



Pennsylvania Natural Heritage Program

information for the conservation of biodiversity

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Building Bridges to Mussel Recovery

by

Jordan Allison, Eric Chapman, and Nevin Welte

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Photo Banner:

Stocking clubshell mussels in Conewango Creek

Jordan Allison

Unbeknownst to many motorists, a tiny slice of freshwater mussel paradise lies beneath the aging steel of Pennsylvania's SR 62 Hunter Station Bridge in Forest County, Pennsylvania. The 300 m long structure carries drivers across not just the Allegheny River but over one of the largest remaining populations of two protected freshwater mussel species, the northern riffleshell (*Epioblasma torulosa rangiana*) and the clubshell (*Pleurobema clava*). The Pennsylvania Department of Transportation (PennDOT) has been planning for the bridge's replacement since 1993, when both species were designated by the U.S. Fish and Wildlife Service (USFWS) as federally endangered.

During planning, PennDOT determined that ~5,000 m² of river bed would have to be disturbed to accommodate causeways for new pier construction and demolition of the old bridge. A pre-construction mussel survey estimated that roughly 170,000 mussels would be impacted, of which the overwhelming majority (137,000) were federally protected. This presented the state with a unique and uncommon scenario in which a mussel

population is dominated not just by one, but two endangered species.

Due to the presence of federally listed species, PennDOT was required to consult with USFWS to ensure that its actions would not jeopardize the continued existence of the species. Conservation measures were adopted to minimize and avoid in-stream impacts by using alternative construction materials and rapid construction techniques. Additionally, mitigation measures for unavoidable impacts required a mussel salvage of the impact area. However, this requirement presented the question of



Hunter Station Bridge

WPC

what to do with so many protected and common mussels. A working group of malacologists from around the country decided that the salvaged mussels would be best used to promote species recovery by translocating them to historically occupied waterways throughout their range. These recommendations created a unique opportunity for state and federal agencies, non-governmental organizations, academic institutions, private consultants and a Native American tribe to work collaboratively on one of the largest freshwater mussel restoration projects ever undertaken in North America.



WPC

Mussel salvage dive operation at Hunter Station

To date a total of seven states - Illinois, Indiana, Kentucky, Ohio, New York, Pennsylvania, and West Virginia - as well as the Seneca Indian Nation have participated in this endangered species recovery project. Imperiled mussels were not handed out haphazardly. In order to participate all interested parties were asked to complete a review of the waterways that they proposed to move mussels to. The review was completed to maximize the chances for long term success and protection of the translocation sites and consisted of an assessment of the stream's historical and existing mussel fauna, fisheries data to ensure that appropriate hosts fishes were present, and a threats analysis that examined factors like invasive species presence and riparian ownership. The USFWS authorized the streams that were to be stocked with pilot populations consisting of 50 to 100 mussels per site. The pilot populations were sampled after one year to determine survival rates. If survival rates were acceptable, then a larger scale stocking was undertaken with the objective of reintroducing or augmenting an existing population with the goal of establishing a self-sustaining population.

Many Pennsylvania streams were considered but only two received endangered mussels. We selected the Shenango River in Mercer County not just because it formerly supported northern riffleshell and continues to support remnant

populations of clubshell, but also because the recovery of either species would be unlikely without human intervention. Impoundments along the Shenango, Allegheny, Beaver, and Ohio rivers have fragmented the species' former habitat creating a gauntlet of barriers that prohibit host fish and mussel dispersal isolating existing populations from one another. The other stream we selected was Conewango Creek in Warren County. Conewango Creek is a direct tributary to the Allegheny and supports a low density population of northern riffleshell which, prior to two dam removals in 2009 and 2014, had not shown signs of recruitment. Our augmentation efforts may help to jumpstart recovery as the stream begins to recolonize naturally from its restored connection to the Allegheny River.



Brian Ferry

Measuring northern riffleshells for the Conewango Creek pilot study.



Jordan Allison

The Hunter Station mussel tagging assembly line in operation.



Jordan Allison

Ryan Miller manning the Allegheny River species sorting table.

With Pennsylvania streams selected for restoration, we established pilot populations at three sites along the Shenango River between Pymatuning Reservoir and Shenango River Lake and at two sites along Conewango Creek upstream of Warren. In 2014, each site received 90 northern riffleshell and 90 clubshell that we stocked into permanent monitoring plots. All individuals were fitted with 12.5 mm long passive integrated transponder (PIT) tags which gave each mussel a unique identifier and facilitated their recapture during monitoring events. After one year we assessed each pilot population for survival and found favorable results at most sites. Northern riffleshell fared well in Conewango Creek with an average survival of 63.4% across both sites, while clubshell's survival rates in both the Shenango River and Conewango Creek were high, averaging 84.4% across all five sites. Based upon the success of the pilot populations, the Shenango River received supplemental stockings of 5,100 clubshells across all three sites during the 2015 and 2016 field seasons.



Charles Bier

An endangered sheepsnose with an epoxied PIT tag and a superglued numbered plastic tag

Conewango Creek received 3,900 clubshells between both sites and one was stocked with 1,500 northern riffleshells.

In addition to endangered species augmentations, the Hunter Station project afforded us the opportunity to undertake projects which were again the first of their kind in Pennsylvania. Two projects aimed at restoring mussel communities in the Clarion River in Forest County and Dunkard Creek in Greene County were initiated through a partnership between PennDOT, the Pennsylvania Fish and Boat Commission (PFBC), United States Forest Service (USFS), and the Western Pennsylvania Conservancy (WPC), along with volunteers.

The first project was the Clarion River. The Clarion River in the early 1900s was described by Dr. Arnold Ortmann, a preeminent malacologist of the day, as running "black as ink," "one of the worst in the state," and devoid of mussels due to extractive industries such as logging, mining, and pollution from associated industrial processes. Because the Clarion was degraded at such an early date, no records of its historical mussel fauna exist. However, improvement in water quality and recent discoveries of living mussels in the Clarion by the USFS, WPC, and Chuck Williams indicated that the Clarion was an ideal candidate for mussel recovery efforts.



Nevin Welte

Stocking a mussel into a Clarion River monitoring plot.

In 2015, 402 mussels of eight species were PIT tagged and stocked across ten Clarion River pilot sites within the Allegheny National Forest. The following year, 382 individuals were recaptured of which 377 were alive giving us a nearly 99% survival rate for recaptured individuals. Due to the mussels' impressive first year survival rate, an additional 23,500 common mussels representing the same eight species plus four new ones were relocated to the Clarion during 2016. This huge

effort by the partnership was an attempt to reestablish our best approximation of a mussel community that had been lost for more than 150 years.

The second project was Dunkard Creek. Dunkard Creek winds its way along the border of Greene County, Pennsylvania and West Virginia and was described by Dr. Ortmann as “splendid in every respect.” Unfortunately during 2009 the creek was devastated by a massive fish and mussel kill attributed to elevated chlorides and an introduced golden algae. Following a 2015 court settlement, PFBC reassessed the fish and mussel community in 2016 and found a partially recovered fish fauna but still vastly depleted mussel fauna. The presence of host fish and improvements in water quality were encouraging signs that life was returning, but it was apparent to us that the mussel community in Dunkard Creek was not going to recover without assistance.



Jordan Allison

Carefully stocking a Dunkard Creek pilot site

PFBC efforts to restore this creek to its once splendid condition began this fall with the reintroduction of 487 common mussels representing 11 species that were collected from the Hunter Station Bridge site. These new “colonists” were PIT tagged and stocked into five pilot sites within the 2009 kill zone. PFBC will monitor the survival of these common mussels in 2017 and the results will be used to determine whether additional mussels can be relocated to Dunkard Creek.

Since 2014, the combined effort of individuals representing PennDOT, PFBC, USFS, USFWS, WPC, EnviroScience Inc., and numerous volunteers has allowed Pennsylvania to move ~36,000 mussels from that tiny slice of mussel paradise beneath the Hunters Station Bridge to four streams within the commonwealth. These efforts either supported



Alysha Texler

A recently-stocked mussel siphoning in its new environment

targeted species recovery projects or promoted the recovery of mussel communities in individual watersheds. We hope that this momentous effort - which would not have been possible without the collaboration of all parties - will serve as a model for future mussel conservation efforts. Above all, we hope that these unassuming mussels will establish enduring populations in their new homes, persisting for the benefit of future generations to come.



Jordan Allison

The Allegheny River just upstream of the Hunter Station Bridge

Acknowledgements: The authors thank PennDOT for providing funding to support the project and specifically recognize Autumn Kelley and Antonia Zawisa for their assistance in the field and with preparation of the interagency agreement. We also recognize WPC’s Ryan Miller, USFS’ Nate Welker and all PFBC, USFS, USFWS, WPC, and EnviroScience staff, and the volunteers that helped make these projects possible.

Forest Interior Bird Habitat Relationships in the PA Wilds

by
David Yeany

Information on forest breeding birds is commonly collected using roadside surveys because bushwhacking off-trail into the heart of potentially rugged forest habitat is often much more challenging and difficult. However, the use of these road-based surveys raises questions about how these methods could affect bird density estimates, determination of fine scale habitat relationships, and conservation decisions for species averse to roadside habitat conditions. In 2015, we saw an opportunity to address some of these questions when our state agencies, sharing these concerns and their implications for management of forest lands, identified a Wild Resource Conservation Program priority to use off-road surveys to explore habitat relationships of forest interior breeding birds. While building off recent PNHP forest bird studies, we partnered with Audubon Pennsylvania to design a project examining breeding bird densities across specific forest communities. We focused on the Pennsylvania Wilds Region in northcentral Pennsylvania, where the largest and most intact forest in the state remains. Our over-arching goal was to determine forest interior bird habitat relationships that could be integrated into existing forest management frameworks by state and federal agencies.

Utilizing off-road surveys is especially important when considering habitat management for forest interior birds, as these species are typically area-sensitive and require contiguous core forest at least 100 m from fragmenting features like roads or pipelines, and standard roadside surveys may under-represent these

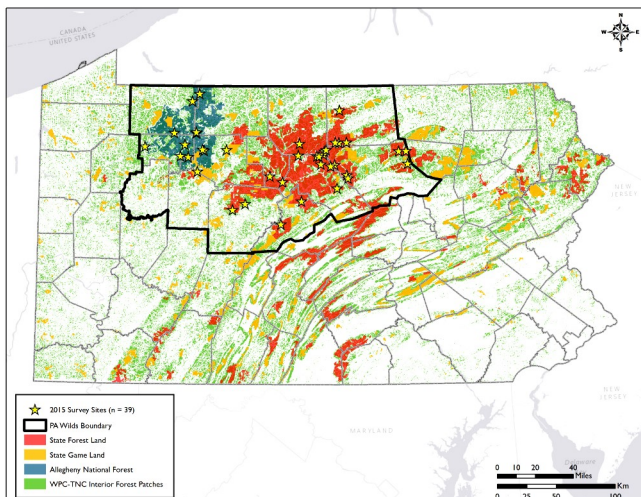


David Yeany

Black-and-white warbler is a forest interior bird most strongly associated with oak forest community types in the PA Wilds.

birds. This project was also well-aligned with the recently completed 2015 Pennsylvania Wildlife Action Plan, as forest-dependent birds account for 40% of the bird Species of Greatest Conservation Need (SGCN) identified in the plan and, among those, at least 21 species are also forest interior birds.

We designed our project with two specific questions in mind: 1) how do forest bird species densities differ across forest community types in the Pennsylvania Wilds, and 2) which landscape and forest structure attributes contribute to these differences? Using Geographic Information Systems (GIS), we selected 711 survey locations across 39 sites in the Pennsylvania Wilds. These sites were distributed across forests managed by the U.S. Forest Service, DCNR Bureau of Forestry, and the Pennsylvania Game Commission. All locations were located within Audubon Important Bird Areas and within interior forest. We focused our selection on seven abundant forest community types from the Pennsylvania Community Classification (Zimmerman et al. 2012) within three forest groups: 1) oak: Dry Oak—Heath, Dry Oak—Mixed Hardwoods, Red Oak—Mixed Hardwoods; 2) northern hardwoods: Red Maple, Black Cherry—Northern Hardwoods, and Northern Hardwoods; and 3) conifer: Hemlock (White Pine)/Hemlock (White Pine) Northern Hardwoods. We distributed survey locations evenly across forest communities, ecoregions, and elevation classes enabling us to isolate effects of forest type as well as landscape and forest structure attributes.



PA Wilds Region outlined in black; stars indicate survey sites

We used a highly efficient field protocol by conducting early morning bird surveys and forest community rapid assessments simultaneously during spring and summer 2015. This enabled us to collect count information for all bird species detected during a five-minute point count while at the same time sampling 45 habitat attributes that could be used to determine species-specific habitat relationships and field validate forest community types. The skill sets of and cooperation among PNHP field biologists was key to implementing these surveys. Through our partnership with Audubon, we were able to use sophisticated data analysis techniques to answer our questions. We made detection-corrected density estimates (singing males per hectare) for 34 of the 85 bird species recorded, using a method that incorporates singing rate and effective detection radius. We found strong associations between forest breeding bird densities and forest groups. In this analysis, there were 23 bird species with significantly higher densities in one of the three forest groups, indicating that our forest groups could be a meaningful coarse classification for managing habitat for the birds we assessed.



Chris Tracey, David Yeany

Simultaneous collection of bird and habitat data increased our efficiency - saving costs and allowing us to reach more survey sites.

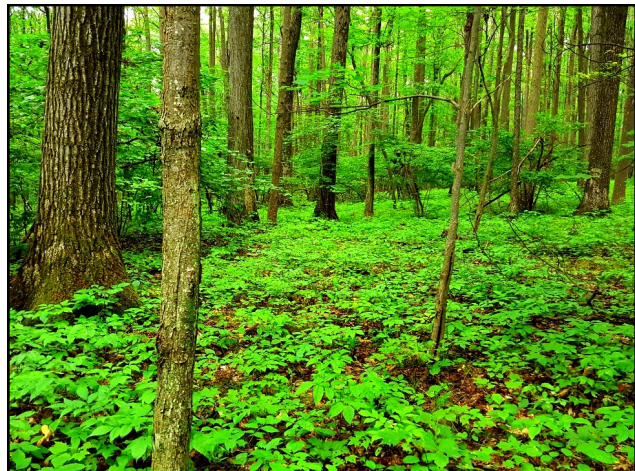
More importantly, we determined how bird densities differed across forest community types. We found that each of the seven forest types held at least one species with its highest density. Looking at just the forest communities where species had their highest densities we can identify forest types with greatest conservation importance (Table 1). Hemlock (White Pine)/Hemlock (White Pine) Northern Hardwoods was by far the forest community holding the most significant conservation value with 13 bird species having their highest densities in this type, more than double any of the six other communities. Included here were eleven forest interior birds and seven SGCN, highlighting the importance of forest communities' dominant conifer components.



David Yeany

Blackburnian warbler is an associate of conifer forest communities.

In a direct comparison between oak forest and northern hardwoods (excluding conifer forest), oak forest communities (18 species) supported higher densities of more species than did northern hardwoods (15 species). But more importantly in this comparison, oak community types supported high densities for nine SGCN versus just three SGCN in northern hardwoods. For example, Dry Oak—Mixed Hardwoods supported the highest density of cerulean warbler when compared across all types and second highest densities of Canada warbler and brown creeper (when conifer forest was removed). Red Oak—Mixed Hardwoods supported peak densities of priority species like black-throated blue warbler, which was also second most abundant in Dry Oak—Heath. Northern hardwoods types supported the highest densities of several widespread forest interior birds that tend to be habitat generalists within the group, like red-eyed vireo, scarlet tanager, and ovenbird. In addition, all three species we evaluated that were associated with edge habitat, American robin,



David Yeany

An example of Red—Oak-Mixed Hardwoods forest in the Allegheny National Forest.



David Yeany

Dense shrub layers in Red Oak—Mixed Hardwoods and Dry Oak—Heath forests contributed to the highest densities of black-throated blue warbler in the PA Wilds.

indigo bunting, and blue jay (Table I), had their highest densities in the northern hardwoods types, perhaps indicative of lower quality conditions in some of these forests. Black Cherry—Northern Hardwoods likely holds the most value of the northern hardwoods types, when directly compared with oak types, as it supported

top abundance estimates for seven forest interior birds and two SGCN (scarlet tanager and winter wren).

Beyond determining these associations with particular forest community types, we also investigated possible reasons for differences by addressing our second research question related to specific forest structure and landscape attributes. To do this statistical test, we used a machine learning technique called boosted regression trees (BRT) in a relatively new way to look for relationships between the 45 habitat variables and bird densities. We performed this forest structure analysis on 22 of the 34 bird species which had density estimates.

Overall, we identified 21 habitat variables that influenced bird densities. The most prevalent landscape attributes were aspect (16 species) and elevation (11 species), while three structural attributes stood out: shrub cover (7 species), snags (5 species), and basal area (4 species). However, only one variable was used in habitat models for all 22 species – Pennsylvania

Oak Forest			Northern Hardwoods			Conifer Forest
Dry Oak—Mixed Hardwoods	Dry Oak—Heath	Red Oak—Mixed Hardwoods	Northern Hardwoods	Black Cherry—Northern Hardwoods	Red Maple	Hemlock (White Pine)/ Hemlock (White Pine) Northern Hardwoods
Cerulean warbler*	Black-and-white warbler*	American redstart	Blue jay	Indigo bunting	American robin	Black-capped chickadee
	Common yellowthroat	Black-throated blue warbler*	Veery	Ovenbird	Least flycatcher	Blue-headed vireo
	Chestnut-sided warbler	Eastern wood-pewee		Rose-breasted grosbeak		Black-throated green warbler*
	Eastern towhee*	Hairy woodpecker		Red-eyed vireo		Blackburnian warbler*
		Hooded warbler*		Scarlet tanager*		Brown creeper*
		Yellow-bellied sapsucker		White-breasted nuthatch		Canada warbler*
						Dark-eyed junco
						Hermit thrush
						Magnolia warbler
						Northern flicker
						Swainson's thrush*
						Winter wren*
						Wood thrush*

Table I: Forest breeding birds in the PA Wilds grouped within forest community type where they had their highest density (singing males/ha). Bolded species had significantly high densities in that forest type. Species in orange are forest interior birds. Asterisk indicates SGCN.

Community Type, and it was the most important attribute in all but one species model, averaging nearly 58% importance. Given what we had learned from the density analysis described above, we tried removing community type from species-habitat models to try to focus more on forest structure, but this variable's contribution to explaining bird habitat associations was so statistically important that we needed to keep it in all species models. Combining this with the structural attributes identified bodes well for using standard community types in forest management for forest interior birds.

Some specific habitat relationships are particularly applicable to forest management for some SGCN. For example, we learned that in the Pennsylvania Wilds black-throated blue warblers have their highest breeding densities in oak forests, specifically Red Oak—Mixed Hardwoods and Dry Oak—Heath. From our species-habitat model we saw that elevation had a strong positive effect on density above about 2,150 ft. More importantly, short shrub cover above 50% had a strong positive effect on density and even stronger above 75%, and nearly the same was true of tall shrub cover. Foresters and land managers can use this information to focus on management for black-throated blue warblers in oak forests where it will benefit them the most and could likely improve the structure for this species in other stands, like northern hardwoods, by increasing shrub cover at appropriate sites.



An example of Hemlock (White Pine)/Hemlock (White Pine) Northern Hardwoods in Tionesta Natural Area

Most birds associated with Hemlock (White Pine)/Hemlock (White Pine) Northern Hardwoods had strong positive relationships with forest characteristics of mature or old growth, structurally diverse forests relatively free from recent human disturbance. Both Swainson's thrush and magnolia warbler density increased with woody debris cover above 20%, while



David Yeany

Mature undisturbed forest canopy was an important feature for black-throated green warblers.

very tall tree canopy height above 25 meters positively affected Swainson's thrush density and tall shrub cover above 50% positively affected magnolia warbler density. Blue-headed vireo density was positively related to increasing basal area with the greatest effects from 130-150 ft²/ac, representing a preference for mature stands with large trees. Both Canada warbler and dark-eyed junco densities showed positive relationships with increasing bryophyte cover, a characteristic of undisturbed hemlock forests. Finally, black-throated green warbler density decreased with increasing area logged over the past 30 years, indicating a negative relationship with anthropogenic canopy disturbance. Looking at these bird species as an assemblage of this forest community type, we can use this information to direct conservation efforts to maintain and protect these forest conditions benefiting an important subset of forest interior birds and SGCN.

Ultimately, our results provide guidance for bird conservation and management on forest lands with good community typing, like our state and national forests, as well as state game lands. We have identified some high quality forest interior conditions that offer direction for habitat conservation and improvements across a significant area of the Pennsylvania Wilds. With our focus on SGCN and forest interior bird densities, as opposed to just mere presence, our study can help match conservation efforts for priority birds and suites of species to the forest communities where their numbers will benefit the most. Our partners at Audubon Pennsylvania will be providing outreach to forest land managers in the Pennsylvania Wilds, conveying the results of this study in a way that will enable their integration into existing tools of forest management and conservation.

David Yeany

Notes from the Field

Vernal Pool Restoration Workshop

Gifford Pinchot State Park (GPSP) in York County, Pennsylvania, has a handful of vernal pools scattered throughout the 2,338 acre park. These pools are known to support three vernal pool indicator amphibians: spotted salamanders (*Ambystoma maculatum*), marbled salamanders (*Ambystoma opacum*), and wood frogs (*Lithobates sylvaticus*). They support other amphibians as well such as American toads (*Anaxyrus americanus*), gray treefrogs (*Hyla versicolor*), and spring peepers (*Pseudacris crucifer*).

The Pennsylvania Natural Heritage Program has been working on a project to restore several areas at GPSP that hold water for a short period in the spring and attract breeding activity of vernal pool amphibians, but do not hold water long enough for their larvae to develop and exit the wetland before it dries up in the summer. We worked with wildlife biologist and wetland ecologist Thomas Biebighauser of the Center for Wetlands and Stream Restoration to develop a plan to recreate functioning wetlands at five sites. Implementation of this plan took place the week of August 1-5, 2016.



Forty participants attended this hands-on restoration workshop to learn practical, low cost techniques for building wetlands.

As part of this project, we hosted a two day workshop for a broad audience including land managers, conservation planners, wildlife biologists, environmental scientists, foresters, hydrologists, engineers, educators, and private landowners. Most of the workshop took place in the field at two restoration sites where we discussed how to select locations for building wetlands, test soil texture, choose appropriate construction techniques, work with heavy equipment operators, and



This small shallow depression (left) held water in early spring but was impacted by a ditch that drained water from the pool. Wood frogs used the site to lay their eggs, but most years the pool dried up before the tadpoles could mature and leave the pool. We repaired the ditch with a groundwater dam which increased the pools' ability to retain water (right) without turning it into a permanent pond.

establish native flowering plants. The Upper Susquehanna Coalition's skilled wetland work crew operated the heavy equipment needed to restore the wetlands. Watch for the spring edition of Wild Heritage News where we will present a feature article on this wetland project. We are looking forward to seeing how the pools look the first spring post-restoration.

This project was made possible by funding from the Amphibian and Reptile Conservancy, the PA Department of Conservation and Natural Resources, Bureau of State Parks Resources Management and Field Services Section, and the Community Conservation Partnerships Program, Keystone, Recreation, Park and Conservation Fund, administered by the PA Department of Conservation and Natural Resources, Bureau of Recreation and Conservation.

We gratefully acknowledge the PA Parks and Forests Foundation, the Friends of Pinchot State Park, and the staff at Gifford Pinchot State Park for their ongoing support.



Monitoring visits from this fall have confirmed that marbled salamanders are breeding in one of the restored pools.

JoAnn Albert, Betsy Leppo

JoAnn Albert

Betsy Leppo

Freshwater Mussels in the Ohio River Watershed

To gain an understanding of the natural resources of a large river with many human influences, PNHP staff members set out to survey the Ohio River's freshwater mussels. The upper part of the watershed in Pennsylvania, New York, and West Virginia drains 23,500 square miles and encompasses diverse urban, agricultural, and natural landscapes. The river was converted from flowing riffle and runs dotted with islands to slow, deep pools when the navigational pools were created, starting in the late 19th century. Since the industrial revolution, the river has received pollution from resource extraction (e.g., coal mining and timber), manufacturing (e.g., steel, glass, and other materials) and storm water. Additionally, the river is a route for the transport of goods to other locations. Barges buzz through the locks and dams moving coal and other materials every day of the year.



Mary Walsh

Ohio River divers, Ryan Miller and Alysha Trexler, prepare to survey for mussels on the river bottom.

Despite past and ongoing threats, the river has experienced improvements in water quality since the peak of industrial pollution. While many assume that there is little life in the deep, silty waters of the river, recent studies of fish indicate that the river is recovering. Because mussel communities in the Ohio River are still under-surveyed, divers from the Western Pennsylvania Conservancy have been donning SCUBA



Alysha Trexler

Crew members (Mary Walsh, Eric Chapman, Mary Ann Furedi, and Ryan Miller) record mussel survey information.

gear and descending to transect lines on the river bottom. Feeling for shells in the top layer of sediments and looking for the telltale shape of mussel siphons, divers pull up freshwater mussels from the sandy river bottom. The diversity, habitat preferences of species encountered, and evidence of population recruitment will be useful for managing the river's resources. Information from the three year project about the freshwater mussel communities, particularly discoveries of species not seen in the river in recent decades or those which prefer high quality habitat, from surveys and distribution modeling will be beneficial to the management of the river. The study will document habitat and provide an understanding of the mussel community that persists in the river.



Alysha Trexler

The pink heelsplitter (*Potamilus alatus*) inhabits the pools of the Ohio River, which have been invaded by non-native zebra mussels (*Dreissena polymorpha*). Zebra mussels are originally from the Black and Caspian seas and were introduced to North America by ship ballast. In the photo above zebra mussels are attached to the pink heelsplitter with strong byssal threads.

Northern Long-eared Bat Survey Effort

Given the recent and massive declines in cave hibernating bats due to White-Nose Syndrome (WNS), PNHP has stepped up our bat survey efforts to figure out where pockets of WNS surviving bats may still exist. Much of our survey focus has been on the federally threatened northern long-eared bat (NLEB, *Myotis septentrionalis*). A species typically thought of as a denizen of forested landscapes, the NLEB usually avoids manmade structures for roosting. It is also much less gregarious in its roosting and hibernating habits than the little brown bat (*Myotis lucifugus*) and Indiana bat (*Myotis sodalis*).



JoAnn Albert

Northern long-eared bat (*Myotis septentrionalis*)

Due to the recent population declines, much more survey effort is typically needed to capture an NLEB. From 2011 to 2016, PNHP staff conducted 78 summer and fall surveys that ranged from May through October. Summer surveys focused on forested habitats used by the bats for roosting and foraging while fall surveys targeted known hibernacula entrances. In the past six years of surveys, we captured 26 NLEBs at 16 different sites across the state. This equates to a roughly 20% success rate in documenting this species based on our data. Figure 1 displays the level of effort necessary to capture a single bat based on our dataset since 2011. As defined by the Pennsylvania Game Commission, "One unit of effort (UE) is equal to 1m² of net area in place for 1 hour - (total m² of capture area) x (minutes in place/60)." Notice that yearly UE has increased dramatically over the past two survey seasons,



JoAnn Albert

Tricolored bat (*Perimyotis subflavus*)

demonstrating how rare the species has become. PNHP staff captured only one NLEB in both 2015 and 2016 while 10 were captured in 2011.

The single NLEB that we documented during this past survey season was captured as part of the Bedford County Natural Heritage Inventory. Over the course of two weeks in August, PNHP staff completed 12 bat surveys in Bedford County. Our total capture of 33 bats consisted of four species that included the NLEB ($n = 1$), tricolored bat (*Perimyotis subflavus*; $n = 1$), big brown bat (*Eptesicus fuscus*; $n = 20$), and red bat (*Lasiurus borealis*; $n = 11$). The fact that we only captured a single NLEB during both 2015 and 2016 in relation to the level of our survey efforts is evidence of the dramatic decline this species has suffered due to WNS.

Units of Effort Necessary to Capture one NLEB

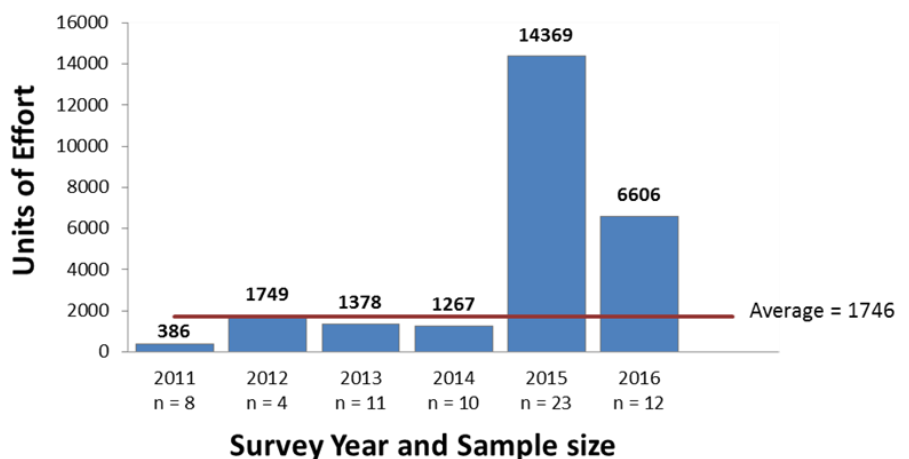


Figure 1: Yearly units of effort necessary to capture a single NLEB

Long-term Monitoring of Wetlands

In the Winter 2015-2016 issue of Wild Heritage News, we introduced a new Heritage project that focuses on several aspects of peatland wetlands. One focus is a continued effort to examine changes in plants and plant communities found in high elevation wetlands in Pennsylvania. These wetlands are typically cooler and thus provide a special environment that supports plants and plant communities ordinarily found farther north in the United States. The effects of climate change, such as rising temperatures and alterations in the hydrological cycle, will likely alter the environmental conditions that support the unique vegetation assemblages in these wetlands. Long-term monitoring is one tool being used to begin to identify and understand changes in target plants and plant communities that may occur in these systems in Pennsylvania.



Mary Ann Furedi

Scattered larch in a woodland community at Two-Mile Run

Two-Mile Run is one of the 30 high elevation wetlands included in this long-term monitoring project. Two-Mile Run is located on the Pocono Plateau in Monroe County, Pennsylvania and is owned and managed by The Nature Conservancy. It is a mosaic of glacial wetlands that began to form in the late Wisconsin Glaciation. A combination of climate, geology, hydrology, basin shape, land use history, disturbance, and water chemistry contributed to the current mix of plant communities. Today, the wetland complex is a mix of forest (Red Spruce—Mixed Hardwood Palustrine Forest and Red Spruce Palustrine Forest), woodland (Red Spruce—Mixed Hardwood Palustrine Woodland and Red Maple—Highbush Blueberry Palustrine Forest), and shrub dominated communities (Leatherleaf—Sedge Wetland, Highbush Blueberry—Sphagnum Wetland, and Highbush Blueberry—Meadow-sweet Wetland). As you walk through the dense stands of red spruce, balsam fir, and tamarack, underlain by a carpet of lush, verdant



David Yeany

A dense layer of sphagnum mosses cover the floor of the Red Spruce Palustrine forest at Two-Mile Run.

green sphagnum moss, you feel more like you are in a remote boreal forest in Canada than the Poconos.

This summer, Heritage biologists visited Two-Mile Run to relocate the permanent monitoring plots established at the site in 2010. We located plots in three different community types; one plot each in the Leatherleaf—Sedge Wetland, the Red Spruce—Mixed Hardwood Palustrine Forest, and the Red Spruce Palustrine Forest. Plant species in each plot were recorded along with their relative abundance following the same methodology employed in 2010. We also assessed target plant populations of red spruce seedlings, balsam fir seedlings, and creeping snowberry. Although no data analyses have yet been conducted to examine changes in plant composition, the plant community types appear to have not changed dramatically over the five years between sampling efforts.



Mary Ann Furedi

Creeping snowberry is one of the target species being monitored at the site.

In addition to the monitoring framework established in 2010 at the site, we added a more thorough survey of the bryophyte community to the sampling effort this year which resulted in an exciting discovery. Pom pom

peat moss (*Sphagnum wulfianum*) was found in the Red Spruce Palustrine Forest, Pennsylvania. Pennsylvania is the southern extent of the range for this moss and the population at Two-Mile Run is only the fourth time it has been collected in the state.



Pom pom peat moss

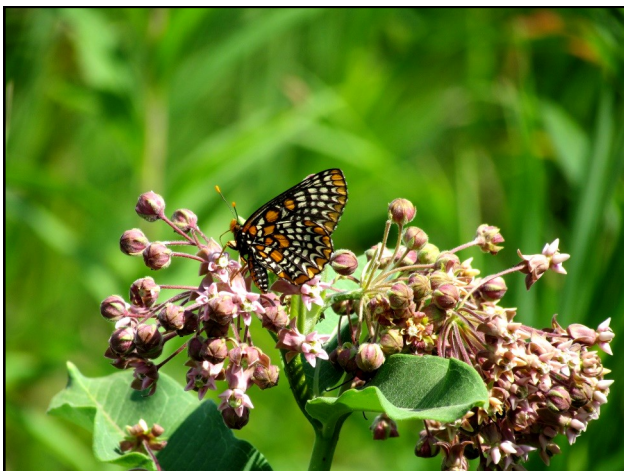
Scott Schuette

If you are interested in visiting Two-Mile Run, the following link provides directions and a map of the trail system at the site <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/pennsylvania/placesweprotect/thomas-darling-preserve-at-two-mile-run.xml#directions>. The plants in these wetland communities are sensitive to disturbance; help to protect them from damage by staying on trails and boardwalks when you visit.

To learn more about the plant community types found at Two-Mile Run, more detailed plant community descriptions can be found at <http://www.naturalheritage.state.pa.us/communities.aspx>.

Regional Conservation of Wetland Butterflies

Pennsylvania is participating in a Northeast Regional Conservation Need (RCN) grant with Maryland, West Virginia, New Jersey, and the District of Columbia. During this two year project we are conducting field surveys to look for populations of Greatest



Betsy Leppo

An adult Baltimore Checkerspot (*Euphydryas phaeton*) nectars on common milkweed (*Asclepias syriaca*). Young Baltimore Checkerspot caterpillars feed on turtlehead (*Chelone glabra*).

Conservation Need (GCN) wetland butterflies; characterizing habitats, host plants, and nectar plants; identifying, planning, and implementing wetland enhancement projects; prioritizing wetlands for habitat enhancement work; and developing computer models of potential habitat for GCN wetland butterflies.



Betsy Leppo

Bog Coppers (*Lycaena epixanthe*) do not stray far from their boggy habitats where large or small cranberry grows (*Vaccinium macrocarpon* or *V. oxycoccos*). The caterpillars feed on cranberry leaves, and the adults like to nectar at cranberry flowers.

During the third quarter of 2016, WPC staff conducted field visits to eighteen wetland sites across Pennsylvania with known or potential populations of GCN wetland butterflies. Habitat management is currently being planned or implemented at six of these sites. A few highlights include discovery of new populations of Baltimore checkerspot (*Euphydryas phaeton*), eyed brown (*Lethe eurydice*) and Delaware skipper (*Anatrytone logan*) at a potential wetland restoration site in Lackawanna County. We revisited bog copper (*Lycaena epixanthe*) colonies at three peatland wetlands where they were previously known to occur, including one site that was first discovered in 1988. During the Asaph Wild Area Bioblitz in Tioga County a new population of the Harris' checkerspot (*Chlosyne harrisii*) was found. We also found a new population of broad-winged skipper (*Poanes viator*) in Montgomery County. Based on the southeastern Pennsylvania location, this is likely a population of the subspecies *zizaniae*, which has adapted to feed on the non-native and invasive common reed (*Phragmites australis*), whereas populations of the nominate subspecies *viator* require wetlands full of native sedges. Data collected from these sites occupied by rare wetland butterflies describe the wetlands in terms of size, condition, and abundance of host and nectar plants. Careful mapping of these sites will improve the data available for the potential habitat computer modeling.

Pennsylvania Conservation Explorer in Review

On March 21, 2016 DCNR launched Pennsylvania Conservation Explorer, an online tool for protecting threatened, endangered, and rare species. The state-of-the-art, web-mapping application utilizes extensive biological and geographic information to help conserve the commonwealth's rich natural heritage.

In its first six months, the Explorer served a large variety of users for a range of conservation products and map services. Fourteen thousand users spent 47,000 sessions using the Explorer, spending an average of ten minutes per session, including an average of seven minutes on the interactive map. Returning visitors accounted for 71% of users and 29% were new visitors. Almost 13,000 PNDI receipts were generated and stored where users can access and manage their projects online. In addition, approximately 500 conservation planning reports per month were created.

Clearly, the Explorer plays an important role in helping meet the goal of protecting the commonwealth's most imperiled natural resources from the impacts of land development. In six months, 8,264 projects were finalized and submitted to state and federal agencies for environmental review. About 67% were "no impact" projects, meaning that natural heritage staff biologists and ecologists can focus on surveys in areas where they're most needed.

Since its launch in March 2016, Pennsylvania Conservation Explorer recorded almost 6,000 "hits," i.e., potential conflicts between threatened, endangered, or rare species habitats and proposed land use changes, including most development projects in the state. Among the various taxa, mussels and reptiles were the most often detected for potential conflicts. Ten species of mussels had 40 or more hits. Five species of reptiles accounted for 878 hits. In total, 537 species reported hits.

Finally, the Explorer is on track to essentially pay for itself in the first year. Fees collected from users (6,299 transactions) helped cover the cost of hardware, software, maintenance, data management, and customer support. The Explorer revenue, in fact, will support about a quarter of the overall cost of the Pennsylvania Natural Heritage Program in state fiscal year 2016. This new revenue will help improve the tool in the future and advance the program in new and innovative ways, perhaps helping better predict where species of concern might occur.

Pennsylvania Conservation Explorer leverages more than 30 years of scientific data and information. The tool generates maps and reports that are specific to user-defined geography, guiding decisions, avoiding detrimental impacts, and carrying out responsible development and management of land and water resources.

Project Counts by Organization Types (6 Months)

Organization Types	Project Count
Private Companies, e.g., Consulting Engineers, Planners and Landscape Architects	4,022
Federal Agencies, e.g., USDA-NRCS, U.S. Fish and Wildlife Service*	1,412
State Agencies, e.g., DCNR, DEP, PennDOT, Game Commission	1,409
Local Governments	654
Non-Governmental Organizations	266
Private Individuals	89
Academic Institutions	10
Other	402
TOTAL	8,264

*includes, in part, private landowner assistance

Measures of Progress

The following Measures of Progress represent a significant cross-section of results of the work that we do as a program. These measures will be reviewed and updated, as needed, to best reflect the activities and goals of PNHP. Progress for these measures reflects seasonality of program activity.

Measure of Progress	Annual Goal (2016)	1st Quarter	2nd Quarter	3rd Quarter	Cumulative Total	Percent of Annual Goal
Biotics Records Updated	300	66	84	136	286	95%
New EOs Documented	800	189	407	327	923	115%
New Records Entered into PACE	350	0	0	238	238	68%
Field Surveys Reported	300	159	49	108	316	105%
New CPPs Developed	400	0	0	321	321	80%
NHAs Updated	150	15	0	21	36	24%
Sites Actively Monitored	35	0	15	10	25	72%

PNHP performs many functions and provides many services as part of its mission. The measures of progress that are detailed here are meant to capture a number of important program activities and provide a picture of our progress in achieving our essential goals. The program goals and the measures provided for those goals will change over time as we complete certain aspects of our work and as new program responsibilities arise.

Biotics Records Updated indicates the amount of activity expended in improving and updating the more than 20,000 records in the PNDI database.

New EOs Documented is a way to measure the success of our inventory effort in finding new occurrences of elements of ecological concern (plants, animals, and exemplary natural communities). Biotics records are created for each new Element Occurrence documented.

New Records Entered into Pennsylvania Conservation Explorer (PACE) indicates our level of activity in reviewing, quality controlling, and entering biotics records into the environmental review data layers. The timely and consistent refreshment of these data are critical to providing protection to the state's species of greatest concern.

Field Surveys Reported is a strong indicator of the effort expended on one of the basic functions of the program – inventory of the state's flora and fauna. Every field visit results in the entering of a field survey, regardless of the outcome of the survey.

New Conservation Planning Polygons (CPPs) Developed is a measure of our progress in creating ecological based mapping for the species and natural communities that we track as part of the PNDI database. Our goal is to have CPPs for all species and communities that we track.

NHAs Updated is a measure of our effort in developing, mapping, and describing sites (Natural Heritage Areas - NHAs) that are important to conservation of Pennsylvania's biodiversity. This process began with County Natural Heritage Inventory projects and will now continue at a statewide level with the updating of existing sites and the creation of new sites. Site polygons will be based upon and consistent with CPPs.

Sites Actively Monitored indicates how many established geo-referenced plots that we visited and sampled. These sites allow us to collect data on structure, species composition, and physical context (soils, hydrology, etc.) in a systematic way and by following the same protocols to directly compare future data to previous data.