Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

WILD HERITAGE NEWS

Summer 2023

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Photo Banner:
Bog Jacob's ladder
(*Polemonium vanbruntiae*)

Cheyenne Moore

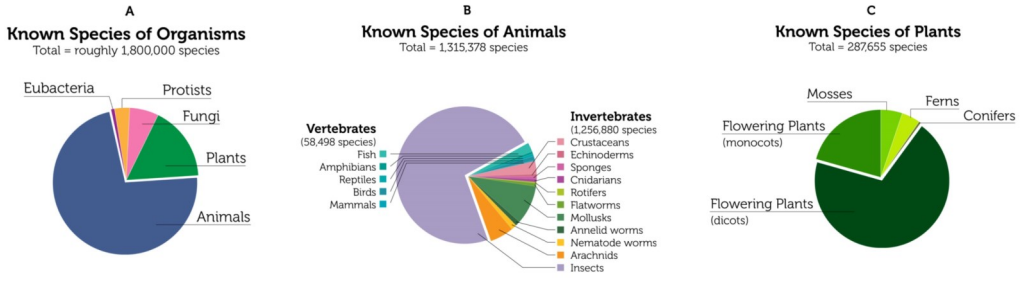
Exploring Another Dimension of Biodiversity in Pennsylvania Conservation Genetics at PNHP

by

Scott Schuette, Botany Program Manager

When people hear the word biodiversity they generally think about all the different living organisms in a given region, whether at the local, state, regional, national, or global scale. This can range from a single-celled fungus to the iconic redwood trees of the Pacific Northwest. Recent estimates of global biodiversity range widely from 2 million to over a trillion species. Other estimates suggest there are approximately 11 million living species on Earth, of which around 2 million have been studied and described by scientists. Discovery of new species continues across the globe. According to Lifegate, nearly 200 new species are discovered each year including fungi, plants, birds, mammals, fish, amphibians, reptiles, and a wide variety of invertebrates (https://www.lifegate.com/10-new-species-discovered-2022). These discoveries harken to the spirit of William Swainson when he said: "The enthusiasm of naturalists is very apt to surprise ordinary people." There has always been a desire among field biologists to make the next great discovery.

With new discoveries comes new estimates for biodiversity. For example, a review of insect diversity suggests that each insect species possibly hosts an additional 12-15 undescribed species of mites, fungi, nematodes, protists, and bacteria. What's even more amazing is that



While nearly 290,000 plant species are known, a majority of the biodiversity on our planet is found among animals with over 1,300,000 known species, and most are insects.
(http://www.ck12.org/biology/Biodiversity/lesson/Biodiversity-BIO/?referrer=featured_content)

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several independent studies using different approaches all arrived at a similar estimate of insect diversity on Earth of about 6 million species! That's three times ALL of the currently known plant, animal, and fungus species on the planet! If each one of those species harbors 12-15 unique micro-invertebrate, fungal, protist, and bacterial species, then the 11 million species on Earth is only scratching the surface of the total biodiversity. This brings to mind a quote from Charles Darwin: "It strikes me, that all our knowledge about the structure of our Earth is very much like what an old hen would know of the hundred-acre field in a corner of which she is scratching." Darwin understood very early that diversity on the planet was likely much more than even the most dedicated explorers could discover in a lifetime.

In the 1950s, the discovery of DNA (deoxyribonucleic acid), a complex molecule that contains the genetic information of an organism, set off a renewed fervor in biological exploration. Scientists now had a new level of diversity to explore. They no longer needed to rely on outward facing character traits; they could now compare the molecular variation between organisms relative to the physical appearances within a specific group. Morphology is often influenced by the environment, causing individuals of a single species to appear very different, and potentially leading to them being described as two different species. However, when the DNA is compared, those apparently different things are not reflected genetically. It goes the other way too. A highly variable species that has a wide range of continuous morphological expression may actually be a complex of multiple species, but the discreet differences are in the arrangement of genetic content, invisible to the human eye.

This genetic diversity is extremely important to the conservation of species and all their variations. The field of conservation genetics is a multidisciplinary applied science that involves the application of evolutionary and molecular genetics to biodiversity conservation. This field has grown in the past 30 years and is now considered by the International Union for the Conservation of Nature (IUCN) to be a key component in conserving biodiversity, which they view as genetic diversity, species diversity, and ecosystem diversity. PNHP also recognizes the importance of genetics in understanding the overall biodiversity of Pennsylvania. Over the past 5 years we have undertaken several different types of genetics studies of plants and animals that were identified as needing these types of investigations.

Charlie Eichelberger

American water shrew (*Sorex palustris*)

Our zoology team, working with the Pennsylvania Game Commission (PGC) and Cassandra Miller-Butterworth, associate professor at Penn State University, Beaver, are investigating the relationships among different subspecies of the American water shrew. As many as ten subspecies of the American water shrew, (*Sorex palustris* Richardson 1828) have been recognized and described in North America. A series of studies over the last decade lumped several of these former subspecies, but few specimens from the portion of the range extending south through the Appalachians were analyzed and there remains a need to clarify the taxonomy of these southern montane shrews. Depending on how these future studies shake out, they could result in fewer or more recognized water shrew taxa. In Pennsylvania, two subspecies of the American water shrew exist, separated by a nearly 100 km gap. Survey work by PNHP zoologists in that range gap resulted in water shrew captures… but of which subspecies? We're finishing a project which assessed the morphology of Pennsylvania's water shrews to see if those results agreed with genetic analyses conducted by our collaborating geneticist, Dr. Miller-Butterworth of Penn State.

Richard Poort,, CC-BY-4.0

Masked shrew (*Sorex cinereus*)

A recent uptick in genetic analyses for mammals have resulted in the rearrangement, lumping, and splitting of genera and species. In Pennsylvania, we have a number of recognized mammals whose taxonomy remains unclear. Taxonomic investigation of some North American shrews and voles with disjunct ranges could have considerable impact on a taxon's extinction risk. One example is the Maryland shrew (*Sorex fontinalis* sensu Merritt 1987), which has been

suggested as a distinct species, a subspecies, or just a morph of the common masked shrew (*Sorex cinereus*). If it's a distinct species, it has a globally restricted range which likely comes with the complementary high risk of extinction. If the opposite is true and it's just a morph of the masked shrew, it's status would be considered secure. The Maryland shrew will continue to be a head-scratcher until genetic work solidifies its taxonomy.

Numerous regional turtle status assessments and conservation plans that PNHP has contributed to have included an element of genetic analysis. These include genetic library building across the range of Blanding's turtle, wood turtle, spotted turtle, bog turtle, and box turtle. Landscape genetics enables us to examine metapopulation factors, such as effective population sizes and levels of migration or inbreeding that can inform our site-level conservation efforts. Additionally, the genetic mapping of turtle species has contributed directly to our efforts at combating the illegal trade in turtles by allowing identification of likely origins of confiscated turtles and providing opportunities for repatriation.

PFBC

PNHP staff taking a sample for genetic analysis of the bog turtle in the northeast. These samples will be collected and analyzed to examine the population structure across the range and to inform conservation efforts.

In 2021 the U.S. Fish and Wildlife Service enlisted Dr. Aron Katz, a research biologist from the U.S. Army Corps of Engineers in Illinois with expertise in Collembola systematics, to develop a research approach to evaluate the distribution, ecology, and genetic diversity of the Heller Cave springtail. The USFWS also engaged the Pennsylvania Natural Heritage Program, the Pennsylvania Game Commission, and the Pennsylvania Fish and Boat Commission to assist with project development and surveys of 16 sites in central Pennsylvania. Cave springtails are tiny, wingless, insect-like animals and there are many look-alike (cryptic) species. Dr. Katz developed a study that combined

USFWS

Project researchers inspect a cave pool, looking for tiny springtails resting on the surface.

traditional surveys of caves to collect springtails with collections of water samples emerging from caves and springs to screen for trace DNA from cave springtails. Use of environmental DNA doesn't eliminate the need for cave surveys and collection of specimens for expert identification. Determination of species is done with specially prepared and slide-mounted specimens that are examined with a compound light microscope. Species determinations are further refined with molecular DNA analysis of specimens. But environmental DNA can be a very useful screening tool to identify priorities for cave surveys and to map species distributions at the local watershed level. Results from this study are pending publication in a peer-reviewed journal.

PNHP is actively involved with population genetic investigations of several plant species in partnership with Bucknell University. Over the past 6 years, we have been successful in acquiring funds through the Wild Resource Conservation Program to explore the

Paul Frederick

Bucknell University professor Dr. Chris Martine (right) and Cheyenne Moore (left) sampling leaf tissue of blue wild indigo (*Baptisia australis*).

population genetic health of 7 different species. Our first project focused on three species, blue wild indigo (*Baptisia australis*), harbinger-of-spring (*Erigenia bulbosa*), and river oats (*Chasmanthium latifolium*). These species are among a long list of taxa for which DNCR has requested genetic information to include as supporting evidence for changes to their regulations. The detailed analyses of genomic variation led to changes in both the S-ranks and regulatory statuses for harbinger-of-spring and river oats. In addition, we found that these species have differing levels of genetic health.

Scott Schuette

Harbinger-of-spring (*Erigenia bulbosa*)

For harbinger-of-spring, relatively large eastern and western populations are not exchanging genetic material due to geographic isolation resulting in low genetic diversity between and within the respective regions. These relatively large populations are also experiencing higher rates of inbreeding depression that further reduces the genetic diversity. Although the populations are large, the genetics suggest that the populations lack enough diversity to withstand a potential population crash due to climate change or other alterations to the habitats. This information was used to justify recommendations to change the regulatory status of the species to protect our populations from further genetic degradation.

River oats is similar with regards to having large eastern and western populations, but this grass species also has a moderately large central population. While the eastern and western populations are genetically isolated by geography, the central and eastern populations have some genetic overlap suggesting they exchanged DNA at some point in their past. This helps maintain the genetic diversity within those populations. This species grows in floodplains and riverbanks where the populations number in the several to tens of thousands of individuals. The large populations coupled with wind-pollination has maintained relatively high genetic diversity, which helps the species be less vulnerable to changing climate conditions. Prior to our study river oats was proposed as a Pennsylvania endangered species, but our results led to a reassessment of the conservation rank and regulatory status and a recommendation that it be considered Pennsylvania rare.

Scott Schuette

River oats (*Chasmanthium latifolium*) in floodplain forest along the Monongahela River.

Blue wild indigo is another riparian species that grows in cobble scour grasslands along the Allegheny River and its major tributaries, as well as in the bedrock scour of the Youghiogheny River. The three remaining populations are genetically distinct from each other with a very large, highly structured population on the mainstem of the Allegheny River, a smaller widely spread out population on the Clarion River, and a very small population on the Youghiogheny River. All populations have slightly lower than expected genetic diversity coupled with average levels of inbreeding. Our results suggest that long term management of this globally vulnerable species needs to account for the genetically structured nature of large populations when considering seed sources for out-planting into smaller disjunct populations to avoid swamping out the existing genetic diversity.

Cheyenne Moore

Close up of wild blue indigo (*Baptisia australis*) from large population along the Allegheny River.

Scott Schuette

Cary Paynter, NC Native Plant Society

John Kunsman

Scott Schuette

Clockwise from top left: box huckleberry (*Gaylussacia brachycera*), white monkshood (*Aconitum reclinatum*), Canby's mountain lover (*Paxistima canbyi*), and bog Jacob's ladder (*Polemonium vanbruntiae*)

Our current projects with Bucknell University focus on three globally vulnerable plants, box huckleberry (*Gaylussacia brachycera*), white monkshood (*Aconitum reclinatum*), bog Jacob's-ladder (*Polemonium vanbruntiae*) and one globally imperiled plant – Canby's mountain lover (*Paxistima canbyi*). These species are all endemic to eastern North America and have disjunct distributions that suggest populations are genetically isolated from each other. We are in the first year of these projects and are just beginning to collect samples for population genomic analyses to determine the genetic health of these species. In addition to genetic health, we are undertaking a different type of genetic analysis called phylogeography that will help us understand spatial relationships among these populations over time on the landscape.

Rachel Goad

Bog Jacob's ladder field team, PNHP botanist Rachel Goad (foreground), PNHP ecologist Claire Ciafre (lower right), Dr. Tanisha Williams (mid left), DCNR PPCA coordinator Cheyenne Moore (mid right), Bucknell undergrad Andy Dorsel.

Working with Drs. Chris Martine, Melody Sain, and Tanisha Williams, we are training students in plant conservation using natural heritage methodologies in conjunction with the wet lab techniques in DNA extraction, purification, sequencing, and analysis. This holistic approach also involves members of the Pennsylvania Plant Conservation Alliance to collect seeds and cuttings from these globally rare plants for propagation because the ultimate goal is actionable plant conservation that prevents species from going extinct.

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.

Mysteries, Monitoring, and Management for our Rarest Plants

by

Jessica McPherson, Botanist

PNHP botanists are working to improve our monitoring efforts for Pennsylvania's globally rare plant species. For many plant species, there is a surprising lack of knowledge about basic elements of their life history and ecology, such as how long the plants usually live, what pollinates them, what light levels they thrive at, and their requirements for seed germination. Some of these knowledge gaps impede our ability to conserve these species or even to develop proper monitoring protocols. Our challenge is to design our data collection to best use the limited time we have during field visits to answer as many of these questions as possible, and adaptively improve our management efforts and protocols in response to what we find. When research already exists, it provides a helpful baseline and reference for our field observations.

Partnerships are also critical in plant research and in translating field data into conservation action. We often work with academic partners (e.g., Bucknell University) on genetic studies. We have partnered with Dr. Peter Zale at Longwood Gardens to explore the potential of conservation horticulture to safeguard some of our most at-risk species through greenhouse propagation, living collections, and restoration plantings. We also work with state agencies, advising on conservation needs for populations on their land, which their staff implement. The Pennsylvania Plant Conservation Alliance plays a role in coordinating these partners in alignment with Plant Recovery Plans for each species.

Rachel Goad

Dr. Peter Zale collecting *Paxistima* cuttings.

Jessica McPherson

Running buffalo clover

Running buffalo clover (*Trifolium stoloniferum*) is a fascinating species that is discernable in early pioneer accounts, which mention abundant white clovers growing where buffalo graze and travel. As the buffalo declined, it appears the plant did as well; there is a large gap in museum collections between 1910 and 1980. It was feared to be extinct in the 1980s, when it was listed as Federally Threatened. Because of its federal status, a range-wide assessment, a recovery plan, and extensive research exists investigating the plant's requirements for disturbance (it likes some, surprise), light levels (partial shade), seed production (often not good), and germination needs (bare soil). Many more populations have been found since it was first listed and, in 2021, it was removed from federal protection.

Despite being known for over a century from Ohio and West Virginia, the species was first found in Pennsylvania in 2019. Because we only have six known locations in the state and it faces ongoing threats from invasive species, it is listed as Pennsylvania Endangered. Along with other states where the plant is present, we will monitor all accessible populations for five years post-delisting. During this time, we hope to gather data on how light levels and disturbance affect populations to help guide management. Two sites are managed by the Bureau of State Parks, and we are partnering with them to adapt recommended mowing and trimming practices utilized in other states to reduce competition for the plants. Successful management must mimic the role buffalo once played in reducing competition and aiding germination.

We have also observed that our populations seem to have very low seed production. Studies show this species needs insect visitation to physically trigger self-pollination; however, no research has been done on what insects visit it and what those insects require. It may be that without a certain density of plants, or the presence of other flowering plants, insects are not attracted to the area. However, this is a question requiring in depth research; hopefully it will attract the interest of a graduate student or researcher!


Cheyenne Moore

Small whorled pogonia in bud

Small whorled pogonia (*Isotria medeoloides*) is federally regulated, with a threatened status; while Pennsylvania once had six populations, today only one extant site is known, with just a few plants. This species is known to be a long-lived perennial, with the twist that it can go dormant below ground and re-emerge years later. PNHP is working with the Pennsylvania Game Commission to steward this population by installing cages to protect plants from wildlife browsing and by removing understory shrubs to increase light penetration to the plants. In this case, with only a few plants that are long-lived perennials, it is possible to collect detailed data on individual plants to detect how they respond to management. The Smithsonian Environmental Research Center has studied this species for decades across its range, building understanding of its biology and ecology. PNHP is working with them to procure range wide samples and facilitate a population genetics study. We are also working with other states to pilot a standardized monitoring protocol for the species.

Spreading rockcress (*Arabis patens*) is a primarily Appalachian species in the mustard family that lives mainly on limestone habitats. In Pennsylvania, many sites have been lost to quarrying and habitat degradation. Most remaining sites are on small fragment natural areas on steep cliffs; their small size and limestone soils make them particularly vulnerable to invasive species. For several years, PNHP staff have been making an annual count of plants at one site in eastern Pennsylvania and coordinating a group of volunteers to remove invasive species. This year we are also attempting to improve our data on two other sites in central Pennsylvania. In floras, this species is listed as a biennial or short-lived perennial. We had assumed it was mainly biennial, because many other species in the mustard family have a reliable biennial growth form; they create rosettes one year, flower the next year, and then die. If it were biennial, seed set and germination would be extremely important to the survival of the populations, because half the plants would die every year. Monitoring would also have to be adapted for plants with very short lifespans, emphasizing the total number of plants and annual germination of new ones over in-depth detail on individual plants, as is useful for long-lived perennials. Upon arriving at our site, however, botanist Rachel Goad observed that many plants had dead stalks from previous years – suggesting that many, if not most, do not die after flowering! Dr. Peter Zale of Longwood Gardens also described his experience observing the species to live indefinitely in a greenhouse setting. With this information, we are recalibrating our monitoring to not only include total population counts, but to track individual plant locations and lifespans for a subset of the population. We are also recording light levels at sublocations within the site, in the hope of detecting whether the species requires management for higher sunlight.


Jessica McPherson

Spreading rockcress with many previous year stems.

Spreading globeflower (*Trollius laxus*) lives in open areas of fens and calcareous palustrine woodlands. Although Pennsylvania used to have ~20 sites, today many populations have been lost, and we have access to only two sites, both in Western Pennsylvania. Dr. Sara Scanga of Utica University researched this species for her PhD dissertation and found that it is a long-lived perennial, but requires medium light levels, and several years of deep


Jessica McPherson

Spreading globeflower

shade will cause local extinction. This year, we took detailed data on plant height, vigor, and seed production at several sublocations within one of our sites. We found that our ungrazed woodland plants were uniformly smaller, less well-developed, and produced much less seed than those located in a grazed field with higher sunlight. We also observed significant deer browse of leaves and fruiting stems. Our challenge now is to devise appropriate management based on these findings. With Scanga's dissertation research as a baseline, we know that light levels are likely significant, and the species may benefit from selective trimming of surrounding woody vegetation. We also collected wild seed to send to Longwood Gardens, where staff will attempt to propagate and maintain the plant as an ex-situ living collection. These plants can also be used to restore populations where they have diminished or been extirpated.

Rachel Goad

PNHP botanists monitoring a population of Canby's mountain lover.

Canby's mountain lover is another Appalachian limestone cliff species. Because it is under threat from a non-native scale insect, PNHP has stepped up efforts to track how our populations are faring. It is an evergreen, long-lived perennial. Our first attempts to monitor the largest of our three populations were challenged by the overall size of the population, difficulty of determining a consistent means of counting this clonal species, patchiness of the plants, and complexity of the rocky cliff habitat. These challenges have frustrated our attempts to census the overall size of the population. We are now taking another approach to understand the impact of the euonymus scale, by establishing permanent plots where we can track smaller-scale changes to individual plant patches over time. We hope this can reveal more about how fast these plants grow, how long individual stems may live, and how much scale insects are affecting the survival and vigor of individual plants. The growth rate of the plants is another surprising basic knowledge gap, but one that is vital to understanding the impact of the scale insect damage, because if plants grow extremely slowly, losses are more devastating.

Rachel Goad

Canby's mountain lover with fruit

Botanists have generally understood the species to have very little sexual reproduction, due to very limited genetic diversity thought to be present at most sites, lack of known pollinators or pollinator observations, and lack of observation of fruiting plants. However, one researcher also suggested that the fruits may drop within 24 hours of ripening, so it may also be that botanists are never at the sites at the right time to see the seed production. This year, however, our botanists were very excited to actually observe a fruit, which conveniently fell off while they were debating whether to collect it. It has now been delivered to staff at Longwood Gardens, who are attempting to germinate it. Our collaborators at Longwood have also collected rooted cuttings of this species, and our hope is that these various sources can become part of an ex-situ collection that will help to safeguard against the serious decline the species is experiencing from the non-native scale insect.

As we gain experience in monitoring, build better datasets on individual populations, and further develop partnerships for conservation implementation, our capacity to conserve our most globally rare plant species is greater than ever before.

About the Author

Jessica McPherson has worked with PNHP for over 20 years as an ecologist and botanist. She currently works on strategic planning for botany, emphasizing site-based planning, habitat-focused plant conservation, building data-driven management through partnerships, and efficient data capture. She has a particular interest in understanding how plants' life history and ecology impact their distribution, rarity, and adaptability to change, and in the ecological influence of soil pH and geology.

Notes from the Field

How to Bee a Good Collaborator

Pete Woods, Inventory Ecologist

For the last three years, Penn State professor Margarita López-Uribe and postdoctoral researcher Nash Turley have been training Master Gardeners to collect bees and establish bee monitoring sites across Pennsylvania. They then transfer the bees to experts at Penn State and beyond, who authoritatively identify them, improving our understanding of the distribution and abundance of Pennsylvania's bee species.

This year they were looking to add a few bee collectors who would focus on collecting bees in high quality natural habitats. PNHP's invertebrate zoologists are a great match for this need, because our work in interesting natural communities brings us to places where rare or under surveyed bee species are likely to be found. In fact, several years ago, we started to collect bees opportunistically during our surveys because interest in native bees and other pollinators had been steadily growing within the conservation community. At the time we had no solid plan for how these bees would be identified by experts, but we figured, correctly, that there would be an opportunity to get our specimens identified.

Pete Woods

Phacelia mining bee on Miami mist

One of the many bees that we collected this spring was found on a patch of Miami mist (*Phacelia purshii*). We have tentatively identified it as the Phacelia mining bee (*Andrena phaceliae*), which has not been reported in Pennsylvania since 1947, but we need to have an expert confirm this identification. This summer we will be

USFWS Midwest Region, CC BY 2.0

Rusty patched bumble bee

surveying for rusty patched bumble bee (*Bombus affinis*) and other bumble bees, through a grant from the USFWS and the Great Lakes Restoration Initiative. That grant only provides support for identification of bumble bees, but any other bees we collect will be available to our collaborators at Penn State.

PNHP will also benefit from the data generated by the Pennsylvania Bee Monitoring Program, because that data will feed into our ongoing efforts to determine conservation ranks for bees for the 2025 update to the Pennsylvania Wildlife Action Plan. Learn more about the Penn State bee monitoring effort at https://lopezuribelab.com/pa-bee-monitoring/

New to PA Plant Discovered

Jessica McPherson, Botanist

Botanist Jessica McPherson and her husband were celebrating their anniversary with a hike in the Laurel Highlands, when she noticed a sedge with bright reddish -purple stem bases. She thought it might be a rare species she was keeping half an eye out for as they hiked; however, on closer inspection, it didn't quite match. In fact, it didn't quite match anything known from Pennsylvania. Looking in a regional flora, she saw that it resembled two southern Appalachian species. She conferred with Dr. Rob Naczi at the New York Botanical Garden and leading expert in the genus in eastern North America – who confirmed her suspicion – that this was a native species that hadn't yet been recorded in Pennsylvania! It is *Carex purpurifera* (purple sedge), a species that occurs sporadically in rich mesic

sites mostly in Kentucky and Tennessee. According to Dr. Naczi, "*Carex purpurifera* has not been recorded for Pennsylvania, but I've long expected it there. Its occurrences are quite localized, especially in the northern portions of its range, and within the last few decades, it has been discovered in the vicinity of areas that had been botanized well in the past, e.g., in portions of Adams County, Ohio. In those cases, it was a matter of a Carex-observant botanist happening upon the particular special place at the right time."

Jessica McPherson

Carex purpurifera plant with eye-catching reddish stem bases

A return trip during working hours found an apparently healthy population of about 200 plants. Based on our observations of this site and discussion with Dr. Naczi, the habitat appears to be midslope areas on the dry side of mesic forest (full canopy) in areas with little herbaceous competition, with an affinity for old disturbances such as logging traces. Soils were very rocky with a bit of calcareous influence elevating the pH in the range of 5.0-6.5. Heritage botanists will be keeping an eye out for this species in other southern-influenced Laurel Highlands mesic forests, and we encourage others to do the same!

Pennsylvania Moth List Updates

Kierstin Carlson, Information Manager

To help fulfill our goal to be the most trusted, accurate, up to date, comprehensive source of natural heritage information for Pennsylvania, we continue to gather information on species that are new to or poorly known in our state. Insects and other invertebrate species far outnumber the vertebrate species on Earth. Moth species alone outnumber the combined bird, mammal, reptile, amphibian, and fish species in Pennsylvania, yet they have received relatively less attention.

In 1984, Dr. Dale Schweitzer was tasked with creating the first list of rare moths and butterflies in Eastern North America for The Nature Conservancy. Charles Bier, Tony Wilkinson, Tom Smith, and others began collecting moths for the Heritage Program at a number of sites in the mid-1980s. The specimens were identified by Dr. Schweitzer and Dr. John Rawlins, moth experts in the eastern U.S.

Surveys continued in the 1990s with the hiring of Betsy Leppo initially as an intern, and later as our invertebrate zoologist. By 1999, there were 155 moth species in the database list gleaned from museum records and field surveys.

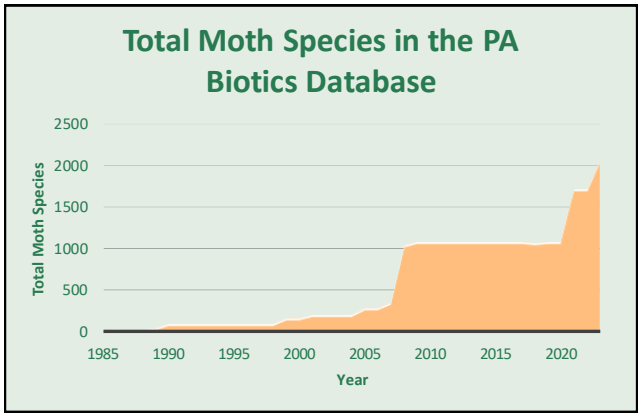
Betsy began working in earnest on the list of moth species in Pennsylvania in 2000 with an initial list of over 1,000 potential species from over two dozen sources. Before we add the names to our database, we must determine if each is truly a recognized species, and that it has confirmed specimens that have been collected in Pennsylvania. Through steady work, small groups of species were added to the database for several years with the most impressive jump in 2008 when over 680 species were added.

Pete Woods

A four-spotted angle moth (*Trigrammia quadrinotaria*) documented by PNHP ecologist, Pete Woods. This moth is a specialist on buckeye.

More biologists were hired who conducted additional surveys in the past two decades. Pete Woods in particular has been conducting surveys that target specialist moths of unique host plants and habitats. Development of our moth list has been greatly bolstered with contributions from other experts in the field, such as long time PNHP collaborators Steve Johnson and Paul Dennehy. These collaborations have resulted in a big addition of another 660 species to the database in 2021, and 339 more moth species this past June. This brings the total to 2,053 species. There are hundreds more that Betsy Leppo is currently gathering

information about that will be added to the list in the future.

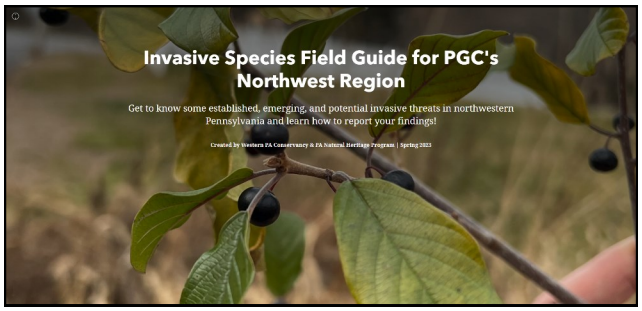


As amazing as the diversity of moths is, they are just one example of the work being done. Other invertebrate groups such as crayfish, snails, mayflies, dragonflies, caddisflies, spiders, grasshoppers, bees, and more have been added to the list as the Pennsylvania Natural Heritage Program has grown.

New Field Guide Created for Game Commission Staff in Northwest Pennsylvania

Amy Jewitt, PA iMapInvasives Program Coordinator

Staff from the Pennsylvania Natural Heritage Program (PNHP) recently compiled a publicly-available digital field guide titled "Invasive Species Field Guide for PGC's Northwest Region" to aid Pennsylvania Game Commission (PGC) staff in conducting invasive species surveys. This resource highlights 26 established, emerging, and potential invasive plants and insects for PGC staff in northwest Pennsylvania to be aware of. The guide explains why each species is a problem as well as identification tips, look-alike species, and preferred habitat.



Included in the guide are a plethora of high-quality images, videos, online resources, and dynamic distribution maps sourced from iMapInvasives. Together, they serve to facilitate a more robust knowledge base for PGC staff to help their agency maintain and protect valuable natural communities, ecosystems, and habitats on Game Lands.

The PGC and PNHP would like to continue collaboration in the future by creating additional field guides for Game Lands throughout the state.

Old Growth Field Work

Jaci Braund, Ecologist
Pete Woods, Inventory Ecologist

PNHP staff have been busy this spring and early summer accomplishing field work for the Old Growth Forest project. Over the winter, we updated the Old Growth Rapid Assessment and field tested the new methods this spring. The main changes include the addition of measuring tree DBH within 10 meters at each point, visually estimating the cover of coarse woody debris within the same 10 meters, and qualitatively assessing the old growth characters on a scale instead of a presence/absence check-mark. While the new methods take a bit longer to complete, we hope the additional effort is not too cumbersome and the data is beneficial to the identification and ranking of old growth forests in Pennsylvania.


Jaci Braund

PNHP ecologist Claire Ciafre measuring the DBH of an old growth red oak tree in western Pennsylvania.

Ecology surveys in old growth forests not only include completing the rapid assessment, but also plant community plots. Several plots and rapid assessment transects were completed this spring in known old growth areas, and within forests that contain populations of potential old growth indicator animal species. PNHP ecology staff conducted surveys within rock houses (cave like features) in the Laurel Highlands and Northern Hardwood Forests of the Poconos to overlap with the known populations of these wildlife species. By overlapping the ecology protocols with these wildlife populations, we hope to get a better

understanding of the old growth status and condition of their habitats, and how these habitats score on the rapid assessment weighted rank system. Ultimately this data may be helpful when managing nearby forests to expand habitat for these species.

Pete Woods

These conks, the fruiting bodies of a polypore fungus in the genus Fomitopsis, are twelve years old. A new layer is added to the conk each year. Long-lived conks like this provide stable habitat for beetles with limited dispersal capabilities.

In addition to ecology surveys, PNHP staff are conducting invertebrate, avian, and bryophyte surveys as part of the old growth forest study. Early this spring, Heritage biologists started looking for a variety of invertebrate species that are indicative of old-growth conditions, using pitfall traps, Malaise traps, funnel traps, and hand collecting. The traps were deployed in late April and will remain in place for the remainder of the summer. We are sampling in both old growth and nearby younger forests to better understand which species may rely on old growth. One of our targets is a family of beetles called polypore fungus beetles. These beetles rely on polypore fungi, which grow abundantly in forests with large volumes of coarse woody debris. Some of these beetles are flightless, and their limited mobility restricts them to older forests that have been stable over long periods of time. We are hoping to catch these beetles in pitfall traps as they walk across the forest floor. Another target is hover flies. The larvae of many species of hover fly live in dead wood or in wet rot pockets in stumps and knotholes. We are hoping to catch these flies by hand netting and with Malaise traps.

Katya Schultz

The black polypore fungus beetle (*Eustrophopus bicolor*) is one of our target species

Jaci Braund

Malaise traps were set up in both old growth and nearby younger forests at two sites this year to survey for invertebrate species that may rely on old growth forests, such as syrphid flies.

Avian surveys have also been set up in Tionesta Scenic and Research Natural Area, Ricketts Glen State Park, and Alan Seeger Natural Area. The surveyors will visit randomly-generated points within the old growth areas and conduct 10-minute listening surveys. We hope to relocate a bird species of concern that has primarily been documented in old growth forests and gather information on other bird species that may rely on these forests. Unfortunately, the survey methods only work if the birds are singing and they typically remain quiet during wet weather, which impacted the spring 2023 surveys. The avian surveys are being planned again for spring 2024.

We also conducted bryophyte surveys within old growth this spring as a general inventory and also to get a better understanding of any moss species that may be indicators for old growth forests in the state. PNHP staff and partners will visit more old growth sites and conduct additional bryophyte and ecology surveys throughout the summer. In the fall, data will be analyzed and the methods may be tweaked one last time before a final version of the rapid assessment can be deployed.

Developing Partnerships for Invasive Species Management

Brian Daggs, Invasive Plant Ecologist

PNHP, through funding from the Richard King Mellon Foundation, is building partnerships to monitor and manage invasive plant species at ten focal sites distributed throughout Pennsylvania. Each site was selected for its ecological significance, rare native species, current and potential partnership opportunities, and severity of threat from invasive plant

species. To jumpstart these partnerships, PNHP staff will survey each site to establish baseline conditions and understand the invasive species threats.

Brian Daggs

Butterfly milkweed growing on a shale barren that overlooks Sideling Hill Creek at one of the project sites in Bedford County.

The sites selected are scattered throughout Pennsylvania, representing the ecosystems and biodiversity of the state from Fayette County in the southwest to Luzerne County in the northeast. At each of these sites, PNHP has engaged a variety of partners from state agencies like the Pennsylvania Game Commission, land trusts such as the French Creek Valley Conservancy and the Lancaster Conservancy, and even private landowners, including local farmers and a private grade school.

Invasive species ecologist, Brian Daggs, along with botanist Jessica McPherson and ecologist Claire Ciafre, spent the late spring and early summer months conducting surveys and mapping the invasive species at each site as well as updating the status of the rare plant species found at the sites. With the data collected from surveys this year, we will formulate an invasive species monitoring plan for each site that will focus on monitoring the spread of invasive species that are already present and the early detection of invasive species that are not yet present, but may soon appear at the sites.

Brian Daggs

Bishop's goutweed, an invasive plant species, forms a dense carpet in a floodplain at a project site, upstream from a population of the globally-rare spreading globeflower.

Brian Daggs

Susquehanna sandcherry, a rare species of cherry found at a project site in Luzerne County.

This work is ongoing, with field surveys set to wrap-up in the fall of this year and the final results and monitoring plans to be finished in the spring of 2024. Although the project is set to finish next year, the partnerships between PNHP and the stakeholders involved, fostered through these sites, will hopefully be maintained to successfully monitor and steward Pennsylvania's natural areas for years to come.

New Hires at PNHP

Adam Hnatkovich

Adam Hnatkovich returned to the Heritage Program in April 2023. Adam previously worked with WPC Heritage as an environmental review specialist, then as an ecologist working on multiple projects with the ecology team. He transferred back to the Heritage Program from WPC Land Conservation and Stewardship, where he was the GIS and information analyst. As our conservation planner, Adam has been coordinating the development of Natural Heritage Area products and outreach efforts, and also working on the next generation of the PA Game Lands Tool (PGLMT). Adam's interests outside of work include board game design and playing music. Adam is also a volunteer for the 501st Legion, a Star Wars costuming group that contributes to fundraising and charity work around the world.

Noah Yawn joined the Heritage team in June 2023 as an ecologist. He is a recent graduate of Auburn University where he completed a double major in Integrative Biology and Geology. Noah brings valuable botanical and ecological experience from his internship with the Southeastern Grasslands Institute and as a research assistant studying one of his favorite plants, *Sarracenia oreophila*. Noah is currently working on several invasive species projects in the northwestern portion of the state and will be involved with some new and ongoing ecology/ botany-focused projects. He is very excited to be working for the Heritage Program and is looking forward to learning the interesting mix of flora and fauna we have in Pennsylvania. Noah's interests in the natural world aren't just limited to work. In his free time, he enjoys caving, photography, kayaking, ridge walking, hunting for cool ferns, and snorkeling.

Noah Yawn

Mitch Meuser

Mitch Meuser started his work as a seasonal ecologist with PNHP in June. From Aliquippa, PA, he graduated from Penn State University and recently worked as a forestry technician and a field research crew leader. In his role at PNHP, his focus is to survey for invasive species threats on State Game Lands; the project is a partnership with the Pennsylvania Game Commission to advance invasive species information gathering. Mitch is mapping invasive plants in areas identified as habitats for a diversity of plants and animals. Information will be stored in the Pennsylvania iMapInvasives database and can be used to determine priorities for invasive species control. Outside of work, Mitch enjoys learning banjo and spending time outdoors, foraging, fishing, kayaking, and deer hunting.

Helena Yu joined the Heritage Data Management team as a data science intern in May of 2023 and will be working with us through the end of the summer. She is currently a rising junior at Carnegie Mellon University where she is double majoring in Statistics & Machine Learning and Artificial Intelligence. Since starting with us, Helena has been developing custom tools that will automate the extraction of data from our observation database and generate survey reports for a user-specified area of interest. Although it can be challenging at times, Helena has enjoyed the process of testing, debugging, and resolving issues while creating the custom toolbox; the sense of accomplishment she feels when her code works flawlessly and produces the desired results with a simple click on a map is incredibly rewarding. Helena is also looking forward to venturing into the field to collect species data where she will be able to experience the front-end of our data products. Outside of work and school, Helena enjoys playing badminton and listening to pop music (especially K-pop and Taylor Swift)!

Helena Yu

This summer, four Western Pennsylvania Conservancy (WPC) seasonal biologists - Delana Kirwan, Caitlin O'Hara, Austin Swanson, and Emily Wojtyna - have been conducting ecological surveys in the Allegheny National Forest as part of the Bureau of Forestry's Good Neighbor Agreement with the U.S. Forest Service (USFS). They are using Field Maps and Survey123 to collect natural heritage data during a 12-week field season in the Upper Mill and Hemlock Run project areas. Their work supports management decisions about forest health, silvicultural practices, and conditions that enhance or threaten biodiversity in Pennsylvania's only national forest.

Kent Taylor

WPC seasonal biologists received field training from USFS staff in the Allegheny National Forest.


Emily Wojtyna

Emily Wojtyna has a Master of Science in Ecology, Evolution, and Systematics from the Ludwig Maximilian University (LMU) of Munich, Germany and a certificate in Environmental Studies from the Rachel Carson Center for Environment and Society at LMU. Working at the Foundation for Sustainable Forests, Emily conducted vegetation surveys in forest gaps and analyzed the dynamics of key habitat resources for both early-successional and mature-forest birds. Emily wrote and self-published a cookbook of local edible mushroom species titled The Amateur Forager's Cookbook: Featuring Edible Wild Mushrooms of Western Pennsylvania. In addition, Emily holds a B.S. in Biological Sciences with a Chemistry minor from the University of Pittsburgh. In her free time, Emily enjoys foraging, doing yoga, and bouldering.


Delana Kirwan

Delana Kirwan earned her B.S. from Pennsylvania Western University, California Campus in May of 2023 with highest honors (summa cum laude) and was a recipient of the Academic Excellence in Environmental Sciences award. She majored in Fisheries and Wildlife Biology as well as Environmental Studies/ Conservation Ecology. Delana participated in the Delmarva Fox Squirrel Conservation Monitoring Project at The Wildlife Society and completed an independent study on North American bats' artificial roost preference, focusing on little brown bat (*Myotis lucifugus*). In her free time, Delana enjoys listening to music and playing guitar, taking her family and dogs on nature-themed adventures, creating floral arrangements, and researching herbalism. She also enjoys assisting friends and family in creating sustainable landscapes as well as sharing her knowledge about the benefits of native plants.


Austin Swanson

Austin Swanson graduated from Penn State University in 2017 with a degree in Wildlife and Fisheries Science. He is the Wildlife Laboratory Coordinator for the Penn State Dubois Wildlife Technology Program, and he has used his summer positions to enhance his professional, educational, and leadership skills. When not in the field, Austin enjoys spending time with family and friends. He currently lives in Ridgway with his fiancé Kaelyn and dog Kali.


Caitlin O'Hara

Caitlin O'Hara graduated from Clarion University of Pennsylvania with a bachelor's degree in Environmental Biology. This is her first field job out of college! Some of her hobbies include running, reading, being with friends and family, camping, and being in the outdoors. In the future she may plan to go back to school for her masters. She is originally from Kane and has lived there all her life.