13. PA Dept. Environ. Resources, Bureau of Topo. and Geol. Survey, Harrisburg, PA.

Berg, T.M., W.E. Edwards, A.R.Geyer, A.D. Glover, D.M. Hoskins, D.B. Maclachlan, S.I. Root, W.D. Savon and A.A. Socolow. 1980. Geologic Map of Pennsylvania. PA Dept. Environ. Resources, Bureau of Topo. and Geol. Survey, Harrisburg, PA.

Brauning, D.W. (ed.). 1992. Atlas of Breeding Birds in Pennsylvania Univ. of Pittsburgh Press, Pittsburgh, PA. 484 pp.

Brooks, Steve. 2003. Dragonflies. The Natural History Museum, London.

Covell, C.V. 1984. A Field Guide to the Moths. Houghton Mifflin, Boston. 496 pp.

Crossley, G.J. 1999. A Guide to Critical Bird Habitat in Pennsylvania. Pennsylvania Important Bird Areas. Pennsylvania Audubon Society, Harrisburg, PA. 219 pp.

Cuff, D.J., W.J. Young, E.K. Muller, W. Zelinsk, R.F. Abler, (eds.) 1989. The Atlas of Pennsylvania. Temple Univ. Press, Philadelphia, PA. 288 pp.

Dayton, G.O., W. B. White, and E.L. White (eds). 1981. The Caves of Mifflin County. Bull. #12 Mid-Appalachian Region of the National Speleological Society. 72 pp. plus figures.

DeGraaf, R.M., and D.D. Rudis. 1981. Forest Habitat for Reptiles and Amphibians of the Northeast. U.S. Dept. of Agric., Forest Service, Northeastern Forest Exper. Sta. 239 pp.

Department of Conservation and Natural Resources. Hemlock woolly adelgid web site. http//www.dcnr.state.pa.us/forestry/woollyadelgid/index.htm.

Department of Conservation and Natural Resources. Invasive Plants in Pennsylvania. Commonwealth of Pennsylvania.

Department of Conservation and Natural Resources. Landscaping with Native Plants in Pennsylvania. Commonwealth of Pennsylvania.

Department of Conservation and Natural Resources. 1982. Geologic map of Pennsylvania. DCNR, Bureau of Topographic and Geologic Survey, Map 7.

Department of Environmental Protection. 1999. Commonwealth of Pennsylvania, Pennsylvania Code, Title 25. Environmental Resources, Chapter 93. Water Quality Standards. Bureau of Water Quality Management.

Dodd, C.K. 2001. North American Box Turtles, a Natural History. University of Oklahoma Press, Normon OK. 231 pp.

Doutt, J.K., C.A. Heppenstall, J.E. Guilday. 1977. Mammals of Pennsylvania. The Pennsylvania Game Commission, Carnegie Institute, Pittsburgh.

Dunkle, S.W. 2000. Dragonflies Through Binoculars. Oxford University Press, New York, New York. 266 pp.

Fernald, M.L. 1970. Gray's Manual of Botany. D. Van Nostrand Co., New York. 1632 pp.

Fike, J. 1999. Terrestrial & Palustrine Plant Communities of Pennsylvania. PA Dept. of Conservation and Natural Resources, The Nature Conservancy, Western PA Conservancy. 87 pp.

Flora of North America Editorial Committee. 2000. Flora of North America North of Mexico: Vol. 22: Magnoliophyta: Alismatidae, Arecidae, Commelinidae (in part), and Zingiberidae. Oxford University Press, New York.

--------- 2002. Flora of North America North of Mexico: Vol. 23: Magnoliophyta: Commelinidae (in part): Cyperaceae. Oxford University Press, New York.

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.
Glassberg, J. 1993. Butterflies Through Binoculars. Oxford University Press, New York, New York. 160pp. plus color plates.
Gleason, H.A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Hafner Press, New York. 3 volumes.
Gleason, H.A., and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Canada, 2nd Edition. The New York Botanical Garden, Bronx, New York. 910 pp.
Hakenkamp, C.C., Ribblett, S.G., and M.A. Palmer. 2001. The impact on an introduced bivalve (Corbicula fluminea) on the benthos of a sandy stream. Freshwater Biology 46:491-501
Haney, C. J., and C. P. Schaadt. 1996. Functional roles of eastern old growth in promoting forest bird diversity, Chapter 6, pages 76-88 In Eastern Old Growth, Prospects for Rediscovery and Recovery (M. B. Davis, editor), Island Press, Washington D.C.
Harlow, W. H. 1957. Trees of the Eastern and Central United States and Canada. Dover Publications, Inc., New York. 288 pp.
Higgins, J., Lammert, M., Bryer, M., DePhilip, M., and D.Grossman. 1998 Freshwater conservation in the Great Lakes Basin: Development and application of an aquatic community classification framework. The Nature Conservancy. Arlington, Virginia. 273 pp.
Hitchcock, A. S. 1950. Manual of the Grasses of the United States. 2nd ed. United States Government Printing Office, Washington.
Holmgren, N.H. 1998. The Illustrated Companion to Gleason and Cronquist's Manual. The New York Botanical Garden, Bronx, New York. 937 pp.
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.
Juniata Clean Water Partnership. 2000. Juniata Watershed Management Plan. Huntingdon, PA.
Kenney, L.P., and M.R. Burne. 2000. A Field Guide to Vernal Pools. Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program., Westborough, Massachusetts. 73 pp.
Lohman, S.W. 1957. Groundwater in northeastern Pennsylvania. DCNR, Bureau of Topographic and Geologic Survey, Bulletin W 4.
Marti, C. D., A. F. Poole, and L. R. Bevier. 2005. Barn Owl (Tyto alba). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology.
McWilliams, G.M., and Brauning, D.W. 2000. The Birds of Pennsylvania. Cornell University Press, Ithaca, NY. 479pp.
Merritt, J.F. 1987. Guide to the Mammals of Pennsylvania. University of Pittsburgh Press for the Carnegie Museum of Natural History. 408 pp.
Mifflin County Conservation District. 2003. Kishacoquillas Valley Watershed Assessment and Restoration Plan. 165 pp. plus appendices.
Mifflin County Conservation District. 2007. Tea Creek Coldwater Conservation Plan. 45 pp. plus appendices.
Mifflin County Conservation District and Lewistown High School. 2005. Lower Kishacoquillas Creek Watershed Assessment. 74 pp.
Mifflin County Planning and Development Department. 2000. Paths and Bridges to the 21st Century: Mifflin County Comprehensive Plan 2000.
Mitchell, J. C., A. R. Breisch, and K. A. Buhlmann. 2006. Habitat Management Guidlelines for Amphibians and Reptiles of the Northeastern United States. Partners in Amphibian and Reptile Conservation, Technical Publication HMG-3, Montgomery, Alabama. 108 pp.
Mohr, C.E. 1976. The world of bats. J.B. Lippincott Company. Philadelphia, Pennsylvania. 162pp.
Myer, G.H. 1989. Geology. pp 12-17 in D.J. Cuff, W.J. Young, E.K. Muller, W. Zelinsk, R.F. Abler, (eds.), The Atlas of Pennsylvania. Temple Univ. Press, Philadelphia, PA. 288 pp.
Myers, W.L., et al. 2000. Pennsylvania Gap Analysis Project: Leading landscapes for collaborative conservation. Final Rep. U.S. Geol. Survey-Gap Analysis Program. (Available at: http://www.orser.psu.edu/PAGAP/gappage.htm. December 14, 2006)
NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: November 30, 2006).

Nedeau, E., Smith, A.K., Stone, J. 2005. Freshwater mussels of the Pacific Northwest. U.S. Fish and Wildlife Service publication. ww.fws.gov/pacific/columiariver/musselwg.htm
Needham, J. G., M. J. Westfall Jr., and M. L. May. 2000. Dragonflies of North America. Scientific Publishers, Gainesville, FL.
Newcomb, L. 1977. Newcomb's Wildflower Guide. Little, Brown, & Company, Toronto, Canada. 490 pp.
Nikula, B., J.L.Loose, and M.R.Burne.2003. A Field Guide to Dragonflies and Damselflies of Massachusetts. Massachusetts Division of Fisheries & Wildlife, Westborough, MA.
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.
Palone, R.S. and A.H. Todd (editors.) 1997. Chesapeake Bay riparian handbook: a guide for establishing and maintaining riparian forest buffers. USDA Forest Service. NA-TP-02-97. Radnor, PA.
Pashley, D.N., C.J. Beardmore, J.A. Fitzgerald, R.P. Ford, W.C. Hunter, M.S. Morrison, and K.V. Rosenberg. 2000. Partners in Flight: Conservation of the landbirds of the United States. American Bird Conservancy, The Plains, VA.
PA Department of Conservation and Natural Resources. (2007). Hemlock Woolly Adelgid. Retrieved February 14, 2007 from http://www.dcnr.state.pa.us/forestry/woollyadelgid/index.aspx).
Pennsylvania Geological Survey and Pittsburgh Geological Survey. 1999. The Geology of Pennsylvania. Charles H. Shultz (ed.). Boyer Printing, Lebanon, PA. 888 pp.
Pennsylvania Natural Heritage Program (PNHP). 2006. Odonate species list. Unpublished.
Peterson, R.T. 1980. Eastern Birds. Peterson Field Guides. Houghton Tioga Company, New York, New York. 384 pp.
Peterson, R.T., and McKenny. 1968. Wildflowers of Northeastern and Northcentral North America. Peterson Field Guides. Houghton Tioga Company, New York, New York. 420 pp.
Pimentel, D., Lach, L., Zuniga, R., and D. Morrison. 2000. Environmental and Economic Costs of Nonindigenous Species in the United States. BioScience 50(1):53-65.
Podniesinski, G., and J. Wagner. 2002. Classification, Assessment and Protection of Forested Floodplain Wetlands of the Susquehanna Drainage. Report to the US EPA and the PA DCNR Bureau of Forestry , Forestry Advisory Services. 160 pp.
Rhoads, A.F, and T.A.Block. 2000. The Plants of Pennsylvania, an Illustrated Manual. University of Pennsylvania Press, Philadelphia, PA. 1061 pp.
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.
Robinson, S. K. 1994. Nesting success of forest songbirds in northwestern Illinois. Final Report, Project W-115-R-3. Illinois Nat. Hist. Surv., Center of Wildl. Ecology, Urbana.
Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, B. G. Peterjohn. 2000. The North American Breeding Bird Survey results and analysis. Version 98.1. Patuxent Wildl. Res. Center, Laurel, MD.
Schweitzer, D.F. 1981. Species Accounts for Species of Special Concern Book (unpubl. draft).
Serrao, J. 2000. The Reptiles and Amphibians of the Poconos and Northeastern Pennsylvania. 48pp.
Sevan, W.D. 2000. Physiographic provinces of Pennsylvania. DCNR, Bureau of Topographic and Geologic Survey, Map 13.
Shaffer, L.L. 1991. Pennsylvania Amphibians & Reptiles. The Pennsylvania Fish & Boat Commission, Harrisburg, PA. 161 pp.
Shertzer, R.H., ed. 1992. Special Protection Waters Implementation Handbook. PA. Dept. Environ Resources, Harrisburg, PA.
Smith, T. 1991. Natural Ecological Communities of Pennsylvania (draft). Pennsylvania Natural Diversity Inventory-East, Pennsylvania Science Office of The Nature Conservancy. Middletown, PA.
Strausbaugh, P.D., and E.L. Core. 1964. Flora of West Virginia, 2nd Edition. Seneca Books, Morgantown, West Virginia. 1079 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.

Thompson, Sue A., editor. 2002. Biodiversity in Pennsylvania: Snapshot 2002. Pennsylvania Biodiversity Partnership, Pittsburgh, Pennsylvania.
Tiner, R.W., Jr. 1987. Mid-Atlantic wetlands: a disappearing natural treasure. U.S. Fish and Wildlife Service and U.S. Environmental Protection Agency. Washington, D.C.
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.
The Nature Conservancy. 1988. Natural Heritage Operations Manual. The Nature Conservancy, Arlington, VA.
The Nature Conservancy. 1999. The National Land Cover Dataset Metadata. The Nature Conservancy Eastern Region, Boston MA.
U.S. Census Bureau (http://quickfacts.census.gov/qfd/states/42000.html)
United States Department of Agriculture, Soil Conservation Service. 1981. The Soil Survey of Juniata and Mifflin Counties, Pennsylvania. 177 pp. plus figures.
Wagner, David. 2005. Caterpillars of Eastern North America - A Guide to Identification and Natural History. Princeton University Press, Princeton, NJ.
Walsh, M., Deeds, J., and B. Nightingale. 2007a. Classifying Lotic Systems For Conservation: Project Methods and Results of The Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy. Middletown, PA and Pittsburgh, PA.
Walsh, M., Deeds, J., and B. Nightingale. 2007b. User's Manual and Data Guide to The Pennsylvania Aquatic Community Classification Project. Pennsylvania Natural Heritage Program, Western Pennsylvania Conservancy. Middletown, PA and Pittsburgh, PA
Wenger, S. 1999. A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation. Office of Public Service & Outreach, Institute of Ecology, University of Georgia, Athens, Georgia.
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.
White, W. B. and E. L. White. 1999. Caves. in C. H. Shultz, ed. The Geology of Pennsylvania. Pennsylvania Geological Survey.
Whitaker, J. O., Jr., and W. J. Hamilton, Jr. 1998. Mammals of the eastern United States. Cornell University Press. Ithaca, NY. 583 pp.
Whitcomb, R. F., C. S. Robbins, J. F. Lynch, B. L. Whitcomb, M. K. Klimkiewicz, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pp. 125–205 in Forest island dynamics in man-dominated landscapes (R. L. Burgess and D. L. Sharpe, Eds.). Springer-Verlag, New York.
Wright, David. 2007. Atlas of Pennsylvania Butterflies, 6th edition. Unpublished document.

GIS Data Sources

Bedrock geologic units of Pennsylvania, scale 1:250,000. Digital datasets prepared by C.E. Miles, T.G. Whitfield, from published 1980 state geologic map. 2001. Pennsylvania Bureau of Topographic and Geologic Survey, DCNR. Available online: http://www.dcnr.state.pa.us/topogeo/gismaps/digital.aspx. Accessed: 2004.

Bishop, Joseph A. 1998. Managed Lands in Pennsylvania. Pennsylvania GAP Analysis Project, Environmental Resources Research Institute.

Bishop, Joseph A. 2004. Pennsylvania Important Mammal Areas Project.

Ecological regions of North America, Level III. 1997. North American Commission for Environmental Cooperation. Available online: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm. Accessed: March 2004.

ESRI Street Map USA. 2005.

Mifflin County Planning GIS Department. 2006. Tax parcel boundaries.

Mifflin County Planning GIS Department. 2006. Mifflin County Caves.

National Agriculture Imagery Program (NAIP) 1-meter resolution color infrared mosaic of Mifflin County, Pennsylvania. 2004. USDA-FSA Aerial Photography. http://www.pasda.psu.edu/summary2.cgi/naip/naip_cirsid_mifflin_2004.xml

Pennsylvania Bureau of Forestry. Pennsylvania Department of Conservation and Natural Resources (PA DCNR). Natural and Wild Areas. Accessed: May 2006.

Pennsylvania Department of Transportation. 2005. PennDOT - Pennsylvania Municipality Boundaries. Bureau of Planning and Research, Cartographic Information Division. Pennsylvania Spatial Data Access (PASDA). http://www.pasda.psu.edu/

Pennsylvania Department of Transportation. 2006. PennDOT - Pennsylvania County Boundaries. Bureau of Planning and Research, Cartographic Information Division. Pennsylvania Spatial Data Access (PASDA). http://www.pasda.psu.edu/

Pennsylvania Natural Diversity Inventory (PNDI) Spatial Database. Pennsylvania Natural Heritage Program, 2006.

Pennsylvania-Small Watershed, Environmental Resources Research Institute, Pennsylvania Department of Environmental Protection, 5/3/1997.

Pennsylvania Spatial Data Access. Digital Orthophoto MrSID mosaic (NAPP,II 1993-1995). Available online: http://www.pasda.psu.edu/. Accessed November 2006.

Pennsylvania Bureau of Topographic and Geologic Survey. 1995. Physiographic Provinces 1:100,000. PA DCNR. Pennsylvania Spatial Data Access (PASDA). http://www.pasda.psu.edu/.

State maintained roadway centerlines of Pennsylvania, 2006. Pennsylvania Department of Transprotation, Bureau of Planning and Research, Geographic Information Division.

USGS National Hydrography Dataset (NHD). Downloaded 2005. http://nhd.usgs.gov/index.html

U.S. Fish and Wildlife Service. 2005. National Wetland Inventory (NWI) for Pennsylvania – polygon. Pennsylvania Spatial Data Access (PASDA). www.pasda.psu.edu

USGS 1:24,000 Topographic quadrangles. Pennsylvania Spatial Data Access (PASDA), downloaded 2003. http://www.pasda.psu.edu/

Warner, Eric D. 2000. Pennsylvania Landcover. Penn State University (PSU). http://www.pasda.psu.edu/documents.cgi/orser/psu-palulc_2000.xml.

APPENDIX I : PA NOXIOUS WEED AND AQUATIC NUISANCE SPECIES LISTS

Legal Reference: Pennsylvania Noxious Weed Control List

IT IS ILLEGAL TO PROPAGATE, SELL OR TRANSPORT THE FOLLOWING WEEDS IN THE COMMONWEALTH

1. **Cannabis sativa**, commonly known as Marijuana
2. **Cirsium arvense**, commonly known as Canadian thistle
3. **Rosa multiflora**, commonly known as Multiflora rose
4. **Sorghum halepense**, commonly known as Johnson grass
5. **Polygonum perfoliatum**, commonly known as Mile-a-minute
6. **Pueraria lobata**, commonly known as Kudzu-vine
7. **Cirsium vulgare**, commonly known as Bull or Spear Thistle
8. **Carduus nutans**, commonly known as Musk or Nodding Thistle
9. **Sorghum bicolor**, commonly known as Shattercane
10. **Datura stramonium**, commonly known as Jimsonweed
11. **Lythrum salicaria**, commonly known as Purple Loosestrife, including all cultivars
12. **Heracleum mantegazzianum**, commonly known as Giant Hogweed
13. **Galega officinalis**, commonly known as Goatsrue
    (Amended November 18, 2000)

    - The first four weeds were included in the Pennsylvania Noxious Weed Control Act in 1982-74.
    - Weeds numbered 5-10 were added by regulations on May 20, 1989.
    - Purple loosestrife was added by regulations on April 12, 1997.
    - Purple loosestrife cultivars, Giant hogweed and Goatsrue were added by regulations on November 18, 2000.

http://www.agriculture.state.pa.us >noxious weed law, accessed April 18, 2007

Pennsylvania Fish and Boat Commission Regulations

Aquatic Nuisance Species (ANS)

Aquatic nuisance species are aquatic animals and plants that have been introduced into waterways in which they do not live naturally. They have harmful effects on the natural resources in these ecosystems and the human uses of these resources.

Some of the least-wanted ANS in Pennsylvania are European ruffe, sea lamprey, hydrilla, spiny water flea, purple loosestrife, Eurasian watermilfoil, Asian clam, and red-eared slider (turtle). In 2004, Northern snakehead were first found in Pennsylvania waters.

It's not always "foreign invaders" that are the problem. White perch and flathead catfish are other examples of species that have turned up where they don't belong. While native to some PA watersheds, they have been introduced to other areas.

Aquatic species banned in Pennsylvania (sale, barter, possession or transportation)

Bighead carp (*Hypophtalmichtys nobilis*)
Black carp (*Mylopharyngodon piceus)*
European rudd (*Scardinius erythropthalmus*)
Quagga mussel (*Dreissena bugensis*)
Snakehead (all species)
Round goby (*Neogobius melanostomus*)
Ruffe (*Gymnocephalus cernuus*)
Rusty crayfish (*Orconectes rusticus*)
Silver carp (*Hypophtalmichtys molitrix*)
Tubenose goby (*Proterothinus marmoratus*)
Zebra mussel (*Dreissena polymorpha*)

DEFINITIONS

- ***Biodiversity*** -- The variety of species, their genetic makeup, and the natural communities in which they occur.
- ***Introduced species*** -- A species living outside of its natural geographic range. Can be deliberately or accidentally introduced or brought into the new ecosystem. Also called *exotic*, *non-native*, *nuisance or invasive species*.
- ***Invasive*** -- Spreading or taking over. Invasive species often take over or dominate a habitat.
- ***Native*** -- An animal or plant originating in a region or geographic range. For example, brook trout are native to Pennsylvania.

STOP the spread of ANS

- When retrieving your boat for the day, check the boat, motor and trailer for weeds and other things "tagging along."
- Wash your boat's hull with hot water or with a high-pressure spray.
- Drain livewells, bilges and other compartments.
- Drain all standing water from your boat.
- Don't dump leftover bait into the water you're fishing, unless you collected the bait there.

http://sites.state.pa.us/PA_Exec/Fish_Boat/ans.htm, accessed April 18, 2007.

APPENDIX II: ODONATA AND LEPIDOPTERA OF MIFFLIN COUNTY

PNHP DOCUMENTED MIFFLIN COUNTY ODONATE SPECIES*

Family Common name	Scientific name	Global rank	State rank
Aeshnidae—Darners			
Shadow Darner	*Aeshna umbrosa umbrosa*	G5T5	S5
Calopterigidae—Broad-winged Damsels			
River Jewelwing	***Calopteryx aequabilis***	G5	S2
Appalachian Jewelwing	***Calopteryx angustipennis***	G4	S1S2
Ebony Jewelwing	*Calopteryx maculata*	G5	S5
Coenagrionidae—Pond Damsels			
Variable Dancer	*Argia fumipennis violacea*	G5T5	S5
Powdered Dancer	*Argia moesta*	G5	S5
Stream Bluet	*Enallagma exsulans*	G5	S5
Hagen's Bluet	*Enallagma hageni*	G5	S5
Fragile Forktail	*Ischnura posita*	G5	S5
Cordulegastridae—Spiketails			
Delta-spotted Spiketail	*Cordulegaster diastatops*	G5	S5
Tiger Spiketail	*Cordulegaster erronea*	G4	S4?
Twin-spotted Spiketail	*Cordulegaster maculata*	G5	S5
Corduliidae--Emeralds			
Clamp-tipped Emerald	*Somatochlora tenebrosa*	G5	S5
Gomphidae—Clubtails			
Dragonhunter	*Hagenius brevistylus*	G5	S5
Southern Pygmy Clubtail	*Lanthus vernalis*	G4	S4
Lestidae—Spreadwings			
Spotted Spreadwing	*Lestes congener*	G5	S5
Common Spreadwing	*Lestes disjunctus disjunctus*	G5T5	S4S5
Amber-winged Spreadwing	***Lestes eurinus***	G4	S3
Slender Spreadwing	*Lestes rectangularis*	G5	S5
Libellulidae—Skimmers			
Widow Skimmer	*Libellula luctuosa*	G5	S5
Blue Dasher	*Pachydiplax longipennis*	G5	S5
Common Whitetail	*Plathemis lydia*	G5	S5
Ruby Meadowhawk	*Sympetrum rubicundulum*	G5	S5
Yellow-legged Meadowhawk	*Sympetrum vicinum*	G5	S5
Black Saddlebags	*Tramea lacerata*	G5	S5
Petaluridae—Petaltails			
Gray Petaltail	***Tachopteryx thoreyi***	G4	S3

*Boldface type indicates species considered Species of Concern by the PNHP.

APPENDIX II (cont.)

PNHP DOCUMENTED MIFFLIN COUNTY BUTTERFLY AND SKIPPER SPECIES[1]

Family Common name	Scientific name	Global rank	State rank
Papillionidae—Swallowtails			
Eastern Tiger Swallowtail	*Papilio glaucus*	G5	S5
Black Swallowtail	*Papilio polyxenes*	G5	S4
Spicebush Swallowtail	*Papilio troilus*	G5	S5
Pieridae—Whites and Sulphurs			
Orange Sulphur	*Colias eurytheme*	G5	S5B
Clouded Sulphur	*Colias philodice*	G5	S5
Sleepy Orange	*Eurema nicippe*	G5	-
Cabbage White	*Pieris rapae*	G5	Exotic
Lycaenidae—Gossamer Wings			
Henry's Elfin	***Callophrys henrici***	G5	S1S3
Northern Spring Azure[2]	***Celastrina ladon lucia***	G5	S3S4
Summer Azure	*Celastrina neglecta*	G5	S5
Eastern-tailed Blue	*Cupido (Everes) comyntas*	G5	S5
Banded Hairstreak	*Satyrium calanus*	G5	S5
Edward's Hairstreak	***Satyrium edwardsii***	G4	S3S4
Riodinidae—Metalmarks			
Northern Metalmark	***Calephelis borealis***	G3G4	S1S2
Nymphalidae—Brushfoots			
Hackberry Emporer	*Asterocampa celtis*	G5	S4
Tawny Emperor[2]	***Asterocampa clyton***	G5	S3S4
Meadow Fritillary	*Boloria bellona*	G5	S5
Common Wood-nymph	*Cercyonis pegala*	G5	S5
Silvery Checkerspot	***Chlosyne nycteis***	G5	S3S4
Monarch	*Danaus plexippus*	G5	S5B
Northern Pearly-eye	***Enodia anthedon***	G5	S3S4
Baltimore Checkerspot	***Euphydryas phaeton***	G4	S2S4
White Admiral	*Limenitis arthemis*	G5	S5
Mourning Cloak	*Nymphalis antiopa*	G5	S5
Pearl Crescent	*Phyciodes tharos*	G5	S5
Gray Comma[2]	***Polygonia progne***	G5	SU
Appalachian Brown	*Satyrodes appalachia*	G4	S4
Aphrodite Fritillary[2]	***Speyeria aphrodite***	G5	S3S4
Atlantis Fritillary[2]	***Speyeria atlantis***	G5	SU
Great Spangled Fritillary	*Speyeria cybele*	G5	S5
Red Admiral	*Vanessa atalanta*	G5	S5B
American Lady	*Vanessa virginiensis*	G5	S5
Hesperiidae—Skippers			
Common Least Skipper	*Ancyloxypha numitor*	G5	S5
Silver-spotted Skipper	*Epargyreus clarus*	G5	S5
Wild Indigo Duskywing	*Erynnis baptisiae*	G5	S5
Eastern Dun Skipper	*Euphyes vestris metacomet*	G5T5	S5
Peck's Skipper	*Polites peckius*	G5	S5
Little Glassywing	*Pompeius verna*	G5	S4
Northern Broken-dash	*Wallengrenia egeremet*	G5	S4

[1]Boldface type indicates species considered Species of Concern by the PNHP.

[2]Based on the Atlas of Pennsylvania Butterflies, 6th Edition, Compiled and Maintained by David Wright. Locations of these species were not mapped for this report.

APPENDIX II (cont.)
PNHP DOCUMENTED MIFFLIN COUNTY MOTH SPECIES*

Family Scientific Name	State Common Name
Apatelodidae—American Silkworm Moths	
Olceclostera angelica	A moth
Arctidae—Tiger Moths	
Hypercompe scribonia	Giant Leopard Moth
Apantesis carlotta	A Tiger Moth
Cisseps fulvicollis	Yellow-collared Scape Moth
Cycnia tenera	Dogbane Tiger Moth
Euchaetes egle	Milkweed Tussock Moth
Grammia virgo	Virgin Tiger Moth
Halysidota tessellaris	Banded Tussock Moth
Haploa clymene	Clymene Moth
Haploa contigua	The Neighbor
Haploa lecontei	A moth
Hypoprepia fucosa	Painted Lichen Moth
Hypoprepia miniata	Scarlet-winged Lichen Moth
Spilosoma congrua	Agreeable Tiger Moth
Drepanidae—Hooktips	
Drepana arcuata	Arched Hooktip
Geometridae—Geometers	
Aethalura intertexta	Four-barred Gray
Anavitrinelia pampinaria	Common Gray
Antepione thisoaria	A moth
Biston betularia	Peppered Moth
Campaea perlata	Pale Beauty
Digrammia ocellinata	Faint-spotted Angle
Ectropis crepuscularia	Small Engrailed
Epimecis hortaria	Tulip Tree Beauty
Eubaphe mendica	The Beggar
Eugonobapta nivosaria	Snowy Geometer
Eulithis diversilineata	Lesser Grapevine Looper Moth
Eulithis gracilineata	Greater Grapevine Looper Moth
Eusarca confusaria	Confused Eusarca
Eutrapela clemataria	Curve-toothed Geometer
Glenoides texanaria	Texas Gray
Haematopis grataria	Chickweed Geometer
Heterophleps triguttaria	A moth
Iridopsis vellivolata	A moth
Lytrosis unitaria	A moth
Macaria aemulataria	Common Angle
Macaria bisignata	Red-headed Looper Moth
Macaria granitata	Granite Moth
Macaria minorata	Minor Angle
Macaria pinistrobata	White Pine Angle
Macaria promiscuata	Promiscuous Angle
Macaria pustularia	Lesser Maple Spanworm Moth
Macaria subcessaria	Barred Angle Moth
Melanolophia canadaria	Canadian Melanolophia
Melanolophia signataria	Signate Melanolophia
Nemoria bistriaria	A moth
Patalene olyzonaria puber	Juniper Geometer
Pero hubneraria	A moth
Plagodis phlogosaria	A moth
Plagodis pulveraria	A moth
Probole amicaria	Friendly Probole
Prochoerodes lineola	large Maple Spanworm Moth
Prochoerodes transversata	large Maple Spanworm Moth
Scopula limboundata	Large Lace-border
Selenia kentaria	Kent's Geometer
Timandra amaturaria	Cross-lined Wave
Trichodezia albovittata	White-striped Black
Xanthorhoe ferrugata	Red Twin-spot
Lasiocampidae—Lappet Moths	
Phyllodesma americana	A moth
Tolype notialis	**Small Tolype**
Tolype velleda	Large Tolype
Limacodidae—Slug Caterpillar Moths	
Apoda biguttata	A moth
Apoda y-inversum	A moth
Lithacodes fasciola	A moth
Parasa chloris	A moth
Prolimacodes badia	Skiff Moth
Sibine stimulea	Saddleback Caterpillar Moth
Tortricidia flexuosa	A moth
Tortricidia pallida	A moth
Lymantriidae—Tussock Moths	
Lymantria dispar	Gypsy Moth
Orgyia leucostigma	A moth
Noctuidae—Owlets	
Abagrotis alternata	Greater Red Dart
Acronicta afflicta	Afflicted Dagger Moth
Acronicta americana	American Dagger Moth
Acronicta fragilis	Fragile Dagger Moth
Acronicta hasta	Cherry Dagger Moth
Acronicta increta	A Dagger moth
Acronicta modica	Medium Dagger Moth
Acronicta ovata	Ovate Dagger Moth
Acronicta retardata	Retarded Dagger Moth
Acronicta rubricoma	Ruddy Dagger Moth

Family Scientific Name	State Common Name
Acronicta spinigera	Nondescript Dagger Moth
Agrotis ipsilon	Dark Sword Grass
Agrotis venerabilis	Venerable Dart Moth
Allagrapha aerea	Unspotted Looper Moth
Allotria elonympha	False Underwing Moth
Amphipoea americana	A moth
Amphipoea velata	A moth
Amphipyra pyramidoides	Copper Underwing Moth
Anterastria teratophora	A moth
Baileya australis	Small Baileya
Baileya dormitans	Sleeping Baileya
Baileya levitans	Pale Baileya
Bomolocha baltimoralis	Baltimore Bomolocha
Bomolocha madefactalis	Grey-eyed Bomolocha
Caenurgina crassiuscula	Clover Looper Moth
Catocala cerogama	Yellow-banded Underwing
Catocala coccinata	Scarlet Underwing
Catocala grynea	Woody Underwing
Catocala ilia	Ilia Underwing
Catocala lineella	Little Lined Underwing
Catocala micronympha	Little Nymph Underwing
Catocala palaeogama	Oldwife Underwing
Catocala retecta	An Underwing moth
Catocala sordida	Sordid Underwing
Catocala ultronia	Ultronia Underwing
Chytonix palliatricula	A moth
Colocasia flavicornis	Yellowhorn
Cosmia calami	A moth
Drasteria grandirena	A Noctuid moth
Elaphria grata	Grateful Midget
Elaphria versicolor	Variegated Midget
Eudryas grata	A moth
Euplexia benesimilis	A moth
Feltia herilis	Master's Dart
Feltia subgothica	Subgothic Dart
Hyperstrotia secta	A Noctuid moth
Idia aemula	A moth
Idia americalis	A moth
Lacinipolia renigera	A moth
Leucania phragmitidicola	A moth
Leucania pseudargyria	A moth
Leuconycta diphteroides	A moth
Leuconycta lepidula	A moth
Lithacodia muscosula	Large Mossy Lithacodia
Lithacodia musta	Small Mossy Lithacodia
Maliattha synochitis	A moth

Family Scientific Name	State Common Name
Meganola minuscula	A moth
Nephelodes minians	A moth
Noctua pronuba	Large Yellow Underwing
Ochropleura implecta	Flame-shouldered Dart
Ogdoconta cinereola	Common Pinkband
Orthodes cynica	A moth
Palthis asopialis	A moth
Panopoda carneicosta	A moth
Panopoda rufimargo	A moth
Panthea n. sp.	A moth
Papaipema marginidens	**A Borer Moth**
Papaipema rigida	A Borer Moth
Polygrammate hebraeicum	A moth
Pseudaletia unipuncta	A moth
Pseudeustrotia carneola	Pink-barred Lithacodia Moth
Pseudorthodes vecors	A moth
Pyrrhia adela	Bordered Sallow Moth
Raphia frater	The Brother
Scolecocampa liburna	Dead-wood Borer Moth
Simyra henrici	A moth
Spragueia leo	A moth
Sunira bicolorago	A moth
Tarachidia erastrioides	A Noctuid moth
Thioptera nigrofimbria	Black-bordered Lemon Moth
Ulolonche culea	A moth
Xestia badinodis	Pale-banded Dart
Xestia normaniana	Norman's Dart
Xestia smithii	Smith's Dart
Zale minerea	A moth
Zanclognatha cruralis	A moth
Zanclognatha laevigata	A moth
Zanclognatha ochreipennis	A moth
Notodontidae—Prominents	
Datana angusii	Andus's Datana
Datana drexelii	A moth
Ellida caniplaga	Linden Prominent
Heterocampa obliqua	Oblique Heterocampa
Hyperaeschra georgica	A Notodontid Moth
Lochmaeus bilineata	Double-lined Prominent
Nadata gibbosa	A Notodontid Moth
Odontosia elegans	Elegant Prominent
Oligocentria lignicolor	White-streaked Prominent
Peridea angulosa	Angulose Prominent
Peridea basitriens	Oval-based Prominent
Peridea ferruginea	Chocolate Prominent
Schizura ipomoeae	Morning-glory Prominent

Family Scientific Name	State Common Name
Pyralidae—Snouts	
Aglossa cuprina	A moth
Blepharomastix ranalis	A moth
Desmia funeralis	Grape Leaffolder Moth
Hypsopygia costalis	Clover Hayworm Moth
Pantographa limata	A moth
Tosale oviplagalis	A moth
Urola nivalis	A moth
Vaxi auratella	A moth
Saturniidae—Wild Silk Moths	
Actias luna	Luna moth
Anisota senatoria	Orange-tipped Oakworm Moth
Antheraea polyphemus	Polyphemus Moth
Dryocampa rubicunda	Rosy Maple Moth
Sesiidae—Clearwings	
Synanthedon exitiosa	Peachtree Borer Moth
Sphingidae—Sphinx Moths	
Darapsa myron	Virginia Creeper Sphinx
Amorpha juglandis	Walnut Sphinx
Lapara bombycoides	Northern Pine Sphinx
Lapara coniferarum	Southern Pine Sphinx
Paonias excaecatus	Blinded Sphinx
Tortricidae--Leafrollers	
Pandemis limitata	Three-lined Leafroller Moth

*Boldface type indicates species considered Species of Concern by the PNHP.

APPENDIX III: FIELD SURVEY FORM

PLANT & ANIMAL SPECIES OF SPECIAL CONCERN REPORT
(PLEASE INCLUDE A MAP – SEE MAPPING INSTRUCTIONS)

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 / Zipcode:

- Landowner aware of the species of special concern? **YES____ NO____**
- Landowner aware that data are submitted to PA Natural Diversity Inventory? **YES____ NO____**
- Landowners are welcome to call the PNDI-East office in Middletown at (717) 948-3962 for more information.
- **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 IV: COMMUNITY CLASSIFICATION

CLASSIFICATION OF NATURAL 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. 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.

Community Ranks

As with species that are of concern, ranks have been assigned to rate the rarity of each natural community type identified for Pennsylvania. Appendix VI lists criteria for global and state ranks. In most cases, the global extent of these communities has yet to be fully evaluated, and no global rarity rank has been assigned. Work is ongoing to refine these ranks and to further develop the ranking system to rate the relative quality of communities within a type.

Community Name (Fike 1999)	**State Rank**
Terrestrial Forests	
CONIFEROUS TERRESTRIAL FORESTS:	
Hemlock (white pine) forest	S4
CONIFER – BROADLEAF TERRESTRIAL FORESTS	
Serpentine pitch pine - oak forest	S1
Serpentine Virginia pine - oak forest	S1
Pitch pine - mixed oak forest	S4
Virginia pine - mixed hardwood forest	S5
Dry white pine (hemlock) - oak forest	S4
Hemlock (white pine) -northern hardwood forest	S5
Hemlock (white pine) - red oak - mixed hardwood forest	S4
Hemlock - tuliptree - birch forest	S4
Rich hemlock - mesic hardwoods forest	S2S3
BROADLEAF TERRESTRIAL FORESTS	
Dry oak-heath forest	S4S5
Dry oak-mixed hardwood forest	S3
Red oak - mixed hardwood forest	S5
Northern hardwood forest	S4
Black cherry - northern hardwood forest	S4
Tuliptree- beech -maple forest	S4
Sugar maple - basswood	S4
Mixed mesophytic forest	S1S2
Sweet gum - oak coastal plain forest	S1
Red maple (terrestrial) forest	S5
Black-gum Ridgetop Forest	S3
Aspen/gray (paper) birch forest	S3 NOT TRACKED
Palustrine Forests	
CONIFEROUS PALUSTRINE FORESTS	
Black spruce - tamarack peatland forest	S3
Red spruce palustrine forest	S3
Hemlock palustrine forest	S3

Community Name (Fike 1999)	**State Rank**
CONIFER – BROADLEAF PALUSTRINE FORESTS	
Hemlock - mixed hardwood palustrine forest	S3S4
Red spruce - mixed hardwood palustrine forest	S3
BROADLEAF PALUSTRINE FORESTS	
Bottomland oak - hardwood palustrine forest	S2
Red maple - black-gum palustrine forest	S3S4
Red maple - black ash palustrine forest	S2S3
Red maple - magnolia Coastal Plain palustrine forest	S1
Great Lakes Region lakeplain palustrine forest	S1
Sycamore - (river birch) - box-elder floodplain forest	S3
Silver maple floodplain forest	S3
Red maple - elm - willow floodplain swamp	S2
Terrestrial Woodlands	
CONIFEROUS WOODLANDS	
Pitch pine - heath woodland	S2
Pitch pine - scrub oak woodland	S2S3
Red spruce rocky summit	S1
Pitch pine - rhodora - scrub oak woodland	S1
CONIFER – BROADLEAF TERRESTRIAL WOODLANDS	
Pitch pine - mixed hardwood woodland	S2S3
Virginia pine - mixed hardwood shale woodland	S2
Red-cedar - mixed hardwood rich shale woodland	S1S2
BROADLEAF – TERRESTRIAL WOODLANDS	
Dry oak - heath woodland	S3
Birch (black-gum) rocky slope woodland	S2
Yellow oak - redbud woodland	S2
Great Lakes Region scarp woodland	S1S2
Great Lakes Region bayberry - cottonwood community	S1
Palustrine Woodlands	
CONIFEROUS PALUSTRINE WOODLANDS	
Pitch pine - leatherleaf palustrine woodland	S1
Black spruce - tamarack palustrine woodland	S2
Red spruce palustrine woodland	S2S3
BROADLEAF PALUSTRINE WOODLANDS	
Red maple - highbush blueberry palustrine woodland	S4
Red maple - sedge palustrine woodland	S4
Red maple - mixed shrub palustrine woodland	S4
Terrestrial Shrublands	
CONIFEROUS TERRESTRIAL SHRUBLANDS	
Red-cedar - prickly pear shale shrubland	S2
Red-cedar - pine serpentine shrubland	S1
CONIFER – BROADLEAF TERRESTRIAL SHRUBLANDS	
Red-cedar - redbud shrubland	S2
BROADLEAF TERRESTRIAL SHRUBLANDS	
Low heath shrubland	S1
Low heath - mountain ash shrubland	S2
Scrub oak shrubland	S3
Rhodora - mixed heath - scrub oak shrubland	S1
Palustrine Shrublands	
BROADLEAF PALUSTRINE SHRUBLANDS	

Community Name (Fike 1999)	**State Rank**
Buttonbush wetland	S4
Alder - ninebark wetland	S3
Alder - sphagnum wetland	S4
Highbush blueberry - meadow-sweet wetland	S5
Highbush blueberry - sphagnum wetland	S5
Leatherleaf - sedge wetland	S3
Leatherleaf - bog rosemary peatland	S2
Leatherleaf -cranberry peatland	S2S3
Water-willow (Decodon verticillatus) shrub wetland	S3
River birch - sycamore floodplain scrub	S4
Black willow scrub/shrub wetland	S4
Poison sumac - red-cedar - bayberry fen	S1
Buckthorn - sedge (Carex interior) - golden ragwort fen	S1
Great Lakes Region scarp seep	S1
Great Lakes Region bayberry - mixed shrub palustrine shrubland	S1
Terrestrial Herbaceous Openings	
Little bluestem - Pennsylvania sedge opening	S2
Side-oats gramma calcareous grassland	S1
Calcareous opening/cliff	S2
Serpentine grassland	S1
Serpentine gravel forb community	S1
Great Lakes Region dry sandplain	S1
Great Lakes Region sparsely vegetated beach	S1
Herbaceous Wetlands	
PERSISTENT EMERGENT WETLANDS	
Bluejoint - reed canary grass marsh	S5
Cattail marsh	S5
Tussock sedge marsh	S3
Mixed forb marsh	S3
Herbaceous vernal pool	S3S4
Wet meadow	S5 NOT TRACKED
Bulrush marsh	S3
Great Lakes Region palustrine sandplain	S1
Prairie sedge - spotted joe-pye-weed marsh	S1S2
Open sedge (Carex stricta, C. prairea, C. lacustris) fen	S1
Golden saxifrage - sedge rich seep	S2
Skunk cabbage - golden saxifrage forest seep	S4S5
Serpentine seepage wetland	S1
Golden saxifrage - Pennsylvania bitter-cress spring run	S3S4
Sphagnum - beaked rush peatland	S3
Many fruited sedge - bladderwort peatland	S2
Water-willow (Justicia americana)- smartweed riverbed community	S4
Riverside ice scour community	S1S2
Big bluestem - Indian grass river grassland	S3
NON-PERSISTENT EMERGENT WETLANDS	
Pickerel-weed - arrow-arum - arrowhead wetland	S4
Spatterdock - water lily wetland	S4

Community Complexes

ACIDIC GLACIAL PEATLAND COMPLEX

GREAT LAKES REGION SCARP COMPLEX

ERIE LAKESHORE BEACH - DUNE - SANDPLAIN COMPLEX
MESIC TILL BARRENS COMPLEX
SERPENTINE BARRENS COMPLEX
RIDGETOP ACIDIC BARRENS COMPLEX
RIVER BED - BANK - FLOODPLAIN COMPLEX

Community Name (Smith 1991)	**State Rank**
SUBTERRANEAN COMMUNITIES	
Solution Cave Terrestrial Community	S3
Solution Cave Aquatic Community	S3
Tectonic Cave Community	S3S4
Talus Cave Community	S2S4
DISTURBED COMMUNITIES	
Bare Soil	N/A
Meadow/Pastureland	N/A
Cultivated Land	N/A
Successional Field	N/A
Young Miscellaneous Forest	N/A
Conifer Plantation	N/A
ESTUARINE COMMUNITIES:	
Deepwater Subtidal Community	S1
Shallow-Water Subtidal Community	S1
Freshwater Intertidal Mudflat	S1
Freshwater Intertidal Marsh	S1
RIVERINE COMMUNITIES:	
Low-Gradient Ephemeral/Intermittent Creek	S5
Low-Gradient Clearwater Creek	S3S4
Low-Gradient Clearwater River	S2S3
Low-Gradient Brownwater Creek	S2S3
Medium-Gradient Ephemeral/Intermittent Creek	S5
Medium-Gradient Clearwater Creek	S3
Medium-Gradient Clearwater River	S?
Medium-Gradient Brownwater Creek	S3
High-Gradient Ephemeral /Intermittent Creek	S5
High-Gradient Clearwater Creek	S3
High-Gradient Clearwater River	S?
High-Gradient Brownwater Creek	S?
Waterfall and Plungepool	S3S4
Spring Community	S1S2
Spring Run Community	S1S2
LACUSTRINE COMMUNITIES:	
Glacial Lake	S1
Nonglacial Lake	S2
Artificial Lake	N/A
Natural Pond	S2S3
Artificial Pond	N/A
Stable Natural Pool	S?
Ephemeral/Fluctuating Natural Pool	S1
Artificial Pool	N/A
Ephemeral/Fluctuating Limestone Sinkhole	S1

APPENDIX V: PNHP PROGRAM RANKS, AND STATE AND FEDERAL STATUS

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).

GNR = Not ranked at the global level. Applies to natural communities that have been designated at the state level but not yet reviewed globally.

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.

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.

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 but this error persisting in the literature.

SU = Possibly in peril in state but status uncertain; need more information.

SX = Apparently extirpated from the state.

APPENDIX V (continued)

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 that 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 V (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.

APPENDIX V (continued)

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

APPENDIX VI: 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 VII: PLANTS, ANIMALS AND NATURAL COMMUNITIES OF SPECIAL CONCERN IN MIFFLIN COUNTY

Plants

Scientific Name	State Common Name
Amelanchier sanguinea	roundleaf serviceberry
Bartonia paniculata	screw-stem
Carex lupuliformis	false hop-sedge
Lactuca hirsuta	downy lettuce
Lithospermum canescens	hoary puccoon
Matelea obliqua	oblique milkvine
Oenothera argillicola	shale-barren evening-primrose
Polymnia uvedalia	leaf-cup
Potamogeton illinoensis	Illinois pondweed
Scirpus ancistrochaetus	northeastern bulrush
Sida hermaphrodita	Virginia mallow
Stellaria borealis	mountain starwort
Woodwardia areolata	netted chainfern

Animals

Scientific Name	Common Name
Mammals:	
Sorex palustris albibarbis	Northern Water Shrew
Myotis leibii	Eastern Small-footed Myotis
Myotis septentrionalis	Northern Myotis
Myotis sodalis	Indiana or Social Myotis
Neotoma magister	Allegheny Woodrat
Birds:	
Accipiter gentilis	Northern Goshawk
Ardea herodias	Great Blue Heron
Tyto alba	Barn Owl
Reptiles & Amphibians:	
Crotalus horridus	Timber Rattlesnake
Freshwater Mussels:	
Lampsilis cariosa	Yellow lampmussel
Butterflies & Moths:	
Calephelis borealis	Northern Metalmark
Callophrys henrici	Henry's Elfin
Chlosyne nycteis	Silvery Checkerspot
Enodia anthedon	Northern Pearly-eye
Euphydryas phaeton	Baltimore Checkerspot
Macaria promiscuata	Promiscuous Angle Moth
Papaipema marginidens	A Borer Moth
Satyrium edwardsii	Edward's Hairstreak
Tolype notialis	A Tolype Moth
Dragonflies & Damselflies:	
Calopteryx aequabilis	River Jewelwing
Calopteryx angustipennis	Appalachian Jewelwing
Lestes eurinus	Amber-winged Spreadwing
Tachopteryx thoreyi	Gray Petaltail

Animals (continued)	
Scientific Name	**Common Name**
Cave Invertebrates:	
Caecidotea pricei	Price's Cave Isopod
Sphalloplana pricei	Refton Cave Planarian
Stygobromus allegheniensis	Allegheny Cave Amphipod
Stygobromus pizzinii	Pizzini's Cave Amphipod
Stygobromus stellmacki	Stellmack's Cave Amphipod
Other Insect Orders:	
Cicindela ancocisconensis	Appalachian Tiger Beetle
Merope tuber	Earwig scorpionfly

Natural Communities

Ephemeral/Fluctuating Natural Pool
Hemlock-Tulip Tree-Birch Forest
Hemlock (White Pine)-Northern Hardwood Forest
Scrub Oak Shrubland

APPENDIX VIII: SUSTAINABLE FORESTRY INFORMATION SOURCES

The ***Pennsylvania Forest Stewardship Program*** is a voluntary program that assists forest landowners in better managing their forestlands by providing information, education, and technical assistance. Participation in the program is open to private landowners who own between 5 and 1,000 acres of forestland. Visit **http://www.cas.psu.edu/docs/CASDEPT/FOREST/Stewardship/1page.html** for more information or contact:

Jim Finley, Assistant Director for Extension
The Pennsylvania State University
School of Forest Resources
7 Ferguson Building
University Park, PA 16802
814- 863-0401; E-mail: fj4@psu.edu

The ***Forest Land Enhancement Program*** complements the Forest Stewardship Program by providing landowners with cost-share dollars to implement their management plans and follow-up technical assistance to encourage the achievement of their long-term forest management goals. For more information, contact:

Jim Stiehler, Forest Stewardship Coordinator
DCNR - Bureau of Forestry
6th Floor, Rachel Carson State Office Building
P.O. Box 8552
Harrisburg, PA 17105-8552
717-787-4777

The ***Forest Legacy Program*** acts to purchase conservation easements or title from willing private landowners. In this program, federal funding is administered through the state Bureau of Forestry to foster protection and continued use of forested lands that are threatened with conversion to non-forest uses. Emphasis is given to lands of regional or national significance. For more information, go to http://www.fs.fed.us/spf/coop/programs/loa/flep.shtml or contact:

Gene Odato, Chief, Rural & Community Forestry Station
DCNR – Bureau of Forestry
6th Floor, Rachel Carson State Office Building
P.O. Box 8552
Harrisburg, PA 17105-8552
717-787-6460; E-mail: godato@state.pa.us

The ***Sustainable Forestry Initiative*** (SFI) program is a voluntary, industry-driven effort developed to ensure that future generations will have the same abundant, healthy, and productive resources we enjoy today. Created in 1995 by the American Forest and Paper Association (the national trade organization representing the United States forest products industry), SFI is a program of comprehensive forestry and conservation practices. Through the SFI of PA program, landowners receive the information they need to enhance their ability to make good forest management decisions, and loggers learn safer, more productive skills and proper environmental practices. For more information, go to http://www.sfiofpa.org/ or contact:

SFI® of PA
315 S. Allen Street, Suite 418
State College, PA 16801
814-867-9299 or 888- 734-9366; E-mail: sfi@penn.com

The ***Forest Stewardship Volunteer Initiative Project*** has an excellent Web site providing general information and links to publications on sustainable forestry.
http://vip.cas.psu.edu/index.html

APPENDIX IX: SELECTED FACT SHEETS FOR SPECIES OF CONCERN IN MIFFLIN COUNTY

Caves and Cave Animals

Stalactite and Flowstone
photo source: Rocky Gleason (PNHP)

Price's Cave Isopod (*Caecidotea pricei*) G3G4 S2S3
Allegheny Cave Amphipod (*Stygobromus allegheniensis*) G5 S2S3
Stellmack's Cave Amphipod (*Stygobromus stellmacki*) G1G2 S1
Refton Cave Planarian (*Sphalloplana pricei*) G2G3 S1

Eastern Small-footed Myotis (*Myotis leibii*) G3 S1B, S1N
Northern Myotis (*Myotis septentrionalis*) G4 S3B, S3N
Indiana Bat (*Myotis sodalis*) G2 SUB, S1N

The Cave Environment

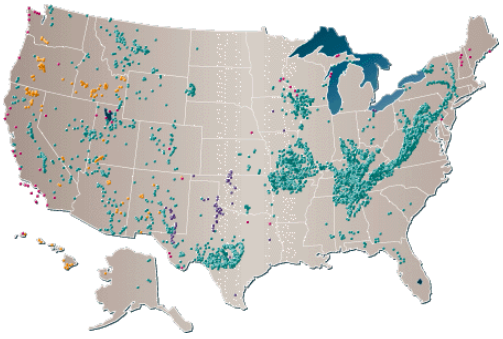
Karst is defined as a landscape with sinkholes, springs, and streams that sometimes disappear into subsurface conduits and caverns. Organisms that make their homes exclusively in this subsurface world are a unique group called troglobites. Troglobites are typically blind and unpigmented, with larger sensory appendages (e.g., antennae) than their surface-dwelling counterparts. It is likely that troglobites evolved from organisms living on the surface that were partially adapted to the cave environment. Some of these subterranean species have survived in caves long after their surface-dwelling relatives have gone extinct or relocated because of dynamic changes on the surface.

Caves provide a stable environment with relatively unchanging temperatures and a total absence of light. Primary producers are almost completely absent in this environment, and organic matter from external sources provides the essential food resource. A variety of invertebrate organisms inhabit the cave environment in both the aquatic and terrestrial habitats. The geology of the region —long linear limestone valleys separated by ridges of sandstones and shales—restricts dispersal and interaction of subterranean organisms and has caused a high number of local species that are relatively rare in their distribution. The invertebrate species of concern found in Pennsylvania's caves include two such native (endemic) species.

A cave amphipod of the genus *Stygobromus*, magnified approximately 8x.

Amphipods and isopods are crustaceans, though the genus *Stygobromus,* an amphipod, has no relatives among surface-dwelling amphipods. *Stygobromus* is considered a relict genus that may have been in the cave environment for millions of years. Stellmack's cave amphipod (*Stygobromus stellmacki*) and the Refton cave planarian *(Sphalloplana pricei)* are species known only to a few caves in Pennsylvania. Price's Cave Isopod (*Caecidotea pricei*) and the Allegheny Cave Amphipod (*Stygobromus allegheniensis*) have a broader distribution in the mid-Atlantic region but have only been found in a handful of caves in Pennsylvania. All of these animals are dependent on the quality of the groundwater in caves and on the influx of organic material for food.

Other animals are associated with caves but also use aboveground habitats. Bats and caves are inextricably related. Different bats throughout the United States use caves for hibernation, rearing young (maternity sites), migratory stopovers, night roosts, and swarming sites. Many of the caves in central Pennsylvania have been identified as hibernacula for multiple species of bats, including three species of concern, but no cave in Pennsylvania has been found to contain maternity colonies. The Pennsylvania Game Commission, over the past 20 years, has been conducting regular monitoring of many sites throughout Pennsylvania with the cooperation of landowners and organized cavers. The loss of bat species in Pennsylvania could greatly affect our ability to protect



General Locations of Caves Across the United States

agricultural crops from pests as well as our continued enjoyment of outdoor recreation.

Hibernating bats in a Pennsylvania Cave
photo source: Rocky Gleason (PNHP)

Threats and Conservation

Many human activities threaten caves and the fauna that depend on them. Pollution in caves due to the nature of karst terrains results in a very real threat. Streams and surface runoff enter sinkholes and caves, bypassing natural filtration through soil and sediment. Porous carbonate rocks easily pass solid and liquid wastes into caves and groundwater. Pollution of water in caves negatively impacts the aquatic and terrestrial species within, possibly causing localized extinctions. Deforestation on the surface causes changes in hydrology and increased sedimentation in caves. Alteration of cave entranceways such as vegetation removal and structural changes, such as closure, affect climatic conditions in the cave, including airflow, temperature, and humidity.

Another major threat to cave biodiversity is increased human visitation, which spans the spectrum from commercialized tourism to recreational caving and can alter temperature, disturb hibernating bats, and introduce pollutants. When bats are disturbed, they use up much of their fat reserves and may not survive through the winter. Hibernacula throughout Pennsylvania are being gated with special entranceways that allow air, bats and other wildlife to come and go, while excluding access by humans. Protection of caves is vital for all fauna that depend on them, especially those populations that depend on the groundwater within. Landowners, state agencies and local cave clubs of the National Speleological Society have been cooperating for more than 10 years to limit human impacts to caves either through the gating of caves or through self-imposed moratoriums on entering caves during significant times of the year.

The Pennsylvania Cave Protection Act 1990 makes it unlawful to disturb or remove natural and cultural features of caves as well as gates or other structures intended to protect caves. However, these protections are dependent on the cooperation of the landowner. Landowners can easily help conserve cave animals by avoiding littering or dumping in sinkholes or cave entrances, buffering karst features from runoff from agriculture or industrial land uses, and working with state agencies and local cave clubs to determine the need for controlling access to caves in winter months when bats may be hibernating.

PNHP
Pennsylvania Natural Heritage Program

References

- Barr, T. C., Jr. 1968. Cave Ecology and the Evolution of Troglobites. Evolutionary Biology. 2; 35-102.
- Bureau of Topographic and Geologic Survey. 2000. Limestone and Dolomite Distribution inPennsylvania. Website: www. dcnr.state.pa.us/topogeo.
- Catherman, C.W. 2004. General Locations of America's Caves. CAVR Website: www.geocities.com/cavevader/caving.
- Holsinger, J.R. 1998. Troglobites: The Evolution of Cave-Dwelling Organisms. American Scientist, March-April: 147-153.
- National Speleological Society. http://www.caves.org/ (Consult for information regarding organized caving and clubs located throughout Pennsylvania as well as cave management and conservation).
- Pennsylvania Game Commission. 2005. Pennsylvania Comprehensive Wildlife Conservation Strategy. http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=496&q=162067.
- Zokaites, C., ed. 1997. Living on Karst. Cave Conservancy of the Virginias. Accessed at http://www.dcr.virginia.gov/dnh/livingonkarst.htm.

Ephemeral/Fluctuating Natural Pools

Pennsylvania Natural Community Type

State Rank: S3 (vulnerable) **Global Rank: GNR** (not yet assessed)

General Description

Ephemeral/fluctuating natural pools, more commonly referred to as vernal pools or seasonal pools, are shallow natural depressions within the forest that seasonally fill with water during spring and fall rains, and dry during the summer months. Vernal pools solely rely on precipitation, groundwater, and runoff for sources of water input. These pools are void of fish species because of the cyclic pattern of alternating wet/dry periods. For this reason, vernal pools support a wide array of organisms that are specially adapted to the varying hydroperiod. The life histories of several invertebrate species and amphibian species are tied to the fluctuating conditions of vernal pools for breeding and development of young. Many other species are known to use these pools as foraging grounds and for hibernation.

A spring season view of a vernal pool

No other group of organisms has their life history tied to vernal pools more than the Ambystomatid salamanders. These species are considered vernal pool obligates, meaning their life histories are directly linked to the alternating wet/dry cycle of vernal pools. Pennsylvania's three species of Ambystomatid salamanders, commonly known as mole salamanders, spend the majority of their lives underground, sometimes up to several meters below the surface! Because of their secretive lifestyles, the mole salamanders are rarely seen by most people. In fact, the only reliable way to see these creatures is to be at a vernal pool, at night, while it is raining, during the breeding season!

The Cycle of Vernal Pools

Beginning in late February through March, the first warm rains of the year cause the ice that has covered the vernal pools to melt, initiating the mole salamander breeding migrations. The first species to enter the pools is the Jefferson Salamander, Ambystoma jeffersonianum. The Jefferson salamander is gray with blue flecking on the sides. The extremely long toes of the Jefferson salamander distinguish it from all other species of salamander in Pennsylvania. Jeffersons arrive at the pools, often crawling over snow, and slip into the water through small gaps and openings in the ice. For the next several days, the male Jefferson salamanders will court the females. Eggs are then deposited in jelly-like masses, usually attached to vegetation or sticks and limbs that have fallen into the pool. After the eggs are laid, Jeffersons will migrate out of the pools and back onto land where they will spend the rest of the year in subterranean retreats.

The migration of the Jefferson salamander usually overlaps with the breeding migrations of the Spotted salamander, Ambystoma maculatum. This robust salamander can grow to be nearly 8 inches long! The spotted salamander is brown to black with brilliant yellow or orange spots on the head and back. These salamanders have been known to form aggregations, known as breeding balls, where dozens of males will cluster around one or two females. Once spotted salamanders have laid their eggs on submerged vegetation and twigs, like the Jeffersons, they will migrate back into the surrounding forest.

Wood frogs (*Rana sylvatica*), spring peepers, (*Pseudacris crucifer*), and gray treefrogs (*Hyla versicolor*), extensively use vernal pools for breeding as well. The calls of these species can sometimes be used to locate vernal pools. The wood frog, which produces a call that sound similar to squabbling ducks, are vernal pool obligates. Wood frogs are pinkish-brown, moderately sized frogs reaching lengths of about three to four inches and have dark brown masks under the eyes. The spring peeper is a small tree frog, which will rarely exceed an inch in length. Spring peepers are light brown with a darker brown "X" across their backs. The call is a high-pitched "peep!" and large deafening choruses are a sure sign that spring is on the way. The gray treefrog is greenish gray with bright yellow patches beneath the legs. Their call is a fluttering musical chirp. Vernal pools can also support many other frogs and toads, including the green frog (*Rana clamitans*), the bullfrog (*Rana catesbeiana*), the American toad (*Bufo americanus*), and the state endangered Eastern spadefoot toad (*Scaphiopus holbrookii*).

A gray treefrog calling at a vernal pool

The vernal pools, now laden with amphibian eggs, are converged upon by a host of other species, which feed on the egg masses, larvae and tadpoles. The spotted turtle (*Clemmys guttata*) and red spotted newt (*Notophthalmus viridescens*) are frequent visitors of vernal pools. These species gorge themselves on the nutrient rich salamander and frog egg masses as well as some of the vernal pool invertebrates. Eastern garter snakes (*Thamnophis sirtalis*) and Eastern hognosed snakes (*Heterodon platirhinos*) can be found hunting for salamanders and toads along the pool margins, and northern water snakes (*Nerodia sipedon*) will feed on the amphibians within the pools.

Vernal pool salamander egg masses and tadpoles

As the spring rains end and summer begins, the water level in the pools drops considerably, often drying up completely. This decrease in water level coincides with the metamorphosis of the larval salamanders and tadpoles into adult salamanders, frogs, and toads. These young salamanders and froglets begin their terrestrial lives, returning to the pools to breed once they attain sexual maturity.

During the summer, drying vernal pool basins provide a unique habitat for an array of plants, some of which are specially adapted to the same cyclic wet/dry pattern upon which the amphibians rely. Vernal pools provide habitat for several rare plant species, including the federally listed Northeastern Bulrush, (*Scirpus ancistrochaetus*).

The onset of fall rains begins to refill the dried pool basins. It is during these rain episodes that the third species of mole salamander in Pennsylvania, the marbled salamander (*Ambystoma opacum*) breeds. The marbled salamander is a stout species, with a jet-black body patterned with unmistakable dazzling white bands. This species breeds in the shallows of the pools with the females laying their eggs under leaf litter and wood within the pool basin. As fall rains fill the pools and inundate the eggs, the marbled salamander eggs will hatch and the larvae spend the winter months beneath the ice, feeding on the aquatic vernal pool insects. For this reason, the marbled salamander larvae are much larger than the larvae of the Jefferson and spotted salamanders in the spring.

Status and Threats

Currently, Pennsylvania tracks Ephemeral/Fluctuating Natural Pools as important natural communities within the forest. Besides providing critical habitat for unique plants, per square inch, vernal pools provide the largest biomass production of vertebrates of any other community in the northeast!

Only within the last few decades have we begun to understand the importance of vernal pools to the ecology of Pennsylvania's forests. Temporary pools have historically been viewed as mosquito breeding pools, of little importance to forest ecology. As a result, a long history of vernal pool destruction exists. Many people have treated vernal pools with pesticides to control mosquitoes. Although mosquitoes will use vernal pools to breed, the animals specially adapted to vernal pools use the mosquito larvae as a food source. Most mosquito eggs laid in vernal pools do not survive to metamorphosis because the vernal pool species feed on the mosquito larvae. Unfortunately, pesticide application to vernal pools can be detrimental to the vernal pool obligates that rely on this unique natural community. Amphibians as a whole are highly sensitive to poisons and the application of chemicals can destroy the intricate food webs in vernal pool communities.

A marbled salamander migrating to a vernal pool

Despite the recent awareness of the importance of vernal pools to forest ecology, vernal pools are not federally protected from modification or destruction. However, vernal pools are protected in the state under the Pennsylvania Department of Environmental Protection's Title 25 Pa. Code Chapter 105. Vernal pools provide critical habitat for a number of species of plants and animals that are specially adapted to the cyclic patterns exhibited by ephemeral/fluctuating natural pools. It is important to protect these ecological gems to conserve the rich biodiversity of the community.

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.
- Shaffer, L.L, 1991. Pennsylvania Amphibians & Reptiles. Pennsylvania Fish Commission, Harrisburg, PA. 161pp.

PNHP
Pennsylvania Natural Heritage Program

Northern Myotis (*Myotis septentrionalis*)

Pennsylvania Mammal Species of Concern

State Rank: S3B (vulnerable, breeding)**, S3N** (vulnerable, non-breeding) **Global Rank: G4** (apparently secure)

Identification

The Northern Myotis (*Myotis septentrionalis*), also known as the Northern Longed-eared Myotis, is characterized by its long-rounded ears that when folded forward, extend beyond the tip of the nose. Also, the shape of the tragus, the flap of skin inside the ear area, is long and dagger shaped compared to the little brown bats curved and blunted tragus. This species has a longer tail and larger wing area than other similar sized bats in this genus. The fur is dull yellow/brown above and a pale gray on the belly. Another characteristic of this species is that the calcar, a spur extending from the foot, lacks a keel. These bats weigh only 6 to 8 grams and have a wingspan of 9 to 10 inches.

photo source: Aura Stauffer

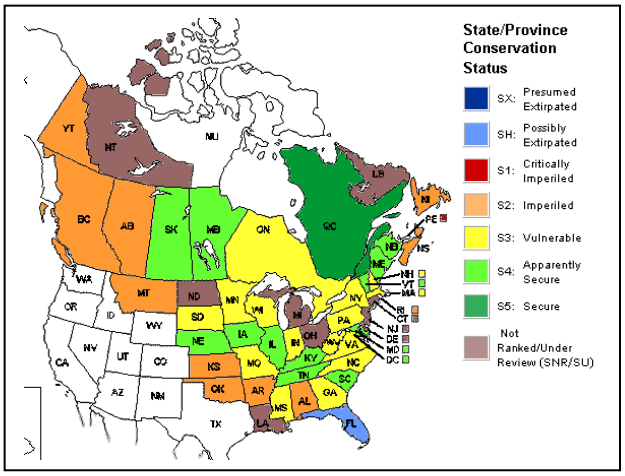
Habitat/Behavior

In the more northern parts of their range the northern long-eared bat is associated with boreal forests. In Pennsylvania, this bay is found in forests around the state. Northern Myotis hunt at night over small ponds, in forest clearings, at tree top level and along forest edges. They eat a variety of night-flying insects including caddisflies, moths, beetles, flies, and leafhoppers. This species uses caves and underground mines for hibernation and individuals may travel up to 35 miles from their summer habitat for hibernation. Maternity roosts are located in tree cavities, under exfoliating tree bark and in buildings.

Status

The status of the Northern Myotis in Pennsylvania is uncertain. The state status of this species currently is candidate rare (CR). More information is needed before adequate management decisions can be made. It occurs throughout Pennsylvania, but has been found in relatively low numbers.

Traditionally, bats have been unpopular with the public because of a misunderstanding of their ecology and due to their presence as pests in homes and barns. However, bats play a very important role in the environment by eating large amounts of insects. For example, a single little brown bat (*Myotis lucifugus*) can eat up to 1,200 mosquito-sized insects in just one hour!



More than 50% of American bat species are rapidly declining or already listed as endangered. The loss of bat species in Pennsylvania could greatly affect our ability to protect our plants from pests and enjoy the outdoors. For more information on bats and bat houses visit the Bat Conservation International website at http://www.batcon.org/.

References

- Bat Conservation International, Inc. 2002. "Bat Species: U.S. Bats: Myotis septentrionalis" Website: www.batcon.org/discover/species/mystep.html.
- Ollendorff, J. 2002. "Myotis septentrionalis" (On-line), Animal Diversity Web. Accessed February 25, 2004 at Http://animaldiversity.ummz.umich.edu/site/accounts/information/Myotis_septentrionalis.htm.

Pennsylvania Natural Heritage Program

Indiana bat (*Myotis sodalis*)

……..

Pennsylvania Endangered Speceis

State Rank: SUB (not yet assessed, breeding), S1N (critically imperiled, non-breeding), Global Rank: G2 (imperiled)

Identification

The Indiana bat, *Myotis sodalis*, is small (7.1 to 9 centimeters, or about 3 to 3.5 inches) and grayish-brown, similar to the much more common little brown bat (*Myotis lucifugus*). *M. sodalis* is distinguishable from its cousin, however, by its duller brown fur, unique triple bands of color running down each of its hairs, and its tight clustering during hibernation – Indiana bats huddle on cave walls at densities of up to 2,700 individuals per square meter (250 per square foot).

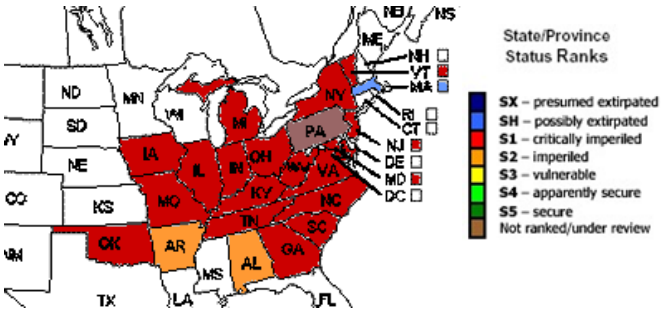
photo source: WPC 2002

Habitat/Behavior

Indiana bats hibernate in caves and abandoned mines, generally near the cave entrance where winter temperatures are cooler – at lower temperatures, the bats' metabolisms slow down, so they use less of their fat reserves as they hibernate. In the summer, the bats frequent wooded areas near streams, roosting in crevices under tree bark or in hollow trees; trees that receive direct sunlight during the day are preferred. Females roost alone or in colonies to bear young. At the south of their range, which runs from the eastern seaboard west to Oklahoma, Indiana bats eat mostly terrestrial insects, including beetles and lepidoptera (moths and butterflies). In the north, and nearer the Great Lakes, they eat more aquatic species, such as caddisflies.

North American State/Province Conservation Status

Map by NatureServe



Status

The Indiana bat is vulnerable to human disturbance of its roosting sites, especially during its winter hibernation – if the bats are aroused while hibernating, they expend the fat reserves they need in order to survive until spring. Contamination of their food supply through the use of pesticides in agricultural areas and loss of summer habitat may also be contributing to the species' decline. A 1995-97 census showed population declines of around 60 percent since monitoring began in the 1960s. The species is protected under the U.S. Endangered Species Act.

Conservation

Preservation of caves used by Indiana bats for hibernation presents an interesting challenge. Access to the caves should be restricted to prevent human disruption of the bats' hibernation; but access restrictions such as doors or walls can block the caves' airflow and raise the temperature inside, preventing the bats from hibernating as deeply and causing them to use their fat reserves more quickly. Such alterations in airflow can have a large impact: Richter et. al (1993) report that replacement of a cave's door with steel bars (which did not impede airflow) was associated with a 10,000-individual increase in the cave's bat population.

Although more research is needed to understand the summer habitat requirements of the Indiana bat, it is known that they roost under the bark of mature trees or dead snags in forests. Increase of old-growth forest acreage and forest contiguoity, especially within several miles of hibernation sites, will likely improve prospects for this species. Understanding the pesticide load which bats are exposed to in areas where they summer is also important to determining whether the bats are being significantly impacted by these chemicals.

References

- Johnson, Scott A., Virgil Brack, Jr., and Robert E. Rolley. 1998. "Overwinter Weight Loss of Indiana Bats (*Myotis sodalis*) from Hibernacula Subject to Human Visitation." *American Midland Naturalist*, 139(2): 255-61.
- Kurta, Allen and John O. Whitaker, Jr. 1998. "Diet of the Endangered Indiana Bat (Myotis sodalis) on the Northern Edge of its Range." *American Midland Naturalist*, 140(2), 280-6.
- Merrit, Joseph F. 1987. *Guide to the Mammals of Pennsylvania*. Pittsburgh: University of Pittsburgh Press. 90-3.
- NatureServe. 2004. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed 23 December 2004).
- Richter, Andreas R., Stephen R. Humphrey, James B. Cope, and Virgil Brack, Jr. 1993. "Modified Cave Entrances: Thermal Effect on Body Mass and Resulting Decline of Endangered Indiana Bats (Myotis sodalis)." *Conservation Biology*, 7(2): 407-15.

PNHP
Pennsylvania Natural Heritage Program

Allegheny Woodrat *(Neotoma magister)*

Pennsylvania Threatened Species

State Rank: S3 (vulnerable), Global Rank: G3G4 (vulnerable/apparently secure)

Identification

The Allegheny Woodrat (*Neotoma magister*) is a relatively large member of this group, ranging from 14-17 inches in total length (including tail). The fur is brownish-gray with slightly darker coloration in the middle of the back. The belly and paws are white and the sides are buffy. The Allegheny Woodrat has large ears and a furry, bicolored tail. The introduced exotic Norway rat (*Rattus norvegicus*) has a naked tail and overall brown coloration, which distinguishes it from the woodrat in Pennsylvania.

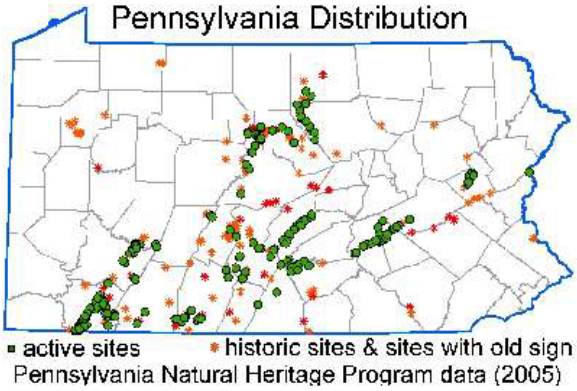
photo source: Cal Butchkowski

Habitat

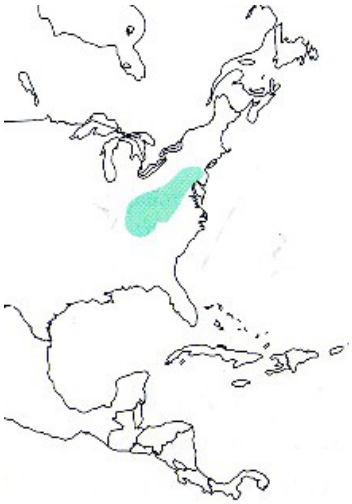
Another name for this species is cave rat because it sometimes inhabits limestone caves. It is also found along cliff faces, in boulder piles and talus slopes. Nests composed of shredded plant fibers are found in dry cave entrances, along narrow ledges and in rock crevices. This species feeds on nuts, seeds, bark, grasses, fruits and berries. They are nocturnal and a relatively shy species that is often found by locating food cashes and latrines.

Status

Distribution of the Allegheny woodrat is primarily along the Appalachian Mountains from New York to Georgia and west to Indiana. Populations in Pennsylvania appeared healthy during the 1940's and early 1950's. However, during bat surveys in 1978 and 1979, John S. Hall from Albright College noted an absence of woodrat sign in caves. Very few locations were occupied in the former range, and woodrats were only found in a few counties during that time. This led to its current status of Threatened in Pennsylvania. It is not clear why this species declined so suddenly in Pennsylvania but it is likely due to a variety of factors. Increased habitat fragmentation, especially in the eastern portion of its range may be a major factor in the decline. Fragmentation from roads and development causes loss of habitat, isolation and increased exposure to parasites. The once relatively isolated ridgetops where the woodrat thrived are not bisected by roads, allowing easy access for humans. These corridors also provide easy access for parasite hosts such as raccoons increasing the frequency of parasite infection among woodrats. Raccoon roundworm (*Baylisascaris*) is a dangerous and quickly spreading parasite that may be devastating to woodrat populations in the east. Intact forest ridges that provide habitat for this species must be protected from further fragmentation and development.



World Distribution



References

- Genoway, H.H. and F.J. Brenner. 1985. Species of Special Concern in Pennsylvania. Carnegie Museum of Natural History. Pittsburgh, PA. 430pp.
- Great Smoky Mountains National Park. All Taxa Biodiversity Inventory. Allegheny Woodrat Species Acct. Website: www.smokiesatbi.or/atbi/species/animals/Mammals/Neotoma_magister.html.
- Pennsylvania Game Commission. Endangered and Threatened Species. Eastern Woodrat Species Profile. Website: sties.state.pa.us/PA_Exec/PGC/woodrat/profile.htm

PNHP
Pennsylvania Natural Heritage Program

Northern Water Shrew (*Sorex palustris albibarbis)*

Pennsylvania Candidate Rare Speceis

State Rank: S3 (vulnerable), Global Rank: G4T5 (apparently secure)

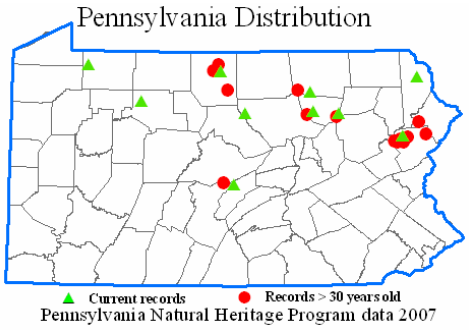
Identification

The northern water shrew (*Sorex palustris albibarbis*) is a relatively large member of the *Sorex* genus, reaching lengths of 130-170mm and weighting 10-16 grams. Water shrews are black to gray in color with a silvery-gray belly and a bicolored tail. Thin chin and throat of this species are whitish, noticeably more so than the belly. The large, partially webbed hind feet have hairs on the toes and sides and there are some hairs present on the fore feet. The northern water shrew (*Sorex palustris albibarbis*) can be distinguished from other water shrews by very specific physical characteristics such as dental and skull features.

Photo source: Charlie Eichelberger (PNHP)

Habitat/Behavior

Water shrews are solitary, short-lived species with an average life span of 18 months. They breed from December to September and have 2-3 litters per year. They are active both day and night and spend their lives in and around water. Water shrews can be found along streams and lake edges, in boulders and sphagnum moss. They dive and swim into water when foraging for food and to avoid predators. Air trapped in the fur allows them to immediately come to the surface when they stop swimming. The fringe of hairs on the hind foot trap air and allow the shrews to walk on water. Easy access to food is essential to the survival of this species. Water shrews can only survive without food for up to three hours. In captivity, they have been found to feed almost every 10 minutes.



Status

Sorex palustris is found throughout most of Canada, the western U.S., the upper northeastern U.S. and the Appalachian mountains. The *albibarbis* subspecies is found in southeastern Canada and the upper northwestern U.S. including north central and northeastern Pennsylvania. Globally, this species is considered secure. However, in Pennsylvania, the northern water shrew is vulnerable and a candidate for listing as rare. It is only found in a few sites around the state and is affected by many factors, which could lead to declines in their populations.

Conservation

Decreased water quality may have a significant effect on this species. A decrease in numbers of aquatic insects may be very detrimental to this species since food is such a limiting factor. Timber harvesting along streams and lake edges may also be detrimental to this species. Many times, they will live in vegetation or crevices along the waters edge. The loss of the overstory could dramatically change the microhabitat conditions on the forest floor. Maintaining natural stream corridors and lake buffers is essential to the protection of this species.

References

- ENature.com Field Guide. Water Shrew (Sorex palustris). http://www.enature.com/fieldguide/
- Genoway, H.H. and F.J. Brenner. 1985. Species of Special Concern in Pennsylvania. Carnegie Museum of Natural History. Pittsburgh, PA. 430pp.
- The University of Michigan Museum of Zoology Animal Diversity Web. Species Account: Sorex palustris (water shrew). http://animaldiversity.ummz.umich.edu/site/accounts/information/Sorex_palustris.html .

Northern Goshawk (*Accipiter gentilis*)

Pennsylvania Candidate Rare Species

State Rank S2S3B, S3N (imperiled/vulnerablebreeding, vulnerable nonbreeding), Global Rank: G5 (secure)

Identification:

The Northern Goshawk is a large forest raptor, occupying boreal and temperate forests throughout the entire Northern Hemisphere. It is the largest member of the genus *Accipiter* that occurs in North America. Males generally weigh between 1.4 and 2.4 pounds, average 22 inches in length, and have a wingspan ranging from 38.5 to 41 inches. Females are slightly larger, weighing, on average, between 1.9 and 3 pounds, and having a wingspan of 41 to 45 inches and an average length of 24 inches.

All accipiters, including northern goshawks, have a distinctive white grouping of feathers that form a band above the eye. In goshawks this band is thick and more pronounced than in the other members of the genus. The eye color of adult goshawks is red to reddish-brown, in juveniles eye color is bright yellow.

The colorings of adult male and female northern goshawks range from slate blue-gray to black. Their backs, the feathers at the leading edge of the wings, and heads are usually dark, and their undersides are white with fine, gray, horizontal barring. Their tails are light gray with three or four dark bands. The coloring of a juvenile goshawk is quite different than that of an adult. Their backs, the feathers at the leading edge of the wings, and heads are brown, and their undersides are white with vertical brown streaking.

Adult Northern Goshawk

Habitat/Behavior:

In the eastern U.S., the northern goshawk nests in hardwood-hemlock (*Tsuga canadensis*) forests, where black birch (*Betula lenta*) and American beech (*Fagus grandifolia*) are preferred nest trees. They prefer mature forests consisting of a combination of old, tall trees with intermediate canopy coverage and small open areas within the forest for foraging. Each pair of goshawks build and maintain between three and nine nests within their home range, but use and defend only one (or less) per year. Northern goshawks are highly territorial and a mating pair will advertise their nesting territory by performing an elaborate aerial display before and during nest construction and/or repair. If their nesting area is encroached upon, they will defend it fiercely. Goshawks breed once yearly, usually between early April and mid-June. The female lays between 2 to 4 eggs that hatch in 28 to 38 days. The young may begin to fly when they are 35 to 46 days old. Juvenile fledglings may continue to be fed by their parents until they are about 70 days old.

The goshawk is a top predator and opportunistic hunter that preys on ground and tree squirrels, rabbits and hares, large passerines, woodpeckers, game birds, corvids, and occasionally reptiles and insects. Prey may be taken on the ground, in vegetation, or in the air.

Range of the Northern Goshawk in North America

Status:

In Pennsylvania, the northern goshawk is near the southern extent of its range in eastern North America. Population trends are difficult to determine due to the paucity of historic quantitative data and because of biases inherent in the various survey methods used to track bird populations. Nesting range in the eastern U.S. is currently expanding as second-growth forests mature.

Conservation Considerations:

Timber harvesting is the principal threat to breeding populations of northern goshawk. In addition to the relatively long-term impacts of removing nest trees and degrading habitat by reducing stand density and canopy cover, logging activities conducted near nests during the incubation and nestling periods can result in nest failure due to abandonment. Following canopy reduction by logging, goshawks are often replaced by other raptors including the red-tailed hawk (*Buteo jamaicensis*).

Because the goshawk is both a top predator and an ecological engineer, its decline contributes to the unraveling of forest ecosystems, stressing other forest dependent species. Northern goshawks play an important role in the forest food web as voracious predators of squirrels, jays, flickers, rabbits, snowshoe hares and songbirds. As builders of numerous, large nests, goshawks provide essential nesting opportunities for many species which can not build their own nests. Empty goshawk nests may be utilized by the great gray owl (*Strix nebulosa*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk, great horned owl (*Bubo virginianus*), short-eared owl (*Asio flammeus*), squirrels, and many other species. Within a decade of goshawks being driven from a forest, their nests collapse from lack of maintenance and a precious wildlife habitat is lost.

References:

- Center for Biological Diversity. 2006. "Northern Goshawk". Available online: **http://www.biologicaldiversity.org/swcbd/species/goshawk/goshawk.html.**
- Clark, W., and B. Wheeler. 1987. *Peterson Field Guides, Hawks*. Boston: Houghton Mifflin Company.
- Johnsgard, P. 1990. *Hawks, Eagles, & Falcons of North America*. Washington: Smithsonian Institution Press.
- NatureServe. 2006. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.7. NatureServe, Arlington, Virginia. Available online: **http://www.natureserve.org/explorer.**
- Pajerski, L. 2005. "Accipiter gentilis", Animal Diversity Web. Available online at: **http://animaldiversity.ummz.umich.edu/site/accounts/information/Accipiter_gentilis.html**.
- 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.

PNHP
Pennsylvania Natural Heritage Program

Great Blue Heron (*Ardea herodias*) Rookery

State Rank: S3S4 (vulnerable/apparently secure), Global Rank: G5 (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. Great Blue Herons may also nest in mixed-species rookeries with other heron species, other waterbirds, or even raptors such as owls and hawks.

photo source PNHP

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.

photo source: Larry Master, NatureServe

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. Broods usually contain two or three chicks. The parents share the tasks of incubating the eggs and feeding the chicks, catching more than 20 percent of their own body weight in fish every day.

Great Blue Herons chicks are covered with a light coat of gray down. Chicks require the most food between 26 and 41 days after hatching, when they may eat 270 grams (about 0.6 pounds) of fish each day. The chicks are ready to leave the nest by the end of the summer.

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.

PNHP
Pennsylvania Natural Heritage Program

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. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer. Accessed 7 March 2005.
- 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.

Barn Owl (*Tyto alba*)

Bird Species of Concern

State Rank: S3B (vulnerable, breeding), **S3N** (vulnerable, non-breeding) **Global Rank: G5** (secure)

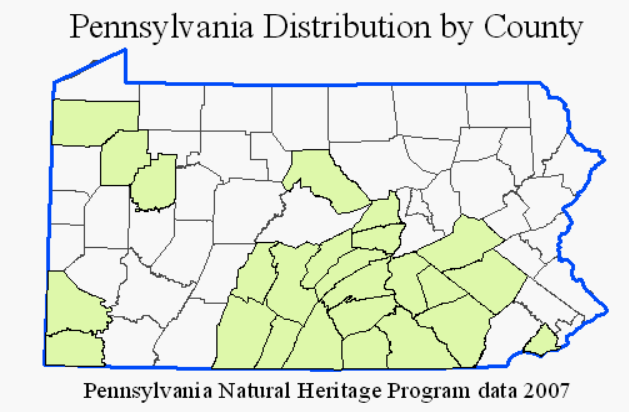
Identification

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

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.

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
- Brauning, D.W. (ed.). 1992. Atlas of Breeding Birds in Pennsylvania Univ. of Pittsburgh 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

PNHP
Pennsylvania Natural Heritage Program

Timber Rattlesnake (*Crotalus horridus*)

Reptile Species of Concern

State Rank: S3S4 (vulnerable /apparently secure) **Global Rank: G4** (apparently secure)

Identification

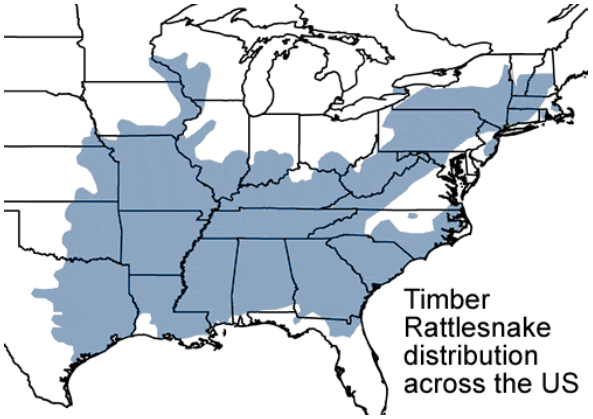
Timber rattlesnakes (*Crotalus horridus*) are easily distinguished from other snakes in Pennsylvania. Timber rattlesnakes are stout-bodied, large snakes reaching lengths of up to 5 feet. Color is extremely variable but usually consists of brown or black bands on bright yellow to black coloration. The head is triangular in shape and a rattle is present at the end of the black tail. This species may be confused with the less common eastern massasauga (*Sistrurus catenatus catenatus*) only present in the western portion of the state. The timber rattlesnake can be distinguished from the massasauga by the lack of white facial lines, the black tail forward of the rattle, and numerous small head-scales.

Habitat

Crotalus horridus is associated with deciduous forests and rocky outcrops. Hibernacula are usually found on south-facing rocky slopes with adequate crevices to provide shelter during the winter months. Males may travel far from the den site in the summer, moving into valleys and low-lying areas. Gravid females are far less mobile and tend to stay within a short distance of the den. Timber rattlesnakes are venomous, however are generally mild-mannered and not likely to strike.

Conservation/Status

Timber rattlesnake numbers have decreased significantly from historic records. This species was once widespread across the state. The remaining populations are usually found in remote, isolated areas. Collection and destruction of habitat are likely the main reasons for reductions in population size. Den sites have been targets for collection and should be the focus of conservation efforts for this species. The state status of the timber rattlesnake is candidate at risk (CA). Though this species is still relatively abundant across the state, it remains vulnerable to exploitation.



Permits are now required to collect rattlesnakes and only one snake can be taken each year. Snake hunts still occur in the state but after capture, snakes must be marked and release and the site of capture. Biologists are gathering information from collectors and individual studies to determine the current status of this species in the state.

References

- Genoway, H.H. and F.J. Brenner. 1985. Species of Special Concern in Pennsylvania. Carnegie Museum of Natural History. Pittsburgh, PA. 430pp.
- 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.
- The Center for Reptile and Amphibian Conservation and Management. Species Accounts: Timber Rattlesnake. Website: http://herpcenter.ipfw.edu/outreach/accounts/reptiles/snakes/Timber_Rattlesnake/

PNHP
Pennsylvania Natural Heritage Program

Yellow Lampmussel (*Lampsilis cariosa*)

Freshwater Mussel Species of Concern

State Rank: S2 (imperiled) Global Rank: G5 (secure)

Identification

The yellow lampmussel (*Lampsilis cariosa*) is a bright yellow, medium-size freshwater mussel that can reach lengths of up to five inches. The mussel has an ovate to elliptical shell and the valves appear inflated in cross section. The shell is thick and strong (Connecticut DEP 2003; Nedeau 2000). The yellow coloration makes it fairly easy to distinguish from other freshwater mussels in Pennsylvania, but it may be confused with the tidewater mucket (*Leptodea ochracea*) and other *Lampsilis* species. The presence of fine green rays on the outer shell of the tidewater mucket is usually a key to distinguishing it from the yellow lampmussel. The yellow lampmussel is also more ovate and is more inflated in cross section than the tidewater mucket (Strayer and Jirka 1997).

photos source: PNHP

Habitat

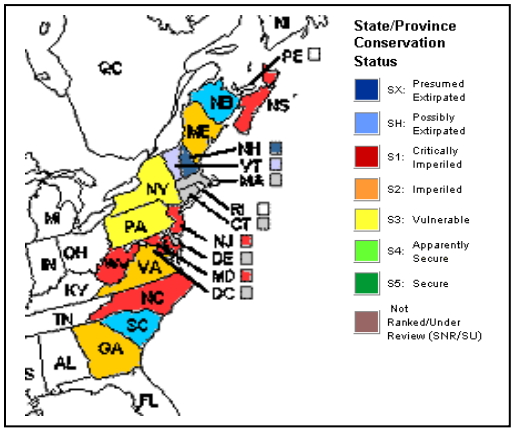
The yellow lampmussel inhabits medium to large rivers throughout most of its range, but is known from lakes and ponds in the north. In Pennsylvania, the yellow lampmussel is found within the Susquehanna and Delaware River drainages. This species occurs in a variety of substrate types including sand, silt, cobble, and gravel (Parmalee 1998; Strayer and Jirka 1997;NatureServe 2005).

Host Fish

The only known larval hosts are the white perch and yellow perch (Wick and Huryn 2002).

Status

The Yellow Lampmussel ranges from Nova Scotia south to Georgia and west to West Virginia. The state status of the Yellow Lampmussel is vulnerable to apparently stable (S3S4) (NatureServe 2005). Though it appears to be relatively abundant in the Susquehanna River, it is less common in tributaries and other river systems in the state. More surveys are required to determine the status of this species and other freshwater mussels in Pennsylvania.



In an assessment of the conservation status of the freshwater mussels of the United States by the American Fisheries Society (Williams et al. 1993), the Yellow Lampmussel was listed as threatened. It has been reported in New York in the Delaware River basin; sightings have not been confirmed because this mussel can be easily confused with *Lampsilis ovata*. The Yellow Lampmussel has declined over large portions of its habitat in New York and is currently listed as threatened even though it appears to be wide ranging throughout the state (Strayer and Jirka 1997). Abundance seems to be declining in many parts of its range in the United States. However, this species appears to be mildly tolerant of eutrophication (nutrient addition to water bodies) and siltation, but is affected by toxins. Competition by the introduced zebra mussel has negatively impacted the abundance of the Yellow Lampmussel, particularly in slow moving waters of larger streams and in lakes (North Carolina Mussel Atlas). This species is thought to be hybridizing with *Lampsilis ovata* and *Lampsilis cardium* through the westernmost parts of its range (Nedeau 2000).

References

- Connecticut DEP. 2003. A Field Guide to the Freshwater Mussels of Connecticut. Hartford, CT 31 pp.
- NatureServe Explorer: An online encyclopedia of life [web application]. 2005. Version 4.5. Arlington, VA. Website: www.natureserve.org/explorer.
- Nedeau, E.J, M.A. McCollough, and B.I. Swartz. 2000. The Freshwater Mussels of Maine. Maine Dept. of Inland Fisheries and Wildlife, Augusta, ME.
- North Carolina Mussel Atlas, Species Information and Status. Website: www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg7b1a1_15.htm
- Parmalee, P.W. and Bogan, A.E. 1998. The Freshwater Mussels of Tennessee. The University of Tennessee, Knoxville, TN 328 pp.
- Pennsylvania Natural Heritage Program. Biota of Concern In Pennsylvania (BOCIP) Lists. Website: www.naturalheritage.state.pa.us/invertebrates.aspx
- Strayer, D.L. and K.J. Jirka. 1997. The Pearly Mussels of New York State. The New York State Education Dept., Albany, N.Y. 113 pp and plates.
- Wick, P.C. and A.D. Huryn. 2002. Biology and natural history of Lampsilis cariosa and Leptodea ochracea (Unionidae) in Maine. Abstracts of the 2002 North American Benthological Society Annual meeting, Pittsburg, Pennsylvania
- Williams, J.D., M.L. Warren, K.S. Cummins, J.L. Harris, and R.J. Neves. 1993. Conservation Status of Freshwater Mussels. Fisheries. 18(9): 6-22.

Pennsylvania Natural Heritage Program

Roundleaf Serviceberry (*Amelanchier sanguinea*)

Plant Species of Concern

State Rank: S1 (critically imperiled), Global Rank: G5 (secure)

Identification

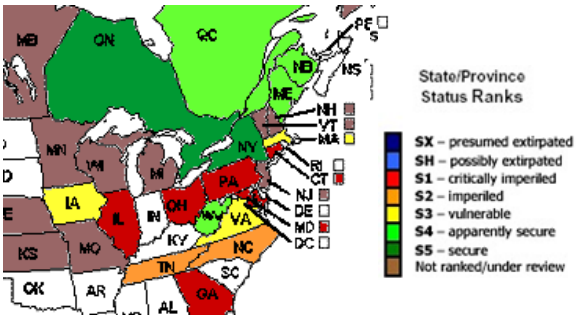
The roundleaf serviceberry is a shrub or small tree. The leaves are alternate, simple, deciduous, and coarsely-toothed on the margin. The flowers, which have five white petals, are grouped in small clusters that appear from late April to mid May. The fruits resemble miniature apples and are reddish to purple when mature. Identification of this species must be done with care because of its resemblance to other serviceberries.

Habitat

The species grows on dry rocky slopes, cliffs, and outcrops in scrubby woods, thickets, and exposed locations. The roundleaf serviceberry is distributed in the more northern and cooler portions of eastern North America. It is known historically and currently from several northern or mountainous counties in Pennsylvania.

North American State/Province Conservation Status

Map by NatureServe



Status

The roundleaf serviceberry has been given a status of Endangered on the Plants of Special Concern in Pennsylvania list by the Pennsylvania Biological Survey and the Department of Conservation and Natural Resources, based on the relatively few historical and recent records that have been documented in the state.

Conservation

The species is unlikely to be noticed except during the brief flowering period in the spring of the year. More field work is needed in order to determine if this status is justified. The plant may have been overlooked because its habitat is not always easily accessible and because of difficulty of identification.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Screw-stem (*Bartonia paniculata*)

Plant Species of Concern

State Rank: S3 (vulnerable), Global Rank: G5 (secure)

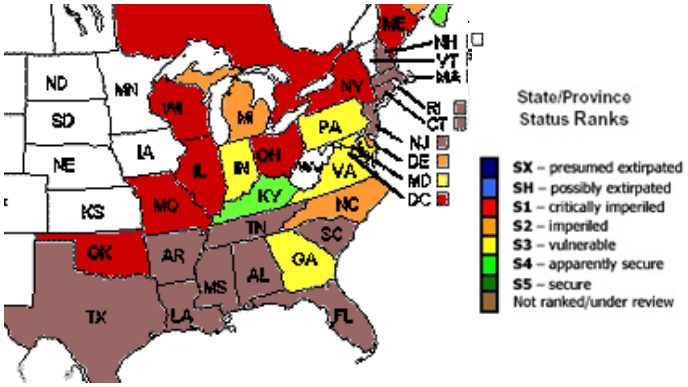
Identification

The screw-stem is a very small (sometimes less than one inch in height), very slender, annual herb. The leaves are tiny, scale-like, and mostly alternately arranged. The flowers are whitish, yellowish, or purplish (with the flower parts in fours) and appear in late summer or fall. Depending on its height, an individual plant may have a single flower or a branched cluster. The fruit is a capsule. The plant is unlikely to be mistaken for any other plant except the related *Bartonia virginica*, which tends to have opposite leaves, shorter flower branches, and often a drier habitat.

photo source: Andrew Strassman (PNHP)

North American State/Province Conservation Status

Map by NatureServe



Habitat

The species grows in moist to wet woods, thickets, seepages, and boggy places. It is often found on hummocks formed by moss or the bases of woody plants. The screw-stem is widely distributed in eastern North America but apparently is most frequent near the coastal areas. Based on historical and current records, the species occurs mainly in the eastern, particularly the southeastern, counties in Pennsylvania.

Status

The screw-stem has been given a status of Undetermined on the Plants of Special Concern in Pennsylvania list by the Pennsylvania Biological Survey and the Department of Conservation and Natural Resources, based on the relatively few historical and recent records that have been documented in the state. More field work is needed in order to determine if the species is of conservation concern. The plant is easily overlooked because of its small size and wetland habitat.

Conservation

The boggy wetlands where screw-stem occurs should be maintained in a natural condition. Historically, they probably had a history of beaver activity that is now lacking from the environment and promotes succession. There is excellent potential for finding additional occurrences of this species in boggy wetlands given its cryptic nature.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Pennsylvania Natural Heritage Program

False Hop Sedge (*Carex lupuliformis*)

Plant Species of Concern

State Rank: S1 (critically imperiled), **Global Rank: G4** (apparently secure)

Identification

False hop sedge is a grass-like plant that grows 1½ to 3 feet (to 1 m) tall. Its common name refers to a superficial resemblance of its flower spikes to fruits of the hop vine. The leaves are linear, elongate, and up to ½ inch (13 mm) wide. The flowers are arranged in bur-like cylindrical spikes at the top of flowering stems. Male and female flowers are found in separate spikes, with usually one slender male spike held above a cluster of 2 to 6 robust female spikes. The female spikes contain densely packed, inflated sac-like structures (perigynia) that have long projecting beaks.

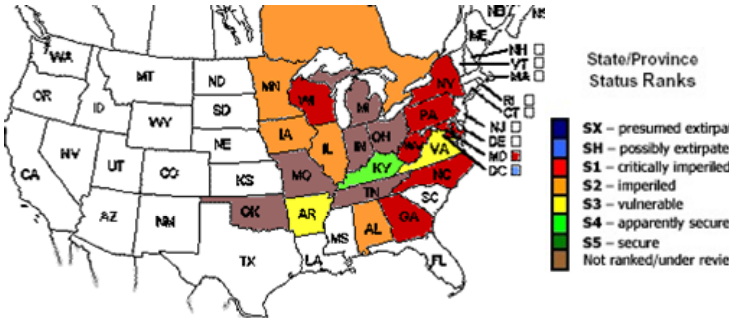
photo source: John Kunsman (PNHP)

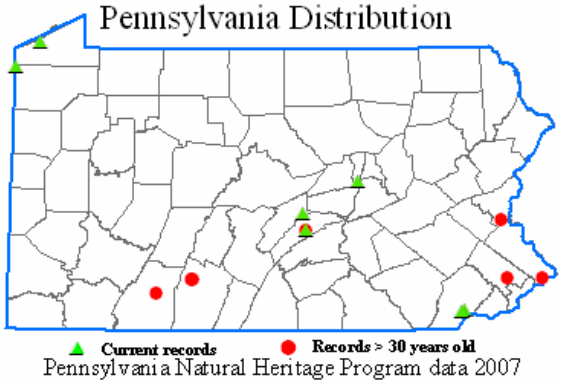
Habitat

False hop sedge has a distribution from Canada south and west to Florida and Texas. In Pennsylvania, the occurrences are mostly in the southern half of the state. This species grows in wetlands, such as vernal ponds, bottomland pools, swamps, and marshes, especially on calcareous substrates.

North American State/Province Conservation Status

Map by NatureServe





Status

The PA Biological Survey considers false hop sedge to be a species of special concern, based on the relatively few occurrences that have been confirmed and the wetland habitat. It has been assigned a rarity status of Undetermined, meaning that more information is needed before a more definite rarity status can be designated.

Conservation

More field surveys are needed to determine the range, abundance, and ecological requirements of the false hop sedge. Creating buffers around wetlands, controlling invasive species, and protecting wetland hydrology will help to maintain occurrences of the species.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer
- Pennsylvania Natural Heritage Program. 2007
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Flora. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T.A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

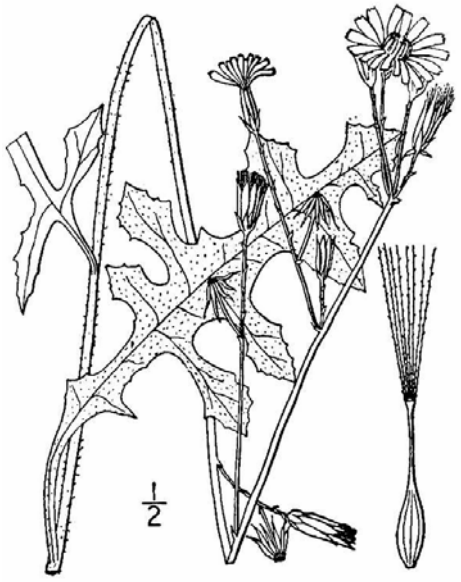
Downy Lettuce (*Lactuca hirsuta*)

Plant Species of Concern

State Rank: S3 (vulnerable), Global Rank: G5 (secure)

Identification

The downy lettuce is an annual or biennial herb with milky sap. The slightly to densely hairy stem can reach 8 feet (2.5 m) in height. The leaves are arranged alternately on the stem and variable in shape and length, but tend to have toothed, pinnate lobes. The flowers are individually tiny and are grouped in yellow flower heads that are 5/8 to 7/8 inch (15 to 22 mm) long at maturity. The individual fruits have a slender "beak" at the top, somewhat similar to dandelions. The flower heads and fruits of downy lettuce are slightly larger than the very similar and much more common species of wild lettuce, *Lactuca canadensis*.

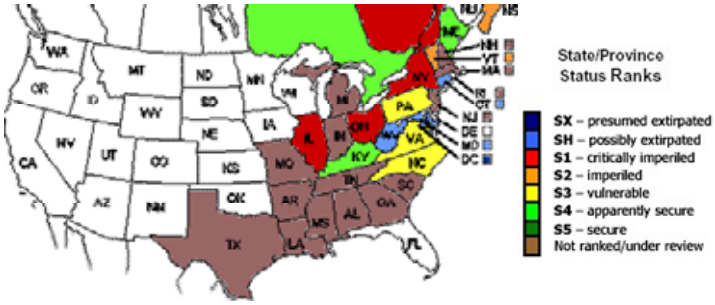


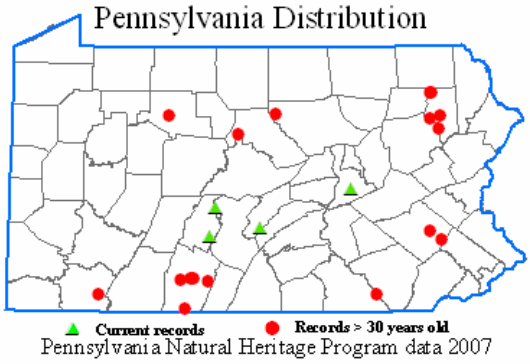
Habitat

The downy lettuce has a distribution from from Canada south and west into Georgia and Texas. In Pennsylvania, it has been found scattered throughout the state. The species grows in open woods, clearings, thickets, powerline and pipeline rights-of-way, and ridgetops.

North American State/Province Conservation Status

Map by NatureServe





Status

The PA Biological Survey considers downy lettuce to be a species of special concern, based on the relatively few occurrences that have been confirmed in the state. It has been assigned a rarity status of Undetermined, meaning that more information is needed before a more definitive rarity status can be designated

Conservation

More field surveys are needed to determine the range, abundance, and ecological requirements of downy lettuce before a more definitive conservation status, if any, can be assigned. Based on current data, it appears to be a short-lived, early successional species that may have a very limited viability at a given occurrence, even under optimal conditions.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia
- USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *Illustrated flora of the northern states and Canada*. Vol. 3: 319.

Hoary Puccoon (*Lithospermum canescens*)

Plant Species of Concern

State Rank: S2 (imperiled), Global Rank: G5 (secure)

Identification

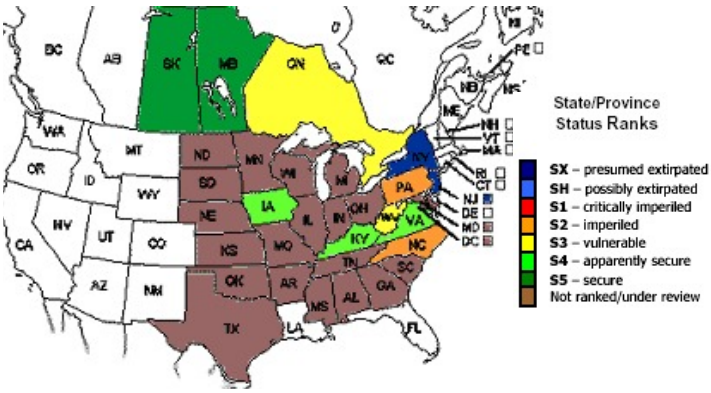
Hoary puccoon is a showy perennial with a stout taproot. It can grow from 4 to 15 inches tall. Short white hairs cover almost all of the plant including the flowers. The genus Lithospermum means, "stone-seeded." Therefore, the seeds, or nutlets produced by this plant are very hard, shiny, and smooth like stones.

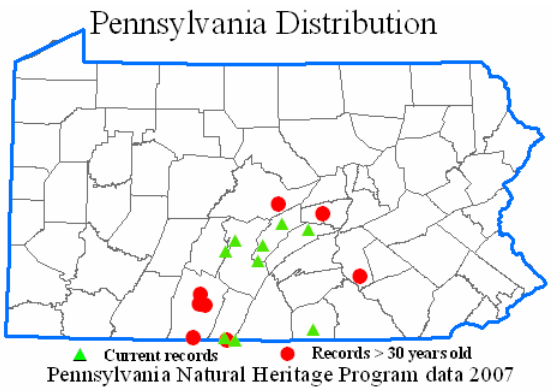
Leaves are alternate, narrowly oblong, and attach directly to the stem without a petiole. Flowers are grouped in clusters that have a flat or rounded top; however, single blossoms are common. The individual flowers are tubular, with 5 lobes, and about a third of an inch across. They bloom in shades of vibrant yellow and orange from late April through May.

Photo source: PNHP

North American State/Province Conservation Status

Map source: NatureServe 2007





Habitat

Hoary Puccoon is found throughout the Eastern United States. In Pennsylvania, it is found on river bluffs, dry rocky hillsides, and barrens, with a preference for limestone substrate.

Status

Throughout the range of this species, habitat loss, land conversion for development, and displacement by invasive species have all played a part in its decline. In some cases, the communities where this species grows are themselves rare or have succeeded into a different community types due to the overgrowth of woody species and invasive species. Some of these preferred community types, like the xeric prairies, depend on fire to "weed out" atypical species.

Conservation

Maintenance of known populations and preservation of the rare communities where hoary puccoon 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.

References

- MissouriPlants. 2007.Missouri Plants [Web application] http://www.missouriplants.com Accessed: February 18, 2007.
- NatureServe.2006.NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. Accessed: February 10, 2007.
- Rhoads, Ann and T. Block. 2000. The Plants of Pennsylvania: An Illustrated Manuel. Philadelphia: Univ. of PA Press. 267.

Shale-barren Evening-Primrose (*Oenothera argillicola*)

Plant Species of Concern

State Rank: S2 (imperiled), Global Rank: G3 (vulnerable)

Identification

Shale-barren evening-primrose is a showy biennial herb that can reach 60 inches (1.5 m) in height. Its erect or ascending stems are smooth and grow from strong, fleshy roots. The leaves grow both basally and alternately along the stem. Stem leaves are narrowly lance-shaped, and up to ⅜ of an inch (1 cm) wide by 7 inches (18 cm) long. Leaves are glossy, dark green and sometimes finely hairy. The flowers are yellow and usually last only one day. Each flower has a round ovary and 4 overlapping petals that are ¾ to 1½ inches (2-4 cm) long. Flowers are displayed from July through September in a spike-like cluster that droops at the top.

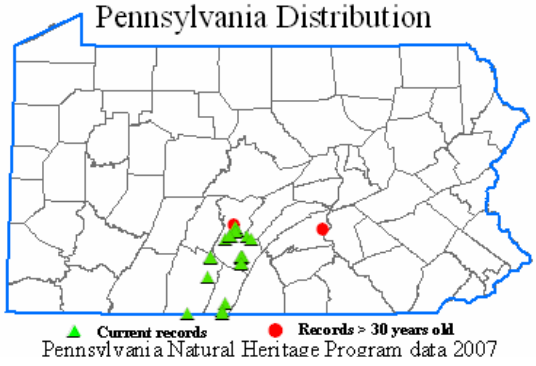
photo sourceJohn Kunsman (PNHP)

Habitat

Shale-barren evening primrose has a relatively small distribution in the Appalachians, from southern Pennsylvania south into Virginia and West Virginia. In Pennsylvania, the occurrences are restricted to a few southcentral counties. The species tends to grow on "shale barrens", which occur on dry, open, usually steep slopes, banks, and cliffs, with shale substrate, typically on southerly or westerly aspects overlooking streams.

North American State/Province Conservation Status

Map by NatureServe



Status

The PA Biological Survey considers the shale-barren evening-primrose to be a species of special concern, based on the relatively few occurrences that have been confirmed and the very specialized habitat. It has been assigned a rarity status of Threatened.

Conservation

Conservation of shale-barrens evening primrose will depend on the protection of existing populations and shale barrens habitat. Many shale barrens may require no active management, although some sites that are more susceptible to woody encroachment may benefit from prescribed fire. Ending gypsy moth pesticide spraying in shale barrens, as well as creating unsprayed buffers around shale barrens, may be necessary to protect this species' insect pollinators. Quarrying may also be a threat to this species.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Leaf-cup (*Polymnia uvedalia*)

Plant Species of Concern

State Rank: SNR (not yet assessed), **Global Rank: G4G5** (apparently secure/secure)

Identification

Leaf-cup is a coarse perennial herb that can reach up to 6½ feet (2 meters) in height. A member of the aster family, this species produces flower heads that look similar to small sunflowers. The leaves a quite large, up to 16 inches (4 dm), and are rough to the touch. The deeply lobed and coarsely toothed leaves have been said to resemble a bear's paw in outline. Leaves are arranged in opposite pairs along the stem. The flower heads are composed of a brownish-yellow center surrounded by 7-13 bright yellow rays. The 2 inch (5 cm) flower heads are produced in leafy, branching clusters at the top of the stems and bloom from July to September.

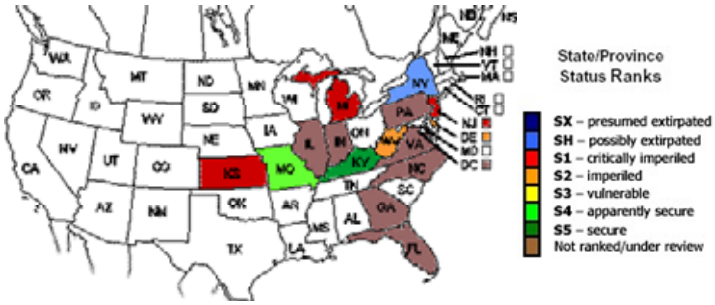
Photo Source: Rocky Gleason (PNHP)

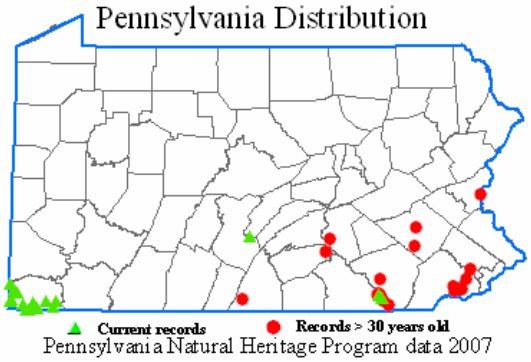
Habitat

Leaf-cup is occurs from New York south to Florida and west as far as Kansas. In Pennsylvania, it grows in ravines, moist thickets, and along the banks of streams or rivers.

North American State/Province Conservation Status

Map by NatureServe





Pennsylvania Natural Heritage Program data 2007

Status

The PA Biological Survey considers the leaf-cup to be a species of special concern, based on the relatively few occurrences that have been confirmed and the localized distribution. It has been assigned a rarity status of Threatened.

Conservation

Protection of leaf-cup will require maintenance of known populations and preservation of stream and riverbank habitat. 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.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Northeastern Bulrush (*Scirpus ancistrochaetus*)

Plant Species of Concern

State Rank: S3 (vulnerable), Global Rank: G3 (vulnerable)

Identification

Northeastern bulrush is a tall sedge with short thick underground rhizomes from where the leaves emerge in May. Superficially, sedges seem to be "grass like" plants; however, there are many differences between sedges and grasses. With practice, the two families are easily distinguished from each other. Leaves are three angled, narrow, green to whitish or brown, and have basal sheaths. Flowers are individually difficult to see without magnification. The grouping of flowers or the inflorescences are more obvious, sometimes resembling the exploding of a fire work. The branches holding the inflorescence droop with age. The fruits, or achenes in this case, are very small, about 1/ 30 of an inch across.

photo source: PNHP

Habitat

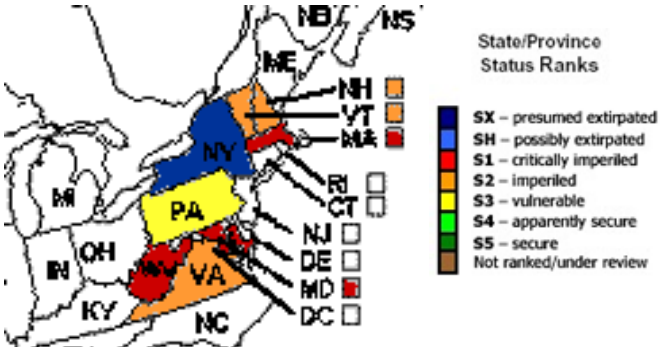
Populations of northeastern bulrush are recorded from Quebec south to West Virginia. Throughout its range including in Pennsylvania, it is found growing on the edges of seasonal pools, wet depressions, beaver ponds, wetlands, and small ponds.

Status

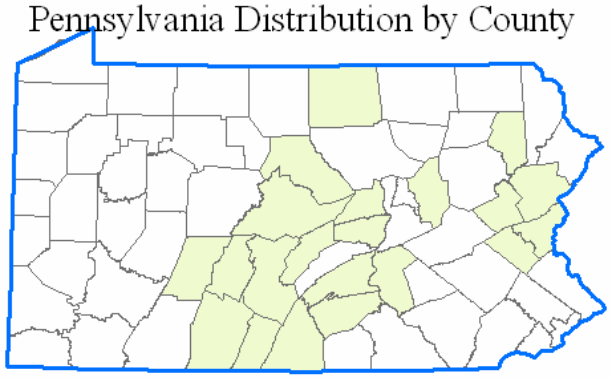
Only 50-60 populations exist throughout its entire range. Pennsylvania has the largest number of occurrences. The decline of this species is attributed to multiple threats: degradation of habitat from road construction and upland runoff, destruction by off road vehicles, and conversion of land for other uses.

North American State/Province Conservation Status

Map by NatureServe



Pennsylvania Distribution by County



Pennsylvania Natural Heritage Program data 2007

Conservation

Slight variations in the natural fluctuation in the water level can harm this plant. Therefore, activities that impact the water table and degrade the plant's habitat such as development, ATV use, agriculture, quarrying, and dredging have been known to destroy several historic locations. Other potential threats to the species include deer browsing, fire, and natural succession.

Management of this species may include enhanced protection from nearby road construction, the implantation of practices to alleviate pollution from upland runoff, and continued protection of current sites from development. Surveys of potential habitat for new populations have been proven to be successful and should be continued. Habitat restoration projects are possible for sites that have suffered degradation. The northeastern bulrush became the second plant in Pennsylvania to be listed as a federally endangered species. Because of this special status, activities that pose a direct harm to the species would be subject to regulation by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

PNHP
Pennsylvania Natural Heritage Program

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Sida; Virginia Mallow (*Sida hermaphrodita*)

Plant Species of Concern

State Rank: S2 (imperiled), Global Rank: G3 (vulnerable)

Identification

Sida is a large perennial herb that grows 3 to 10 feet (1-3 meters) tall. Its stems are hairy when young but become smooth with age. The leaves grow alternately on the stem and resemble long-pointed maple leaves. They usually have 3 to 7 irregularly toothed lobes, with the middle lobe being the longest. The white flowers, which bloom from July to October, are arranged in stalked clusters that grow from the upper stem leaf axils. Each flower has 5 petals that are each about ⅓ inch (8 mm) long.

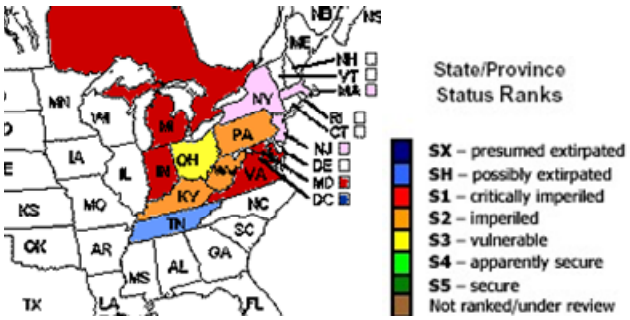
photo source: John Kunsman (PNHP)

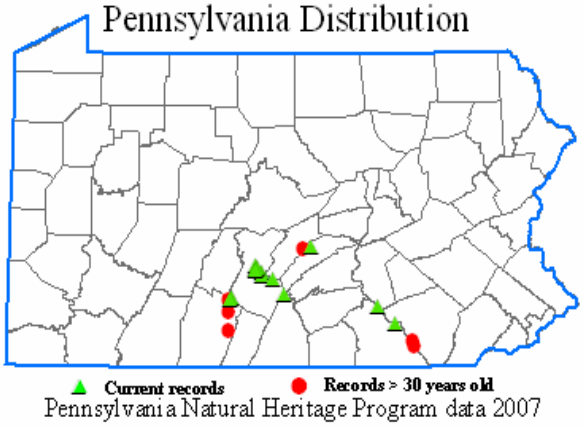
Habitat

Sida has a rather localized distribution in Midwestern and mid-Atlantic portions of eastern North America. In Pennsylvania, the occurrences are restricted to the Juniata River and lower Susquehanna River watersheds. The species grows on streambanks and bottomlands, as well as disturbed places like roadsides and railroad grades that are in proximity to the stream corridors.

North American State/Province Conservation Status

Map by NatureServe





Status

The PA Biological Survey considers Sida to be a species of special concern, based on the relatively few occurrences that have been confirmed and the localized distribution in the state, as well as rarity throughout its global range. It has been assigned a rarity status of Endangered.

Conservation

Maintenance of known populations and preservation of the unique habitat where Sida thrives will be crucial to its survival. Removal of encroaching invasive species along river corridors and the establishment of buffers surrounding known sites will help to improve habitat quality. Recognition and protection of populations along roadsides and in other unprotected areas will also be important.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Mountain Starwort (*Stellaria borealis*)

Plant Species of Concern

State Rank: S1 (critically imperiled), **Global Rank: G5** (secure)

Identification

The mountain starwort is a small, slender, rather delicate perennial that is usually less than eighteen inches in height. The leaves have a lance or linear-lance shape and are oppositely arranged. The flowers are only a few millimeters long, often lack petals, and are grouped individually or in a cluster that are present from May to August. The fruit is a many-seeded capsule. Other species in the genus *Stellaria* have a similar general appearance and also grow in wetlands.

Habitat

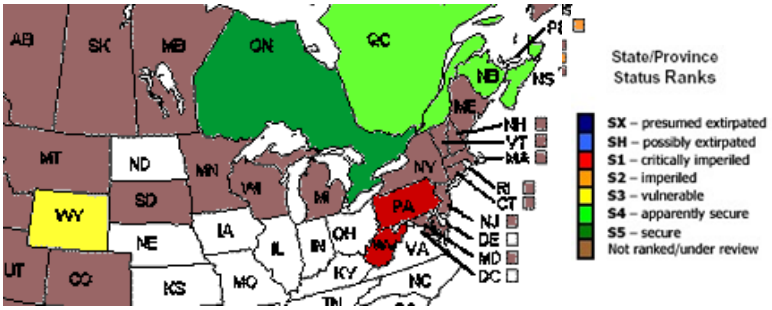
The species grows in wet soil in and around seeps, springs, and streamlets in cool woods and swamps. The mountain starwort is widely distributed in the more northern and cooler portions of North America. It occurs mainly in the northern and mountain counties in Pennsylvania.

Status

The mountain starwort has been given a status of Undetermined on the Plants of Special Concern in Pennsylvania list by the Pennsylvania Biological Survey and the Department of Conservation and Natural Resources, based on the relatively few historical and recent records that have been documented in the state.

North American State/Province Conservation Status

Map by NatureServe



Conservation

More field work is needed in order to determine if the species should be of conservation concern. The plant is easily overlooked due to its inconspicuous appearance and wetland habitat.

Pennsylvania Natural Heritage Program

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia

Netted Chainfern (*Woodwardia areolata*)

Plant Species of Concern

State Rank: S2 (imperiled), Global Rank: G5 (secure)

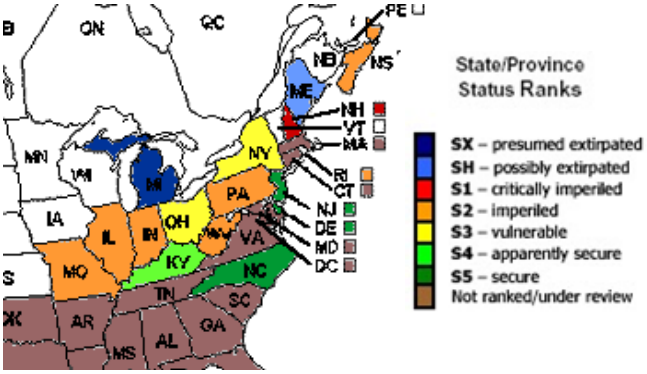
Identification

The netted chain fern is a herbaceous perennial with creeping underground stems. The plant may produce sterile and fertile (spore-bearing) leaves. The sterile leaf has a broad, flattened blade that is divided into alternately arranged leaflets or lobes along the leaf stalk. Mature plants may produce a specialized fertile leaf with deeply divided but much narrower lobing and with spore-bearing structures, giving it much less of a leaf-like appearance. The sterile leaf is somewhat similar to that of the sterile leaf of the sensitive fern (*Onoclea sensibilis*), but the leaflets or lobes of the latter species tend to be oppositely arranged along the leaf stalk.

photo source: Andrew Strassman (PNHP)

North American State/Province Conservation Status

Map by NatureServe



Habitat

The species grows in moist to wet woodlands, thickets, seepages, and bogs, usually in acidic conditions. The netted chain fern occurs throughout the eastern half of North America, but is apparently most frequent near the coastal areas. The species is distributed widely across Pennsylvania, with most of the historical and current occurrences in the southeastern counties.

Status

The netted chain fern has been given a status of Threatened on the Plants of Special Concern in Pennsylvania list by the Pennsylvania Biological Survey and the Department of Conservation and Natural Resources, based on the relatively few historical and recent records that have been documented in the state.

Conservation

Additional field work is needed in order to justify this status, as recent field work has shown that the species may be more frequent and more widely distributed than previously believed.

References

- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer.
- Pennsylvania Natural Heritage Program. 2007.
- Rhoads, A.F. and W.M. Klein, Jr. 1993. The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas. American Philosophical Society, Philadelphia.
- Rhoads, A.F. and T. A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press, Philadelphia