Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

WILD HERITAGE NEWS

Fall 2022

Inside This Issue

Photo Banner:
Algerine Swamp at dawn

David Yeany

Tracking Changes in Pennsylvania's Peatlands

by

Mary Ann Furedi, Ecological Assessment Manager

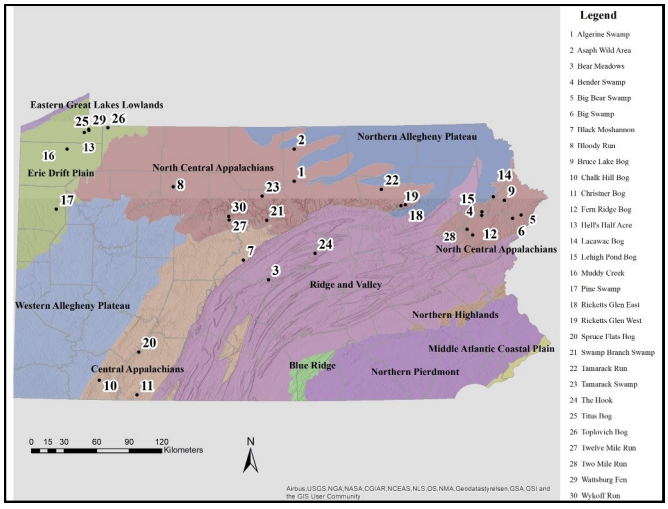
Pennsylvania Natural Heritage Program (PNHP) biologists document rare species and plant communities, and they investigate how and why these elements change over time. How are these species impacted by the spread of invasive species and climate change? Monitoring is one tool we use to help answer these questions. By conducting repeat visits to sites, we can track the health of populations and habitats and identify potential threats. This information provides greater insight into the dynamics of Pennsylvania's natural resources and the opportunity for more proactive responses to population declines and threats.

The peatland monitoring project is a great example of a multi-disciplinary monitoring effort being conducted by PNHP staff. Peatlands represent a unique group of wetlands in Pennsylvania. This broad class of wetlands includes bogs, fens, seepage wetlands, and some forested wetlands. Peatlands are defined by the accumulation of a layer of organic matter that forms under water-logged conditions (a.k.a. peat). This layer of peat offers high carbon storage capacity in these wetland systems. While peatlands occur globally, they are most common in cooler environments. In Pennsylvania, peatlands are found in the glaciated regions of the state and at high elevations in the Appalachian Mountains. The cooler climate at high elevations provides habitat for northern-affiliated plants and communities, many of which are state-listed, whose southernmost range extends into Pennsylvania. Pennsylvania peatlands exist as pockets of boreal refugia and provide habitat for some of our uncommon bird species and invertebrate specialists.

Mary Ann Furedi

A view of the floating bog mat at Promised Land State Park.

Like most wetlands in Pennsylvania, peatlands are under threat from a variety of sources, many directly related to human activities. Development, both in peatlands and the surrounding landscape, has contributed to peatland loss and degradation. Drainage and filling for agriculture and land conversion have reduced peatland area and altered hydrology. Surrounding land use has contributed to the pollution of these areas and further hydrological alteration. The spread of invasive species into these systems has interrupted the balance of species and resulted in biological losses. Climate change is exposing these communities to higher temperatures, changes in precipitation patterns, and an increase in extreme weather events; all factors that will likely alter the environmental conditions that support the unique biological assemblages found in these wetlands.



The locations and names of the 30 peatland sites included in this monitoring effort.

Given the biological importance of peatlands and their vulnerability to climate change and other anthropogenic stressors, PNHP biologists began an effort to better understand these systems in Pennsylvania. In 2010 and 2011, we established a long-term monitoring network of 30 sites, mostly on public lands. The initial focus was to establish permanent plots and transects in target plant communities to document current conditions and then revisit these monitoring units in the future to track change over time. We also included a census of target plant species, like bog-rosemary (*Andromeda polifolia*) and black spruce (*Picea mariana*), that were deemed extremely vulnerable to climate change based on NatureServe's Climate Change Vulnerability Index (CCVI). At each site, we were interested in collecting baseline data to examine changes in plant community structure and composition, shifts in plant communities within sites, and whether the climate change vulnerable species were declining and what was replacing them.

Mary Ann Furedi

Bog rosemary (*Andromeda polifolia*) is a target monitoring species for the project.

Mary Ann Furedi

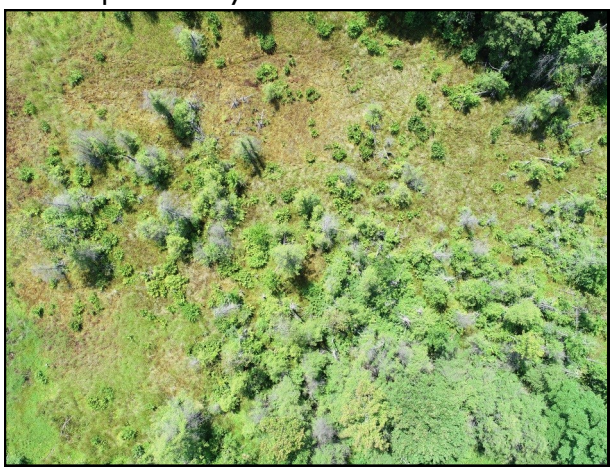
Our team of ecologists sampling a Cotton-grass Poor Fen community.

From 2016 to 2019, we returned to the 30 sites to conduct a second round of monitoring. In addition to resampling the original target plant species and plant communities, we added inventories of bryophytes, birds, and flying insects. This additional effort provided more comprehensive baseline data for the sites. Additionally, some species in these taxonomic groups are indicators of high-quality peatland habitat that serve as excellent barometers of change within these systems and provide useful future monitoring metrics.

Using data collected in the plant community plots, we found that no community level shifts had yet been detected at any of the sites. The plant communities identified during the first round of sampling were still the same during the second visit in 2016-2019. This wasn't surprising given that only five to seven years had passed between visits.

Although we did not detect overall changes within our plant communities of interest, at nine of the 30 sites, we documented newly dead (dead since the visits in 2010-2011) and dying trees that were considered important components for those community types. At one northwestern site where a monitoring plot was established in a Red Maple – Black Ash (Hemlock) Palustrine Forest, most of the black ash (*Fraxinus nigra*)

were either dead and dying due to emerald ash borer (*Agrilus planipennis*). The dead and dying trees at the other eight sites were all conifer species and included hemlock (*Tsuga canadensis*), tamarack (*Larix laricina*), red spruce (*Picea rubens*), and black spruce (*Picea mariana*). Most of these sites were located in the Pocono region of the state. This was an alarming trend, and we will continue to monitor the health of trees at our sites during future visits. The reduction or loss of these keystone species would alter the plant communities at our sites and could have a negative cascade effect on the other flora and fauna that depend on the ecological services provided by the trees.



Brad Georgic

Arial imagery taken with a drone that shows some standing dead trees and browned out cranberry (in the upper left corner) at one of the monitoring sites.

For our target species monitoring, no significant changes were seen in the target plant populations except for one site. At one of our northwestern sites, Cotton-grass Poor Fen is one of the dominant communities where cranberry (*Vaccinium macrocarpon*) is very abundant. When we visited the site in 2018, we noted that cranberry plants were very brown and crispy as if severely desiccated although the sphagnum carpet was saturated. The loss of cranberry at this site would certainly alter the community composition and have cascade effects on other species that use cranberry (e.g., cranberry is the primary host plant for some invertebrates). We will continue to monitor the health of cranberry at the site during future visits.

We systematically sampled bryophytes at the 30 peatland sites to document dominant bryophyte species as well as identify any species of conservation concern. We were able to greatly improve on the inventory and documentation of bryophytes given the addition of Scott Schuette, PNHP bryologist, to the monitoring team. In fact, much of what we now know about

Mary Ann Furedi

Scott Schuette demonstrating the species of sphagnum found on a small hummock.

bryophyte diversity and distribution in peatlands in Pennsylvania is the direct result of this project. Scott identified a total of 93 bryophyte species across the 30 sites. An exciting outcome of this baseline monitoring work was that Scott identified and documented rare, threatened, and endangered bryophyte species at almost every peatland site. For example, he documented two mosses, *Isopterygiopsis pulchella* and *Plagiomnium medium*, in Erie County that had not been collected there in more than 100 years!

Mary Ann Furedi

David Yeany identifying an interesting bird at Tamarack Swamp.

David Yeany, PNHP avian ecologist, led the extensive effort to document bird usage of peatlands in Pennsylvania. Bird surveys were conducted across 390 point count locations which included the 30 long-term monitoring sites and an additional 20 peatland sites. He recorded 110 bird species across all sites and detected 21 of the 22 peatland indicator birds. Thirty-one bird Species of Greatest Conservation Need (SGCN) were observed across sites which accounts for nearly 35% of all bird SGCN in Pennsylvania. David recorded detections for 18 bird species of conservation concern

that are tracked by PNHP. To give an example of one of his many exciting finds, the PA Endangered yellow-bellied flycatcher (*Empidonax flaviventris*) was detected at three sites. His surveys yielded the first discovery of a yellow-bellied flycatcher breeding pair in western Pennsylvania in at least 30 years!

David Yeany

The PA Endangered yellow-bellied flycatcher is a specialist of red spruce and hemlock peatlands and one of the rarest breeding birds in Pennsylvania.

A tremendous amount of effort on the part of Betsy Leppo (PNHP invertebrate zoologist) and Pete Woods (PNHP inventory ecologist) went into all aspects of the invertebrate surveys. From the results of the daytime transect surveys and nighttime blacklight surveys, they found at least one species of interest (which includes insect peatland indicators, SGCN species, or other species of concern) per site, with most having far more. They found that sites with more of a mixed matrix of plant communities and areas of open water had the greatest species diversity due to the assorted habitats available for insect use.

Betsy Leppo

Silver-bordered fritillary (*Boloria selene*)

They too had numerous exciting discoveries during the course of their inventory work. One of their most surprising finds was the silver-bordered fritillary (*Boloria selene*), an imperiled butterfly species considered to have a high affinity for peatlands. It was last reported in one of our western Pennsylvania sites in 1978 and was documented again during the site visit in 2016!

Peatlands not only provide numerous ecological functions such as water and carbon storage but are also biologically diverse. The findings from our inventory efforts provide overwhelming evidence for the multi-faceted importance of peatlands in Pennsylvania. Given that we have already begun to see changes at some sites means that it is imperative to continue monitoring and work to further protect and conserve these biological hotspots in our state. Our goal is to continue this work and collaborate with partners throughout the northeastern United States to examine changes in these unique wetlands.

This research is supported through a U.S. Environmental Protection Wetland Program Development Grant (CD-963295-01-PA DCNR) and the Pennsylvania Department of Conservation and Natural Resources.

About the Author

Mary Ann has worked with the Pennsylvania Natural Heritage Program for 15 years as a community ecologist and currently serves as the Ecological Assessment Manager. She received her B.S. in Biology from Fairleigh Dickinson University and her Ph.D. in Biology from West Virginia University. Her projects generally focus on characterizing the current conditions of natural systems in Pennsylvania and understanding how these systems change over time.

Climate Change Vulnerability of Plants in Pennsylvania

by

Scott Schuette, Botany Manager

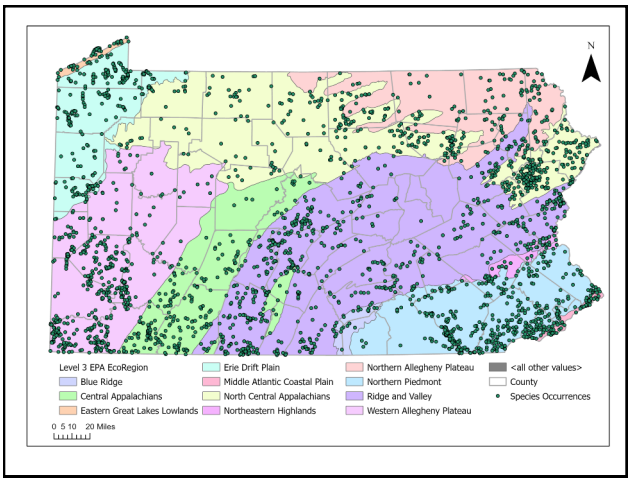
Scott Schuette

Water avens is highly vulnerable to climate change due to projected changes to water availability. This plant grows in calcareous wetlands, a group of plant communities of conservation concern.

Climate change in Pennsylvania is contributing to changes in ecosystem structure, shifts in species ranges, and changes to the timing of plant growth and flowering. These changes disrupt how and when organisms interact within an ecosystem and can lead to inefficient pollination, fruit production, and altered seed dispersals. Among the most prevalent changes are increased temperatures and erratic precipitation events. When compared to baseline climate data from 1971 to 2000, the average annual temperature is projected to increase by 5.9˚F by the middle of this century. According to the 2021 Pennsylvania Climate Impacts Assessment, temperatures are expected to reach 90˚F or more an average of 37 days per year, a significant increase from the five days per year during the baseline period. Likewise, during the same timeframe, Pennsylvania has seen an 8% increase in average annual precipitation. This is due in large part to increased frequency, magnitude, and intensity of heavy rainfall events. Many of these events happen outside of the historical spring and fall wet seasons and lead to flooding events that disrupt plant and animal interactions and life cycles. These extreme wet periods are often followed by long periods of drought putting additional distress on the flora and fauna of Pennsylvania. This is especially problematic for wetland ecosystems where there is expected to be a net drying effect even with increased temperature and precipitation throughout the state.

These gradual, yet dramatic changes, will lead to alterations to the growing season and likely impact the phenology of many plant species, result in potential shifts of species ranges, and localized extirpations in habitats with narrow climatic tolerances. The development of an effective adaptation and mitigation strategy requires that we have a baseline understanding of those species and ecosystems most likely impacted by, and vulnerable to, changing climate.

As a way of understanding species vulnerability, NatureServe developed the Climate Change Vulnerability Index tool (CCVI). This useful tool provides a rapid assessment of direct and indirect factors, sensitivity and adaptive capacity factors, and documented and modeled responses for each species. In 2011 PNHP used an early iteration of this tool to assess edge of range plant and animal species as well as plants from high elevation wetland habitats. In that study, 60% of the 40 plant species were considered highly to extremely vulnerable. Those results led DCNR to adopt long-term monitoring studies in several different habitats, including high elevation wetland habitats identified most vulnerable to climate change. The number of plants assessed represented a very small fraction of the flora, and DCNR sought additional CCVI assessments to help inform plant species conservation.



Map of element occurrences for all species analyzed showing coverage in all Level 3 EPA Ecoregions.

We employed the CCVI tool for two recently completed projects assessing the vulnerability of an additional 120 plant species to climate change in Pennsylvania. The species were selected based on their range edge in the state, their current conservation rank, and inclusion in DCNR regulatory status updates. In addition to the species vulnerabilities, we identified macrohabitats and mesohabitats within Level 3 EPA Ecoregions of vulnerable species to provide guidance for landscape-level recommendations. Nearly 3,300 data points were assessed for the 120 species across four

climate variables: 1) Predicted change in temperature, 2) Available annual moisture (Hamon AET:PET moisture index), 3) Historical Thermal Variation, and 4) Historical Precipitation Variation. The data points covered the extent of the state and all Level 3 EPA Ecoregions. However, some regions had more data points than others; others were tightly clustered within specific habitat types within the ecoregions. Using these species datapoints we were able to identify the ecoregions likely to experience drier conditions under moderate climate change scenarios. These include the Western Allegheny Plateau, Central Appalachian Mountains, the Ridge and Valley, and the Blue Ridge ecoregions. The wetter ecoregions include the North Central Appalachian Mountains, the North Allegheny Plateau, and Erie Drift Plain.

A majority of the plants assessed (71 of 120) scored highly to extremely vulnerable to climate change with an additional 20 species scoring moderately vulnerable. There were clear patterns as to the spatial distribution of the species with regard to their range edge and degree of vulnerability. Southern edge of range species were more likely to be extremely vulnerable than northern edge of range and core range species (Figure 1). Within macrohabitat types, palustrine habitats had more extremely vulnerable species than terrestrial, riparian, and lacustrine habitats. Terrestrial habitats had more highly vulnerable species than palustrine, riparian, and lacustrine habitats (Figure 2).

Regarding the range edge of the assessed species, wetland species in the northern tier of Pennsylvania and terrestrial species in the southern tier of Pennsylvania have the highest vulnerabilities to changing climate conditions (Figure 3). It's plausible that the different types of wetland and terrestrial species within those tiers are at greater risk of localized extirpations and will need to shift their ranges in response to increasing inhospitable habitats. Table 1 (page 7) highlights the different habitats most impacted by changing climate due to the number of vulnerable species and their geographic range edge. The salient message from this table is that calcareous habitats, whether terrestrial or wetland, are at higher risk of rapid species shifts and need to be prioritized for monitoring and conservation. The same is true for natural wetland types in the northern part of the state. Fortunately, PNHP has an established long-term monitoring study for 30 high elevation wetlands ranging from acidic bogs to calcareous fens that are primarily in the northern half of the state.

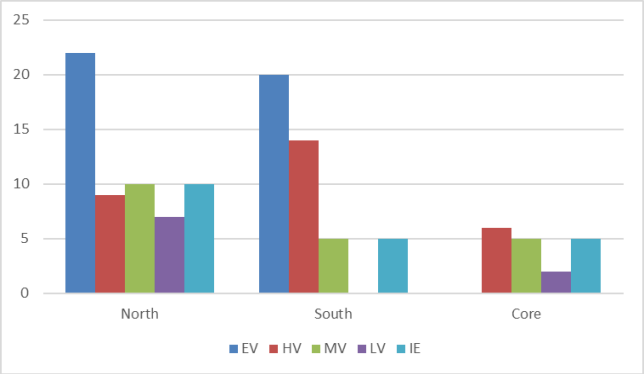


Figure 1: Cumulative species vulnerabilities by the geographic range edge. X-axis represents the range edge groups and the Y-axis represents the number of species scored as extremely vulnerable (EV), highly vulnerable (HV), moderately vulnerable (MV), least vulnerable (LV), and insufficient evidence (IE)

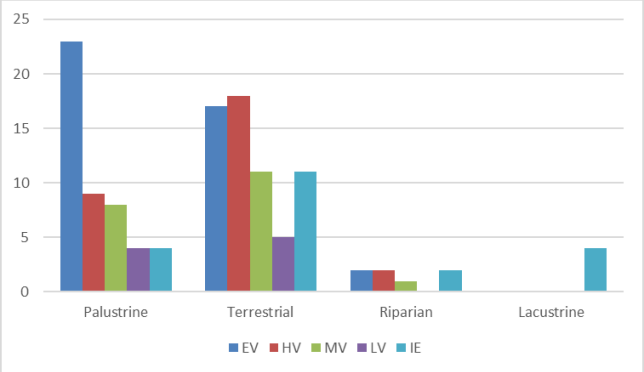


Figure 2: Cumulative species vulnerabilities by macrohabitat association. X-axis represents the groups of macrohabitats and the Y-axis represents the number of species scored as extremely vulnerable (EV), highly vulnerable (HV), moderately vulnerable (MV), least vulnerable (LV), and insufficient evidence (IE)

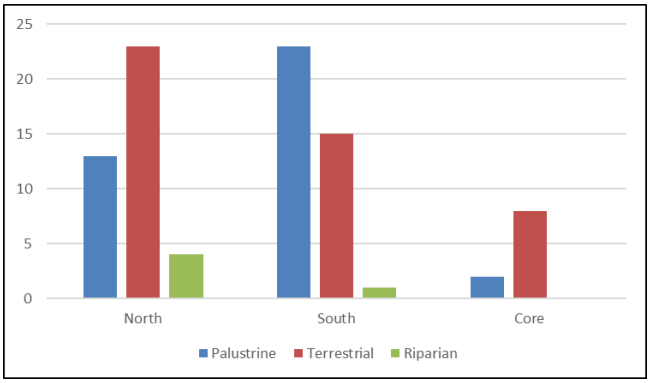


Figure 3: Comparison of species vulnerabilities in palustrine, terrestrial, and riparian habitats with respect to the species range edge. X axis represents the range edge group and the Y-axis represents total number of species that scored moderately, highly, and extremely vulnerable.

Our results are consistent with the results from the 2011 study and brings the total number of plants assessed for climate change vulnerability to 160 with 72% of those species being at risk to climate change impacts. Among the adaptive capacity variables for each species, the barriers to movement, dispersal ability,

hydrological niche, restricted habitat, pathogens, and competition, were the most important factors in increased vulnerability. For example, species that grow in habitats that historically had very little variation in annual precipitation such as shale barrens, limestone cliffs woodlands, and outcrops are very likely to see declines due to the increased frequency of precipitation events. Likewise, species that are dependent on narrowly defined hydrological regimes are highly vulnerable to loss or reduction due to lower moisture availability in drier regions of the state. In wetter regions species declines will be attributed to inundation, as well as increased water table levels, alterations to the hydrological cycle, and the associated impacts to water chemistry and species competition.

Climate change is impacting our natural environment and shifting the landscape of plant communities in Pennsylvania. Rare plants are likely to have increased competition from both native and non-native species that could lead to localized extirpations. As climate shifts, plants that are adapted to a wider range of conditions will have a competitive advantage over those with narrower environmental niches. Although predictions suggest that there will be increased precipitation in some areas of the state, other areas will have lower available moisture due to temperature increases that drive plants to absorb and release water at higher rates. This leads to an overall net drying effect of wetlands in the state that will increase the physiological stress in wetland species, especially those from calcareous wetlands. Interior forested wetlands such as vernal pools, seeps, swamps, and peatlands rely on canopy cover to reduce rates of water loss through temperature mediation. Loss of forest cover would accelerate the drying process and lead to rapid changes in vegetation cover.

Climate change was historically a relatively slow process. However, the rate of change is accelerating. The good news is that with a better understanding of how species are responding to changing climate, through empirical research we can work to develop effective management strategies including maintaining and/or enhancing genetic diversity within and among populations, preserving connected landscapes, increasing the number and size of contiguous habitat refugia, and employing assisted species migration when appropriate. For some of our rarest communities and species such as those associated with limestone and mafic geologies, very targeted conservation approaches will be needed. In addition to conserving habitats in rare geologies, it is crucial that we maintain healthy forest buffers around watersheds and healthy, functional watersheds especially around climate change vulnerable wetlands.

About the Author

Scott has worked with the Pennsylvania Natural Heritage program for 11 years as an inventory botanist and bryologist. He currently serves as the Natural Heritage Botany Program Manager at Western Pennsylvania Conservancy. He received his PhD in Plant Biology from Southern Illinois University. His projects focus on rare plant inventories, climate change impacts to plant species, and bryophyte inventory and conservation.

Terrestrial		Palustrine	
North	South	North	South
Rich Cove Forests	Cool Rocky Northern Hardwood Forests	Calcareous wetlands	Acidic Wetlands
Calcareous Outcrops & Cliffs	Calcareous Woodland		Calcareous Wetlands
Rich Bottomland Forests	Rich Bottomland Forest		Cool Forested Wetlands
Calcareous Forests	Calcareous Dry Rocky Forests		Mesic Forests
Shale Barrens	Shale Barrens		Swamps

Table 1: Macrohabitat and mesohabitats most impacted by changing climate based on geographic range edge.

Notes from the Field

Invertebrate Discoveries

Pete Woods, Inventory Ecologist

When working at Presque Isle State Park in Erie County, PNHP biologists have been looking at insects on hoptrees (*Ptelea trifoliata*) and for the third year in a row, we found a Pennsylvania state record moth on the trees. This year it was the hoptree leafroller moth (*Agonopterix pteleae),* whose caterpillars make a living by, as you may have guessed, rolling the leaves of hoptree into protective little tubes. They then reach out from both ends of the tube to munch on the adjacent leaf surface. Our biologists collected a number of these caterpillars, and fed them fresh hoptree leaves until they pupated, and a few weeks later they emerged as adult moths. These moths are common on Presque Isle, which has Pennsylvania's only large population of hoptree. As far as we know, this is the first time they have been documented in the state with photos and specimens. As a specialist that uses a rare species as its only host, this will be a species of conservation concern for Pennsylvania. Much smaller populations of hoptree are scattered along the Erie coast of Pennsylvania, and in future surveys we hope to determine if this moth lives in any of those. This was the last of the specialist moths we had hoped to find on hoptree, but if we find the hoptree bark beetle (*Phloeotribus scabricollis*) next year, we will let you know.

Pete Woods

A hoptree leafroller moth on spearmint flowers

Pete Woods

Birds would like to prey on hoptree leafroller caterpillars, but the leafrolls they construct make them difficult to reach.

In the spring we collected some caterpillars on yellow buckeye (*Aesculus flava*) in Washington County, Pennsylvania. The caterpillars soon finished feeding and dug into the soil to pupate. The first of the moths emerged recently, and confirmed our suspicion that this was the buckeye pinion moth (*Lithophane joannis*), which, as far as we know, has not been found in Pennsylvania before. Although this is a first for the state, it is probably not a rare species here. These moths are not attracted to lights, so they can easily go undetected. They might even be quite common in the southwestern counties of Pennsylvania where yellow buckeye grows. On the same survey, biologists documented a four-spotted angle moth (*Trigrammia quadrinotata*), another specialist on buckeye, which has only been found several times in Pennsylvania.

Pete Woods

Buckeye pinion caterpillars hatch in the fall, and overwinter as caterpillars, so they are ready to complete their development on the tender spring leaves.

This summer PNHP biologists found an interesting gall on flower buds of mountain bugbane (*Actaea podocarpa*). The gall is made by a fly, and the species is probably new to science. Please keep your fingers crossed as we try to rear adult flies from these galls so we can work toward describing this species.

A Thousand Invertebrates Get Some Love

Betsy Leppo, Invertebrate Zoologist

The Pennsylvania State Wildlife Action Plan (SWAP) was last revised in 2015, and will be updated again in 2025. This provides an opportunity to revisit the conservation status of wildlife in Pennsylvania, including invertebrates. There are more than 11,000 invertebrate species believed to occur in Pennsylvania, and about 750 of them have been assessed for conservation status using the standardized ranking methodology developed by NatureServe. Species assessments typically examine the known distribution and number of occurrences for each species in the state or region, threats to those occurrences, and short- and long-term population trends. Many invertebrate groups lack basic presence/absence data for the state. While there is often existing data that can be utilized, it is associated with specimen labels and other non-digitized formats that are not readily accessible.

Pete Woods

The white-lipped ornamented jumping spider (*Habronattus cognatus*) uses habitat with loose sand and sparse vegetation, an uncommon habitat type in Pennsylvania.

PNHP received a State Wildlife Grant and a Wild Resource Conservation Fund grant to fuel an effort to gather, digitize, and analyze information for conservation assessments. We will use these grants to explore untapped information for invertebrates, with an emphasis on pollinator groups such as flower flies, bees, wasps, longhorn beetles, and moths. We will assess species from other diverse terrestrial and aquatic taxonomic groups such as craneflies, mayflies, caddisflies, stoneflies fireflies, ladybugs, ground beetles, fairy and clam shrimp, and grasshoppers, crickets and katydids, and spiders. The 399 invertebrate Species of Greatest Conservation Need (SGCN) included in the 2015 SWAP will also be reviewed and updated as necessary.

Betsy Leppo

The seaside grasshopper (*Trimerotropis maritima*) needs sandy shores, which are in short supply in Pennsylvania.

We will work collaboratively with various taxonomic experts along with Pennsylvania's two largest natural history museums (Academy of Natural Sciences of Drexel University and Carnegie Museum of Natural History), and our largest state university system (Penn State University). Our goal is to complete conservation assessments on over 1,000 invertebrate species that were not previously evaluated, and gather data on many more. Information on species determined to be SCGN will be entered in a comprehensive database for the Pennsylvania SWAP, along with recommended conservation actions, which will eventually feed into the Pennsylvania Conservation Opportunity Area Tool. We are seeking additional funding to round out this ambitious effort and are very happy to give Pennsylvania's invertebrates some much needed love and attention.

Limestone Cliff Updates

Rachel Goad, Botanist

Sites with limestone outcroppings are known to host interesting plant species. One site in Bedford County hosts a bevy of special plants that have been the focus of research by PNHP and others. Last year, PNHP received funding to support removal of invasive pests to protect the quality of the site and its populations, and to develop better population monitoring methods for Canby's mountain lover (*Paxistima canbyi*). This year, we are extending this work to include genetic assessment of Canby's mountain lover with the addition of academic partners from Bucknell University.

PNHP is collaborating with Bucknell University's Dr. Chris Martine and Dr. Tanisha Williams, postdoctoral researcher Dr. Melody Sain, and new graduate student

Isaac Buabeng to investigate population genetic factors and any resulting conservation implications for Canby's mountain lover at this and other special sites in Pennsylvania. For its part, PNHP will assist the team in obtaining plant material for genetic analysis and will provide training to students on standard conservation methodology, including NatureServe's Core Methodology, Rank Calculator, and Climate Change Vulnerability Index tools.

Rachel Goad

Dr. Melody Sain (left) and PNHP Ecologist Claire Ciafré collect morphometric data on a rare *Liatris*.

The Bucknell team recently joined PNHP botanists at the Bedford County limestone site to become more familiar with Canby's mountain lover and other limestone-loving denizens. While there, the team helped PNHP botanists collect morphometric data on a rare blazing star (*Liatris* sp.) also occurring on site. This project is an example of our ongoing collaboration with academic partners, where cutting edge genetic methods help to fill critical knowledge gaps that will allow PNHP and its partners at DCNR to make conservation decisions based on the best available data.

Specimen Data Sharing Improvement

Kierstin Carlson, Associate Information Manager
Steve Grund, Botanist

Preserved specimens and their associated information are very important to scientific research, conservation, and species management decisions. They document the presence and physical characteristics of an individual at a particular time and place, allowing for myriad studies into evolution, genetics, species relationships, health, abundance, migration and distribution, habitat requirements, phenology, adaptability, extinction risk, and things we haven't even thought of yet.

At the beginning of the Pennsylvania Natural Heritage Program in 1982 (then known as the Pennsylvania Natural Diversity Inventory, or PNDI), we searched for and entered information from many herbaria and zoological collections by physically visiting the collection and transcribing the data by hand onto our paper data collection forms. From the 1990s until 2018, some institutions like the Carnegie Museum of Natural History Herbarium received annual research grants from the Pennsylvania Wild Resources Conservation Program to conduct field surveys and compile reports of new or redetermined specimens of species of concern added to their collections that year. Data from these reports were then entered into PNHP's Biotics database. These reports represented significant effort for the Carnegie Museum staff. They were originally received as hard-copy only and in later years as Word documents or pdfs, which are not easily searched and used as a database.

As computing and internet use have grown, many institutions have been digitizing their specimen collections. For example, Bonnie Isaac, (Collection manager for the Section of Botany, co-chair of collections at Carnegie Museum of Natural History) has led the enormous, ongoing effort to transcribe, scan, and determine collection location coordinates for the entire Carnegie Museum Herbarium collection (https://carnegiemnh.org/30-years-ago-today-bonnie-isaac/). The digitized collection has been loaded into the Mid-Atlantic Herbaria Consortium portal (https://midatlanticherbaria.org/portal/) of SEInet, an on-line database primarily of scanned specimens and transcribed specimen information that also houses other recorded observations from professional and community scientists, state Floras, and checklists. The Mid-Atlantic Herbaria Consortium includes collections in New York, Pennsylvania, Maryland, Delaware, Washington D.C., and New Jersey, and has links to ten other portals, covering the entire continent. Symbiota

Carnegie Museum of Natural History

Carnegie Museum Herbarium scan of intermediate woodfern (*Dryopteris intermedia*) specimen collected by O.E. Jennings on 9/19/1919 in Allegheny County.

is the software and portal host for SEInet and other specimen data portals, covering a range of taxonomic groups around the world. The PNHP botany and information management staff have been given full access to the Mid-Atlantic Herbaria Consortium portal. In return, we share our plant data with the Carnegie Herbarium to assist with their survey planning and research. Then, we can get the results back from those surveys to improve our data even further!

Over the decades, species of concern have been added or removed from our tracking list, and some specimens have had identification changes or other corrections. Now that collections like these are digital, it is possible for Heritage data management and botany staff to search, view, and download current specimen information at any time, without any additional effort by Herbarium staff. We can easily compare our Biotics records directly to downloads of specimen data, bulk load new records, update determinations, and make corrections in a quicker and more comprehensive way; maintaining our information in better alignment with the information at the Herbarium. Because of recent updates to Biotics, we can tie the specimen catalog number directly to the mapped features which will make our data much easier for all users to work with. This will help us meet our goal to be the most trusted, accurate, up to date, comprehensive source of natural heritage information for Pennsylvania, and better support all the uses of that information.

Allegheny National Forest Ecological Surveys

Kent Taylor, Natural Resource Program Specialist

PNHP seasonal biologists Eric Schill, Faith Diffenderfer, Marissa Calvert, and Gordon Stansbury completed summer fieldwork in the Allegheny National Forest (ANF) in August. Some of this season's highlights included finding several rare orchids, broad-winged hawk nestlings, and American chestnut. Their work on behalf of the U.S Forest Service also included participating in fish surveys and a timber rattlesnake radio telemetry project.

Kent Taylor

Left to right: Gordon Stansbury, Faith Diffenderfer, Marissa Calvert, and Eric Schill.

Kent Taylor

Eric Schill surveys unique wildlife habitats in the North Kane area of the ANF.

In selected areas of the ANF, the biologists recorded their findings to support sustainable silvicultural management. Ecological surveys were conducted in 77 forest stands on approximately 1,600 acres of federally managed lands. The biologists worked alongside Pennsylvania Department of Conservation and Natural Resources (DCNR) and U.S. Forest Service staff through a Good Neighbor Agreement. The data collected helps the U.S. Forest Service decide what areas of land should be protected for plant species, wildlife, and habitats of concern.

Each of the biologists brought unique skills and experience from their various backgrounds. Field surveys involved walking transects in forest stands northwest of Kane, Pennsylvania. These areas were designated by the U.S. Forest Service for potential reforestation or timber harvests. Transects were recorded using GPS, Survey 123, and Field Maps apps on iPads. The biologists identified and located mast trees and shrubs, conifer species, water features, regional forester special species (RFSS), rich species sites, non-native invasive species (NNIS), stick nests, lingering ash, wildlife habitat features such as boulders, open areas, and other noteworthy site-specific features. When features of interest were discovered, data was recorded by the biologists, then reviewed and curated by the U.S. Forest Service. Marienville Ranger District Wildlife Biologist John Weyant, GIS Coordinator Jeff

Sprovkin, Botanist Tyler Costlow, DCNR District Forester Cecile Stelter, and DCNR Program Specialist Kent Taylor all played major roles in training the team and providing support throughout the summer.

With these surveys completed, the U.S. Forest Service has greater situational awareness, informing better decisions about setting aside reserve areas for plants and wildlife. As Pennsylvania's only national forest, the ANF remains an extremely important conservation area for species diversity in the region.

Emerging Invasives in Venango County

Brian Daggs, Invasive Plant Ecologist

Brian Daggs

Allegheny River at the Oil City marina

Several aggressive invasive plant species have recently taken root along and around the Allegheny River in Venango County. The bends and banks of its stretch from Oil City to Franklin are rich with history and biodiversity, and it is there that we uncovered the early signs of serious invasions.

Brian Daggs

Mile-a-minute (*Persicaria perfoliata*)

The first of several significant findings is a small population of the invasive vine, mile-a-minute (*Persicaria perfoliata*), growing on the banks of Riverfront Park at Franklin, Pennsylvania. This annual herb is very fast-growing, smothering other vegetation beneath dense mats of vines. This population was originally found in 2021, where only a small cluster was observed. This year, we found multiple clusters on the riverbank, indicating that this species is spreading quickly.

Brian Daggs

Flowering rush (*Butomus umbellatus*)

Just downstream from Franklin, at the outlet of Lower Twomile Run, we discovered flowering rush (*Butomus umbellatus*), growing in the shallow margins of the Allegheny River. This herbaceous plant grows in aquatic and wetland habitats, where it can form dense colonies that outcompete native vegetation.

Further upstream, at the Oil City Marina and Campsite, another emergent aquatic invader, floating primrose-willow (*Ludwigia peploides ssp. glabrescens*), was found on the edge of the river. Another 2021 find, this species had reduced presence this year, likely due to lower average water levels. However, we also identified additional points downstream where the species had spread.

Brian Daggs

Floating primrose-willow (*Ludwigia peploides ssp. glabrescens*)

The last high-priority invasive identified in the area is hydrilla (*Hydrilla verticillata*), a submerged aquatic weed that forms dense colonies underwater. We followed up on a report of this species in the Justus Reservoir at Twomile Run Park and then surveyed Twomile Run downstream from the dam and found two additional points where hydrilla was established. Twomile Run drains directly to the Allegheny River, where hydrilla establishment could have major impacts on the river's ecosystems.

We are in contact with local organizations to coordinate and recommend management efforts for these invasive species. Removal efforts are most effective in the early stages of invasion when eradication is still possible. Any additional findings for these species should be reported to iMapInvasives.

Zombie Moths in the Old Growth Forest!

Ephraim Zimmerman, Science Director

We led off our last edition of Wild Heritage News with an article about our new focus in old growth forests in Pennsylvania. The interaction between organisms within ancient ecosystems is fascinating – and we can't stop talking about what a great project this is! These old growth forests are home to some of the oldest trees in Pennsylvania with eastern hemlocks estimated to be over 500 years old. During one excursion, the diversity of mushrooms of old growth ecosystems was on full display.

Meredith Seltzer

Meredith Seltzer

Fungi were on full display when PNHP staff were assessing old growth character at Hearts Content Natural Area.

Jaci Braund

A moth that had likely been infected with cordyceps fungi.

There is probably no interaction more fascinating than the relationship between cordyceps fungi, and its host. cordyceps, an entomopathogenic fungus, invades a host such as insects and other arthropods (people and their pets are not susceptible - thankfully!). The fungus then replaces insect tissue with its own – forming this spiny ghost-like skeleton. Cordyceps 'mind controls' the infected insect, forcing it to crawl up the end of a tree branch where it releases the fungal spores.

While conducting the rapid assessment methodology to assess old growth character of hemlock forests in the Allegheny National Forest, specifically Hearts Content Natural Area and the Tionesta Research and Scenic Areas in Warren County, Pennsylvania, PNHP ecologist Jaci Braund noticed a strange spiny – skeleton-like form perched on a branch of a fallen tree – this zombie moth was most likely infected by cordyceps.

This discovery reinforces just how wild (albeit creepy) nature can be!

Links to more information:
https://www.cookforestconservancy.org/2020/10/moth-infected-with-zombie-fungus/
https://www.youtube.com/watch?v=vijGdWn5-h8&t=4s