Pennsylvania Natural Heritage Program

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WILD HERITAGE NEWS

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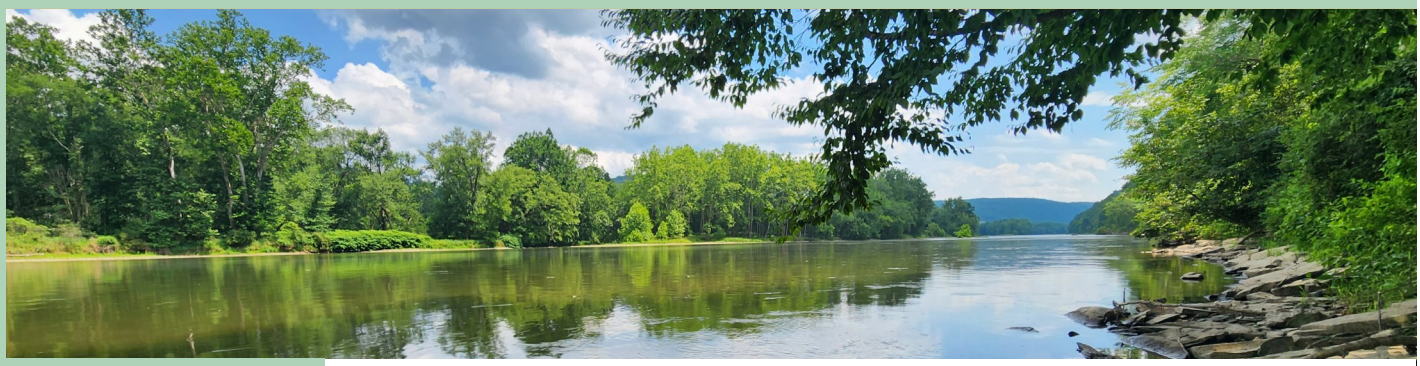


Photo Banner
Allegheny River
Brian Daggs

Inside This Issue

Monitoring the Upper Middle Allegheny

by
Ephraim Zimmerman, Science Director
Mary Walsh, Invertebrate Zoology Manager
Molly Reif, Geospatial Data Analysis Team Lead, USACE

The Upper Middle Allegheny River between Warren and Tionesta, Pennsylvania has been the focus of scientific research and management by PNHP and partners for decades because of its long-recognized importance to rare freshwater mussels and other aquatic community conservation targets. This stretch of river is within a portion of the waterway that was designated as a Wild and Scenic River by the U.S. Congress in 1992. The U.S. Forest Service manages the over 500,000 acre Allegheny National Forest on either side of the Upper Middle Allegheny River along with seven Allegheny Wilderness Islands within the river channel.

Flowing water is the major ecological driver in large river ecosystems. Large dams, such as the Kinzua Dam, upriver of Warren, Pennsylvania, greatly alter the natural flow regime and thus are significant features affecting the river's aquatic and riparian habitats. Kinzua, completed in 1965, was built to control flooding and protect Pittsburgh and other communities downstream, to provide hydroelectric power, and support transportation through the system of locks and dams on the Lower Allegheny and Ohio River Valley. The Kinzua Dam's impact on the aquatic and riparian ecosystem is evident for many miles downstream.

In the Allegheny River there are competing needs for natural habitats, water quality, and water infrastructure. Dams and flood control structures slow or restrict the flow of water, altering the frequency and duration of flood events, and reducing their intensity. Dams have a moderating effect on river ecosystems as extreme low flows and extreme high flows

U.S. Army Corps of Engineers

Kinzua Dam water release

are reduced or eliminated. The higher than natural baseflows due to the Kinzua Dam releases also maintain water quality in the Allegheny River; pollutants from point sources on the river and from tributaries with mine drainage would otherwise be concentrated at low flows. The dam outflows maintain a minimum river flow and prevent very low flow events, typical natural events, in which aquatic organisms may be stranded or perish from high summer temperatures at low water levels. While reducing very high and very low flows has certain benefits, the natural flow fluctuations that occur in unmanaged systems help to maintain the channel and floodplain habitats to which native species are adapted.

The ecological impacts of flow modifications are most evident on the river floodplain, where reduced frequency and intensity of flood events result in shifts from floodplain wetlands to upland plant communities. In the absence of regular flooding, there have been documented shifts from open riparian habitats dominated by shrubs and grasses, to riparian forests and woodlands. Invasive non-native plant species are also able to outcompete native plants due to the change in the natural disturbance regime.

Noah Yawn

Upland meadow and forest species colonize riparian habitat with changes in the natural flood regime.

The impacts of flow alteration on aquatic communities within riverine ecosystems are a little less noticeable and less understood. Native wildlife species have thrived downstream of the Kinzua Dam. The Upper Middle Allegheny River supports high densities of a diverse freshwater mussel community (23 species reported in recent surveys), including some of the most abundant populations of federally threatened and endangered species which are declining in other parts of the eastern and midwestern United States. It is also known for dense beds of submerged aquatic vegetation

Mary Walsh

Specimens of eight freshwater mussel species collected from a transect in the Allegheny River.

(SAV), which is an indicator of ecosystem health and supports unique ecological functions. In light of continued development pressure in the watershed and climate change, managers are exploring future management that might be needed to maintain the river's critical habitat resources. Human-caused climate change, which is expected to bring more water to the Upper Allegheny Region in the form of large precipitation events, will increase the chance of catastrophic flooding, further necessitating the need for additional flow management and flood control – which will in turn impact the aquatic and riparian habitats and species.

The Sustainable Rivers Program

Recognizing the complexities of flow management in this system, the U.S. Army Corps of Engineers (USACE), which manages the Kinzua Dam, partnered with The Nature Conservancy (TNC) in 2013 to develop and implement a Sustainable Rivers Program (SRP) for the Allegheny River. TNC's SRP uses science-driven models to achieve environmental flow goals in regulated systems to ensure water infrastructure operations, maintain critical habitat resources for rare species, and restore areas degraded by human development activities.

PNHP has been an active partner in the SRP effort in the Upper Middle Allegheny, assisting with the development of the ecosystem flow recommendations at the Kinzua Dam and chairing the Mussel Workgroup for the SRP. Flow recommendations are intended to restore a natural flow regime that supports habitat and connectivity, flushes sediments, and maintains the river channel and islands.

An Integrated Approach

Monitoring continued this year as PNHP ecologists joined a team of over 30 scientists and technicians from the U.S. Army Engineer Research and Development Center (ERDC), Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX), Allegheny National Forest (ANF), and U.S. Geological Survey (USGS) to conduct field and airborne surveys that will be used to document and map floodplain vegetation communities, SAV, and mussel habitat, as well as validate airborne lidar bathymetry in this stretch of the Upper Middle Allegheny River. This information will guide development of an approach to evaluate floodplain and SAV plant communities using remote sensing technologies and support USACE's ecosystem flow recommendations to inform restoration and reduce flood risk in managed rivers across the region.

Traditional field-based methods for monitoring riverine ecosystems are time-intensive and may not accurately capture conditions over expansive areas. The ERDC research team hypothesized that a more strategic coupling of field-based techniques and remote sensing technology would provide an opportunity to document, quantify, and map larger areas on a more comprehensive level and better prepare for and adapt to future management needs downstream of the Kinzua Dam and other managed river systems.

Ephraim Zimmerman

Brian Daggs (PNHP) accompanied Matt Balazik and Molly Reif from the USACE ERDC to collect information to ground-truth SAV beds in the Allegheny River.

A Collaborative Field Effort

In July, the group, led by ERDC's Geospatial Data Analysis, Coastal Ecology, and Forest Ecosystem Dynamics Teams, was on the river for eight days straight, visiting specific sites within a 15-mile stretch of the Allegheny to measure and collect SAV and characteristics of riparian plant communities. The field survey campaign was coordinated with the JALBTCX team's remote imaging (airborne hyperspectral imagery and topobathymetric lidar) over the same area. Biologists from the USACE's Pittsburgh District office provided the jet boat and logistical support for the team.

Ephraim Zimmerman

PNHP's Scott Schuette and the USACE's Riparian Forestry crew, led by Nathan Bean and Molly Reif, assessed forest habitat structure on the islands and forested banks of the Allegheny using various measurement tools to ground-truth maps using high-resolution aerial images.

After a day spent working together to get our bearings and introduce the out-of-staters to the Allegheny River ecosystem, the group split into two teams – one team collecting SAV and the other focusing on forested and non-forested floodplain communities. Using the USACE's jetboat, the SAV team, recorded over 600 points within the study area, mapping dense beds of water celery (*Vallisneria americana*) in the deeper channels, scrub-brush-like riverweed (*Podostemum ceratophyllum*), which was tightly attached to river cobble in the shallow, swift-moving current, and the curtain-like stands of pondweeds (*Potamogeton nodosus, P. illinoiensis, P. zosteriformis*) and waterweed (*Elodea canadensis*) at the heads of islands in the channel.

Brian Daggs

Water celery (*Vallisneria americana*)

Noah Yawn

PNHP's riparian vegetation team Noah Yawn, Ephraim Zimmerman, and Scott Schuette accessed sites by canoe to collect plant species composition data from open riparian wetlands along the Allegheny.

The riparian team took to canoes supplied by Allegheny Wilderness Outfitters and paddled downstream in the study area each day. In all, the group recorded over 400 points representing specific plant communities and stands of emergent and floodplain species. Riparian points included simple observation of large patches of a single species and detailed plots representing the herbaceous, shrub, and forest plots seen along the river. We identified a number of higher-quality examples of Silver Maple – Floodplain Forest supporting rare and uncommon plant species such as tufted hair grass (*Deschampsia caespitosa*), green dragon (*Arisaema dracontium),* and sweet Indian plantain (*Hasteola suaveolens*), as well as sites invaded by Japanese and Bohemian knotweed (*Reynoutria japonica, R. x bohemica*).

Ephraim Zimmerman

Sweet Indian plantain (*Hasteola suaveolens*)

There was a notable absence of the Big Bluestem – Indiangrass River Grassland, a riverscour prairie-like community endemic to the Middle Allegheny. It is not clear why this type is not present in this stretch of the river. However, this type appears to be limited to the river floodplain downstream of the confluence of several other large creeks and rivers, such as French Creek, Oil Creek, and the Clarion River where the velocities and volume of the river are high enough to deposit substrate and create shoals and broader floodplain habitats. Graminoid (grass-like plants) dominated communities were present, however, composed of large tussocks of Emory's sedge (*Carex emoryi*) and prairie cord grass (*Spartina pectinata*). However, the invasive species reed canary-grass (*Phalaris arundinacea*) was also present, invading this and other floodplain types, forming dense monocultures.

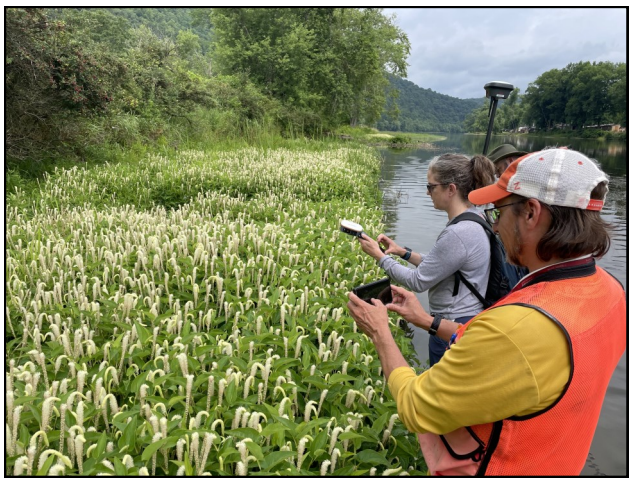
Ephraim Zimmerman

One of the more interesting natural plant communities documented in the survey area along the Allegheny River was a large graminoid dominated scour grassland, where floodwaters and ice scour limit the growth of trees and woody plants.

As a follow-up to previous studies in the Allegheny River by PNHP which characterized rare species habitats, a 2024 study is quantifying the freshwater mussel populations in the study reaches downstream of Kinzua Dam. The JALBTCX airborne data will be applied to models of mussel habitat, used to map floodplain vegetation and SAV communities, and improve inland bathymetric lidar data collection and processing in riverine environments.

Conclusions

This section of the Upper Middle Allegheny River remains a focus of our work. We will analyze the data over the next few months and provide the results to the USACE. ERDC will develop detailed maps using both the field collected and remote sensing data. The ground-truthed occurrence data will enable ERDC to develop detailed maps using simultaneously collected airborne hyperspectral imagery and topo-bathymetric lidar data by the JALBTCX. This will provide an improved method to consistently monitor terrestrial and aquatic riparian environments and restoration and maintenance activities below large USACE-operated dams in the region. The SAV and riparian plant community data will be used to inform the Pennsylvania



Ephraim Zimmerman

The team collects the location of a large patch of lizard's tail to identify the signature from aerial imagery.

Community Classification, in which we are proposing to add three SAV community types and one additional riparian grassland type. Estimates of freshwater mussel population sizes and ecosystem services also can be measured against changes that may occur with the implementation of ecosystem maintenance flows.

Additionally, the products and methods from this research further support the SRP and other planning efforts to improve riparian/SAV habitat evaluation and monitoring of impacts associated with all USACE restoration efforts. Specifically, the data will be useful for USACE District planners and local partners looking to inform and better link restoration or operational impacts, such as those connected with riverine restoration projects or environmental flow (e-flow).

Noah Yawn

Morning mist on the Allegheny River

About the Authors

Ephraim Zimmerman is the Science Director for the Pennsylvania Natural Heritage Program, where he has worked for 21 years. He received his B.S. in Wildlife Biology from Colorado State and an M.S. in Forest Ecology from the University of Michigan. With PNHP, his primary focus has been on plant community inventory, mapping, and classification.

Mary Walsh has been with the Pennsylvania Natural Heritage Program for 22 years as an aquatic zoologist and currently serves as the Programs Invertebrate Zoology Manager. She has a B.S. in Ecology, Ethology, and Evolution from the University of Illinois and an M.S. in Ecology from Pennsylvania State University. She also coordinates the iMapInvasives program for PNHP, which focuses on tracking and controlling invasive plant and animal species in Pennsylvania in collaboration with the PA Department of Agriculture, PA Department of Conservation and Natural Resources, and NatureServe.

Molly Reif is the Geospatial Data Analysis Team Lead in the ERDC's Environmental Laboratory and stationed at the JALBTCX in Mississippi. She has a B.A. and M.A. in Geography from the University of Arkansas. Her research focuses on evaluating airborne and spaceborne imagery and lidar for terrestrial and aquatic vegetation characterization to support USACE Civil Works.

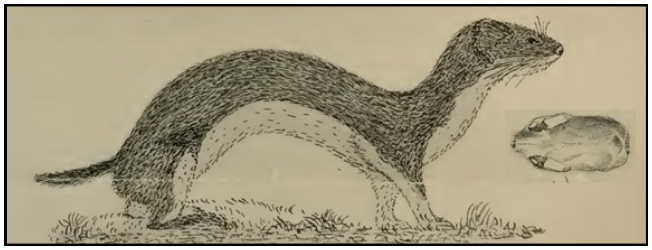
Surveys for "Stinky Fighters" in Western Pennsylvania

by
Charlie Eichelberger, Vertebrate Zoology Manager
Ryan Miller, Zoologist
Lauren Sherman, Zoologist

Charlie Eichelberger

Some Native American cultures have viewed weasels as omens bringing wealth and power and have prominently incorporated weasel skins into clothing and adornments.

In western culture, few animals have been as vilified as weasels. Exaggerated descriptions such as "blood-thirsty" or having "a lust for killing" and "thorn-like teeth" have helped form an unfair character assassination of the group, and today many still consider the weasels vermin. The word "weasel" itself is used in English to describe a deceitful or treacherous person, and such slanderous descriptions have unfortunately tainted what we truly know about weasels and the roles they play in ecosystem function. In contrast to how western cultures have viewed weasels, certain Native American peoples revered them as omens bringing wealth and power, and frequently used weasel skins prominently in clothing and adornments. Perceptions are changing, and just as the public's view of predators such as the larger canids, felids, and ursids has shifted away from universal vilification, the mustelids have slowly been regaining their respect as our fellow mammalian neighbors.



Rhoads 1901

The first description of least weasel in Pennsylvania was made by S.N. Rhoads in 1901 from Washington County. The species has been described as "pencil long" with a "skull the size of a jelly bean."

The least weasel was first described by Carl Linnaeus (1766) from Sweden and was found to have a Holarctic distribution with specimens described from North America (Saskatchewan) by Outram Bangs (1896). Bangs dubbed the least weasel as *Putorius rixosus* or "stinky fighter" due to their musky odor and fearless predatory behavior. Five years later, Samuel Nicholson Rhoads of the Academy of Natural Science, found the least weasel in Pennsylvania and described it as *Putorius allegheniensis*; a separate species from *rixosus* based on the vast distance from Bang's locality and slight differences in body measurements. For now, all least weasels from across the northern hemisphere are currently recognized as *Mustela nivalis*.

John MacGregor

The least weasel is the smallest carnivore in the world and is characterized by a short tail without a black tip. Their diet consists primarily of small mammals and they may take voles weighing more than they do!

The first focused study of the least weasel in Pennsylvania since Rhoads's description was carried out by famed ornithologist George Miksch Sutton of the Pennsylvania Game Commission (PGC) in which he coarsely mapped the location of least weasels reported through the bounty system from 1925-1929. This effort was later repeated by Neil Richmond and Robert McDowell as part of the PA Mammal Survey, examining bounty submission data from 1948-1951. The combined map from these two studies showed the least weasel's stronghold as the western third of the state with a few observations from central and northern Pennsylvania along the New York border as far east as Bradford

County. Richmond and McDowell were also able to use their data to calculate the relative abundance of the least weasel to the other two species of weasels, the long-tailed weasel (*Neogale frenata*) and American ermine (*Mustela richardsonii*). They found the relative abundance of the least weasel to other weasels was only1.6%. Until our recent efforts, this 1952 survey was the last dedicated study of least weasels in the state, making it one of Pennsylvania's most neglected mammals.

Image from Kosack 2023

From 1915-1935, weasels made up 83% of all the skins submitted for bounty in Pennsylvania, and this 1923 photograph displays a catch of eight specimens which would be worth approximately $220 in todays dollars. Despite an annual average of over 52,000 weasels submitted during the bounty program, weasel populations were so high that the system proved ineffective at controlling their populations. Today, sightings, let alone harvest of a single weasel, are fairly uncommon occurrences. Note that none of the weasels pictured here are least weasels.

Today, the PGC summarizes weasel harvest through their Furbearer Population and Harvest Monitoring reports. Data from the historic bounty system can be broadly compared to these modern harvest reports as long as we acknowledge the substantial differences motivating how the data were collected, including influencing factors such as the Great Depression, fuel prices, and pelt values. Although these are two very different datasets, from a very high-level, the data suggest a rather dramatic decline in the relative abundance of weasels when comparing early 20th century (1915-35) to contemporary (1985-2022) harvest data. The change in relative abundance compared to other mammals show a -99.2% change for the weasels. Other analyses of weasel specimen and record submissions from Pennsylvania further support the downward trend, and a recent study of similar weasel data from across all of North America echo similar alarming declines of between 87% and 94% (Jachowski et al., 2021).

Charles Bier

We prioritized surveys for least weasels, around "recent" (less than ~20 years old) records and observations, such as this least weasel kit in a nest found beneath a corrugated metal coverboard in a meadow in Sarver, PA on May 4, 2010. Note the very right side of the frame included a freshly dead meadow vole (*Microtus pennsylvanicus*).

This apparent decline in weasels has led to a renewed interest in assessing populations in Pennsylvania; particularly focusing on the presumed scarcest species, the least weasel. Over the past two years a collaborative effort between PNHP, PGC, and other cooperators was conducted to test different passive detection methods for weasels using game cameras. This project was aimed at conducting surveys near the most recent and historic records of least weasels, and to help develop passive camera trapping protocols for all weasel species.

With the results of a small pilot project in hand, we settled on testing three different game camera survey techniques, setting clusters of different camera arrangements to test the efficacy and efficiency of each technique at weasel detection. Our arrays consisted of an Ammostela can set, a bucket set, and an oblique set.

Charlie Eichelberger

Our arrays consisted of an oblique trap (left), an Ammostela (center), and a bucket trap (right).

The Ammostela is based on a European trap design and consists of a large ammunition can housing a game camera focused on a double-sided entry way. The camera captures side-profile images of animals entering the Ammostela traps. The bucket set was similar to the Ammostela in that it contains an enclosed camera with a double-sided entry way, except that the camera is affixed to the bucket lid, offering a top-down view. Both of these sets were baited with commercial trapping lure and some included Kill Squeak audio lures which periodically emit the sounds of rodent squeaks. The oblique set consisted of a game camera facing a PVC tube baited with commercial trapping lure and an overhanging bait. All three camera sets contained a scale bar to allow us to identify photographed weasels to species… not as easy of a task as one might think since there is some size overlap between species depending on the sex and age of individuals. We placed our arrays in potential habitat for approximately 60 days and collected photo cards every 20 days when we refreshed the bait.

PNHP

A least weasel detected in an Ammostela trap in Erie County.

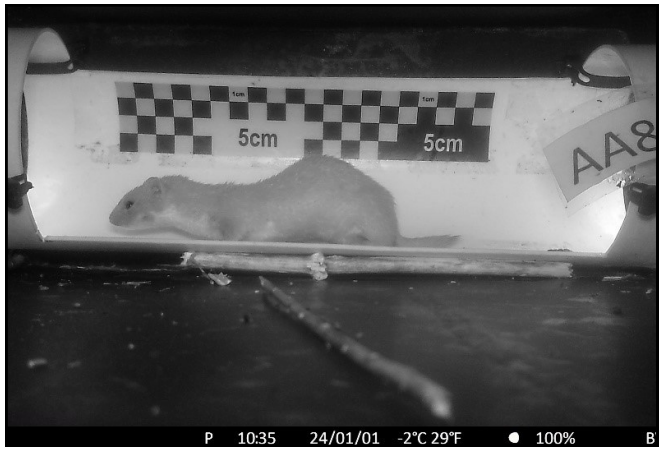
Twenty-one locations in 11 counties were surveyed through this effort, with a total of 179 arrays run totaling 23,395 trap nights. Our surveys collected 740,029 images which all needed to be reviewed. Weasels visited the traps 229 times, resulting in1,981 total weasel images. Nineteen of those visits were of least weasel represented by 348 least weasel images. Four of our Ammostela traps were visited by least weasels, including three from a site in Erie County and one from a site in Indiana County. Although we followed up on most of the recent least weasel records and observations mapped in preparation for our surveys, least weasels were only detected at one of those sites.

Charlie Eichelberger

The habitat where least weasels were detected in Erie County.

At the Erie County site, we captured a least weasel on camera nine times from December 2023 through March 2024. After the initial detection, we moved four other traps to within about 50 meters of the trap where it was first detected to collect more information on the movements of that weasel. Only after 81 additional survey days was the weasel recorded from traps in proximity to where it was originally recorded. The habitat at this site is a goldenrod-dominated (*Solidago* spp.) meadow with thick thatch supporting a high small mammal prey base. Published accounts suggest that least weasels rarely need to hunt more than 50 meters from their burrows as long as food sources are plentiful. These results from Erie County support the thought that in Pennsylvania, least weasels have small hunting territories and that they require large amounts of survey effort to detect.

PGC regional Wildlife Biologist, Justin Duncan, also captured least weasels on camera in an Ammostela trap at the end of December 2023 in Indiana County. Least weasels were recorded from the same trap seven more



Justin Duncan

A least weasel in an Ammostela trap set in Indiana County.

times until the trap was moved to another location at the end of January. The habitat at this site is also a goldenrod dominated meadow, with thick fence rows bisecting the open habitat.

In reviewing just our least weasel detections, encounters consisted of 17 average images collected, with 79% of those encounters occurring during daylight hours, and 60% from sunrise to noon. No clear hunting activity patterns are evident and least weasel activity is more likely driven by metabolic demands rather than diel activity patterns.

Fero Bednar

A least weasel with its microtine meal. Some least weasel individuals will molt their pelage into a pure white form during the winter months.

Our recent survey effort was the first dedicated to detecting least weasel in the state in 70 years, and while the team learned a lot through the surveys, our limited results make it clear that least weasel need more study in Pennsylvania to better assess where populations are and how they're doing. All indications are that they are difficult to detect and likely support the conclusion that the species has become quite scarce in Pennsylvania. Future efforts to survey for weasels will pair our bucket sets with drift fencing, a technique being used to "capture" difficult to detect species of mammals and herptiles. In addition to more survey work, we also owe our "stinky fighters" a revision of their persona; away from the negative hyperbole playing on fears and towards the respect for the important roles they play in the balance of Pennsylvania's ecological systems.

About the Authors

Charlie Eichelberger has been with the PNHP for 19 years, currently serving as the Vertebrate Zoology Manager. His work is primarily focused on secretive and undersurveyed mammals and herptiles. He loves his job, and the people he works with.

Ryan Miller has worked for the Heritage Program for 18 years and is the staff Zoologist for the Pittsburgh Office. He has an Associates Degree in Wildlife and Fisheries Management from WVU and a Bachelor's degree from Clarion University. His projects include the eastern massasauga rattlesnake, green salamander, and freshwater mussels.

Lauren Sherman joined the PNHP as a Zoologist in June of this year. Her previous experience has focused mainly on amphibian species and birds, but she's eager to jump into some exciting mammal projects with PNHP.

Notes from the Field

Bountiful Bryophytes

Scott Schuette, Botany Manager

This field season proved bountiful for finding a bundle of neat bryophytes. With a number of ongoing projects investigating old growth forest diversity, globally rare shale barren plants, and riparian communities along the Allegheny River, PNHP bryologist Dr. Scott Schuette collected and verified several new records of rare bryophytes in Pennsylvania.

Noah Yawn

Hooker's sharp-leaved moss has a very specific microhabitat in southwestern Pennsylvania where it may be found growing at the base of large sandstone boulders that have groundwater seepage and maintain, cool moist conditions year round.

For starters, PNHP ecologist Noah Yawn found another "new" population of Hooker's sharp-leaved moss (*Hookeria acutifolia*) while conducting old growth forest assessments at Bear Run Nature Preserve. This the second discovery of an endemic moss that hadn't been seen or collected in Pennsylvania since the 1940s. Another rare moss, Andrews' bracted squirrel-tail moss (*Leucodon andrewsianus*), was collected from an old growth white oak tree growing on one of Pennsylvania's premier shale barrens, representing a new locality in the state bringing the total number of extant occurrences to seven. This species grows on mature white oak and ash trees, generally associated with old growth forests or other late successional woodlands.

Similarly, we found feathery Neckera moss (*Neckera pennata*) growing on a gnarly beech tree at Heart's Content Recreation Area in the Allegheny National Forest. This species is widely used as an indicator of old growth forest stands. The collection data would support this. *Neckera* was mostly collected in the late

Erik Danielsen, https://www.inaturalist.org/

Andrews' bracted squirrel-tail moss (*Leucodon andrewsianus*) is another likely mature forest indicator that grows primarily on white oak and other low- tannin hardwoods. This species is easily identified in the field by the presence of numerous little leafy propagules growing from the axils of leaves giving it a fuzzy tail look.

1890s, but then collections seem to stop until the early 2000s suggesting that some forests had trees reach the appropriate size and age for new populations to establish.

Finally, a collaborative project with the Army Corps of Engineers to classify riparian plant communities along the upper middle Allegheny River provided an opportunity to survey large river islands for rare plants and plant communities. During these surveys we found all three species of hornworts known from Pennsylvania. These species are all considered rare in the state, but this is largely due to their ephemeral life

Noah Yawn

Feathery Neckera moss on shade grown beech bark in Hearts Content Recreation Area of the Allegheny National Forest is a bona fide mature forest indicator that is distinguished by the flat, wavy leaves along the stem.

history strategy of growing on moist, exposed sandy soils associated with stream and river banks. They become apparent when water levels recede, giving the spores an opportunity to germinate and complete the plant's life cycle before autumn rains raise the water levels.

The discovery of these new bryophyte occurrences demonstrates the importance of getting out and looking around the special places in Pennsylvania. These reports are important to our understanding of the bryodiversity of a given area. This accumulated knowledge is captured in species checklists such as one recently published in Evansia the bryophyte field journal of the American Bryological and Lichenological Society. Dr. Schuette co-authored this publication with Dr. Don Davis, a retired professor from Penn State University. This collaborative publication (https://doi.org/10.1639/0747-9859-41.2.57) increased the number of bryophytes known from 49 to 100 species in Perry County and identified five of those to be of conservation concern. Ultimately, the more we look, the more we find and that helps PNHP direct our efforts to the conservation of these small, but resilient plants.

Dispatch from the Coastal Plain: Return to the Oldenlandia

Rachel Goad, Botanist

The Atlantic coastal plain is a region of flat, low-lying land that borders the eastern coast of the U.S. and it hosts an incredible diversity of plant species. Pennsylvania's southeastern corner includes a very small slice of coastal plain, and while much of it has been impacted by urbanization, fragments of this habitat and its plant associates remain. Some Atlantic coastal plain species reach their northern limits in southeastern Pennsylvania and are considered threatened or endangered.

One such species is clustered mille grains (*Oldenlandia uniflora*) – an imperiled species that is proposed as endangered in Pennsylvania, and which reaches its northern range extent in Pennsylvania, New Jersey, and New York. This annual member of the coffee family lives in muddy drawdown zones of pond shores and seasonal ponds of the coastal plain. It has hairy stems and opposite leaves with sessile flowers in its leaf axils. With just one known occurrence in Pennsylvania, PNHP botanists have been seeking to determine whether the species still occurs in the state.

Claire Ciafré

Flowers of *Oldenlandia uniflora*

Rachel Goad

Oldenlandia uniflora on a muddy pond shore.

We connected with an expert from Delaware – a state with much more coastal plain habitat than Pennsylvania – to prepare for the search. Bill McAvoy is the state botanist of Delaware, and while he is nearing retirement, his energy and enthusiasm for plants and their conservation isn't waning. He generously took ecologist Claire Ciafré and me on a whirlwind trip to visit a number of species of interest in Pennsylvania to where they're found in Delaware, just south of Pennsylvania's border. While we didn't manage to find *Oldenlandia* during that trip, we spent time in its preferred habitat and discussed its habit, life-history, and phenology, all of which were helpful in understanding the species and mounting a more effective search.

Back in Pennsylvania and armed with more information, we visited our site and spent time looking intensely for *Oldenlandia*. Claire Ciafré noticed the presence of our tiny target in a muddy drawn down pond shore. We also found less abundant, but larger plants in moist depressions elsewhere on site, giving us an appreciation for the adaptability of this little annual. We eventually recorded thousands of plants present at the site. It's likely that the size of this population fluctuates from year to year based on hydrological conditions, but for now, we're glad to report that it still occurs here in the commonwealth.

Community Scientists Survey for Invasive Jumping Worms

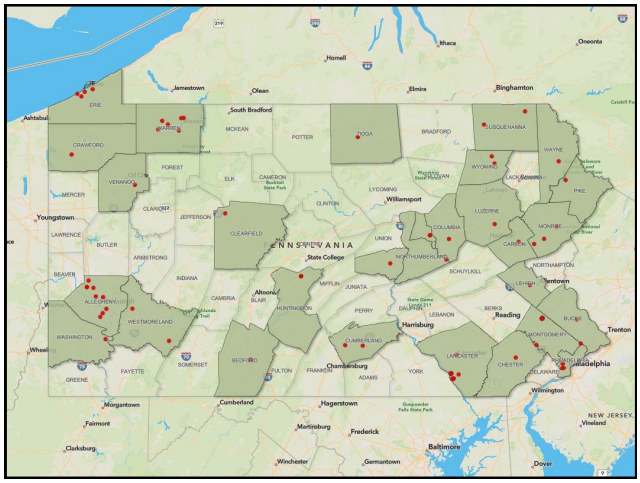
Amy Jewitt, PA iMapInvasives Program Coordinator

In July 2024, the Pennsylvania iMapInvasives Program hosted a new volunteer event called the Jumping Worm Jamboree. This statewide survey encouraged natural resource professionals and community scientists to get outside and search for invasive jumping worms (*Amynthas-Metaphire*) in Pennsylvania and report their findings to iMapInvasives.

Kirk Wattles, Penn State Master Gardener

Jumping worm shown next to nickel.

Though relatively new to the general public, this invertebrate invader has been present in the landscape for some time and can be found in yards, gardens, parks, and natural areas. According to data from iMapInvasives, confirmed reports indicate that 29 counties currently have populations of this soil-dwelling species, with two of those counties (Chester and Philadelphia) being newly recognized based on participant data collected during the 2024 Jamboree. A total of 17 people participated in the Jamboree with surveys occurring in 14 counties. Participants gained valuable insight into the harm caused by jumping worms from a virtual training provided by iMapInvasives staff and Dr. Annise Dobson of Yale University and Yale School of the Environment.



Megan Kresse

The current distribution of invasive jumping worms in Pennsylvania according to data from iMapInvasives.

One event participant, Mike Estep, provided the following excerpt based on his participation in the event: *"The need for focused observation means we take in the landscape with greater attention to detail. In doing so, we discover more than just invasive species - we experience the richness of nature in a way that transforms an ordinary walk into a deeply insightful encounter with the world around us."*

Learn more about the results of the 2024 Jumping Worm Jamboree in the following ArcGIS StoryMap: https://storymaps.arcgis.com/stories/603398daeb34455a86158dec06ad4865.

New and Noteworthy 2024 Field Season Finds

Noah Yawn, Ecologist

The 2024 field season was very rewarding, especially because I was able to work in a variety of habitats across western Pennsylvania. I was lucky to find a handful of novel populations of state-tracked threatened and endangered plant species this summer.

Noah Yawn

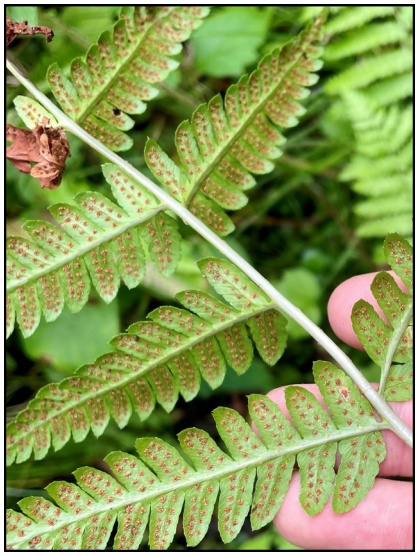
Clonal gametophytes of the Appalachian shoestring fern (*Vittaria appalachiana*) under a sandstone rock overhang.

Alongside the rest of the PNHP ecology team during old growth site assessments, as well as other fieldwork, I located three new occurrences of the enigmatic Appalachian shoestring fern (*Vittaria appalachiana*), which is only known to exist as a clonal gametophyte and lacks the ability to produce reproductive sporophytes. This peculiar species may turn out to be more common in the unglaciated areas of Pennsylvania than previously thought, given its inconspicuous bryophyte-like appearance within sheltered rock bluff habitats.

Noah Yawn

Northern yellow lady's slipper orchid (*Cypripedium parviflorum* var. *makasin*) in fruit.

While working on iMapInvasives surveys alongside invasive species ecologist Brian Daggs in northwestern Pennsylvania, I was ecstatic to find three state rarities within a high-quality hemlock palustrine forest woodland—one of my favorite habitats to explore. The most surprising was a new location for northern yellow lady's slipper orchid (*Cypripedium parviflorum* var. *makasin*), which had many healthy plants and a few stems that had successfully produced seed pods. I also found a handful of northern green orchids (*Platanthera aquilonis*), which are only known from a few sites in northwestern Pennsylvania and serve as an indicator of high-quality habitat. Both of these orchids are reportedly declining in the southern parts of their respective ranges due to a number of factors, and so finding healthy occurrences of each was quite exciting and encouraging. Clinton's wood fern (*Dryopteris clintoniana*) is another species that I always keep an eye out for in high quality palustrine forest areas, and this was no exception. I found new occurrences for this species in two separate wetland complexes, each of which had dozens of healthy, reproductive plants.



Noah Yawn

Clinton's wood fern (*Dryopteris clintoniana*) is readily identified by its sori pattern.

The Rediscovery of an Elusive Tick-Trefoil

Claire Ciafré

In April 2023, members of the Pennsylvania Vascular Plants Technical Committee voted to change the proposed status of stiff tick-trefoil (*Desmodium obtusum*) from endangered to extirpated. This decision was not made lightly, and was based on a re-evaluation of herbarium specimens across the state, numerous unsuccessful surveys for it at its historic localities, and an assessment of all observations in the genus uploaded to iNaturalist. The species was last seen in 1996, but it hadn't been seen since and no appropriate habitat for it remains at the site.

Claire Ciafré

The segmented fruits are helpful for distinguishing stiff tick-trefoil from tall tick-trefoil, with which it co-occurs.

Several months after it was declared to be extirpated, New York botanist Steven Daniel visited a Pennsylvania serpentine barren and picked a trail at random. As he hiked he documented the organisms he saw using iNaturalist. One of these was of a tick-trefoil he knew he'd never seen before, so he gave it a genus-level identification hoping someone more familiar with the genus could identify it on the platform. When I saw the observation six days later, I immediately recognized it as stiff tick-trefoil.

I visited the site this year to relocate and confirm the plants and collect data on the population. Even though Steve told me that he suspected that "it is hiding in plain sight, and you will find more when you survey there," I was unprepared for the number of plants I found. After a day of surveying just a portion of the site, I found 435 individuals in seven distinct clusters, and more are likely to be found elsewhere nearby. The species was last collected from the site on September 25, 1932.

While it may seem incredible that the species had been overlooked at a well-visited site for so many years, the plants are easy to miss among other plants even when it is most visible. This rediscovery highlights the important

contributions of sharp-eyed community scientists and suggests that other historic populations of the species could still be re-found.

An Ironclad Old Growth Indicator

Claire Ciafré

PNHP staff have been investigating species closely associated with old forests to help us to better understand their importance for increasingly rare animals such as Swainson's thrush and green salamander. Recognizing these close relationships and potential old growth indicator species can help us identify "new" tracts of potential old growth forest that have previously gone unnoticed. However, some potential old growth indicators may be easily overlooked. For example, several species rely on the abundance and composition of fungi present in old growth forests to survive.

Woody bracket or shelf fungi, also known as conks, are perennial fruiting bodies that can persist and grow for months to years. Beetles not only feed on bracket fungi, but they also burrow within them to lay eggs, develop as larvae, and/or overwinter. The brackets are so important that horned fungus beetle (*Bolitotherus cornutus*) males fight with one another for large, high-quality brackets in the genus *Ganoderma*. Larger brackets can support more offspring, and so females prefer to mate males which have claimed the biggest fungi. If the forest these beetles inhabit is logged, the regenerating trees can't yet support the bracket fungi and the beetles must fly to a new forest stand to live and complete their life cycle. It can take dozens of years for some fungi to re-establish in a stand, and the beetles will not return without them.

Mary Ann Furedi

Claire Ciafré perches on a sturdy shelf fungus to reach an eastern ironclad beetle on the fungi above her.

However, not all beetles are capable of leaving or returning when their forest is logged. The eastern ironclad beetle (*Phellopsis obcordata*) cannot fly, and it requires bracket fungi in the genus *Fomitopsis* to successfully live and reproduce. *Fomitopsis* strongly prefers mature, dead trees, and typical logging practices prevent trees from reaching the stage where they can support the fungus for long. If the fungus is no longer continuously present in a stand in sufficient amounts, the eastern ironclad beetle is unable to disperse to where the fungi are still present and the beetle population dies. The beetle, once widespread in the eastern United States, now appears to be in severe decline and limited to old growth and possibly old second growth forests. It is therefore considered to be an excellent indicator of old forest conditions.

Claire Ciafré

An eastern ironclad beetle feeding on the underside of a bracket fungus.

There are only five known recent records of the eastern ironclad beetle in Pennsylvania, the latest of which was found by PNHP staff during surveys in an old growth tract of Bald Eagle State Forest. The beetles can be reclusive and might hide under bark, but they can sometimes be found feeding on the bracket or perched nearby. As its name suggests, the beetle has a highly-armored appearance because of its ornately sculptured carapace. The forked fungus beetle also has an ornate carapace and can be confused for this species, but the eastern ironclad beetle is much flatter. Eastern ironclad beetle isn't yet tracked by PNHP, but it will be soon, so please report them if you see one!

Assessment work at Forrest H. Dutlinger Natural Area

Mary Ann Furedi, Ecological Assessment Manager

Mary Ann Furedi

Abundant hemlock and fern edge Beech Bottom Trail, one access trail into Forrest H. Dutlinger Natural Area.

During the 2024 field season, PNHP ecologists continued work on the old growth forest project. This ongoing project focuses on documenting and characterizing older growth forests in Pennsylvania. One target site for 2024 was the old growth tract within the Forrest H. Dutlinger Natural Area (abbreviated as Dutlinger NA). Dutlinger NA is a 1,521 acre tract located in Clinton County. It is part of the much larger Hammersley Wild Area contained within the Susquehannock State Forest. The area was named after Forrest H. Dutlinger, a pioneer in forestry in Pennsylvania who dedicated over 50 years of service to the commonwealth. This old growth tract received some celebrity status earlier this year when it was officially inducted into the Old-Growth Forest Network.

The approximate 158 acre Dutlinger tract has an interesting history. Although many of the trees in the Hammersley Wild Area were logged in the early 20th century, the tract was spared due to a boundary dispute between logging companies. What remains today is a stand dominated by eastern hemlock (*Tsuga canadensis*) of varying sizes along with hardwood species like red oak (*Quercus rubra*), red maple (*Acer rubrum*), and birches (*Betula* sp.). During their old growth assessment, PNHP ecologists measured hemlocks with diameters of almost four feet! Some of the hemlocks are estimated to be nearly 400 years old.

Noah Yawn

Noah Yawn, a PNHP ecologist, demonstrating the large diameter of one of the many hemlocks found at the site.

Besides the presence of very large trees, our staff documented other characteristics associated with old forests like buttressed trunks and unique bark patterns, abundant downed woody material of varying decay classes, nursery logs, and landscape related features. Hemlock woolly adelgid (*Adelges tsugae*) was noted as one stressor that could dramatically impact the health of hemlocks at the site. Fortunately, DCNR Bureau of Forestry is aware of this issue and has been treating the trees to combat this infestation. It is hopeful that as we better understand the characteristics of old forests and recognize the threats they face, we can translate findings into management efforts to help these forest relics from the past continue to thrive into the future.

Noah Yawn

An example of a bryophyte covered nursery log with some tree seedling regeneration.

Although it is a more technical hike, the Dutlinger NA is accessible to the public and well worth the effort. Check out the following link for the Susquehannock State Forest Wild and Natural Areas to learn more. https://www.dcnr.pa.gov/StateForests/FindAForest/Susquehannock/Pages/Wild_NaturalAreas.aspx

Visit the Old-Growth Forest Network in Pennsylvania to learn about other old growth sites in the commonwealth. https://www.oldgrowthforest.net/pennsylvania.

2024 Mussel Restoration Activities

Nevin Welte, Mussel Biologist
Jordan Allison, Fisheries Biologist
Scott Ray, Species Recovery Biologist II

PNHP staff, partners, and cooperators were involved in multiple mussel restoration projects in 2024.

Common mussels

Efforts to restore Dunkard Creek's mussel fauna continued this field season with the addition of 4,867 common mussels at two Dunkard Creek restoration sites. The mussels were propagated, cultured, and uniquely tagged at Pennsylvania Fish and Boat Commission's (PFBC's) Union City Aquatic Conservation Center and included plain pocketbook (*Lampsilis cardium*), wavyrayed lampmussel (*L. fasciola*), and fatmucket (*L. siliquoidea*).

Mary Walsh

Fatmucket

PFBC and its partners at the Western Pennsylvania Conservancy (WPC) and PennWest Clarion University initiated a four-year NFWF-funded project to advance mussel restoration efforts in the Clarion and Kiskiminetas rivers. The NFWF project is building upon 2015 and 2016 efforts that stocked nearly 37,000 tagged mussels along 38 miles of river. In October, partners, along with the Pennsylvania Department of Conservation of Natural Resources and volunteers, stocked each river with 2,316 tagged two-year-old mussels. Three species, plain pocketbook, wavyrayed lampmussel, and fatmucket were stocked into study plots at each site to monitor growth and survival.

Rare mussels

WPC, PFBC, Maryland Department of Natural Resources (MDNR), the Commonwealth University of Pennsylvania Lock Haven, and the Susquehanna River Basin Commission initiated NFWF-funded active restoration efforts to restore freshwater mussels into the West Branch Susquehanna River.

Mary Walsh

Yellow lampmussel

Mussels were collected from several West Branch sites to serve as broodstock at MDNR's mussel propagation facilities. Mussels raised by Maryland will then be stocked upstream of the Lock Haven dam at up to ten reintroduction sites. In 2024, a total of 60 adult male yellow lampmussels (*Lampsilis cariosa*) were tagged and stocked at six of the reintroduction sites (10/site) upstream of Lock Haven. The survival, growth, and retention of these pilot mussels will be used to gauge the suitability of the relocation sites by assessing growth and survival in 2025. Additional restoration efforts that involve a common Atlantic coastal mussel, the eastern elliptio (*Elliptio complanata*), are anticipated in 2025.

Endangered mussels

PFBC and its partners the Pennsylvania Department of Environmental Protection (PA DEP) and the U.S. Fish and Wildlife Service (USFWS) White Sulphur Springs National Fish Hatchery have actively pursued recovery of the state endangered pistolgrip mussel (*Tritogonia verrucosa*). The 2024 pistolgrip stocking of Dunkard Creek, Allegheny River, and Ohio River represents the largest single stocking effort to-date. Settlement funds and the PA DEP have supported these projects.

Nevin Welte

White Sulphur Springs National Fish Hatchery pistolgrips about to be stocked into the Ohio River

Nevin Welte

PFBC divers preparing to stock pistolgrips in the Ohio River (left to right: Dakota Raab, Josh Arnold, Kyle Clark).

To date, Dunkard Creek has been stocked with 1,800 pistolgrip mussels produced in a joint effort by both the USFWS White Sulphur Springs National Fish Hatchery and the PFBC Union City Aquatic Conservation Center. Pistolgrip mussels have also been stocked into the Allegheny River and the Ohio River. A total of 10,285 USFWS-produced pistolgrips were stocked this year, including 1,500 into Dunkard Creek, 6,000 into the Allegheny River, and 2,785 into the Ohio River. An additional 1,700 pistolgrips are being cultured at the ACC for anticipated release in 2025.

An Endangered Species Success Story

Mary Ann Furedi, Ecological Assessment Manager

It is an infrequent event when a plant or animal is removed from the federal Endangered Species List. However, sometimes we have the opportunity to celebrate a species' recovery and delisting. This year, northeastern bulrush (*Scirpus ancistrochaetus*) became one of those success stories.

Mary Ann Furedi

Close-up of a northeastern bulrush inflorescence

Northeastern bulrush is a perennial sedge found in vernal pools, wet depressions, and marshes in Virginia, West Virginia, Maryland, Pennsylvania, New York, Massachusetts, and Vermont. The sedge was first listed as endangered in 1991 under the federal Endangered Species Act. At that time, only 12 extant populations and nine historical ones were known from across the species' range. Pennsylvania had only four reported northeastern bulrush sites at the time of listing. It was clear that the amount of information on this species was limited and that more was needed to guide future species reviews, conservation and management activities, or to further refine the species listing.

An increase in effort to better understand northeastern bulrush followed the federal listing of the species. In Pennsylvania, PNHP staff, along with other contributors, worked to expand the knowledge of the bulrush's distribution within the state. Through survey work, the number of known populations grew from four to the almost 100 populations known today. A long-term monitoring effort was established by PNHP staff that led to more detailed information on population dynamics and habitat requirements. Additional work was done by collaborators to examine the range wide genetics of the species and the bulrush's response to light and water availability. Collectively, this information was adequate to propose delisting of the species.

Mary Ann Furedi

PNHP staff will continue to track how altered precipitation patterns due to climate change affect northeastern bulrush populations.

PNHP staff are proud to have played a role in the success story of northeastern bulrush. However, our work isn't over yet. Our staff will continue to monitor northeastern bulrush to ensure that populations remain stable and thrive in Pennsylvania.

Mushroom Moments & Fungal Finds

Hannah Huber, Conservation Mycologist

The campaign has launched for Pennsylvania to finally adopt official state fungi. The Pennsylvania Biological Survey's Mycological Technical Committee gathered eight species nominations from the state's six mycology clubs and put forth a public survey to narrow down the

candidates and collect concerns and priorities. Committee members Pete Woods (PNHP) and lichenologist James Lendemer (New York State Museum) also identified a candidate for state lichen. While lichens represent symbioses between fungi, algae, and/or cyanobacteria, they are named based on the fungal partner (mycobiont) and therefore classified as fungi. Why does Pennsylvania need two official state fungi, both a state mushroom and state lichen? Well, California has both, and they are both prominent forms of fungi with important roles in the environment. If legislation can be successfully passed, Pennsylvania would be the eighth state with a state mushroom, and the second state with a state lichen.

Hannah Huber

Jerry Hassinger next to a hemlock reshi (*Ganoderma tsugae*)

Nearly 1,300 people responded to the survey. The hemlock reishi (*Ganoderma tsugae*) was the first place winner among all the major voting blocks – the mycology clubs, the foragers, the state agency-affiliated, and the wider public. With 88%, respondents also supported the Pennsylvania toadskin lichen (*Lasallia pensylvanica*) for state lichen. The lichen was described from Pennsylvania in 1801 and our state continues to see the bulk of the world's observations of this species. The hemlock varnish shelf helps decompose and recycle already dead or dying eastern hemlock (our state tree). Both the lichen and the polypore are easily identifiable even for beginners.

Species that could be identified by a beginner if they're prudent enough to find them are the target species of the Northeast Rare Fungi Challenge, created by the Fungal Diversity Survey. This year, community mycologists of Pennsylvania found three of the target species: the rooting tube-pore polypore (*Pseudofistulina radicata*), the Appalachian spindle coral (*Clavulinopsis appalachiensis*), and the yellowish-green Entoloma (*Entoloma flavoviride*). The observation of the rooting tube-pore polypore may represent a new population, whereas the other two come from previously known populations.

Barbora Batokova

Pennsylvania toadskin lichen (*Lasallia pensylvanica*).

Notably, when you DNA sequence fungi, "*every day* is a rare fungi challenge," says Stephen Russell, founder of the Mycota Lab, which is working towards a comprehensive inventory of North American macrofungi and receives specimens from mycology clubs all over to support this mission. If the DNA of a specimen doesn't closely match any species in DNA data repositories, Stephen labels it with a "temp code," a placeholder, to indicate that it could be a new species, or it could be a previously described species whose type collection is buried in a fungarium and hasn't yet been DNA sequenced. There are roughly 670 uniquely temporary-coded, DNA-sequenced mushroom observations in Pennsylvania on iNaturalist. Over 400 of those were 2023 observations, and so far, 12 are new this year (DNA results tend to lag for at least several months).

Finally, the Pennsylvania Natural Heritage Program website now has a page under Resources dedicated to fungi, including a mycology club directory, links to the Northeast Rare Fungi Challenge and the PABS Mycological Technical Committee's resources, and information on becoming more mycologically-inclusive linguistically. There's "mushroom" for additional content to come!

The Value of Negative Surveys

Pete Woods, Invertebrate Zoologist

"Never be so focused on what you're looking for that you overlook the thing you actually find." This quote from author Ann Patchett applies to field surveys just as well as it does to other aspects of life. I was thinking about this quote after I had a long streak of "negative" surveys this year, surveys where I didn't find the rare insect I was seeking. Negative surveys are not a bad thing – it is important to collect data about where a species does NOT occur. Also, if we find a species

every time we look for it, it probably isn't rare enough for us to be tracking. But I was thinking about this quote because even when I don't find my primary target, I know there is always something to be found, often a different rare species. Here are a few examples:

While searching in vain for Appalachian grizzled skippers this spring, I drove by some patches of Carolina wood vetch (*Vicia caroliniana*) and stopped to look for ants on them. The ants led me to caterpillars of the Appalachian silvery blue butterfly (*Glaucopsyche lygdamus* ssp. *lygdamus*), a specialist on Carolina wood vetch whose caterpillars feed honeydew to ants in exchange for their protection against predators.

Pete Woods

A caterpillar of the Appalachian silvery blue, on Carolina vetch, being tended by an ant.

During a different but equally unsuccessful search for Appalachian grizzled skippers, I stopped at a roadside patch of wild yam (*Dioscorea villosa*) in Buchanan State Forest because our collaborator Tony McBride of the New Jersey DEP recently discovered that this is the host plant of the brick red borer moth (*Papaipema marginidens*). This moth had always been a mystery to us, and was impossible to find as a caterpillar, because we didn't know what plant to look on. Some of the wild yam shoots were wilted at the tip, and inside each wilted tip was a single recently hatched caterpillar, which turned out to be a brick red borer.

Later in the spring, while failing to find northern barrens tiger beetles (*Cicindela patruela*) at a reclaimed coalfield in Indiana County, I found common roadside skippers (*Amblyscirtes vialis*). Despite the common name, these skippers are not at all common in Pennsylvania. The skippers were using the big bluestem grass (*Andropogon gerardii*) that had probably been planted as part of the reclamation efforts.

As a general rule, interesting or unusual habitats support interesting or unusual species, and PNHP biologists try to be prepared to recognize whatever they find, even if it is not what they were looking for.

Vernal Pool Hydrology Monitoring: Cheap, Speedy, and Fun with Friends

Betsy Leppo, Invertebrate Zoologist

The Pennsylvania Natural Heritage Program has been working with partners to monitor the health of thirty vernal pools located within two state parks in Pennsylvania. One of the most important qualities of a vernal pool is its hydroperiod, which includes the depth of the water in the pool basin, and the timing and duration of its dry phases. Getting consistent information on hydroperiod can be challenging and time consuming, but technology can help. In 2022, we obtained a Healing the Planet grant from Keep Pennsylvania Beautiful and the Giant Company. We used this grant and matching funds to purchase the supplies needed to set up photo and water depth monitoring stations.

In order to monitor hydroperiod, we installed water depth gauges in all the pool basins. Each gauge has a small temperature and light sensor that rests on the bottom of the pool. These units are relatively cheap, easy to install, and collect a consistent set of data. Once the pools dry up in the fall it is easy to walk into the pool basin and retrieve the sensor data with a cell phone app and a Bluetooth connection.

Betsy Leppo

A water level staff gauge for CrowdHydrology, a citizen science program used by 'Adopt-a-Pool' volunteers and casual park visitors to document seasonal water level changes. The data are open access and available for download from http://www.crowdhydrology.com/.

Photographs taken from a Chronolog station showing the same vernal pool in a dry period (top) and near maximum depth (bottom).

We have downloaded the first year of data from many of the pool basins and are beginning to explore the results. The sensor data works well for identifying periods of low or no water in the pool basins. The Chronolog photos and the CrowdHydrology water depth data collected by trained volunteers and other park visitors correlate nicely with the sensor data, and help to confirm and clarify the readings we are getting from the sensors. Thank-you to the Friends of Pinchot and the Penn State Master Watershed Stewards who have 'adopted' vernal pools and did an outstanding job monitoring them this year!