Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

WILD HERITAGE NEWS

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Photo Banner:
Old growth forest at Laurel Hill State Park

Jaci Braund

New Interest in Old Forests

by

Jaci Braund, Ecologist

Most people picture massive, towering trees when they think of an old growth forest, and they usually aren't thinking of Pennsylvania. Old growth forests are present in small, remnant pockets in Pennsylvania. Some still contain very large trees, but there is much more to these forests than just big trees.

Old growth, old forest, and late-successional forest are all terms used currently in what can be described as a renaissance of ecological inquiry into these rare forest types. While these terms sound similar, they are identifying quite different aspects of forest succession. Of the three, old growth is used most widely and most incorrectly. Old growth, sometimes referred to as "virgin" forests, should be reserved for the forests that were never timbered following European settlement and have reached a natural expression of the ecosystem, including natural disturbances. It is generally accepted that most of the eastern deciduous forest was in old growth condition before European settlers began clearing land in the 1700s. Old growth forests continued to dwindle over the next two centuries as industry progressed, and old growth stands remain in Pennsylvania typically due to access issues or survey errors. The term old forest, and similarly late-successional forest, can be applied to forests that experienced some level of anthropogenic disturbance but have since begun to recover and are attaining old growth character.

Estimates of old growth in Pennsylvania are difficult to determine because of inconsistent use of terminology. Many sources suggest that of the forested areas

Jaci Braund

This six acre section of Laurel Hill State Park was spared for unknown reasons while the rest of the park was timbered from 1886 to 1940.

in the northeast, Pennsylvania included, less than one percent of those are considered old growth. In Pennsylvania, it is likely that several thousand acres are old growth, mainly in the Allegheny National Forest, Cook Forest State Park, and scattered difficult-to-access ravines and steep slopes. The secondary forests, or those that were once timbered, are now beginning to achieve some old growth character and are much more abundant than old growth.

Pete Woods

Although large trees are not the only identifying feature of old growth forests, they can be quite thrilling to find. This is a red oak with a DBH of 127 cm.

Much can still be learned about these old forests and many researchers are revisiting old growth forests with an eye on climate change mitigation. It was once argued in academia that old growth forests reach a peak in carbon storage and the rate of carbon sequestration slows, however this has recently been disproven. While young trees and forests have a faster rate of carbon sequestration, the storage potential in an older forest is much greater and whole tree carbon accumulation increases with age and size. Carbon calculations and carbon credits are becoming needed tools for achieving net-zero goals.

Making headway on these goals currently involves reforestation and forest management primarily on private land. Forest management techniques can be tailored toward old growth character which will increase carbon storage potential. In addition to the private market interest in managing for carbon, the Bureau of Forestry has set aside over 500,000 acres as "proposed" old growth, or areas on state forest land that are pulled out of timber rotation. These areas are not necessarily in the carbon market, but there is interest in how to manage for old growth and how to assess the overall condition and ecological function of old growth in Pennsylvania.

With this renewed interest, there are still some simple questions to answer about old growth in Pennsylvania. Mainly, what is old growth and where is old growth? We know anecdotally that about a dozen locations are considered old growth, but at what point are the secondary forests considered old forests and capable of functioning similarly to an old growth forest? How do these forests differ in structure, function, and condition from younger forests? Understanding the old growth character for Pennsylvania's forests, and then identifying secondary forests that are attaining this character will be important in moving forward with old growth as related to carbon mitigation in the future. PNHP is proposing a multi-year study to help answer these old growth questions.

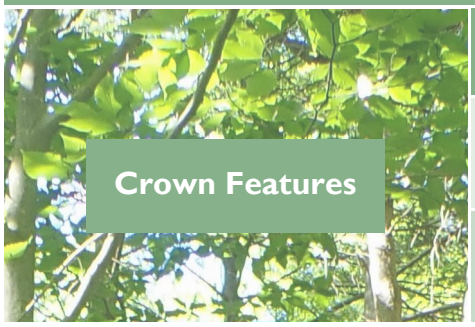
PNHP began old growth surveys in the 2021 field season and have continued through 2022. Field methods in 2021 included completing a plant community plot within old growth and collecting data on coarse woody debris volume to use for carbon metrics. However, the siting of these plots assumed that the places sampled were old growth, as they were believed to be, but no assessment to determine if they were truly old growth forests had been done. After a deep dive into the literature and coordinating meetings with fellow ecologists in the northeast, a new method was developed to identify old growth in Pennsylvania.

The new method was modeled after other state Heritage programs in the northeastern U.S., where ecologists formulated a method to quickly determine if a forested stand features at least some level of old growth character, whether it is old growth or an old secondary forest. The Pennsylvania method of old growth assessment is being tested at old growth sites in 2022 and involves recording some forestry measurements, such as basal area, and recording observations of old growth character (see page 3).

Jaci Braund

A common feature of old forests is a variety of age classes, with large, small, and standing dead trees.

Old Growth Character Used in the Old Growth Rapid Assessment in Pennsylvania



Old Growth Character	Description
Large branches	Thick, gnarled; reflects a tree that has experienced numerous disturbance events
Small crown volume	Resembles a celery stalk; indicates slower growth; use in combination with other trunk features
Buttressed stumps	A large, noticeable fanning or flaring of the base of the trunk
Highly sinuous trunk	Amount of waviness between stem nodes; indicates tree bending toward available light over time
Low stem taper	The main trunk is cylindrical, not narrowing with height
Unique bark patterns	Bald spots; irregular flaking; unrecognizable in old age
Pit and mound topography	Bare ground elevated slightly; result of a tree that uprooted; tree may or may not be present; generally takes at least 50 years to form
Numerous large trees	Generally over 60 cm, may be over 100 cm; high DBH not always a reliable character
Little or no evidence of cut stumps or haul roads	Many cut stumps and haul roads would indicate widespread harvest; a few might suggest select harvested forest
Numerous long-lived trees	Hemlock, white pine, oaks, etc. Early successional species would be red maple, tulip, aspen, although these can grow old.
Diverse coarse woody debris (CWD)	CWD present in a variety of decay classes
Nursery logs	Tree species growing directly on a decaying log, or mature trees of similar age and size growing in close proximity, as if they germinated on a decaying log
Late-successional tree species in CWD layer	If recognizable, would be hemlock, oaks, beech

(Left) Nurse logs occur when a decaying tree on the forest floor provides suitable habitat for germinating seeds. The four younger hemlocks in the central area of the photo were all about the same height and diameter, indicating they may have germinated along the same nurse log at least a few decades ago. The nurse log is no longer visible. (Jaci Braund)

Jaci Braund

Old growth forests will have higher amounts of coarse woody debris that are also in different decay classes.

Ideally, this assessment will be summarized into a weighted score to understand the level of old growth character that a forest is attaining, and foresters or scientists can easily collect this data to submit to our program.

Standardizing these methods will allow for further study and understanding of old growth and aging secondary forests. Not only will this method help to answer the question of locating old growth and old forests, but it can be used for future management of secondary forests. Some old growth character, such as crown volume or numerous large trees, can be managed for. Management toward old growth may be as simple as leaving the forest alone and letting nature take its course, or it can involve some silviculture techniques to speed up some of the structural aspects of old growth.

Because these methods were adapted from scientific literature and other ecologists in the northeast, they will likely evolve. Through trial and error, we may learn that some aspects of the assessment are tailored for northern forests and may not apply directly to a number of forest types in Pennsylvania. Although canopy height can be indicative of old growth, there can be old forests situated on poor or difficult sites with high winds, low moisture levels, or thin soils where trees simply do not grow very large. Methodology will need to be adapted to address old growth metrics for sites with poor growing conditions. Viewing these forests with an eye on old character, however, will help to create a visual of successional phases and ultimately guide the overall understanding of old growth condition in Pennsylvania.

A secondary phase of this project will be to map old growth and old forests in Pennsylvania and learn more about faunal associates. These stands will be mapped initially as plant communities and will be evaluated based primarily on the rapid assessment. Ideally, the surveyor will complete the rapid assessment within a well-buffered forest and take additional notes on old growth character in the surrounding forest. If the surveyor begins to note younger-forest attributes, then the data collection will end. Based on these areas, PNHP plans to begin zoology surveys in old forests in

Jaci Braund

Stem sinuosity, or a twisting of the main trunk, is an old growth character that reflects a tree that has grown toward changing light gaps in the canopy.

Jaci Braund

Buttressed roots, or a flaring of the lower trunk, are a common feature of old growth trees.

Jaci Braund

An old growth black-gum (*Nyssa sylvatica*) displaying unique bark patterns, including large blocks and bald patches.

the spring of 2023. We will try to determine which animal species are old growth obligates and to understand which aspects of an old forest these species need. From literature reviews and PNHP zoology staff knowledge of old growth, there are a few target species for surveys: Swainson's thrush, tetratomid and fungus beetles, syrphid flies, rock voles, and green salamanders. Initial inventories will likely aim to establish baseline data within old forests and nearby secondary forests for comparison. These inventories will hopefully lead to management strategies to accelerate or at least support the transition of younger forests to older and eventually old growth forests.

David Yeany

Swainson's thrush is one of Pennsylvania's rarest breeding songbirds. They nest in mature and old growth hemlock forests with concentrations in Potter and Sullivan counties and the Allegheny National Forest.

Pete Woods

The forked fungus beetle (*Bolitotherus cornutus*) lives on large polypore fungi, such as this hemlock varnished conk (*Ganoderma tsugae*), and it tends to be associated with mature forest.

Most of the old growth remaining in Pennsylvania is dominated by eastern hemlock. Treatment for the hemlock woolly adelgid is on-going, however many of the oldest trees have succumbed to infestation and much of the old growth hemlock is being replaced by sweet birch (*Betula lenta*). Along with the rapid assessment and zoology inventories, PNHP plans to analyze the condition of old growth and old forests using the Ecological Integrity Assessment (EIA). The EIA provides an unbiased score that is determined by condition of the forest, nearby anthropogenic attributes, and more. It is currently used for other plant communities but has not yet been evaluated for old growth forests. Some metrics, such as a minimum mapping size, will likely be clarified in this evaluation.

The new ecological interest in old growth and old forests will be far-reaching. While most, if not all, of old growth in Pennsylvania is currently protected from timbering, there are many acres of aging secondary forests that should be evaluated for old growth character. Because these forests are natural carbon sinks, they are attracting greater attention, but their significance goes much further than just carbon. Their intrinsic value in the form of long-lived trees, variable forest structure, natural canopy gaps, and decaying wood provides many more benefits for the ecosystem. PNHP intends to focus in on these old forests, investigate a number of possible indicators and connections, and advocate for a deeper look into the biodiversity of these relatively rare communities.

About the Author

Jaci Braund first joined PNHP in 2015 with the environmental review team and then transitioned to her current role as Ecologist in 2018. Her work mainly focuses on refining the plant community classification for Pennsylvania, along with the occasional rare plant survey. Outside of work, Jaci enjoys kayaking, gardening, and winemaking.

Mapping Climate Refugia in Pennsylvania

by

Anna Johnson, Planning Coordinator

Natural habitats in Pennsylvania are currently experiencing many of the predicted impacts of climate change, including increased flooding and precipitation, loss of snow cover, higher average temperatures, and increased frequencies of storms. This translates into shifting distributions of many of our rare species, many of which are already struggling to adapt to the changing climate. PNHP biologists have been using the Climate Change Vulnerability Index to assess the degree to which rare species in Pennsylvania are at risk of decline as a result of climate change. This tool has found that some of our species are extremely vulnerable to climate change, including such organisms as the eastern hellbender, eastern spadefoot, white-fringed orchid, bog -rosemary, and balsam fir. On the other hand, some species were found to be quite resilient to climate change and unlikely to have their ranges dramatically impacted; species such as the Appalachian cottontail, bog goldenrod, and timber rattlesnake.

Pete Woods

Bog-rosemary (*Andromeda polifolia*) is a rare plant species in Pennsylvania considered extremely vulnerable to climate change since it relies on cool, high-elevation wetlands, a habitat that is expected to decline with increasing temperature and changing precipitation. Bog-rosemary was modeled as part of this project.

So, while we know that climate change is certainly occurring all around us, it is much more difficult to map and manage the impacts of climate change on specific populations, natural communities, or habitats. A major task, moving forward, for conservationists and natural resource managers is to continue to identify which species and habitats are at the greatest risk of loss or radical change due to climate change and to manage accordingly.

A wide variety of climate change adaptation, resistance, and mitigation strategies are available to natural resource managers. One increasingly popular climate change resistance strategy is to identify climate refugia and focus efforts on managing these locations. Climate refugia are areas of the landscape that are relatively protected or buffered from climate change by geophysical characteristics (e.g., elevation, aspect, geology), which potentially would preserve safe pockets of habitat for species. These refugia can shelter source populations of rare species that are losing habitat elsewhere and give species more time to adapt to the changing climate. Areas of climate-resilient habitat that may function as climate change refugia have already been mapped for much of North America; one example is The Nature Conservancy's resilient lands analyses. However, since Pennsylvania's species are differentially impacted by climate change and vary dramatically in their tolerances, preferences, and adaptation strategies, it is unlikely that generally defined climate refugia areas will be equally supportive for all species of concern.

From 2019 to 2022 with funding from a DCNR Wild Resources Conservation Program (WRCP) grant, PNHP scientists conducted a modeling project to assess potential climate change refugia in Pennsylvania. The primary goals of this project were to 1) identify and map a suite of high-priority stable climate areas (refugia) in Pennsylvania that support site-level conservation efforts for a variety of species groups and habitats, and 2) determine the most threatened habitat types, species, and natural communities which are unlikely to be protected within—or connected to—these refugia in the near-future. In general, this project was meant to address the question "refugia for which species?" This is a necessary piece of information to have prior to developing actionable management plans for our rare species and natural communities.

Our approach to this project was to develop climate envelope models for a broad set of rare plant species for which PNHP collects data. These models allowed us to predict and map how the geographic and ecological niches of each species were likely to shift as a result of climate change between now and 2050. We focused on what scientists call a "bioclimatic niche" for each species; that is, a suite of climate variables such as

annual precipitation, maximum summer temperature, or last frost date, combined with 11 surficial geology variables describing soil texture, parent material, and pH. Species were selected for inclusion in the project to represent a range of habitat associations, life history strategies, and hypothesized climate change vulnerabilities. In all, 172 different species were modeled, representing 12 different habitat associations.

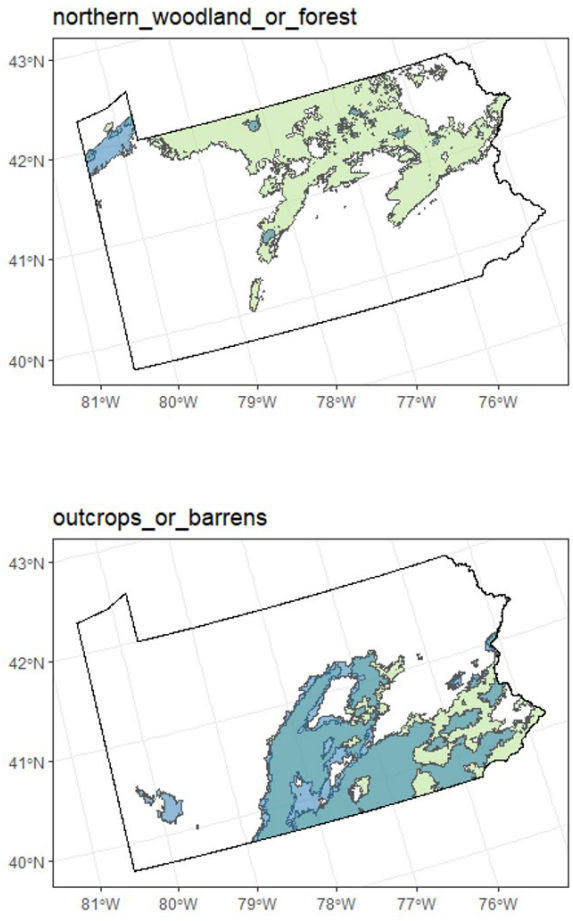
Three of the plant species modeled in this project, representing three of the different focal habitat types. From left to right, 1) mountain bugbane (*Actaea podocarpa*), associated with rich woodland or forest habitats, 2) showy lady's-slipper (*Cypripedium reginae*), associated with calcareous wetlands, and 3) hoary puccoon (*Lithospermum canescens*), associated with outcrops and barrens. (Photos: Pete Woods)

We relied mostly on Heritage Element Occurrence data from Pennsylvania, as well as data shared with us from our neighboring state Heritage programs. We supplemented Heritage data with species locations gleaned from community science datasets (iNaturalist and GBIF data). Data organizing, joining, formatting, and reviewing was a major effort for this project. One common issue with creating climate niche models for species is that we often lack vetted and representative occurrence data. Taking advantage of the expertise of Heritage biologists allowed us to evaluate and do our best to maximize the quality of our input data.

Because of the inherent uncertainty in models of future scenarios, we chose to use a "stacking" and "ensembling" model approach in this study. For each individual species, three different kinds of climate envelope models were run, and then the results were ensembled (averaged). Then, we "stacked" the models within each habitat group; that is, we added together all the ensembled models for each species within each habitat grouping to create a single model output (in our case, a map of Pennsylvania!) that displayed the number of species in that habitat group in each 1 km grid cell across the state (the scale at which we modeled our data) that might have suitable habitat currently and in the future. These maps were used to identify current hotspots of suitable habitat for each species group, as well as future suitable habitat hotspots, and measure their change in size and location over time. The portions of the landscape which we expect to function as climate refugia were defined as the areas of Pennsylvania that were stable across current and future climate scenarios.

We also assessed the overlap between current and future species richness hotspots with some of the major conservation planning data products for Pennsylvania: climate change connectivity corridors, currently protected areas, high-priority geophysical settings, and The Nature Conservancy's map of generally resilient areas of the landscape. We were interested in whether certain habitat type refugia areas were potentially being left out of the conservation planning data products that are specifically meant to guide future decision-making about land protection or management in Pennsylvania.

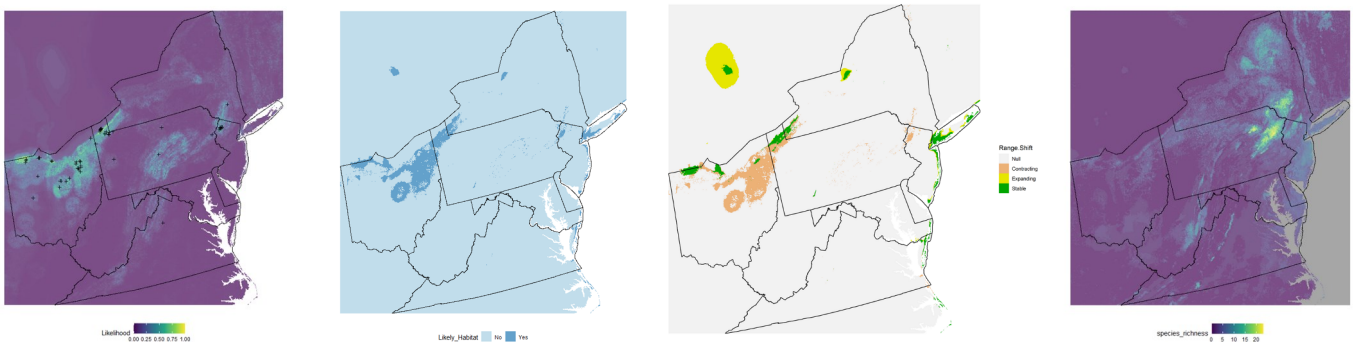
What did we find, after doing all of this analysis? As we expected, species associated with different habitats in Pennsylvania are probably going to have very different experiences of climate change. Species associated with



An example of the current and future species richness hotspots mapped for two of the focal habitat groups. Compare between current (light green) and future (darker blue) predicted species richness hotspots for the habitat groups.

	# of Species Modeled	Habitat Area Change as a Result of Climate Change	Climate Change Connectivity	Currently Protected Areas	High Priority Habitat Grouping by Geophysical Settings	Resilient Sites
Acidic Wetlands	30	Strong decrease	Well represented	Well protected	Poorly associated	Well represented
Calcareous Wetlands	24	Strong decrease	Moderately well represented	Poorly protected	Moderately associated	Moderately well represented
Northern Woodland or Forest	7	Strong decrease	Well represented	Well protected	Poorly associated	Well represented
Outcrops or Barrens	20	Strong decrease	Moderately well represented	Poorly protected	Highly associated	Moderately well represented
Wetland Generalist	25	Strong decrease	Well represented	Moderately well protected	Moderately associated	Moderately well represented
Riverscour	7	Slight increase	Moderately well represented	Poorly protected	Moderately associated	Moderately well represented
Serpentine Barrens	7	Slight increase	Poorly represented	Poorly protected	Moderately associated	Poorly represented
Tidal Marshes	6	Slight increase	Poorly represented	Poorly protected	Moderately associated	Poorly represented
Habitat Generalist	6	Little change	Poorly represented	Poorly protected	Highly associated	Poorly represented
Calcareous Outcrops and Barrens	7	Large increase	Well represented	Moderately well protected	Highly associated	Well represented
Open, Disturbed	8	Large increase	Poorly represented	Poorly protected	Moderately associated	Moderately well represented
Rich Woodland or Forest	25	Large increase	Moderately well represented	Poorly protected	Highly associated	Moderately well represented

A qualitative summary of the general pattern of changing suitable habitat area as a result of climate change for each focal species habitat group, and the strength of the association between the species habitat groups and the suite of conservation planning datasets used in this study. “Association” was measured based on overlap between the stable refugia areas for each species group and the other focal planning data sets.



Left to right, maps showing a progression of the model outputs generated by this project.

a) A single climate envelope model for a single species, depicting bioclimatic niche likelihood under current climate.
b) The result of ensembling (averaging) all three model types for a single species, and converting to a presence/absence surface for habitat under current climatic conditions.
c) A comparison of the habitat area across current and future climate scenarios. “Stable” habitat areas (dark green) are suitable in both current and future scenarios. “Contracting” habitat(orange) is suitable in present time but not future time periods, while “expanding” habitat (light green) is suitable in future but not present times.
d) Each ensemble model for each species is “stacked” within habitat groups, to create a species richness surface.

some habitats are likely to experience much more dramatic shifts in bioclimatic habitat suitability in the near term (next 30 years) and may require more targeted and dramatic interventions to preserve populations and support climate adaptation. And, while some habitat groups aligned well with areas of Pennsylvania which are considered *generally* resilient to climate change and are prioritized for climate change connectivity planning (for example, northern forest or woodland species, acidic wetland species), other habitat groups were consistently missed in these more generalized data sets (for example, serpentine barrens species and tidal marshes species). See page 8 for a summary of results.

Mary Ann Furedi

Bruce Lake Bog is an example of an acidic wetland that will likely be impacted by climate change.

Some habitat types appeared to be at overall greater risk of loss of suitable habitat in Pennsylvania as a result of climate change. The degree of climate risk to habitat, however, was generally decoupled from the degree to which each habitat group is associated with the major environmental datasets that are used for prioritizing conservation planning decisions in Pennsylvania. For example, acidic wetlands species are expected to experience a strong decrease in the overall area of suitable habitat as a result of climate change, but for now are well represented within protected lands, resilient sites, and by our recent climate change connectivity analysis. Thus, conservation planning efforts that make use of these datasets are likely to benefit this group of species.

In contrast, species associated with calcareous wetlands are also expected to experience a strong overall decrease in habitat area as a result of climate change, but they are poorly protected and only moderately well represented within generally resilient sites and within the climate change connectivity analysis. The calcareous outcrops and barrens species group may actually increase its area of suitable bioclimatic niche space in Pennsylvania in the near future, and also is well associated with climate change connectivity priority areas, generally resilient sites, as well as already being moderately well-protected. Species groups like serpentine barrens and tidal marshes, however, showed little change in overall bioclimatically suitable habitat over time, and were also poorly protected and poorly associated with resilient sites and climate change connectivity priority areas. This suggests that despite potentially not experiencing as direct a threat to habitat as a result of climate change as other species groups, they are also currently excluded from some of the primary datasets used to prioritize conservation planning decisions.

Overall, what we see with this climate refugia mapping project is that the climate future in Pennsylvania is complicated. There is no "one size fits all" response to climate change. To protect the full range of Pennsylvania's biodiversity, we will need to take a variety of approaches, consult and develop a wide range of conservation tools, and broaden our conservation partnerships across the state. Luckily, the amazing wealth of data and expertise that PNHP has accumulated over our 40 years of conservation work in Pennsylvania has well-positioned us to address the complex challenge of climate change in our state and ensure that the full range of our natural ecosystems remain diverse and functional for many years to come.

Look for more detailed methods, data, and maps developed in our climate refugia project to be made available later this year.

About the Author

Anna Johnson began working for PNHP in 2018 as a conservation planning communication specialist. While a plant and pollination ecologist by training, since joining PNHP she has been mostly in the office, developing conservation tools. She loves finding ways to make complex ecological issues, stories, and data more accessible to more people. She received a BA in liberal arts from St. John's College and a PhD in Geography and Environmental Systems from the University of Maryland, Baltimore County.

Notes from the Field

Putting Evening Grosbeak on the Road to Recovery

David Yeany II, Avian Ecologist

In the fall of 2021, our evening grosbeak conservation project expanded when we received funding from the Knobloch Family Foundation to join the Road to Recovery Initiative as one of their pilot projects for Species on the Brink of Endangerment. Evening grosbeak (*Coccothraustes vespertinus*) is in steep decline in North America with a 92% loss in the past half-century. As part of Road to Recovery, our new objectives included 1) creating an international evening grosbeak working group to guide research and develop conservation strategies within a co-production framework, and 2) collecting full annual cycle information on evening grosbeaks across their continental range using new tracking technology.

The formation of the working group is ongoing, co-led by PNHP and our partner the Finch Research Network (FiRN). In these early stages we are seeking a diversity of new members, identifying stakeholders, and compiling the current state of knowledge about the evening grosbeak decline. At the same time, we began tagging efforts outside of Pennsylvania to track populations within the major regions of the species' winter range.

In March and April 2022, we traveled with partners from Powdermill Avian Research Center (PARC) and FiRN to field sites in Minnesota and Maine to begin evening grosbeak tagging efforts and make connections with local stakeholders. Sax-Zim Bog in northern Minnesota is well-known for its great gray owls (*Strix nebulosa)*, northern hawk owls (*Surnia ulula),* and other boreal birds – including evening grosbeaks. Here, our local partner, the Friends of Sax-Zim Bog, helped us locate sites for grosbeak trapping and tagging.

David Yeany II

A male evening grosbeak is ready for release wearing a Lotek Sunbird satellite tag. Grosbeak bills turn from bone colored to bluish green as hormone level change and breeding conditions approach in the spring.

Unfortunately, when we arrived there were very few evening grosbeaks around the Sax-Zim Bog. In seven full days of effort, we caught and banded just five grosbeaks and were able to tag just two of those birds. Not the numbers we wanted, but it was the first ever deployment of Lotek Sunbird satellite tags on evening grosbeaks! These satellite tags, weighing just 2-2.5 g, communicate with the Argos satellite system to capture fine scale (<250 m-1500 m) tracking data for bird movements in near real-time. Never before were tags available with this locational accuracy for birds as small as evening grosbeaks and without the need to recapture birds to retrieve tag data, as with geolocators.

David Yeany II

A female evening grosbeak sports the first ever satellite tag deployed on this species during our tagging effort in Minnesota.

Our work in Aroostook County, Maine was much more successful. Our partners at FiRN facilitated access to several sites with higher abundance of wintering evening grosbeaks and worked with landowners to provide the necessary site preparations for success. In seven days, we caught 77 evening grosbeaks, banded 62, and tagged 41 – 11 with Sunbird satellite tags and 30 with radio nanotags tracked via the Motus Wildlife Tracking System. In Maine, we also witnessed firsthand some of the potential threats leading to declines in grosbeaks. We found conjunctivitis, a finch eye disease, in 26% of our sample, several sick grosbeaks were preyed upon by corvids (i.e., American crow, common raven), and we saw car collision mortalities from grosbeaks gritting – collecting tiny stones and salt to aid digestion – on the road.

David Yeany II

Mallory Sarver (PARC) and David Yeany (PNHP-WPC) process an evening grosbeak during our tagging effort in Maine.

During the months since tagging, we have been monitoring the data transmitted from our 13 tagged birds, with some impressive results. As of this writing, we have collected over 2,600 positions for these birds. We have been able to track birds from their wintering areas in the United States to probable breeding areas in Canada. We are seeing that these routes are not necessarily direct and that birds may linger in other "stopover" areas for extended periods. There is much more to learn, but this information can help guide conservation of the species and sleuth out key limiting factors for populations.

Evening grosbeak tracks from two birds tagged in March at Sax-Zim Bog in Minnesota from the same flock. The yellow track shows the male traveling more than 500 km due north into Ontario while the red and blue track shows the male traveling more than 750 km northwest into Manitoba.

Looking ahead to this upcoming grosbeak season (October-April), we have plans for tagging efforts in Pennsylvania, New York, Minnesota again (due to our small sample size), and one western site to begin incorporating data from western evening grosbeak subspecies in the Intermountain West and the Pacific Northwest. We will also continue to build the evening grosbeak working group and welcome new stakeholders with interests in conserving this species. The Road to Recovery Initiative is setting up its pilot projects on a longer time-scale than most conservation efforts, but we will continue to seek support for this work if we are truly going to put evening grosbeak on the road to recovery.

Large Yellow Lady's Slipper

Mary Ann Furedi, Ecological Assessment Manager

Mary Ann Furedi

A cluster of large yellow lady's slippers.

PNHP ecologists completed the final report for a Wild Resources Conservation Program (WRCP) funded project that focused on expanding our knowledge of large yellow lady's slipper (*Cypripedium parviflorum* Salisb. var. *pubescens* (Willd.) Knight). Large yellow lady's-slipper is an orchid found in Pennsylvania, but little formal work had been done previously to explore the life history, current population conditions, and threats associated with this species in Pennsylvania.

A literature review was done to determine what ecological and distribution related information was already known for large yellow lady's-slipper. We discovered that Deller (2005) had completed a nearly exhaustive review. Information from Deller's work, coupled with Pennsylvania specific information, were incorporated into a species background summary.

A combination of data sources was used to understand the distribution of large yellow lady's-slipper in Pennsylvania. The species had been documented in 15 counties within the last 25 years and one county held a record greater than 25 years. From this information, we selected 15 sites for field visits to assess population size, habitat, and potential threats. To determine population

size, a low intensity monitoring approach was used at 13 sites, which included a census of vegetative and flowering stems and whether stems occurred as clusters or single stems. A high intensity monitoring approach was employed at two populations to gain a better perspective of stage structure within populations and reproductive success in terms of seed capsule formation. Large yellow lady's-slipper was found at 14 of the 15 sites. Population estimates ranged from six stems to over 600 stems. The stage structures of the two populations were skewed more towards the adult stages. Capsule formation varied by population and years. Given that previous population estimates from these sites were minimal or inconsistently collected, it is difficult to draw conclusions about the stability or vulnerability of these populations. Smaller populations, however, appear to persist over time. The dataset from this project does provide an excellent baseline for future monitoring work and population-level comparisons.

The habitat at each of the 15 sites was characterized by plant community type using accepted Natural Heritage sampling protocols. Except for one site, populations were found in more continuous forest stands under mostly closed canopies. Populations were generally located on slopes ranging from gently sloping to very steep. The southeastern sites had greater boulder cover as well. The community types represented included a number of hardwood communities, with more than half being Tuliptree-Beech-Maple forests.

Mary Ann Furedi

Jaci Braund, PNHP ecologist, recording plant related data.

A combination of sources was used to conduct assessments of known and perceived threats for large yellow lady's-slipper in Pennsylvania. A list of potential threats was developed from the literature and from a public knowledge questionnaire. The species is listed as Pennsylvania Vulnerable (PV) due to perceived drug-

Mary Ann Furedi

Some browsing visitors captured on the game camera.

trade pressures and horticultural pressures so more research was done to explore the validity of these threats. Site-specific threats were also documented during visits to the 15 populations. In addition, game cameras were deployed at three populations in an attempt to capture activity at those sites. We found that all sites had some level of threat and this should be considered when planning management activities for the species.

Based on the results of this project, it is likely there are additional large yellow lady's-slipper populations in Pennsylvania. Additional survey efforts are suggested. We also recommend using a consistent approach for estimating population size, like the low intensity one used for this project. The life history of the species, timing of site visits, and documentation of threats should all be components of a monitoring effort. Consistent data collection would allow for more confidence when comparing multi-year population estimates and help in the determination of the actual vulnerability of the population.

Rare Plant Updates

Claire Ciafré, Ecologist
Rachel Goad, Botanist

With hundreds of plant species tracked by PNHP and numerous staff in the field checking up on them, there's a lot of news about rare plants to share! This spring we collected data and conducted stewardship on populations of globally rare species, as well as others that are globally secure but rare in Pennsylvania. Many species are threatened by factors that are unlikely to be mitigated without human involvement, so PNHP is increasingly involved in addressing these stewardship needs.

One species in critical need of stewardship is black-seeded spear grass (*Piptochaetium avenaceum*), a woodland grass with seeds which drill into the soil by twisting a 2-inch-long tail. While still globally secure, black-seeded spear grass is at the northern edge of its range in Pennsylvania where it has severely declined due to habitat loss and invasive species encroachment. It is now on the verge of being extirpated from the state, with just a couple of small populations left. One of these hadn't been seen since 2006 despite several thorough searches by PNHP staff. This spring we were able to relocate this population but found only two plants. Without careful stewardship, this population and its habitat will soon be gone.

Claire Ciafré

PNHP staff treat Canby's mountain lover (*Paxistima canbyi*) for euonymus scale and survey the population while trying not to slide down the steep slope.

For globally rare species whose loss in Pennsylvania could bring them one step closer to extinction, PNHP staff collaborate with state partners to develop and implement Recovery Plans which lay out monitoring, research, and management needs. Canby's mountain lover (*Paxistima canbyi*), a globally imperiled shrub, is one such species. Its stewardship needs to include not only invasive plant removal but also the treatment of an invasive insect, euonymus scale, which feeds on and damages the plants. This spring we treated plants for scale and removed Oriental bittersweet (*Celastrus orbiculatus*), an invasive plant that outcompetes Canby's mountain lover and acts as an alternate host for the euonymus scale.

Like Canby's mountain lover, spreading rockcress (*Arabis patens*) is globally vulnerable, reaching the northern edge of its range in Pennsylvania. Limestone bluffs and outcrops along the Conococheague Creek in Franklin County are home to this and other rare species. PNHP has been working with landowners and a crew of dedicated volunteers to remove invasive species like burning bush (*Euonymus alatus*) and make space for rare species like spreading rockcress, as well as shooting-star (*Primula meadia*) and green and gold (*Chrysogonum virginianum*). When we visited the site this year, we found these and other species in full bloom.

Rachel Goad

Spreading rockcress, shooting star, and rue anemone (*Thalictrum thalictroides*) bloom at this special site. Orange pin flags mark spreading rockcress individuals so stewardship can be focused in areas where it is needed most.

We conducted a survey of the spreading rockcress at this site and found that the population increased by over 400% since 2018, suggesting that stewardship efforts are improving conditions for this species. Hopefully, as conditions continue to improve, other species present at the site will also recover and expand. One such species is the globally imperiled white alumroot (*Heuchera alba*). This species has never been seen blooming at this site and had to be identified by transplanting an individual and growing it in more favorable conditions. It flowered in captivity just a week after our visit this year, and we hope to see it flowering in the wild at this site in years to come.

Bog Jacob's ladder (*Polemonium vanbruntiae*) is a globally vulnerable species of wet meadows and forests. Unfortunately, deer browsing often prevents it from effectively producing seed; mitigating this threat is part of the recovery plan for this species. Cages can help plants survive the strong deer

Rachel Goad

Bog Jacob's ladder, newly caged, will hopefully go to seed this year now that is protected from deer browse.

browse pressure now present across so much of our landscape. This spring, we erected a cage at one population in Sullivan County to protect plants in that location. We'll be revisiting this and other caged bog Jacob's ladder plants later this year to evaluate whether our cage design effectively protects these individuals.

Our stewardship efforts for rare and very vulnerable plant populations will dovetail with the work of the Pennsylvania Plant Conservation Network (PPCN). The PPCN, which was started through DCNR in close coordination with PNHP, coordinates and facilitates on-the-ground stewardship efforts for native rare, threatened, and endangered plants. PNHP can only do so much and the PPCN will be developing a network of volunteers that will add considerably to our efforts and hopefully represent a long-term stewardship strategy.

Heller Cave Springtail Surveys

Betsy Leppo, Invertebrate Zoologist

The Heller Cave springtail belongs to a group of tiny, wingless, insect-like animals in the Arthropoda class of Collembola, which includes nearly 10,000 described species worldwide. Collembola occur in a wide variety of habitats and are especially common in leaf litter and soil. Collembola that have adapted to caves are an important part of those ecosystems, supporting subterranean food webs and nutrient cycling.

The Heller Cave springtail was first collected from Heller Cave in Blair County by Keith Christenson in 1997 and was formally described as *Typhlogastrura helleri* by Kenneth Christiansen and Hanghang Wang in 2006. It was possible that the Heller Cave springtail could be limited to one cave system, as many other cave-adapted springtails are endemic to a single cave due to their small size, lack of wings, and overall limited mobility.

Ryan Maurer

Two Heller Cave springtails

In 2011, the Center for Biological Diversity petitioned for listing the Heller Cave springtail under the Endangered Species Act after a proposed limestone quarry threatened to destroy Heller Cave. In 2012 the U.S. Fish and Wildlife Service (USFWS) determined that listing may be warranted and scheduled the species for a listing decision by 2024.

In 2021 the USFWS enlisted Dr. Aron Katz, a research biologist from the U.S. Army Corps of Engineers in Illinois with expertise in Collembola systematics, to help gather the data needed for the species status assessment and listing decision. Dr. Katz developed a study proposal to evaluate the distribution, ecology, and genetic diversity of the Heller Cave springtail using specimens collected in cave surveys, and a novel environmental DNA assay to detect them using cave and spring water samples. The USFWS also engaged the Pennsylvania Natural Heritage Program, the Pennsylvania Game Commission, and the Pennsylvania Fish and Boat Commission to assist with project development and surveys.

Aron Katz, USACE, ERCD-CERL, Champaign, IL

Greg Turner (left) and Michael Scafini (right) of PGC aspirate over 100 springtails directly from racoon scat.

For 25 years, it was not known if the Heller Cave springtail was truly limited to Heller Cave, because Collembola had never been collected from nearby caves. In spring of 2022, Pennsylvania was finally poised to go underground to answer some questions. In January and March of 2022, project collaborators surveyed 16 sites in central Pennsylvania, including caves and springs within 20 kilometers of the original Heller Cave system. Unfortunately, we were unable to get permission to access Heller Cave itself. Fresh specimens from the original site are still needed for a definitive assessment of the genetic and conservation status of the Heller Cave springtail. But regardless, we made some very interesting and useful discoveries.

Betsy Leppo

Greg Turner, volunteers from the Mid-Atlantic Karst Conservancy (Ryan Maurer and Hope Brooks), and Dr. Aron Katz emerge from a cave after a muddy survey.

Dr. Katz drafted a technical report and is preparing a publication to share the results with the scientific community. We are eager to share more findings as the report and publication are finalized, so stay tuned. But we will leave you with this teaser…some springtails really love racoon scat!

New Jersey Rockfall Surveys

Jeff Wagner, Director, Natural Heritage Program

Several years ago, the New Jersey Natural Heritage Program (NJNHP) approached us, wondering if we could assist them in surveys of steep road cuts and rock outcroppings of Mt. Tammany on the New Jersey side of the Delaware Water Gap along Interstate 80. They had seen the web-based series "Plants are Cool Too" produced by Chris Martine at Bucknell University and thought we were a good fit for the work they needed to do with the New Jersey Department of Transportation (NJDOT). For that video and project, PNHP staff assisted in scaling the Shikellamy cliffs at Shikellamy State Park in Union County in search of a rare plant species.

This project has required visits to the site every two weeks during the growing season to survey the area where a rockfall mitigation project is being planned. The search has involved flying a drone, searching with high resolution spotting scopes, and climbing/rappelling. The work has been challenging but our team working closely with NJNHP has persevered and found several of the target species within and just outside the project area.

Alex Dogonniuck

NJNHP botanist, Jason Hafstad, looking at the Delaware River from a perch on Mt. Tammany.

One plant species, mountain spleenwort (*Asplenium montanum*) is a rare plant (S2) in New Jersey. On our first outing to the site, with the use of spotting scopes and binoculars, we found it growing in crevices of the almost vertical roadcut. Subsequent visits revealed that it was scattered throughout the outcrops at the base of Mt. Tammany. However, wild bleeding heart (*Dicentra eximia*) which is a critically imperiled plant in New Jersey eluded our botanists and everyone who helped survey the site. NJNHP had a historic record for it at the site but none of our investigators could find a single plant. But one day, at the very end of the day, we convened across the river to discuss next steps. We had spotting scopes and were casually scanning adjacent outcrops to the primary project area and spotted a pink flowering plant hanging from a crevice. It was *Dicentra*! Subsequent visits resulted in the mapping of a number of clumps growing on the outcrop.

Alex Dogonniuck

Wild bleeding heart (*Dicentra eximia*)

We will continue the project until September, documenting all plants seen in all parts of the site. NJNHP and NJDOT will use the information to mitigate impacts to the rare plants on the site. Our assistance to a sister program is what the Natural Heritage Network is all about – combining our expertise to collect the best and most comprehensive data on biodiversity throughout the hemisphere.

Managing Tree-of-Heaven to Control Spotted Lanternfly

Amy Jewitt, Invasive Species Coordinator and
Brian Daggs, Invasive Plant Ecologist

The spotted lanternfly is currently at the forefront of almost every invasive species conversation in Pennsylvania. It is the subject of countless articles and factsheets made to raise awareness of this planthopper's voracious appetite for grapevines, fruit trees, and various hardwoods. In an effort to prevent the spread of spotted lanternfly in Pennsylvania, the

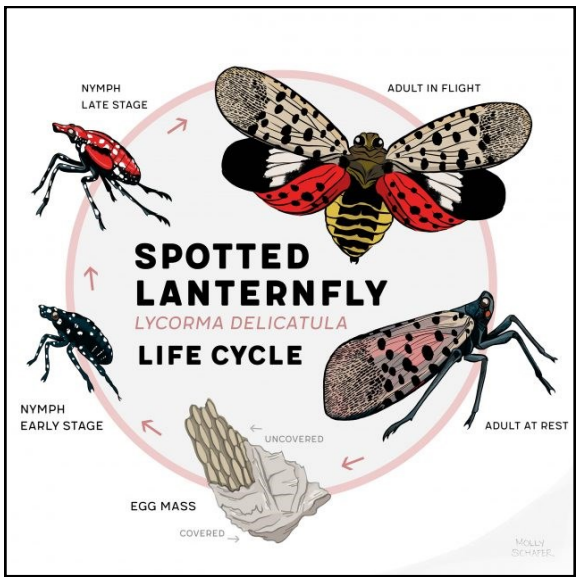
Brian Daggs

A large Tree-of-Heaven, identified while road-cruising by its growth form, with branch tips that appear to curve upwards and lack thin, fine twigs.

Pennsylvania Natural Heritage Program (PNHP) is looking to target its primary host plant, tree-of-heaven.

Tree-of-heaven is an invasive species in its own right. It's a fast-growing tree native to east Asia which reproduces in large numbers and outcompetes native species. The spotted lanternfly, also native to east Asia, evolved alongside tree-of-heaven, which provides spotted lanternflies the needed resources to reproduce in large numbers.

The lanternfly's expanding range could spell trouble for the vineyards of Erie County in Pennsylvania, as grapevines are especially susceptible to these pretty, yet destructive insects. In a pro-active measure, PNHP along with other member organizations of the Lake Erie Watershed Cooperative Weed Management Area (LEW CWMA) conducted surveys throughout the county with a focus on an 18-mile stretch between the city of Erie and the New York State border where the landscape is dominated by vineyards. We surveyed in the spring of this year before most other trees leafed out and tree-of-heaven was easier to spot. Tree-of-heaven colonies were identified, and we are taking steps to communicate with landowners to treat and remove these trees.



This year the iMapInvasives program is hosting a new community science event that encourages observers from across Pennsylvania to search for spotted lanternfly and tree-of-heaven. A special online map allows participants to choose their preferred survey area(s) and search for both species from June to November. Findings are reported to either Penn State Extension's online reporting tool (specifically for presences of spotted lanternfly) or the iMapInvasives database. So far, over 50 locations across the commonwealth have been claimed for surveying.

If you'd like to participate as an on-the-ground surveyor in this event, there's still time to get involved! Here's what to do:

- Scan the QR code in this article to watch an online training video.
- After watching the video, email the event coordinator, Amy Jewitt (ajewitt@paconserve.org), to record your name on the event roster.
- Claim one or more survey locations using a specially-made online interactive map.
- Visit your claimed survey locations in-person 2-3 times during the summer/fall and report your presence and absence findings for both spotted lanternfly and tree-of-heaven.

Prizes will be awarded in December 2022 to five lucky participants of this event!

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