



Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

WILD HERITAGE NEWS

Summer 2017



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Photo Banner:
Kettle hole bog

Ephraim Zimmerman

You Have to See These Places

by
Ephraim Zimmerman

“You have to see these places – they will blow your mind!” is what Rocky Gleason, PNHP Ecologist, said to me when I asked him to show me some of the peatlands of the Poconos and the Glaciated Low Plateau region of northeastern Pennsylvania. Peatlands are rare wetland communities and several types are scattered across the glacial landscape of the Poconos. PNHP ecologists, botanists, and zoologists have been interested in peatlands and other rare plant communities in this area since our program was established, because these ecosystems tend to support plant and animal species limited to northeastern Pennsylvania.

While the Poconos have always been important to our program, a number of projects recently converged, including the updates of the Wayne and Monroe County Natural Heritage inventories, the EPA-funded peatland wetland inventory and assessment, and the update of the terrestrial portion of the Pennsylvania Community Classification. This allowed PNHP ecologists to spend more time

investigating the composition, condition, and ecological variables (e.g., soils and landforms) of these interesting natural plant communities.

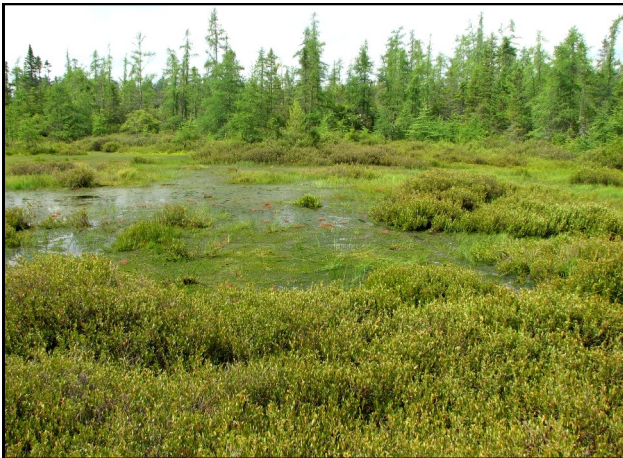
Most of the natural plant communities of the Pocono Plateau and Glaciated Low Plateau regions of northeastern Pennsylvania are there because of ice-age glaciers, which reached their extent 10,000 to 15,000 years ago. Upon receding, they left broad valleys, wetland depressions, and natural lakes underlain by sandstone and shale. In some areas glacial scouring resulted in large expanses of bedrock, scraped clean by the ice. In other areas,



Exposed bedrock in Luzerne County

Rocky Gleason

glaciers left deep deposits of rock, sand, silt, and clay. Large ice chunks that broke off from the retreating glacier and melted in place formed deep depressions, called kettle holes, which filled with water and vegetation, forming natural lakes, ponds, and wetlands. These glacial landforms left by the retreating Illinoian and Wisconsin glaciers are the foundation for several interesting plant communities restricted to the region located between the Kittatinny Ridge in Carbon County and the Delaware River on the border with New Jersey. These communities include peatlands of the glacial kettle holes, Red-cedar – Prickly Pear Shrubland on the shale cliffs above the Delaware River, scrub oak barrens growing on sandstone bedrock formed by the scraping glacial ice, and the mosaic of pitch pine, scrub oak, and mixed heath woodlands of the mesic till barrens.



Crooked swamp, an example of a Black Spruce – Tamarack Peatland Forest community.

Rocky Gleason

Peatlands, including bogs and fens, are some of the most recognizable features of the Pocono region. They are a specific type of wetland ecosystem containing a substantial amount of peat (> 30 cm), which is partially decomposed plant material – mostly sedges and peatmosses (*Sphagnum* spp.). One of the communities found in the peatland ecosystems of the Poconos is the Black Spruce – Tamarack Peatland Forest community that occurs in small watersheds at the origin of streams and where the bedrock is acidic. There is limited opportunity for surface water to add nutrients as it passes over the soils and rocks of the watershed before entering the wetland. Peatlands like the Black Spruce – Tamarack Peatland Forest are often referred to as boreal as they support many plant species more common north of Pennsylvania. Some boreal species found in this community include dwarf mistletoe (*Arceuthobium* sp.), blackpoll warbler (*Setophaga striata*),



David Yeany

White-throated sparrow, a Species of Greatest Conservation Need in Pennsylvania, nests in boreal habitats like Black Spruce – Tamarack Peatland Forest. About 83% of the species' North American population breeds in the boreal zone.

white-throated sparrow (*Zonotrichia albicollis*), and yellow-bellied fly-catcher (*Empidonax flaviventris*). Peatlands that support communities such as the Black Spruce – Tamarack Peatland Forest, which hold both rare and common plant species of northern latitudes such as creeping snow-berry (*Gaultheria hispidula*), black spruce (*Picea mariana*), and many others are important subjects for climate change study. The undecomposed peat provides a historical record of past climate and environmental conditions as the acidic conditions prevent breakdown of pollen and plant material within the peat. They also serve as refugia for species found more commonly to the north of Pennsylvania, but limited in their distribution here. As global climate change progresses, many boreal species within this community type may not be able to tolerate the increasing temperatures or changes in precipitation. PNHP ecologists are monitoring the potential changes



Narrow-leaved gentian

Rocky Gleason

in plant and animal composition over time in a long-term monitoring study in peatlands. There are several sites within the Poconos where PNHP scientists have assessed the composition of the ecosystems and are monitoring populations of rare plant species, the condition of the natural plant communities, and the

birds and invertebrates found there with the intention of following these sites over time to assess changes in the communities due to climate change.



Ephraim Zimmerman

Yellow Run Barrens Rhodora—Mixed Heath—Scrub Oak Shrubland

Another extremely interesting ecosystem of the Poconos is the mesic till barrens. The till barrens are a unique complex of globally rare plant communities known only from the southern Pocono Plateau of Pennsylvania and restricted to specific deposits left by the Illinoian glacier. Till is the term for the unsorted material (also called “drift”) deposited by glacial ice. In the southern Poconos, the till is heavy, clayey, acidic, and deep. Barrens communities are a mixture of wetland plants and plants usually associated with xeric soil conditions such as rhodora, scrub-oak, sheep laurel, and blueberries. Bracken fern, cinnamon fern, and sedges make up the herb-layer with scattered pitch pine and oak trees in the sparse overstory. There are a number of rare plant species in these communities including climbing fern (*Lygodium palmatum*) and variable sedge (*Carex polymorpha*). In the absence of fire, native overstory trees have slowly crept in and, in some places, a canopy of mixed oaks and red maple has formed. The Nature Conservancy, DCNR Bureau of Forestry, and the Pennsylvania Game Commission have been working to restore the Pitch Pine – Rhodora – Scrub Oak Woodland and Rhodora – Mixed



Rocky Gleason

Climbing fern

Heath – Scrub Oak Shrubland communities on the Weiser State Forest, Game Land #141, and on TNC’s Long Pond preserve.

The Red-cedar – Prickly Pear Shale Shrubland is found in the far northeastern edge of Pennsylvania on the steep slopes and outcrops of Devonian shales and siltstones of the Mahantango Formation along the Delaware River. The erosive processes of flowing water resulted in these high, steep cliffs as the river water cut down through the bedrock. Soils are typically very thin and rocky. The plant communities of south-facing shale outcrop barrens are sparse and the species there are able to tolerate the droughty soils, high temperatures, and poor soils. These ecosystems are often described as the “deserts of Pennsylvania” where scattered shrubs grow with prickly pear cactus, and other plants grow in whatever soil is available in small pockets and crevices in the rock. The soil of this community is extremely dry and vegetation is sparse. In general, fire is not thought to play much of a role here, since the excessively well drained droughty soil never develops the necessary accumulation of fuel needed to sustain a fire.



Steve Grund

Prickly pear

There are many opportunities to visit places that support these spectacular ecosystems on properties managed by the DCNR, the Pennsylvania Game Commission, and conservation organizations like The Nature Conservancy. The mesic till barrens may be the most easily accessible of the three types. Mesic till barrens are found on TNC’s Long Pond Preserve (<http://bit.ly/2vxHfvm>). A Weiser State Forest tract within the watershed of Yellow Run in Carbon County supports a patch of Rhodora – Mixed Heath – Scrub Oak Shrubland is another interesting place to visit. It is accessible by hiking trails near Jim Thorpe, Pennsylvania, but you might want to wait until after the prescribed

fires this fall. It will be very exciting to see the response of these communities to much needed fire - a recommended management activity to maintain the open shrubland conditions.



Pitcher plant

Rocky Gleason

Visiting the Pocono peatlands may be a little more difficult as often they are not visible from the road or are located on private properties or tucked away in the mountains. There are several bogs open to the public that are managed by state agencies and conservancies. Probably the most accessible is Tannersville Cranberry Bog (<http://bit.ly/2ffxVtV>), managed by the Nature Conservancy but there are bogs throughout the region. Ricketts Glen, Tobyhanna, and Gouldsboro state parks in Columbia, Luzerne, Sullivan, and Monroe counties – all have bogs where the peat is thick and carnivorous sundews and pitcher plants abound.



Rock outcrop on the Delaware River

Rocky Gleason

Running around the shale barrens on the Delaware River is not advised. These are very sensitive ecosystems and dangerous! The loose shale slips and slides and can be very treacherous. However, you may see the outcrops along the Delaware while visiting the

Upper Delaware Scenic and Recreational River <https://www.nps.gov/upde/index.htm>.

The communities of the Poconos and adjacent glaciated regions of northeastern Pennsylvania are truly unique, and our efforts will contribute to better conservation. With the ever-increasing threats from human development, fragmentation, and effects of global climate change, the landscape and the plant and animal species making up these communities are threatened. Natural succession without fire and with invasive species poses additional threats. Conservation organizations and our state management agencies are working to protect and restore these areas. Our primary goal is to provide information to guide land protection, restoration, prescribed burning, and invasive plant control activities. Our ecological assessment and long-term monitoring activities provide information for mitigation and management and help us understand how these ecosystems are changing over time, especially in response to climate change.

The Poconos and Glaciated Low Plateau region of northeastern Pennsylvania is a fantastic part of the state, supporting globally rare plant communities found nowhere else. Rocky was right – I was blown away – and you will be too!

About the Author

Ephraim has worked with the Pennsylvania Natural Heritage Program for 14 years as a natural community ecologists, and currently serves as the Science Director for the Natural Heritage Program at the Western Pennsylvania Conservancy. He has been involved in many projects to map, describe, and assess plant communities and ecosystems of Pennsylvania's state parks, national parks, and other public and private lands. With members of the Pennsylvania Biological Survey's Ecological Communities Technical Committee, Ephraim updated the wetland portion of Pennsylvania's Plant Community Classification in 2012 and is currently working on an update of the terrestrial communities of Pennsylvania.



Ash Mortality: The Bigger Picture

by

Pete Woods

A few days ago, when I lifted the lid of my trap and looked inside, my heart jumped when I saw the angel. Not because I haven't seen one before, but because whenever I see one I wonder if it will be the last one I see. The angel (*Olceclostera angelica*) is a moth; one of many species that are threatened by the loss of ash trees to the emerald ash borer (EAB). My trap confirmed that, at least for the moment, one of those species is still here.



Pete Woods

Angel (*Olceclostera angelica*)

EAB arrived in North America from Asia sometime during the 1990s and was first detected in Pennsylvania in 2007. It has since spread throughout the state, and been found in all but a few eastern counties. All species of ash in the genus *Fraxinus*, including the four (or possibly five) species in Pennsylvania and a dozen other species across North America, are highly vulnerable to the beetle whose larvae burrow through the inner bark of the trees until the trees die. The effects of EAB are devastating to ash. In areas where the "killing wave" of EAB passes through, it kills nearly 100% of the ash trees larger than one inch in diameter. As saplings grow into the vulnerable stage, they are killed by EAB, until the seed bank is depleted and no ash trees are left. The



Colorado State Forest Service

Emerald ash borer

timber industry and landowners who have lost trees are very familiar with EAB, and many people know about it because of the bans on moving firewood. But few people are aware of the threat to a whole community of invertebrates that depend on ash trees. EAB could drive approximately 100 species of invertebrates to extinction.



Pete Woods

Emerald ash borer larvae bored under the bark of this ash tree until the inner bark was so riddled with galleries that the tree could not survive. These tunnels were exposed by a woodpecker flaking the bark off the tree.

Some of the invertebrates you can find on an ash tree are generalists, herbivores able to use a wide variety of host plants. For the most part, even if many populations of these generalists are affected by the loss of ash trees, the invertebrate species themselves will not be placed at severe risk of extinction. One example is the honeybee (*Apis mellifera*), which can rely on ash trees as a major source of pollen in the spring. Other invertebrates on ash trees are specialists; they use ash trees exclusively and cannot survive on other plants. Over thousands or millions of years they have adapted to the chemistry and ecology of one genus of tree (and in many cases to one species of ash), the unique habitat that is their home. They have fine-tuned their own biology to this unique habitat, to the point where they cannot survive without it.

Across North America, at least 98 species of invertebrates are thought to depend mostly or exclusively on ash trees. This number is almost certainly an underestimate. A few of these species might have additional hosts, and should not be on this list. Others have been mistakenly thought to use other hosts, while they are actually ash specialists. There are undoubtedly other ash specialists that have never been associated with a host plant and still others that have never been described by science.

Some of these invertebrates rely mainly on ash trees, but can also survive on one or a few other related plants in the ash family (*Oleaceae*). Within Pennsylvania, this family includes the rare fringetree (*Chionanthus virginicus*), and a number of introduced plants, including lilac (*Syringa vulgaris*), two species of forsythia (*Forsythia* spp.), and four invasive species of privet (*Ligustrum* spp.). These species are all much less abundant than ash trees, and it is not clear that they would be able to support ash-specialists in the absence of ash trees. Still, it is an intriguing possibility that privet, an exotic invasive plant that is threatening diversity in natural areas, just might become a resource that keeps native species from going extinct. It should be emphasized, however, that most of the ash specialists are not known to use these other hosts.

Part of PNHP's role in the conservation of ash trees and their invertebrate fauna is to understand which of Pennsylvania's native species are at risk from EAB. This is a challenging question, both because our state lists of invertebrates are very incomplete, and because our knowledge of their biology is limited. In 2015, PNHP biologists first tried to answer this question as part of the revision of Pennsylvania's State Wildlife Action Plan (SWAP), which began with identifying which species should be considered Species of Greatest Conservation Need. Ten ash-dependent species were included in the SWAP, with the understanding that the list was incomplete.

Since that time, the scientific literature surrounding this issue has grown, while databases of species records have expanded and become more available, and PNHP's field surveys have detected additional species. At this time, PNHP's list of ash-dependent invertebrates has grown to 17, and with additional research and field work it is expected that this list will continue to grow.

Many of Pennsylvania's ash specialists are moths from a variety of families and representing a variety of ecological strategies. The **angel** (*Olceclostera angelica*) can be recognized by the two tiny clear windows near the tip of each forewing. With its dark eyes, and its thick "fur" with patterns of tan and pale gray with dark speckles, this moth always reminds me of a barn owl. The **splendid palpita** (*Palpita magniferalis*) is a small moth boldly marked in black and white, but, like most moths, it is well camouflaged on the right background. The **ash borer** (*Podosesia syringae*) is a day-flying moth that mimics a paper wasp, presumably because predators that do not want to risk a sting avoid eating them. Its caterpillars bore into ash trunks. The **ash**

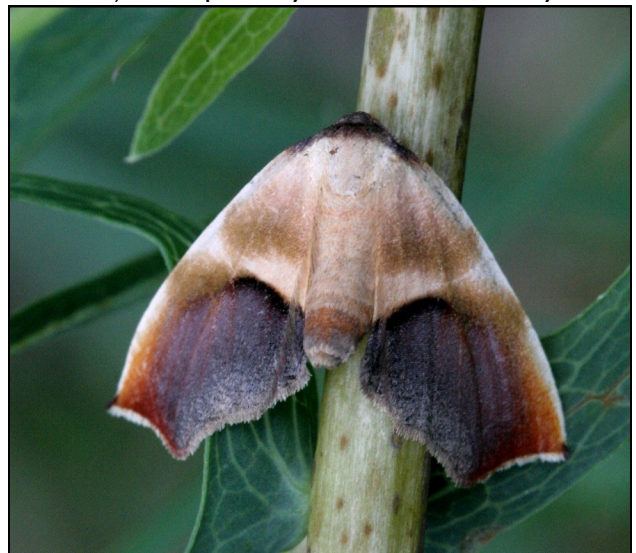


Pete Woods

Splendid palpita

sphinx (*Manduca jasminearum*) and the **great ash sphinx** (*Sphinx chersis*) are both members of the sphinx moth family. The nocturnal equivalent of hummingbirds, they can be found hovering in front of flowers while they drink nectar with their long proboscis. While the adults are pollinators of many flowers, the caterpillars eat only ash leaves.

Grote's swallow (*Copivaleria grotei*) wears shades of gray, often laced with olive green, while the **purple plagodis** (*Plagodis kuetzingi*) has a dramatic purple patch on each forewing. Caterpillars of the **ash tip borer moth** (*Papaipema furcata*) burrow into the young branches of ash trees. One of the earliest collectors of the species said the caterpillars were found in twigs of ash-leaved maple (*Acer negundo*), also known as box elder, but no host but ashes have been reported since, and this report is thought to probably be an error in plant identification. The **fringe tree swallow** (*Symphistis chionanthi*) has reportedly been collected many times in



Megan McCarthy

Purple plagodis

Ash tip borer moth (*Papaipema furcata*)

D. Gordon E. Robertson (Wikimedia Commons)

Pennsylvania, but recently a very similar species (*Sympistis forbesi*) which uses a different host was described for the first time, and the Pennsylvania specimens of this group need to be re-examined so that we can be sure which species is/are really here.

The smaller moths, called micromoths, are generally less studied, and we know less about their distribution. For example, the **ash leaf cone roller moth** (*Caloptilia fraxinella*) is known from states to the north, west, and south of Pennsylvania. This tiny moth is probably here, but has never been documented. The caterpillars use silk to roll up the edge of a leaf into a protective shelter where they live and feed. Bark-mining moths in the genus *Marmara* have caterpillars which excavate long, winding mines in the inner bark of woody plants. There are three species that exclusively use ash trees, and although none have previously been reported from Pennsylvania, they could all easily be here. While I was researching this article, I started looking for these species on ash saplings during my fieldwork. In Crawford County I found the mines made

Mines of *Marmara fraxinicola*

Pete Woods

by one of these species, ***Marmara fraxinicola***, which has no common name. I brought home several stems with mines, and with luck, the adults will emerge in the next several weeks.

Other orders of insects also contain ash specialists in Pennsylvania. The **black-headed ash sawfly** (*Tethida barda*) has a caterpillar-like larva and eats only ash leaves. The **fringetree lace bug** (*Leptoypha mutica*) sucks the sap from ashes and fringe tree. The **ash bullet gall midge** (*Dasineura pellex*) lays its eggs in ash leaves, and the eggs and larvae coax the leaf into growing galls that both feed and protect the larvae until they mature. The **woolly ash aphid** (*Prociphilus fraxinifolii*) spends part of its annual cycle on ash leaves, and then overwinters on the roots of ash trees, where it has a unique symbiotic relationship with a mushroom, the **ash bolete** (*Gyrodon merulioideus*). The bolete creates protective structures to house the aphids, and in return it is able to feed on the honeydew excreted by the aphids. This is probably the only species of mushroom that specializes on ash trees, but there are probably a number of other fungi that are ash specialists. Four species of **ash bark beetle** (*Hylesinus* spp.) occur in Pennsylvania, as well as an uncertain number of other ash-eating beetles.



Hamilton (Wikimedia Common)

Ash bolete is a mushroom threatened by the loss of ash trees.

If EAB continues to spread unchecked and kills all the ash trees in its path, a small mass extinction likely would occur over the next few decades. Similar small mass extinctions probably occur whenever a newly introduced pest or pathogen sweeps across its new host's range and causes mass mortality. For example, chestnut blight (*Cryphonectria parasitica*) caused the extinction of at least five moth species that specialized on American chestnut (*Castanea dentata*), along with an uncertain number of other invertebrates that were

never documented. The American chestnut is beginning to recover with the planting of blight-resistant stands of trees, and this is rightly considered a great conservation achievement, but only generalist insects will populate the chestnut forests of the future; the distinctive fauna that once relied on these trees is mostly extinct.

The threat of each pest or pathogen depends on how much mortality it causes in its host, and the number of species that depend on the host. EAB is worse than most threats, because it kills so many species of host trees so effectively. Just a few of the many threats our forests have faced and are now facing include Dutch elm disease, beech bark disease, hemlock wooly adelgid, and viburnum leaf beetle. The Asian longhorned beetle will surely be in this category if it becomes established, and a new and mysterious disease called beech leaf disease has recently appeared in Ohio and has spread to northwest Pennsylvania. Each of these host plants has a fauna associated with it which is now threatened.



Pete Woods

This green ash (*Fraxinus pennsylvanica*) is one of the "lingering ash" that survived the first wave of beetles.

It is possible to save individual ash trees with injections of insecticides, but this will generally not save the invertebrates on these trees, because the insecticides spread throughout the tree and kill any insect eating any part of the tree. There is anecdotal evidence that the woolly ash aphid is able to survive some insecticide treatments, so this species and its symbiont the ash bolete might be able to survive. The use of insecticides would also benefit any insect species that uses only saplings. The three bark borers are thought to be in this category, generally using trunks less than half an inch in diameter. A small population of mature trees, protected with insecticide, could create a steady source of seeds, and thus seedlings.

In my own neighborhood, where EAB swept through several years ago, I occasionally find an ash tree several inches in diameter, which has managed to survive the initial wave of EAB. These survivors are known as "lingering ash," and it is hoped that their resistance or tolerance to EAB is genetically based, and can be used to breed EAB resistance into the next generation of ash trees. It is possible that these trees are able to support remnant populations of some ash-dependent invertebrates.

Part of EAB's success is due to the fact that it has escaped from the predators, parasites, and pathogens that evolved with it and kept it in check in its native range. Biological control is an attempt to restore this balance by introducing one or more of those agents to the new range of the pest. Although the history of biological control is checkered, modern biological control methods can be safe if the biocontrol agent is tested thoroughly to determine if it is truly specific to the target organism.

Four species of parasitoid wasps from Asia have been approved for use against EAB, and starting in 2011 three of those have been deployed at sites across the commonwealth. One of the wasps attacks EAB eggs, and the other two attack the larvae. The goal is not to stop the initial "killing wave" of EAB, which is considered unavoidable, but to establish and build up populations of the wasps, which will hopefully prevent EAB populations from growing out of control in the future. The biocontrol wasps may not help the survival of ash-dependent invertebrates during the first wave of EAB, but will be critical to recovery of any that survive.

About the Author



Pete Woods has worked for the Pennsylvania Natural Heritage Program as an inventory ecologist for 10 years, conducting field surveys for a wide variety of plants and animals. His current work focuses mainly on invertebrates. Pete received his BS in ecology from Cornell University and his MS in wildlife and fisheries biology from the University of Vermont.

Notes from the Field

Bog Turtle Conservation

In 2015, the Pennsylvania Fish and Boat Commission (PFBC), with cooperating participation from Connecticut, New Jersey, Maryland, and Massachusetts, was awarded funding through the Competitive State Wildlife Grant program for a project directed towards the conservation of the bog turtle (*Glyptemys muhlenbergii*). The project actions included developing a conservation plan, conducting a coordinated population assessment, testing eDNA techniques for detecting bog turtle populations, and implementing priority habitat and population management projects. The overarching objective of this project is to protect and maintain the northern population of bog turtle and its habitat through planning and implementation of conservation actions that will lead to the recovery of the species. The Mid-Atlantic Center for Herpetology and Conservation (MACHAC), working with PFBC, served as the regional project lead, and the Pennsylvania Natural Heritage Program (PNHP), assisted with the conservation planning, population assessments, and data management.



Kathy Gipe

The bog turtle (*Glyptemys muhlenbergii*), a state endangered and federal threatened species, is a victim of habitat loss and illegal collection, some of which can be improved by close population monitoring and habitat management.

In Pennsylvania, record keeping and data management have often been cited as impediments to establishing conservation priorities and baselines for bog turtle sites. PNHP records are maintained in a format that is customized for Heritage program (network) data, but does not easily merge with various other regional bog turtle data sets. Reorganizing and updating the PNHP

bog turtle data set has been a priority for facilitating integration of regional data sets, and will allow USFWS to perform biologically meaningful 5-year species status assessments. Herpetologist, Kathy Gipe, reviewed every bog turtle data record in Biotics in cooperation with data management staff and updated

records where needed. These records are now ready for upload to the regional USFWS database, where even more site and project tracking fields can be associated with each record for better conservation planning and management of sites.

In addition to data crunching in the office, Kathy assisted MACHAC with annual inventory and monitoring surveys for bog turtles within Pennsylvania. This has included identifying known sites where populations are likely to persist to serve as long-term monitoring sites, as well as surveying sites with no prior records for the turtle. Kathy spends several days each fall and spring assisting with bog turtle surveys for these efforts. For fall 2016 and spring 2017, the project team surveyed 17 sites and captured 72 bog turtles; including finding two newly discovered populations. The project funding continues through 2018.



Lori Erb

Kathy Gipe conducting a survey for bog turtles, Pennsylvania's smallest turtle species.

The Curious Case of the Golden Corydalis

Botanists and ecologists are generally intrigued by what types of plants tend to grow in spectacular or otherwise unique habitats on the landscape. For example, when driving along a sheer cliff that overlooks a river, one prevailing thought comes to mind, "I wonder what plants are growing up there?" This question inspired Dr. Scott Schuette (PNHP Heritage Inventory Manager) and Dr. Chris Martine (Bucknell

University Professor of Biology) to collaborate on a project at Shikellamy Cliff overlooking the west branch of the Susquehanna River.

During the week of June 6, 2017, Schuette and Martine coordinated a search for the Pennsylvania endangered golden corydalis (*Corydalis aurea* subsp. *aurea*) that required the rappelling expertise of Charlie Eichelberger (PNHP Terrestrial Zoology Coordinator) and Dr. Jae Cantley (Bucknell University Botanist). This Pennsylvania endangered plant is known only from one existing population on a 360-foot cliff above the confluence of the east and west branches of the Susquehanna River. Several plants were discovered along the lower portions of the cliff due to the help of Warren Abrahamson and Wayne McDiffet from the Merrill Linn Conservancy, who have been observing the population for about 10 years. Interestingly the nearest populations to the one in Pennsylvania are in central New York. How these plants got to central Pennsylvania is the making of an interesting story. While the plants are known from the lower portions of the cliff, there were no surveys for the plants higher up on the cliff, so Eichelberger and Cantley rappelled down the cliff in search of additional plants as a way to determine the population extent of golden corydalis at this site in Pennsylvania.



Charlie Eichelberger preparing to descend the cliffs to search for golden corydalis at Shikellamy State Park.

Scott Schuette



Views of the sheer, east-facing cliff at Shikellamy State park from across the west branch of the Susquehanna River.

Scott Schuette

This work highlights the exciting and excellent conservation work that can be achieved through partnerships between the Heritage program, academic institutions, and conservation organizations throughout the state.

Hope for Dunkard Creek

Nearly eight years ago, a devastating pollution event and algae bloom destroyed the most diverse stream in the Monongahela River drainage - Dunkard Creek. In Pennsylvania waters an estimated 42,997 fish, 15,382 freshwater mussels including the state and federally endangered snuffbox (*Epioblasma triquetra*), and 6,447 mudpuppies (*Necturus maculosus*), the known host for the state endangered salamander mussel (*Simpsonaias ambigua*) were killed. Post-kill quantitative and qualitative assessments of the mussel community in Pennsylvania and West Virginia have recovered only two individuals of a native species, the pink heelsplitter (*Potamilus alatus*) as well as numerous invasive Asian clams (*Corbicula fluminea*). A combination of factors, including the presence of bivalves, improving water quality and recovering host fish populations, motivated the current mussel recovery effort.



Dunkard Creek

Amy Jewitt

Pennsylvania's recovery efforts were initiated following the Pennsylvania Fish and Boat Commission's (PFBC) settlement with Murray Energy in 2015. In late September 2016, biologists from the Pennsylvania Natural Heritage Program and PFBC collected 497 common and rare mussels representing 12 species from the Allegheny River at Hunter Station in Forest County, Pennsylvania for relocation to Dunkard Creek. All mussels were tagged with a passive integrated transponder tag – a unique identifier that helps facilitate individual identification and detection. These tagged mussels were stocked into four Dunkard Creek mainstem sites and a reference site.

In June of 2017, the stocked mussels were monitored to assess survival after one year in their new homes. Results of the monitoring indicated that survival at several mainstem stocking sites was good particularly near the towns of Blacksville, West Virginia (87%), and Mount Morris, Pennsylvania (71%). A stocking site on the Pennsylvania Fork had poor survival (23%) and will not be considered for future restoration efforts. These data suggest that Dunkard Creek mainstem sites are suitable candidates for additional mussel stocking as mussels become available. Future Ohio River basin salvage efforts and mussels propagated by the U.S. Fish and Wildlife Service's White Sulphur Springs National Fish Hatchery will be used to help restore the Dunkard Creek mussel fauna.



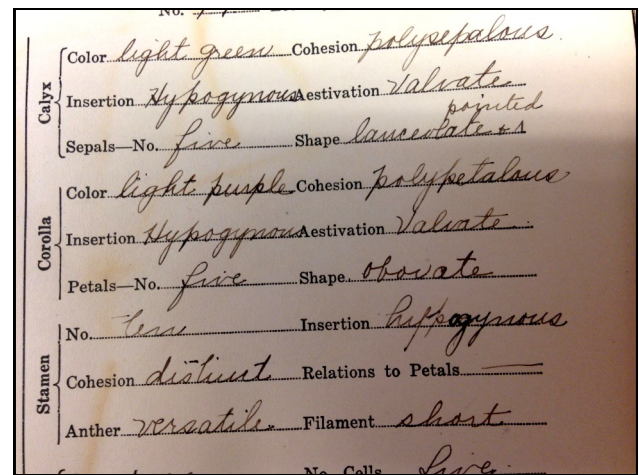
Hunting for tagged Allegheny River mussels in Dunkard Creek.

Amy Lewitt

Botanical Capacity and a Schoolbook Herbarium

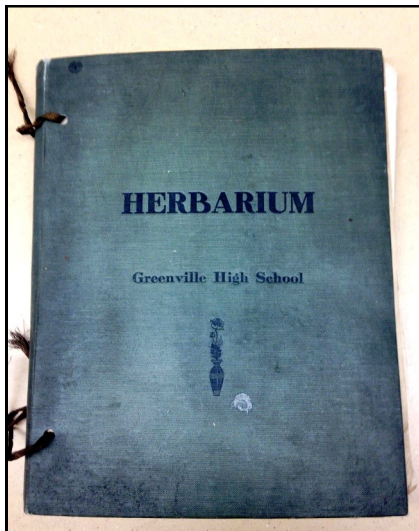
In our botany library at PNHP, we have an old book, bound with ribbon, dated 1917. The title of the book by Nadene McLenahan is *Herbarium*. A publisher did not print this book; a sophomore at Greenville High School in Mercer County made it. Pressed plant specimens

occupy half of the pages. The other pages contain detailed technical information about the species, including drawings of plant parts and schematic representations of floral structures. The book provides us with some perspective about changes in how our society views the importance of botanical knowledge.



If you have not attended a botanical conference in the last ten years, you probably have not been privy to “all the hoopla,” but *botanical capacity* is currently a big issue for professional botanists and ecologists. What does that jargon mean? Botanical capacity refers to the expertise necessary to assess the conservation status of the elements of our native flora, to manage the land in a way that preserves those floral elements, and to train the next generation of botanical experts. Without sufficient botanical capacity, we cannot do a good job of conserving our native flora, and the problem gets more difficult to address the longer that capacity remains insufficient. We in the United States are currently experiencing a critical shortage of botanical capacity (for details, see www.bgci.org/files/UnitedStates/BCAP/bcap_report.pdf).

Perhaps the best way to celebrate the 100-year birthday of this book is by considering the lessons it has to offer. As long as people still cherish nature, botany will never be an outdated science. We usually think of the problem of insufficient botanical capacity in terms of university programs, but perhaps one way to recover



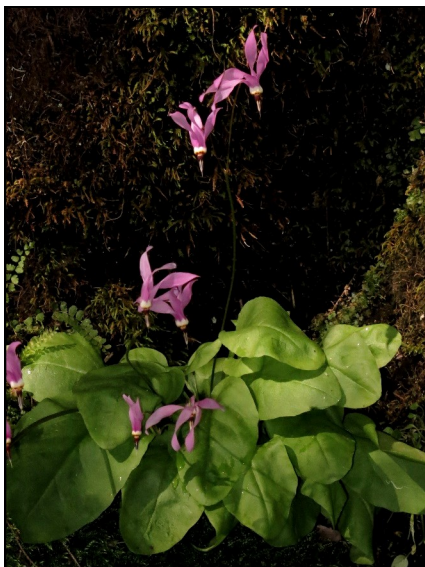
interest levels in institutes of higher education is to focus on getting younger people interested in and knowledgeable about plants. Student herbaria are likely antiquated in the U.S., but perhaps a high school competition to see who can document the most species with

photographs at a web application like iNaturalist would be the modern equivalent.

Nice job making that herbarium, Nadene McLenahan!

Jeweled Shooting-star

The Pennsylvania flora recognizes two species of shooting-star (jeweled shooting-star and common shooting-star) that are morphologically different and have distinct habitat preferences. The habitat for jeweled shooting-star (*Primula fassettii*, formerly *Dodecatheon meadia* var. *amethystinum*), is found primarily in the Susquehanna River drainage on dripping-wet, steep, (often vertical or overhanging) cliffs and bedrock outcrops that occur along river and creek edges. These small-niche habitats usually support lush growths of mosses, liverworts, a few scattered columbines, and other wildflowers. The habitat of common shooting-star (*Primula meadia*, formerly *Dodecatheon meadia* var. *brachycarpum*) is found primarily in the Potomac River drainage and typically consists of rich limestone bluffs and woodlands,



Jeweled shooting star (*Primula fassettii*)

Rocky Gleason

which are shared with a multitude of other species including calcium-loving plants such as chinquapin oak (*Quercus muehlenbergii*), fragrant sumac (*Rhus aromatica*), bladdernut (*Staphylea trifolia*), and green-and-gold (*Chrysogonum virginianum*).

Recent surveys to revisit several occurrences of jeweled shooting-star and common shooting-star have documented that populations are persisting but the quality of the habitats is diminishing. Unfortunately, invasive species have become well established in or near many of these populations, threatening the long-term viability of the species at these locations.



Rocky Gleason

Winged euonymus can form a dense thicket, casting deep shade over the habitat.

In Dauphin County, a survey along several miles of the Wiconisco Creek documented a floodplain and adjacent bluffs seriously infested with dense stands of an introduced shrub commonly used as a landscape ornamental – winged euonymus, also called burning bush (*Euonymus alatus*). A previous survey of this site in the late 1990s made no mention of this species in the field notes or associated plant lists, suggesting a recent explosive expansion of this shrub along the creek. The small cliffs where jeweled shooting-star occurs are becoming overrun by the shrub, creating dense shade and diminishing available habitat. Furthermore, several locations along the creek previously documented as supporting jeweled shooting-star are now covered in winged euonymus and no shooting-star plants were found.

A survey along the Swatara Creek in Dauphin County relocated most of the previously documented population of jeweled shooting-star, but much of the adjacent habitat was choked with English ivy (*Hedera helix*), which was dangling in long, thick strands over the

bedrock cliffs. Another introduced landscape plant, yellow archangel (*Lamium galeobdolon*), has invaded the habitat from the base of the cliff. Although concerted efforts to eliminate this plant from the property have been underway for several years, there has been little success in removing this invasive species from the jeweled shooting-star habitat.

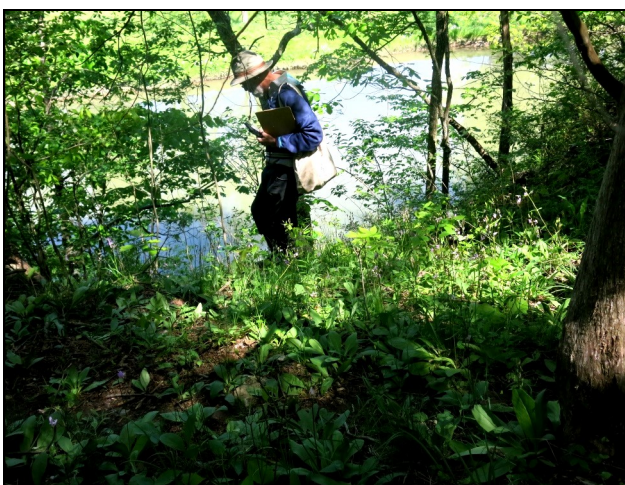


Rocky Gleason

Yellow archangel (*Lamium galeobdolon*) invading the cliff from below.

In Lancaster County, a survey along Chickies Creek found a population of jeweled shooting-star persisting within deep shade cast by overhanging Norway maples (*Acer platanoides*). In addition, lesser celandine (*Ficaria verna*, formerly *Ranunculus ficaria*) was well established along the floodplain and lower slopes of the bedrock outcrop, beginning to occupy the same rock crevices currently hosting the shooting-star.

Along the Potomac-draining Conococheague Creek in Franklin County, a population of common shooting-star was persisting despite the dense competition from numerous invasive species including Japanese



PNHP

Common shooting-star (*Primula meadia*) habitat

honeysuckle (*Lonicera japonica*), amur honeysuckle (*Lonicera maackii*), winged euonymus (*Euonymus alatus*), autumn-olive (*Elaeagnus umbellata*), multiflora rose (*Rosa multiflora*), garlic-mustard (*Alliaria petiolata*), and dame's-rocket (*Hesperis matronalis*). Besides this collection of problematic invaders is the particularly aggressive barren brome (*Bromus sterilis*) – an invasive grass that can quickly colonize and overwhelm a susceptible habitat. In the adjacent woodland, this grass forms a near monoculture beneath the tree canopy.



Rocky Gleason

Barren brome grass forms a near monoculture beneath the woodland canopy.

In most of these surveys, the property owners were aware of the significance of the shooting-star populations on their property and the dangers posed by the spread of introduced plants that have escaped from landscaped gardens. Numerous plants still available for sale in the landscape trade are aggressive invaders that can escape their intended location and quickly overwhelm native plant populations. It is very important to be thoughtful about what plants we introduce into our gardens.

The owners also acknowledged that without some management action to reclaim the habitat from invasive species, many of these populations of species of conservation concern will likely have much reduced long-term viability. The Heritage program is interested in raising awareness of these issues and helping to guide management in areas supporting species of conservation concern. We hope to provide support and encouragement for habitat improvement at these shooting-star populations, as well as many other populations of the most-at-risk species.

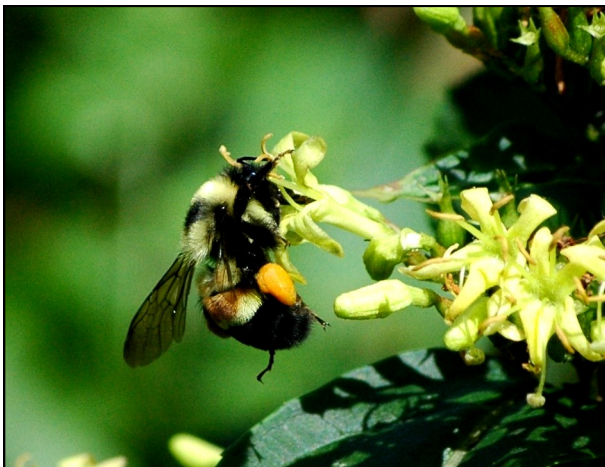
First Bumble Bee Protected under the ESA



Sam Droege
USGS Patuxent Wildlife Research Center Native
Bee Inventory and Monitoring Lab.
Image provided by Smithsonian's National Zoo

Museum specimens provided much of the historical context for the extent and severity of the decline of the rusty patched bumble bee.

On March 21, 2017, the rusty patched bumble bee (*Bombus affinis*) became the first bumble bee to receive protection under the Endangered Species Act. The rusty patched bumble bee formerly ranged from eastern North and South Dakota, east across the Great Lakes to Maine and the southern edges of Quebec and Ontario in Canada, and south to northern Georgia. In the past 20 years, populations of the rusty patched bumble bee have declined dramatically. The U.S. Fish and Wildlife Service (USFWS) completed a Species Status Assessment in 2016 and determined that the number of known populations has declined by 91%, and the overall range has been reduced to 8% of its historical extent. The cause of their decline is likely a combination of factors including diseases and pests spread by commercial bees, habitat loss and fragmentation, pesticides, invasive species, and climate change.

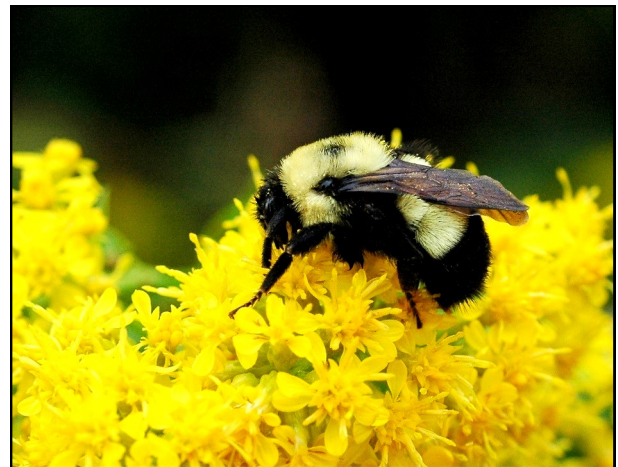


Susan Carpenter
University of Wisconsin—Madison Arboretum

Bombus affinis female workers and males have the name-sake rusty brown patch on the front half of the second abdominal segment. The hair on the back of their heads is mostly black.

There are eighteen species of bumble bee (genus *Bombus*) known presently or historically from Pennsylvania. The rusty patched bumble bee used to be widespread in the state with specimens dating back to the beginning of the 20th century. It was commonly collected between the 1960s and the early to mid-1980s. Sometime after that, populations went into a precipitous decline. The most recent collection in Pennsylvania was of a single worker bee taken in Delaware County in 2006. The rusty patched bumble bee used to be common in a variety of habitats including prairies, grasslands, marshes, agricultural areas, residential parks, and gardens usually in close proximity to woodlands. Interestingly some of the last known populations of the rusty patched bumble bee are in urbanized areas around Minneapolis/St. Paul, Madison, Milwaukee, and Chicago. Locations protected from pesticides that produce a variety of flowering plants throughout the growing season and provide suitable nesting and overwintering sites can provide vital habitat for pollinators in both wild and developed landscapes.

Identifying bumble bees requires patience and careful observation. Some bee species exhibit variety in their markings and the male, worker female, and queen bees may have unique markings as well. Specimen collections provide permanently preserved examples of individuals that are necessary in studies of species diversity, life history, and conservation status. Data from museum collections were instrumental in assessing the status of rusty patched bumble bee and other declining species. The Academy of Natural Sciences of Drexel University in Pennsylvania houses the type specimen that was used for the original scientific description of *Bombus affinis*. Ezra Cresson who was an entomologist at the Academy



Susan Carpenter
University of Wisconsin—Madison Arboretum

Queens are similar to workers but are larger in size and lack the rusty patch on the abdomen. This female is a fall gyne. She will become a queen the following spring when she establishes her own colony.

formally named the species in 1863. An image of the type specimen is viewable at <http://www.anspblog.org/first-bumblebee-on-endangered-list/>

The USFWS website for this species includes links to the comprehensive Species Status Assessment, a map of the current and historical range, and guidance for researchers, citizen scientists, land owners, and land managers interested in bee conservation and the implications of endangered species status for project reviews and surveys (<https://www.fws.gov/midwest/endangered/insects/rpbb/index.html>). A twenty minute documentary called 'A Ghost in the Making: Searching for the Rusty-patched Bumble Bee' uses stunning photography to illustrate the story of the rusty patched and other bumble bees (<http://www.rustypatched.com/>). The Xerces Society provides a wealth of information on bee identification, life history, habitat management, and other related conservation topics. Their page on the rusty patched bumble bee is viewable at <https://xerces.org/rusty-patched-bumble-bee/>. The Bumble Bee Watch program (<https://www.bumblebeewatch.org/>) works with citizen scientists to identify and document bumble bee populations in North America and provides the data for conservation efforts.

Vernal Pool and Herp Surveys in State Parks

During the spring, JoAnn Albert, Charlie Eichelberger, Betsy Leppo, and Ryan Miller completed vernal pool and herpetofauna surveys in eight state parks across the commonwealth for a WRCP grant. We held a vernal pool assessment training at Cook Forest State Park with Clarion University (which is a partner for this grant). We located and mapped 60 vernal pools and assessed them for overall health and quality. Several



Ryan Miller discusses vernal pool management with park manager Bill Wasser at Goddard State Park.

JoAnn Albert

high quality vernal pools were located with fairy shrimp, spotted and Jefferson salamander, and wood frog indicator species. We also conducted surveys in the selected state parks for reptiles and amphibians. Species of note that we discovered in the parks were wood turtles, spotted turtles, timber rattlesnakes, coal skinks, and queen snakes. Park managers will receive a series of recommendations and BMPs tailored to protect and enhance vernal pool habitats and upland habitats of the species of concern that were found.



JoAnn Albert

Heritage staff surveying a state park vernal pool complex.

Mixed Mesophytic Forest

As part of our effort to update the terrestrial portion of the Pennsylvania Plant Community Classification *Terrestrial and Palustrine Plant Communities of Pennsylvania*, PNHP ecologists are scouring the landscape for high quality examples of rare communities. We are recording plant species composition and ecological data (like soils, topography, and landform) to better describe our upland forests, woodlands, and grasslands. Heritage ecologists are re-examining areas identified in the County Natural Heritage Inventory reports as having occurrences of high quality or uncommon communities.

One extremely rare type in Pennsylvania is the Mixed Mesophytic Forest community (S1, G4), which is limited to the southwestern counties in Pennsylvania. This forest community barely extends into Pennsylvania, but is common in West Virginia, Kentucky, Ohio, Indiana, and Tennessee where it is found in rich, mesic coves and lower slopes of the Ohio River Valley, characterized by deep soils, often below outcrops of limestone, dolomite, and calcareous sandstone. The overstory of this "edge of Appalachia" forest is diverse, containing sugar maple, tuliptree, oaks, basswood, ash,



Ephraim Zimmerman

Goldenseal

hickories, and yellow buckeye. A number of uncommon shrubs, such as leatherwood, pawpaw, and bladdernut, make up the understory. The ground-flora, influenced by the moist, calcareous soils, is comprised of water leaf, wild ginger, blue cohosh, Virginia bluebells, twin-leaf, trilliums, goldenseal, and ramps.

It is sometimes difficult to tell the Mixed Mesophytic Forest community from other diverse forest communities, such as the Sugar Maple – Basswood Forest community, which is a much more common community type in Pennsylvania. The overstory of the sugar maple forest is much less diverse and yellow buckeye is conspicuously absent. Another difference between the Mixed Mesophytic Forest and the more common Sugar Maple – Basswood are the soils supporting the two communities. The soils supporting the Sugar Maple – Basswood Forest are often shallower, drier, and lower in pH, which is usually around 5.5-6.0, whereas the Mixed Mesophytic Forest is often found on soils that have a pH of 7.5 – 8.0.

In Pennsylvania, the Mixed Mesophytic Forest community has only been recorded at one location in Pennsylvania by PNHP, at Mason-Dixon Park, situated along Dunkard Creek near Mt. Morris, Pennsylvania on the border with West Virginia. It is suspected to occur at several other locations in Greene and Fayette counties including areas on public land. Large-scale logging and conversion of this community type for agriculture and strip-mining have greatly reduced this community type's extent. Heritage ecologists and botanists are working to identify remaining locations of this uncommon, diverse community along with records of associated rare plants as part of the 10-county update for the Southwest Pennsylvania Region County Inventory Update.



Ephraim Zimmerman

Mixed Mesophytic Forest

Measures of Progress

The following Measures of Progress represent a significant cross-section of results of the work that we do as a program. These measures will be reviewed and updated, as needed, to best reflect the activities and goals of PNHP. Progress for these measures reflects seasonality of program activity.

Measure of Progress	Annual Goal (2017)	1st Quarter	2nd Quarter	Cumulative Total	Percent of Annual Goal
Biotics Records Updated	300	137	207	344	100%
New EOs Documented	800	234	286	520	65%
New Records Entered into PACE	350	0	0	0	0%
Field Surveys Reported	300	76	104	180	60%
New CPPs Developed	400	275	228	503	100%
NHAs Updated	150	0	0	0	0%
Sites Actively Monitored	35	0	0	0	0%

PNHP performs many functions and provides many services as part of its mission. The measures of progress that are detailed here are meant to capture a number of important program activities and provide a picture of our progress in achieving our essential goals. The program goals and the measures provided for those goals will change over time as we complete certain aspects of our work and as new program responsibilities arise.

Biotics Records Updated indicates the amount of activity expended in improving and updating the more than 20,000 records in the PNDI database.

New EOs Documented is a way to measure the success of our inventory effort in finding new occurrences of elements of ecological concern (plants, animals, and exemplary natural communities). Biotics records are created for each new Element Occurrence documented.

New Records Entered into Pennsylvania Conservation Explorer (PACE) indicates our level of activity in reviewing, quality controlling, and entering biotics records into the environmental review data layers. The timely and consistent refreshment of these data are critical to providing protection to the state's species of greatest concern.

Field Surveys Reported is a strong indicator of the effort expended on one of the basic functions of the program – inventory of the state's flora and fauna. Every field visit results in the entering of a field survey, regardless of the outcome of the survey.

New Conservation Planning Polygons (CPPs) Developed is a measure of our progress in creating ecological based mapping for the species and natural communities that we track as part of the PNDI database. Our goal is to have CPPs for all species and communities that we track.

NHAs Updated is a measure of our effort in developing, mapping, and describing sites (Natural Heritage Areas - NHAs) that are important to conservation of Pennsylvania's biodiversity. This process began with County Natural Heritage Inventory projects and will now continue at a statewide level with the updating of existing sites and the creation of new sites. Site polygons will be based upon and consistent with CPPs.

Sites Actively Monitored indicates how many established geo-referenced plots that we visited and sampled. These sites allow us to collect data on structure, species composition, and physical context (soils, hydrology, etc.) in a systematic way and by following the same protocols to directly compare future data to previous data.