Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

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Photo Banner:
Lowville fen, sundew on sphagnum hummock

Jessica McPherson

Pennsylvania Fens

Ancient Biodiversity Hotspots on the Edge of Survival

by

Jessica McPherson

A fifth century farmer awakens one morning in the East Anglia region of modern-day England, looks out over an expanse of grassy wetland, and tells their family "we're moving the cows to the fen today" or perhaps, "we're cutting hay off the fen today." They would have been speaking Old English, so most of the words would have been quite different, but the word "fen" would have been the same. It has been in continuous usage for over 1500 years. What did the farmers see when they looked at this wetland? Did they perceive the remarkable number of different kinds of plants inhabiting the fen? Did they notice that small white flowers with delicate green veins tracing the petals thrived in the wake of the cattle grazing, and did they have a name or a use for them? Maybe they called the water "sweet," or had some other colloquial term to describe its mineral-richness and the effect the water had on the hay they grew there. Did the word "fen" mean any or all these things, to our fifth century residents?

Today ecologists define fens as wetlands where water flow is nearly continuous throughout the year, sourced primarily from groundwater rather than surface runoff, flooding, or rainfall. Although historically there has been a strong association of the term "fen" with high pH wetlands, today fens are often defined by water source then further qualified based on their pH. When the groundwater flows through calcium-rich materials before reaching the wetland, it creates a high pH, mineral-rich environment termed a "rich fen." If the groundwater flows through acidic materials, the wetland has a low pH and is termed a "poor fen."

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Groundwater surfaces continuously in fens, providing relatively stable hydrological conditions.

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A close-up showing the diversity of plants that can be found in fens: the bright red shoots of a fen-specialist willow (*Salix myricoides*), slender strands of sedge (*Carex interior*), marsh fern (*Thelypteris palustris*), skunk cabbage (*Symplocarpus foetidus*), and golden ragwort all crowded together.

From a botanical perspective, rich fens are some of the most species-dense ecosystems on the planet. Measured at small scales, like plant species per square meter or per 100 square meters, they are more diverse than tropical rainforests. They owe their diversity to a combination of hospitable but not-too-hospitable conditions. In herbaceous stages, light is abundant, which always brings out a crowd of early-successional light lovers usually not found in shaded environments. Groundwater flow means water is continuously available, and there are usually a variety of microhabitats with slightly different hydrological regimes, allowing plants with different water needs to find their niche. In rich fens, calcium is often abundant, which chemically binds other necessary but limiting nutrients like nitrogen and phosphorus. This allows a group of specialist plants with adaptations for gleaning these nutrients at high pH to hold their own while preventing highly competitive generalists of larger stature, like broad-leaf cattail (*Typha latifolia*), from outcompeting everything else.

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Rich fens host a tremendous diversity of wetland plants because they offer a wide variety of microhabitats. Very slight elevations play a role in supporting this diversity. Light loving high-pH specialists may be found at the edge of seepage channels, while acid-loving species like sundew (*Drosera rotundifolia*) can establish on the tops of sphagnum hummocks, above the influence of the calcareous groundwater.

The agricultural practices of our fifth century farmers helped to maintain the fen in its most diverse form by removing nutrients in the form of plant biomass, and by maintaining the herbaceous character of the wetland rather than allowing woody plants to overtake it. These practices continued in much of Europe up until the last century, when modern mechanized agriculture caused either the overexploitation or the abandonment of these peculiar wet hayfields. Many were drained, fertilizers were applied, and grazing either increased or ceased entirely. As a result, fens lost their characteristic diversity; vegetation shifts occurred where highly competitive generalists like common reed (*Phragmites australis*) established and outcompeted the smaller-stature fen species. Conservation practitioners realized that the management regimes of the past needed to be reinstated or mimicked, and now whole handbooks for assessment and restoration of fens have been written detailing how to address nutrient enrichment, hydrological alteration, and vegetation management.

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The invasive species common reed (*Phragmites australis*) has established in this fen, and without control efforts, the low-growing fen community will be overtopped and outcompeted.

Fens also occur in North America, and likely have a somewhat similar history, although our lens on it is complicated by our colonial past. There appears to be very little information in ecological literature on how or if Native Americans managed fens. However, there is abundant documentation that Native peoples used fire and other management techniques more generally on a broad scale; it is likely fens were affected by these burns. As Europeans colonized North America, many fens in our region experienced similar light agricultural use. Did European farmers recognize these landscapes from their experience at home and integrate them into their husbandry with the same techniques? Perhaps they even noted those same delicate green-veined white

Rachel Goad

Grass of Parnassus (*Parnassia glauca*), a specialist of open rich fens

flowers, although the eastern North American plants are a different species of the same genus, grass of Parnassus (*Parnassia glauca*).

In the last century, a similar pattern of degradation and more recent neglect has occurred in North American fens as well. Today there is a growing understanding that many fens need active management to continue to support the full range of native diversity they are capable of hosting. However, the relative importance of fire and techniques mimicking light agriculture is an open question, as our systems may have experienced both in their histories of human management.

In Pennsylvania, our fens occur primarily in the glaciated regions of the state, where groundwater flows through glacial till materials. Zones of groundwater seepage can be very extensive in glaciated regions, and fens should be viewed as part of a complex of related communities that include phases in various successional stages: herbaceous, shrubland, woodland, and palustrine forests. In northwestern Pennsylvania calcareous groundwater is abundant and rich fen communities are common. PNHP ecological studies have identified a set of rich fen plant community types that occur specifically in this region. Rich fens also exist in the calcareous valleys of central and eastern Pennsylvania where ground water flows through layers of limestone. Most fens in Pennsylvania have some degree of peat accumulation. In both rich and poor fens, the open herbaceous successional phase is usually the most diverse. How was this open condition maintained historically, when without disturbance most of our landscape tends towards forest? Did blowdowns, beaver, or other disturbances create temporary openings? Did fire management by Native Americans

Successional Stages of Fens

Community types have been described for Pennsylvania's fens that align with stages ranging from open herbaceous, short shrub, tall shrub, to woodland and forest.

Sedge – Mixed Forb Fens are broad, flat expanses with a diverse mix of sedges, grasses, and other herbs, often over very deep peat.

Short Shrub - Mixed Forb Calcareous Slope Fens often occur over small seepages and have a varied substrate of gravel, open water, and peat hummocks. Herbs are intermixed with shrubs of low stature.

The Alder-leaved Buckthorn – Inland Sedge – Golden Ragwort Shrub Fen has taller shrubs mixed with herbs, sedges, and grasses.

In this rich fen woodland, white pine (*Pinus strobus*), larch (*Larix laricina*), and poison sumac (*Toxicodendron vernix*) co-occur with black ash (*Fraxinus nigra*).

affect these systems? Did large herbivores like elk and eastern bison play a role in keeping fens open? If open fens were not stable, but progressed through successional cycles to some extent, did herbaceous species regrow primarily from seed banks, or were they dispersed by waterfowl or large herbivores from nearby populations?

Jessica McPherson

Light grazing keeps shrubs and trees from overtopping this sedge – mixed forb fen.

Most of Pennsylvania's fens are adjacent to areas that are farmed, or were previously farmed. In cases where farming has ceased, there has been increased colonization by woody species. This transformation may eventually crowd out herbaceous fen diversity. Even without a complete historical picture, it seems clear that we need to explore active management to maintain herbaceous openings. However, it is also possible that in some places high flow of groundwater seepage naturally prevents shrub and tree establishment at a very small scale; management to prevent woody growth may not be necessary in these cases.

Fens are not obvious and relatable ecological features like rock outcroppings or old-growth forests. They can be thick and hard to move through, they don't have the dramatic boreal beauty of bogs, and while there are a few stand-outs like the showy lady's slipper (*Cypripedium reginae*) or grass of Parnassus, many of the species are not showy, but rather grass-like and inconspicuous. Despite the lack of flair, fens are very much worth getting to know, as there are few other ecosystems in our state that host as many plant species, and as many habitat specialists. There are almost 50 vascular plants that use fens as an important habitat. Thirty-eight of them are legally listed as Pennsylvania Endangered, Threatened, or Rare, while five more are on the Pennsylvania Watch List.

Jessica McPherson

The graceful drooping spikes of Mitchell's sedge (*Carex mitchelliana*), found in a calcareous seepage woodland.

Fens are also important habitats for animals. They are one of the primary habitats of the federally threatened bog turtle in eastern Pennsylvania. Fens can be habitat for a long list of dragonflies and damselflies, as well as butterflies and moths, although many also use other kinds of wetlands. Sedges are a strong component of fen vegetation, and six uncommon butterflies in Pennsylvania have caterpillars that feed on wetland sedges: two-spotted skipper (*Euphyes bimacula*), black dash (*Euphyes conspicua*), Dion skipper (*Eupyes dion*), eyed brown (*Lethe eurydice*), mulberry wing (*Poanes massasoit*), and broad-winged skipper (*Poanes viator viator*).

Betsy Leppo

Eyed brown butterfly (*Lethe eurydice*)

Today in Pennsylvania, as in Europe, many of the state's fen landscapes have already been lost to hydrological conversion for farming and other uses. Our remaining fens face an unprecedented combination of threats: hydrological alteration, nutrient enrichment, invasion by non-native species, woody plant succession, loss of diversity from chronic overbrowsing by whitetail deer, and climate change. Furthermore, because fens are less common on the landscape than they once were, local metapopulations have almost certainly declined for individual plant species, resulting in genetic loss and reduced ability to reestablish at new sites.

We can look to the work already done in Europe for potential solutions to some of these problems, particularly restoring hydrology, nutrient management, active vegetation management techniques, and restoration of desirable species. One of the most threatening invasive species to our fens, common reed,

is a shared problem on both sides of the pond as it is introduced from Europe. Conservation practitioners in midwestern states where fens are more common on the landscape, also have a longer history of management experience. However, we also need assessment of our local ecosystems and their history, and careful trials to determine what management techniques work best in local contexts.

Jessica McPherson

This fen is in a later-successional stage, with dense shrub and tree growth, and may need management to allow species that require high light conditions, such as the showy lady's slipper, to persist.

PNHP has studied fens through several lenses over the years. Because fens often host clusters of rare plants, they have been a focus for botanical documentation for over forty years. Much of our early data in northwestern Pennsylvania was contributed by Jim Bissell of the Cleveland Museum. Of the "top tier" of highly diverse botanical sites identified in our recent botany planning efforts, 23 of 136 total sites in the state include fen habitat. The only other kind of habitat represented so heavily in the top tier of botanical sites is bog habitats. While bogs and fens are similar in that they both occupy pH extremes and have clusters of state-rare plants, bogs tend to contain primarily low-pH specialists and to be species-poor overall, while fens host high-pH specialists in addition to a wide variety of wetland species, and are exceptionally diverse. As we review our top tier of sites, we are focusing on how our fens have changed over time since the earliest data collected by the program, and on gathering the information needed to support science-based management for their conservation. We are also working to build partnerships to implement much needed stewardship and active management at fen sites.

PNHP has also explored plant community composition and environmental characteristics of fens through several studies. In 1994, PNHP did vegetation plots and hydrological studies at fen sites across the state. From 2016-2018, we revisited many of these sites and added plot data for additional sites through an investigation of peatlands in Pennsylvania. This study refined the definitions of the plant community types associated with fens. Several fen sites have been also been included in our peatland wetlands monitoring project, which is designed to detect changes that may be occurring due to climate change.

Fens are tremendous reservoirs of plant and animal diversity, but they also face significant challenges; they need stewardship to reduce the impacts of deer browse and invasive species, they need adaptive active management to maintain high-diversity openings, and fairly technical assessments of nutrient loading and hydrology. We are building capacity to meet these challenges through collaborative efforts involving PNHP, the Pennsylvania Game Commission (PGC), and the PA Plant Conservation Network (PPCN). Some current initiatives in northwestern Pennsylvania to evaluate and treat invasive species on State Game Land will serve as a pilot to demonstrate what can be done to maintain these unique communities with relatively small amounts of effort and time (see following article).

Humans have been intimate partners in the maintenance of these highly diverse ecosystems for millennia. However, in the last century shifts in farming practices coupled with shifts away from rural living have resulted in knowledge of them vanishing from our collective consciousness. As they approach the edge of viability, we are now rediscovering them. If fens are to persist into the future despite the many challenges they face today, we will again have to play an active role, this time as conservation stewards. Hopefully stewardship and active management, drawing on lessons from ecological history and a growing body of knowledge around restoration practices, can preserve these botanical treasures so that future generations can also get to know them.

About the Author

Jessica McPherson is a botanist with a strong interest in plant ecology. She has a particular interest in the role of pH and geology in plant ecology.

Restoring Fens' Rare Plant Populations on State Game Land

by

Tim Hoppe

The ground was saturated and spongy as we walked into the dense stand of common reed (*Phragmites australis*). It had all the feel of a hidden weekend party. Papers, disposable cups, and 5-gallon buckets littered the ground. Flagging hung from vegetation at all levels in various colors. However, in this case the cause was not a party, but a collaborative, well-planned assault on invasive species.

Past glaciation has awarded northwestern Pennsylvania the distinction of having the highest ecological value fen habitats in the state. What sets fens apart from other wetlands is they are fed by ground water rather than surface water or runoff. These water sources often encounter glacial deposits rich in mineral nutrients.

PGC

Showy lady's slipper orchid (*Cypripedium reginae*), a species of rich fens that is threatened by deer browse and shading.

Fens support the highest floral diversity of all wetlands and support many rare and uncommon plant, mammal, reptile, land snail, butterfly, skipper, and dragonfly species. In Pennsylvania, ten of the top fifteen priority ranked fens for biodiversity occur on State Game Lands (SGL's).

Directly in support of the Pennsylvania Game Commission's (PGC's) mission and challenges, and acting as a good steward, the northwest region of the PGC initiated an active role in managing these critical and unique habitats. Like many other habitats in Pennsylvania, one of the largest threats to fens are invasive species. Considering the rarity of plants supported by fens, many factors must be considered when working within these sites.

The following is an example of collaborative efforts between Pennsylvania Natural Heritage Program partners - the PGC and the Western Pennsylvania Conservancy (WPC) to restore one such site, hereafter referred to as "the fen" to safeguard sensitive information.

PGC

A canopy of invasive common reed shades rare plant species.

At less than 0.5 acres, the fen boasts exceptional populations of five plant species of conservation concern. The fen was typically free of non-native species, other than the usual invasive shrub species (Asian honeysuckle, multiflora rose, and glossy buckthorn) which are found around its periphery. In 2016, common reed was found invading the fen. PGC land managers Shayne Hoachlander, Dustin Stoner, Rich Cramer, and WPC ecologist Christopher Tracey took quick action by hand-applying glyphosate to the invading plants in late September of 2016. Follow up monitoring did not take place until August of 2019, when Hoachlander (now retired), led PGC wildlife biologist Tim Hoppe to the fen and discovered dense common reed now covered nearly two-thirds of the site. Fortunately, many of the rare plant species were still holding on beneath the canopy of common reed. However, it was apparent that a concerted effort would be needed to restore the fen and ensure these species of concern remained.

In late spring of 2020, Hoppe reached out to WPC PNHP staff to collaborate on a management approach for the fen. Hoppe, Tracey, Jessica McPherson (WPC botanist), Hoachlander, and George Miller (current PGC land manager), met on-site in July to more closely examine the fen and begin planning efforts.

In a general sense, the treatment of invasive species is straightforward. The site and degree of colonization will dictate whether you can completely eradicate the targeted invasive or just keep it at a manageable level. In either case, you must assume there will be collateral damage to non-target plants when using herbicides. Because the fen supports so many rare plants, every precaution needed to be considered.

The site was mapped using GPS to note the treatment area and rare species, and to plan access for the ARGO and staff.

Upon examination the fen was divided into two areas based on the degree of common reed colonization and assemblage of rare plants. Visually, the areas of highest rare plant diversity correlated to the lowest common reed density. We concluded that the highest density areas would be treated mechanically, and the lowest areas would receive hand application.

Jessica McPherson

These paper cups protect rare plant species from incidental herbicide application.

As a baseline to measure the success of management activities, WPC ecologists set up a vegetation monitoring plot. Prior to treatment, application areas were flagged. Individual rare plant locations were identified by single pink flagging located above the plants, and especially herbicide-sensitive species were also protected with 5-gallon buckets and paper cups.

Christopher Tracey

A roof mounted cage on the ARGO allowed herbicide to be sprayed from above to get good coverage on the actively growing areas of common reed.

Mechanical treatment was achieved by utilizing an eight wheeled amphibious utility vehicle (ARGO) operated by PGC biologist Hoppe. Habitat management crew member Corry Clabbatz applied herbicide from atop a platform/cage mounted on the ARGO roof; this elevated perch provided an ideal vantage point to assess herbicide overlap and vegetation coverage. The goal was to apply a uniform coverage to the common reed but prevent runoff to non-target species. We limited disturbance to the substrate and hummocks by driving the ARGO to the edge of the area, then applying herbicide as the unit reversed. The eight large tires on the ARGO spread the weight of the vehicle over a larger area, thereby reducing compaction and peat disturbance. We applied herbicide in 20-foot wide bands until the entire unit was treated.

PGC

To gauge the amount of herbicide reaching the understory plant zone from the ARGO, sheets of heavy white paper were randomly placed on the ground. This allowed us to see individual droplets of herbicide.

Christopher Tracey

The crew works to apply herbicide to common reed throughout the fen.

All hands-on deck! PNHP staff and PGC habitat managers and foresters then suited up with gloves and Tyvek suits to apply herbicide by hand. Application was achieved by dipping a cotton glove, placed overtop a chemical resistant glove, into a bucket of mixed herbicide. Care was taken to prevent excess dripping to non-target plants.

PGC

Herbicide was applied by hand in the less invaded sections of the fen to prevent spraying native species.

Common reed stems were wiped individually, covering at least 50% of the foliage, focusing on the top half of the plant. Applicators began at the inner edge of the treatment area and applied herbicide as they backed out to reduce entering areas already treated. The site was monitored two weeks following treatment to gauge impact to common reed. Additional assessment will take place in the growing season of 2021 to begin planning measures for follow up treatment.

The treatment of this site hinged on collaborative efforts, dedicated staff, and a well thought out plan. The coming weeks and years will reveal if the objectives were met. Regardless, this experience will provide a foundation for an even better plan moving forward.

About the Author

Tim Hoppe joined the Pennsylvania Game Commission in 2000 and currently serves as a regional biologist. His work primarily focuses on supporting statewide wildlife surveys and research initiatives. Tim has a strong interest in habitat management and seeks innovative ways to address issues. He received an AS in Wildlife Technology from Penn State, Dubois and a BA in Natural Science, Mathematics and Wildlife from Edinboro University.

Notes from the Field

Managing River Flows

Mary Walsh

The effects of dams on flowing waters include altered water temperature and hydrology, reduced connectivity of habitats, and changes in sediment transport, which ultimately impact the flora and fauna in rivers and associated floodplains. The Kinzua Dam at the Allegheny Reservoir and Youghiogheny Dam at the Youghiogheny River Lake have changed the natural river flows since they were installed by the Army Corps of Engineers (ACE) in 1960 and 1944, respectively. Partnering with The Nature Conservancy and the ACE, PNHP is studying the ecological features of both rivers and their relationship to flows.

Ryan Miller

The scuba crew surveyed mussel habitat near an Allegheny River island.

With the help of WPC Watershed Conservation Program staff, PHNP ecologists documented freshwater mussels, floodplain forests, and scour prairie grasslands in a 2020 study. Donning SCUBA gear, ecologists counted the relative abundance of freshwater mussels and identified submerged aquatic plants in reaches of the Allegheny River. Additionally, we mapped and described plant communities and rare species within floodplain habitats adjacent to the river channel. A drone was used to document floodplains, submerged aquatic vegetation beds, and mussel habitats. Along the Youghiogheny River ecologists studied the habitat of floodplain plants in frequently scoured locations. Using images of the river level from field cameras, we related the inundation of plant habitats to river flows from a U.S. Geological Survey gage. Ecologists evaluated the pattern of flooding at the sites and how changes in flow may affect the plant habitat.

Information from the project contributes to an initiative by the ACE to restore components of natural flows which would have occurred prior to the dams. PNHP staff members presented ecological considerations for river management at the Allegheny River Adaptive Management and Monitoring Workshop in September 2020. At the virtual workshop participants from agencies and universities provided feedback about monitoring the proposed changes to dam management. Information from PNHP studies provide background information for management plans and may be used for future monitoring.

Meredith Malone

Mary Ann Furedi and Mary Walsh measure mussels and record data.

Bear Run Conifer Plantation Restoration Update

Ephraim Zimmerman

During the Great Depression, the Civilian Conservation Corps established conifer plantations on thousands of acres of devastated forest land across Pennsylvania. Inspired by their work, Edgar Kauffmann Jr., the son of the Pittsburgh retail giant who built Fallingwater, planted nearly 100 acres of red pine, white pine, and

Andy Zadnik

The conifer plantations represent an “island of conifers in a sea of hardwoods.” The understory beneath the planted conifers is considerably different from the adjacent Red Oak – Mixed Hardwood Forest primarily due to the lack of light beneath the dense conifer canopy.

Norway spruce on former pasture and agricultural fields surrounding the now iconic house designed by Frank Lloyd Wright. In all, nearly 100,000 seedlings were planted between 1957 and 1959, spaced 8 feet apart in rows. This area is now known as the Bear Run Nature Reserve, a 5,000-acre natural area managed by the Western Pennsylvania Conservancy, and these stands of non-native or "out of place" conifers are in decline. In 2018, the stewardship staff at WPC began an effort funded by the National Fish and Wildlife Foundation to accelerate succession to native forest of red and white oak, sugar maple, beech, and other hardwoods, consistent with the stewardship goals for the property.

Andy Zadnik

PNHP ecologists and stewardship volunteers documented the overstory, understory, and ecological factors of each monitoring site within the restoration area.

Working with our stewardship colleagues at WPC, PNHP scientists conducted baseline breeding bird surveys and rapid vegetation assessments within the conifer stands slated for conversion to native hardwoods. We also surveyed areas of the forest that currently support native red oak and northern hardwood forest stands. We were particularly interested in what was growing outside the plantations that are dominated by the three species of planted conifers and which birds were using these areas. The information from the native forest stands will help us understand and further manage the plantations to reflect the plant and bird diversity found in the surrounding forest. WPC also worked to control invasive shrubs across at least 20 acres within and adjacent to the conifer stands.

The results of the surveys provide a baseline for monitoring change over time in bird species and plant composition within the restored stands. From our surveys in 2018, we found that despite the dominance of conifers in the overstory, native tree and shrub species were quite abundant, having seeded in over the years since the conifer stands were planted. Tree species including red maple, red oak, white oak, sweet birch, tuliptree, and cucumber tree were present in a majority of the conifer stands surveyed. Abundance of non-native invasive plants in the conifer stands was greater than in the native forest stands, with non-native invasive plants documented in a majority of the pine and spruce-dominated plots. Only the Tuliptree – Red Maple Forest (an early successional, but native canopied forest) had any occurrences of non-native plant species.

We detected 41 bird species during 2018 and 2019 breeding season surveys. We detected a total of seven bird Species of Greatest Conservation Need (SGCN) across both conifer stands and native forest areas: black-and-white warbler, black-throated blue warbler, black-throated green warbler, brown creeper, Louisiana waterthrush, scarlet tanager, and wood thrush. We found that forest interior bird abundance comprised 88% of the native hardwood community and 79% of the conifer stands. We observed a marked difference within the two different conifer stand types with forest interior bird abundances comprising 69% of spruce-dominated stands versus 84% in the pine-dominated stands, perhaps indicating higher quality forest habitat in the pine-dominated stands. Not surprisingly, the conifer-dominated stands supported a higher diversity and abundance of edge habitat and early successional bird species than were found in the native hardwood stands, which is indicative of anthropogenic habitat alterations in the treatment areas.

Andy Zadnik

Opening the canopy will allow more light into the understory, promoting the growth of native trees like this white oak seedling.

In knowing what the vegetation and bird community composition currently looks like in the pine and spruce-dominated stands as well as in the native hardwood stands, we can hypothesize what some of the changes from the Norway spruce and pine removal may be. The dominance of red maple in the understory and seedling

strata suggests a future forest comprised largely of red maple. It also indicates that our efforts to convert these stands to native plant communities will be successful without having to augment future canopy tree species with plantings. The prevalence of invasive plant species in the conifer-dominated stands is concerning and should be a major focus of management activities going forward.

David Yeany

Black-throated green warbler, a forest interior specialist and a Species of Greatest Conservation Need, is a species which we expect to decline in abundance as a result of conifer removal at Bear Run.

It is unclear whether the shift to native forest will result in a reduction of invasive plant abundance as the forest matures over time, or if the invasive plants will stall succession toward native forests. We expect to see an initial increase in edge habitat species abundance with new forest canopy gaps and perforation followed by a decrease in edge habitat diversity and abundance as broadleaf deciduous tree and shrub species fill-in the gaps left by conifer removal. Managing invasive plant species in these gaps will be a key to the success of native tree and shrub species growth. We expect to observe a decrease in conifer specialist abundance. In particular, we may see a decrease in abundance of golden-crowned kinglet, Blackburnian warbler, black-throated green warbler, and brown creeper. Some species like Blackburnian warbler may be able to shift to nearby hemlock forest, but more selective (e.g., spruce dependent) species like golden-crowned kinglet, may not. Finally, small-gap specialists like hooded warbler or American redstart may increase in abundance.

We hope to return to these survey areas over the next few years to see how the forest evolves following our restoration and to assess our hypotheses.

Botany Update from the Conowingo Islands

Rachel Goad

An hour south of Harrisburg, the Susquehanna River flows through an ancient gorge, where eroded, exposed bedrock forms a complex landscape of broad shallow expanses and hulking islands, braided through by river channels. It is a stunning and special place. Many rare plants have been documented here in the past, including species that reach the northern extent of their range in this area, and species restricted to the peculiar habitats present.

Rachel Goad

The many cracks and crevices of this river-scoured bedrock host a diversity of low-growing plant species.

In 2020, a team from PNHP, including volunteers Nate Hartley and Sadie Seaman, surveyed from Piney Island in the north to Sicily Island in the south on foot and by boat, with the intention of visiting formerly known occurrences and recording any new ones along the way. We documented 26 tracked plant species, including a few very rare species only known from historic collections in this area. Two of these historic re-finds were butterfly pea (*Clitoria mariana*), last reported from this area in 1939, and cymose beak rush (*Rhynchospora recognita*), last reported here in 1899.

Rachel Goad

Butterfly pea (*Clitoria mariana*) in full bloom

Butterfly pea has an affinity for dry, open, sandy areas and reaches its northern range extent in southeastern Pennsylvania. Our group found hundreds of blooming plants sprawling along a sandy, shrubby island shoreline when we visited in early August. This may be the largest and most robust population of this species in the state; only one other population is currently known.

Rachel Goad

This rocky shoreline experiences regular flooding that inhibits the establishment of trees.

Cymose beak rush grows in moist seepages on rock outcrops, as well as in a variety of other moist habitats, and is also near its northern range extent in Pennsylvania. We found plants growing in cracks and crevices of an outcrop meadow community with a diverse array of other graminoids, forbs, and shrubs. Only two other extant populations of this species are known from Pennsylvania with one of these being found in a very similar rocky crevice habitat along the Youghiogheny River. Interestingly, that occurrence is on the other side of the eastern continental divide. Both of these occurrences were found in areas that have been periodically inundated or scoured by the river, and this disturbance is likely critical to the maintenance of their habitats. Across the U.S., river-scoured communities are becoming increasingly recognized for the diversity of rare and specially adapted species they support. PNHP scientists have been working to understand these communities across Pennsylvania, and finds like these help us to better understand these exceptional natural places.

Canby's Mountain Lover Gets Needed Help

Steve Grund

What a poetic name, Canby's mountain lover! Is it a plant that grows on Canby's Mountain? No, in fact it isn't particularly associated with mountains, as one might expect from the name. It grows in a mountainous region, but it tends to grow in the valleys where limestone is generally found in the Appalachians. When Asa Gray realized that the specimen William Canby had sent him represented a species new to science, he needed to coin a Latin name for the plant. Noting how similar it was to *Paxistima myrsinites* of northwestern North America, he determined it should be assigned to the same genus, *Paxistima*. To honor the discoverer, he called it *Paxistima canbyi.* Because *P. myrsinites* is called mountain lover, our eastern species became known as Canby's mountain lover.

Canby's mountain lover is known only from the Appalachian region, from Tennessee to Pennsylvania; the three most northern stations are in Bedford County. Based largely on the number and size of the known occurrences, NatureServe assigned it a global conservation rank of G3 (Globally Vulnerable). In 2017, we adjusted that rank to G2 (Globally Imperiled). The reason for the increased concern is that the species is under attack from a non-native scale insect, the euonymus scale (*Unaspsis euonymi*), and botanists from our NatureServe partners further south, especially the Kentucky Natural Heritage Program, had documented serious decline in Canby's mountain lover populations as a result of scale infestations. Euonymus scale also infests a number of non-native species, including Asian bittersweet (*Celastrus orbiculatus*), which is highly invasive. Asian bittersweet is rampant in Bedford County, and not a believer in social distancing, it passed the scale to Canby's mountain lover.

Andy Kubis, The Allegheny Front

Canby's mountain lover is a low shrub with evergreen leaves. It is Globally Imperiled due to a non-native scale insect that has been decimating populations of Canby's mountain lover throughout its limited range.

In 2010, PNHP botanists examined plants at a site owned by the Western Pennsylvania Conservancy (WPC) and did not find any euonymus scale on Canby's mountain lover, but we did find the scale on Asian bittersweet, which had spread throughout the site and would have been a threat to Canby's mountain lover

Andy Kubis, The Allegheny Front

Steve Grund, one of the PNHP botanists, examines the stem and leaves of Canby's mountain lover for the presence of scale insects.

even without the scale. By the next year it had made the jump, and in 2012 we started treating with horticultural oil. Horticultural oil is safe for humans and plants, but suffocates the scale if applied at the right time. A few years later we found the scale on Canby's mountain lover at a nearby state park, and the Bureau of State Parks started treatment there. This year our efforts were bolstered at both sites with volunteers obtained through the Pennsylvania Plant Conservation Network. The last few times we were at the WPC site we found no scale! We are not going to declare victory yet, in fact this spring the scale appeared to have done considerable damage to the plant at that site before the first treatment of the year, but it is looking as if a long-term program of monitoring and treating as necessary has good prospects for success. We love Canby's mountain lover!

Our efforts to save Canby's mountain lover were featured in a story this summer on the public radio program Allegheny Front (https://www.alleghenyfront.org/the-race-to-save-the-rare-mountain-lover/), and that story was picked up by the national program Here and Now (https://www.wbur.org/hereandnow/2020/08/20/save-rare-plant-species-extinction).

Citizen Scientists Search for Invasive Water Chestnut

Amy Jewitt

The Pennsylvania iMapInvasives Program strives to engage and educate natural resource professionals and citizen scientists on issues related to invasive species by utilizing creative methods that encourage people to search for and report their findings (both presence and absence) of invasive species. By continually adding new and updated data to this publicly-available, online database we can better serve the needs of those interested in learning about invasive species distributions in Pennsylvania.

In July, the Pennsylvania iMapInvasives Program hosted its 4th annual Water Chestnut Chasers Challenge, a special event that encourages participants to search for a particular invasive species, water chestnut (*Trapa natans*), across the state. Participants utilized a variety of collection methods to enter their data into iMapInvasives including the mobile app and online database.

Several Master Watershed Stewards from southeastern Pennsylvania participated in the 2020 Challenge, along with others representing academia (Penn State University), NGOs (Glade Run Lake Conservancy and PNHP), and one state agency (PennDOT). Together, participants collected a total of 270 data points, including presence, approximate, and absence data. The top surveyor, Jim Walter (Master Watershed Steward) surveyed over 50 different locations!

Ed Hawkey

Ed Hawkey observed this infestation of water chestnut in a neighbor's privately-owned pond, later removing 1,600 pounds of the aquatic weed from the site.

Several notable accomplishments resulted from this year's WCCC. Ed Hawkey (Master Watershed Steward) observed a water chestnut infestation in a neighbor's pond in Bucks County, and not only reported the infestation to iMapInvasives, but also removed 1,600 pounds of the aquatic weed from the pond! Additionally, Jim Walter noted the presence of water chestnut in a detention basin and after communicating with the land owner, he was able to set in motion a series of events that led to the complete eradication of water chestnut at this site!

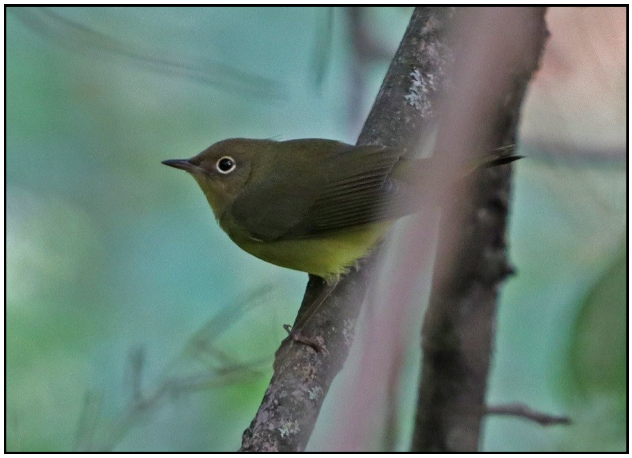
Plans are in place to host the WCCC in 2021, along with the Invasive Species Scavenger Hunt, which was hosted for the first time in 2020.

Call to Action: Lights Out for Migratory Birds

David Yeany

Each fall and spring, hundreds of millions of migratory passerines or songbirds pass through Pennsylvania. The vast majority of these species migrate at night, navigating via landmarks, solar/lunar positioning, and even magnetic fields. Many of these songbirds stopover in natural habitats to rest and refuel before the next leg of their journey. The volume of birds is magnified during fall migration due to the abundance of young birds hatched in the spring and summer migrating for the first time.

Advancements in technology allow tracking of nocturnal songbird migration via weather radar and even predictions of high-volume migration events. Just 10% of all nights within a migration season will account for more than 50% of birds migrating, leading to a handful of very intense passerine migration events. Migration alerts can be forecast by region or city as a call to action to help reduce one of the most significant hazards to migratory birds – building collisions. Outside lights can disorient, confuse, and even "trap" migrating songbirds at night and contribute to increased mortality and collisions.



David Yeany

Connecticut warbler is a rare sight in Pennsylvania seen only during migration. This hatch year bird was using Frick Park in Pittsburgh as migration stopover habitat. The species breeds in boreal forested wetlands and winters in South America.

PNHP follows these migration alerts to better inform our own projects and to share important conservation actions with the public. During mid-September, we had several nights of high intensity bird migration coinciding with a migration stopover monitoring project as part of the Allegheny Bird Conservation Alliance that we are conducting at the Pittsburgh Parks Conservancy's Frick Park Clayton Hill forest restoration site. PNHP put calls to action on social media for Pennsylvanians to turn out lights to prevent bird mortalities when more than

David Yeany

A migrating mourning warbler also stopped over in Frick Park this September. This species is elusive, usually hiding in thickets. They breed in Pennsylvania's higher elevations in successional forests and into Canada. In fall they fly south to Central and South America for the winter.

55 million birds were forecast to migrate through the state over just a few days. The public response was viral, as people took notice of this natural phenomenon and took conservation action. The intense migration was seen during our restoration monitoring with our avian ecologist recording a high diversity and/or numbers of migrants – especially warblers, vireos, and thrushes. Large parks and natural areas serve as important places for migrating songbirds to rest and refuel. Even smaller urban parks and backyards with native plants can play a vital role in bird migration.

Ohiopyle Wetland and Stream Restoration

JoAnn Albert

In late summer, PNHP staff in partnership with DCNR Bureau of State Parks, Wetland Restoration LLC, and Beran Environmental restored stream and wetland habitats at six locations in Ohiopyle State Park. Several of the sites were impacted by dams and ponds that were constructed before the property became part of the park. Our goals were to restore wetland and stream habitats with more natural hydrology and vegetation. These restored habitats will benefit a variety of wildlife that need cool, free-flowing mountain streams, vernal pools, and/or small meadow openings in the forest.

Part of the project focused on stream habitat along Long Run Creek, a forested stream that supports naturally reproducing native brook trout. We removed several stream impoundments including a large manmade pond, restoring significant in-stream trout habitat, allowing for aquatic organism passage, and enhancing long-term watershed resiliency.

Thomas Biebighauser

Ryan Miller

JoAnn Albert

JoAnn Albert

At one of the Ohiopyle State Park restoration sites we removed a large abandoned concrete swimming pool to create a spring fed wetland and wet meadow. The restored wetland quickly turned into an amphibian nursery. Just six weeks after construction, dozens of gray treefrog metamorphs were exiting the wetland and moving into the surrounding meadow.

We also created breeding habitat for vernal pool amphibians which were using degraded habitats such as road ruts due to a lack of sufficient suitable habitat in the park. An abandoned concrete pool was restored to a natural spring fed wetland and wet meadow. Small, fish-free wetlands support specialist wildlife, and wet meadows are particularly important for native pollinators. We seeded the disturbed areas with a native wetland seed mix, and in September, planted over 700 perennials, shrubs, and trees. We are looking forward to seeing the sites next spring, but within weeks of the restoration new plants were growing and several species of frogs and salamanders had moved in.

Thanks to our partners for their hard work and support which allowed this project to happen. We will be offering a webinar on the restoration in 2021 with dates to be determined - stay tuned! These projects were supported with funds from the Pennsylvania Bureau of State Parks, DCNR Community Conservation and Partnerships Program, and the National Fish and Wildlife Foundation.

Yellow Stoneroot Borer Rediscovered in Pennsylvania

Pete Woods

Pete Woods

Horsebalm blooms August and September. Its yellow flowers are lemon-scented.

The yellow stoneroot borer (*Papaipema astuta*) is a moth whose caterpillars bore into the stems of stoneroot, also known as horsebalm (*Collinsonia canadensis*). This globally rare moth was found several times in southwestern Pennsylvania between 1903 and 1967, but no one has reported it from the state since then. This group of moths is known for having very localized populations, and for not dispersing long distances, so I thought it could easily still be here, but had avoided detection.

I started searching for the moth in 2013. Whenever I found a patch of stoneroot in the summer (from May through July) I looked at the lower stems carefully for a hole where a caterpillar had bored into the stem, but I never saw the hole - until 2017. That's when I saw a

Pete Woods

This caterpillar is nearly full-sized, and it fills the stem that it has hollowed out.

wilted stoneroot plant while doing a bioblitz in Allegheny County. The stem had a hole, and when I split it open, there was a fat *Papaipema* caterpillar!

There are several species of *Papaipema* that might use a stoneroot plant. One of them, the dark stoneroot borer (*P. duplicata*), which is also globally rare, has caterpillars that are indistinguishable from the yellow stoneroot borer. To identify my caterpillar, I would have to rear it to adulthood. An odd thing about *Papaipemas* is that while most of the species are specialists, only using one or a few plant species as caterpillar hosts, all *Papaipema* caterpillars are perfectly happy to live in a carrot or potato or whatever root vegetable you have around. So, I brought the caterpillar home, drilled a hole into a carrot, and the caterpillar crawled in and made itself at home. When it finished its development, it buried itself in the peat moss that I provided, and it pupated. When it didn't emerge within a month, I dug it up and found only a mass of wasp cocoons. The wasps had parasitized the caterpillar before I found it. This is a very common occurrence among this group of moths.

Pete Woods

The first yellow stoneroot borer to be documented in Pennsylvania for many decades.

In 2019 I found another caterpillar in a similar situation in Fayette County. This caterpillar, too, was parasitized. In 2020 I went back to both sites, and at the first site I found a single caterpillar, which died during pupation from an unknown cause. At the Fayette County site, I found four caterpillars, and evidence of numerous others that had already left their stoneroot plants. All four of those caterpillars turned into adults in September, proving that the golden stoneroot borer is still here in Pennsylvania.

I will continue to look for more populations of this moth, as well as two other globally rare moths that use stoneroot. I also hope to work with landowners and land managers to help protect these moths, which are threatened by deer browse, habitat loss, and invasive plants. If you would like to help with my survey efforts, please keep an eye out for large populations of stoneroot, aka Canada horsebalm. If you find a patch of more than 50 plants, please post a photo of it to iNaturalist and mention approximately how many plants you saw. I will see your posts and will try to visit the site.