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Pennsylvania Endemics

by Rebecca Bowen,
Ecological Services Section Chief,
Bureau of Forestry



What's an endemic? You hear the word endemic a lot...but what does it mean? Are there any endemics in Pennsylvania? What's the difference between endemic, native and indigenous?

Ok, so let's start from the beginning. The [dictionary](#) defines endemic as being "prevalent or peculiar to a particular locality, region or people." That can include things like language, traditions and culture as well as a region's plants and animals.

The [National Geographic Style Manual](#) defines endemic as "occurring nowhere else, restricted or peculiar to a locality or region." [The United States Fish and Wildlife Service](#) explains endemics as "native species that are confined to a certain region or having comparatively restricted distribution," and the more remote or cut off an area is the greater the chance that those species will be found there and nowhere else.

"Indigenous" is a similar word, but means that something is native, not brought in from elsewhere although it may occur elsewhere. "Native" implies birth or origin at a particular place.

Endemic plants and animals are then, by definition, very restricted in their range. That often makes them rare worldwide, but they may be common in their particular home range. True endemic plants and animals depend on specific climates or microclimates and can't survive elsewhere, which makes them vulnerable. They are adapted to their specific homeland, and if it is altered or they are relocated, they don't fare so well.

So, does Pennsylvania have any endemics?

Well, the short answer is maybe...we don't know for sure. There have been some species that seemed to be endemic, and then turned out not to be.

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Administered by the
PA Department of conservation & Natural Resources
In cooperation with the PA Game Commission and
PA Fish & Boat Commission



Pennsylvania Endemics (continued...)

And there are some species which may, yet, prove to be endemic but more research is needed. The nature of these species is that they are localized, secretive and difficult to study. That makes it hard to say, with 100 percent certainty that a species is found here and nowhere else. Here's a look at some of the species that were considered endemic to Pennsylvania—that were either found elsewhere, or turned out not be a "true" species. And a few that still may pan out.

Animals

The Kittatinny red-backed vole (*Clethrionomys gapperi rupicola*) is a small, secretive rodent that is found in the black and yellow birch and hemlock forests along the Kittatinny Ridge in Berks and Schuylkill counties. It is a close relative of the southern red-backed vole (*Myodes gapperi*).



Southern red-backed vole
(*Myodes gapperi*)
(photo: D. Gordon E. Robertson, Wikimedia.com)

Recently, scientists looked more closely at this vole and its relatives and determined that the Kittatinny red-backed vole is really just a population of the southern red-backed vole with some unique qualities—not a true endemic species.

Biologists previously thought that a small flatworm called the Refton Cave planarian (*Sphalloplana pricei*) was only found in Pennsylvania, but it has now been found in other states as well. This flatworm lives in dark



A planarian (*Schmidtea mediterranea*)
(photo: Claire G. Stevenson and Wendy Scott Beane, Wikimedia.com)

cave pools or streams, feeding on invertebrates or scavenging on debris. [Cave species](#) like this are likely suspects to be endemic, as they spend their entire lives in only one cave and tend to be separated from other populations. However, they could travel amongst caves, being picked up by birds or other animals in egg or larva form. The Refton Cave planarian is a [State Wildlife Action Plan](#) species of Immediate Concern, and a state Responsibility species. This means that Pennsylvania has a responsibility to protect these populations as it is still globally very rare.

Pennsylvania has some near-endemic reptiles and amphibians. Approximately 90 percent of the global population of the shorthead garter snake (*Thamnophis brachystoma*), and about 80 percent of the world population of the mountain earth snake (*Virginia pulchra*) are found in the Commonwealth. Yet, while these species are very rare in the rest of the world, they are not listed as threatened and endangered species in Pennsylvania, partly because their populations are plentiful enough that they are not in danger of extinction in Pennsylvania, or that their habitats are not under threat.



Shorthead garter snake
(*Thamnophis brachystoma*)
(photo: Tom Diez/ Pennsylvania Fish and Boat Commission)

Insects

The flypoison borer moth (*Papaipema* sp. 1) may be endemic; it inhabits pitch pine-scrub oak barrens in northeastern Pennsylvania that have abundant flypoison lily (*Amianthemum muscotoxin*) for the caterpillars to feed on. When scientists discover a new species, they write up a description and publish it in a scientific journal. This species has not had a description published yet, so it can't officially be considered as a "species." Flypoison borer moth is currently only known to be found in Pennsylvania but might eventually be documented in adjacent states.

Pennsylvania Endemics (continued)



Flypoison lily
(*Amianthemum muscotoxin*)

(photo: Homer Edward Price, Wikimedia.com)

Currently, our only known true endemic species is the Heller Cave springtail (*Typhlogastrura helleri*), a small semi-aquatic insect. The only place it is known to be found in the world is one cave in Blair County, but, again, that's likely a result of being difficult to find and survey. Biologists may one day observe this species in a cave in another state, but this species has a good potential to be endemic to Pennsylvania.

Plants

Botanists are pretty sure that Goat Hill chickweed (*Cerastium arvense* var. *velutinum*) is known only to be found at Goat Hill Barrens, a dry site with a [particular soil called "serpentine,"](#) near the border with Maryland. However, it is probably also in other serpentine sites in Maryland, just not reported yet. But for now we can claim it as a Pennsylvania endemic. Even if it is confirmed in Maryland, it can definitely be described as a "serpentine endemic," meaning it is only found in serpentine soils.



Goat Hill Serpentine Barrens, Chester County

(photo: Pennsylvania Natural Heritage Program)

Lichens may be a good bet. Some newly observed and not-yet-described species of lichen might be endemic to Pennsylvania. Though, like many of the species listed here, lichens are not often surveyed; so we don't know for sure. So far, the only places we've found them are in Pennsylvania.

The Loyalhanna lichen (no scientific name yet) was brought to the attention of lichen scientists by Jim Shaulis of Pennsylvania DCNR's Bureau of Topographic and Geologic Survey, who says he finds it anywhere there is an outcrop of the Loyalhanna limestone.



Jim Shaulis collecting the first specimen of the Loyalhanna lichen

(photo: Pete Woods, Pennsylvania Natural Heritage Program)

James Lendemer at the New York Botanical Garden has also described at least one other lichen species he suspects of being an endemic.

So, why doesn't Pennsylvania have more endemics (or any for sure)? When you think about the definition, that the habitat of the species has to be extremely unique and cut off, it makes sense. While our state has lots of varied habitat—from intertidal marshes, to expansive woods, to boulder fields—there aren't many habitats that are found in Pennsylvania and not connected, now or in the past, with neighboring habitat. Also, the species that are potentially endemics (the lichens and cave species) are ones that are really hard to survey, so not much is known about them. The more scientists can study these habitats, the more we'll learn about our potential Pennsylvania endemics. ✓

From the Editor's Desk

By Rebecca Bowen, Editor of *Keystone Wild!Notes*

First of all, let me start by saying that I am very excited to be part of the Wild Resource Conservation Program! I am humbled to be part of a program that reaches so many people, in so many ways—from school science classrooms, to state agencies, to scientists researching in the field. I know I have big shoes to fill and a lot to learn, and look forward to the process. As its new editor, my hope for the future of *Keystone Wild!Notes* is that we continue to grow and explore new media and provide the readers an educational connection to Pennsylvania's natural diversity and resources.

This fall issue is packed with informative and interesting articles. We look at things you probably didn't know lived in Pennsylvania. It will be fun to learn about animals and plants that people typically associate with other places, as well as some species that don't "belong" in Pennsylvania, but ended up visiting here by accident. We also take a look at Pennsylvania's endemic species: plants and animals that live here and nowhere else on earth...or do they? Get to know DCNR's Executive staff (and me) a little better. You'll learn about the potential for stable isotopes to be used as a conservation detective tool and how researchers are restoring habitat for the northern flying squirrel.

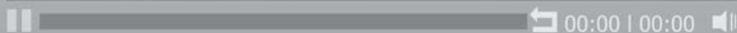
I hope my first issue will be as enjoyable for the audience as it was for me to work on. Thank you for letting me be a part of this great program!



WRCP Videos Available Online

The two most recent WRCP documentaries, "**Fungi: Pennsylvania's Hidden Treasures**" and "**Dangerous Invasions,**" can be viewed online at www.pacast.com.

Just click on the Productions tab to see these and other Commonwealth Media Services videos.



Rebecca Bowen is the Ecological Services Section Chief in DCNR Bureau of Forestry.

Some of the things you'll read about in this issue:



Northern Flying Squirrel
(photo: Greg Turner, Pennsylvania Game Commission)



Sundew, an unusual Pennsylvania Plant
(photo: David G. Smith, Delaware Wildflowers.org)



Species you may be surprised to know live here
(photo: Tim Rains, National Park Service)



Wild!Notes sat down for a chat with two of DCNR's Executive Staff: Ellen Ferretti, the Department's Secretary and Dan Devlin, the new Deputy Secretary for Parks and Forestry. We asked them a few questions about life, jobs and what they like about WRCP

Wild!Notes: Thank you Ellen and Dan, for sitting down with us and talking about your experiences. Ellen, tell us a little about yourself. Where are you from? Do you have any experiences that shaped your love of nature?

Ellen: I grew up in "Cork Lane," Pittston Twp. Luzerne County. I loved the outdoors and the fruit and evergreen trees in our yard. Everyone had fruit trees back then. My neighbor gave me a blue spruce when I was little to plant in my backyard. I loved that tree! It grew up with me and reminded me of him every day. While my connection with nature began in my back yard, being surrounded by former surface mine "strippings" didn't allow me to expand much beyond the yard. I would wander around the strippings, but I know now that they weren't exactly a natural landscape! I truly got an appreciation for the great outdoors when my family and friends visited [Tobyhanna](#) and [Gouldsboro](#) state parks. The water and woods were a whole other realm to explore, and I did just that...to the point of exhaustion every time we went!

In high school, the environmental movement was just ramping up, and I got involved in our ecology club. Back then recycling was a groundbreaking concept, so we held paper drives and picked up trash in local natural areas and recycled what we could.

I knew I wanted to get into the environmental field in college. [Wilkes College](#) was starting a curriculum called "Earth and Environmental Science." While I liked the idea, I spent two years in biology and then transferred over to the EES program. The bio courses helped me gain a lot of math, science and chemistry knowledge that I then applied to EES. In college, I belonged to the environmental science club. We would do site cleanups, hikes and other outdoor activities. We were not a large class, but we were engaged and active in pursuing our ideas about the environment. I remember going to [Francis Slocum](#) state park for botany classes and other places in the area for geology field trips. It was great fun, and we learned a lot.

Wild!Notes: You were really on the cusp of the environmental movement! What about you, Dan? What early experiences influenced your love of nature?

Dan: I was born in Abington, Pennsylvania but I spent most of my youth in Bucks County. My family owned a camp near Pipersville on the Tohican Creek, and we would spend most weekends and much of the summer at the cabin. This experience along with my father taking me along on his hunting trips helped fuel my appreciation of the out-of-doors and my desire to pursue a profession that would continue that passion for nature.

Wild!Notes: Sounds like you both come by your love of the outdoors naturally. So, tell us about your jobs. What's it like to be the head of a Department, and what experiences helped you get there?

Ellen: My current position is secretary of the Department of Conservation and Natural Resources, which, if I may say so, is the best job in the world working with the best people. I am honored to be the first female to be appointed

Ellen Ferretti DCNR Secretary and Dan Devlin, Deputy Secretary for Parks and Forestry



Ellen Ferretti, DCNR Secretary



Ellen cuddles a bear cub.



Dan Devlin, Deputy Secretary, and his dogs at home.

Ellen Ferretti and Dan Devlin (continued)

secretary of DCNR by Governor Tom Corbett in December of 2013. DCNR's many bureaus encompass our [State Forests](#), [State Parks](#), [Topographic and Geologic Survey](#), [Recreation and Conservation](#), [Facility Design and Construction](#), Administration, Information Technology and Human Resources. All of these program areas have a solid backing from executive staff, including the Offices of Education, Communications and Partnerships, Policy and Legislative Affairs.

I've had many job experiences that tie in with the environment and have equipped me with a diverse background in conservation and environmental science. After college, I stayed home and raised my children. When I returned to the work force in 1989, I was fortunate to have been offered a position with Westinghouse Environmental and Geotechnical Services. It was there I began a career in environmental consulting, which exposed me to real world applications for my degree, including some that didn't even exist when I went to college! It was a priceless experience and laid the groundwork for my next several years of professional work. Eventually, I found my way to the non-profit world by volunteering with the [Pennsylvania Environmental Council](#) (PEC) and (formerly) Back Mountain Land Trust, now the [North Branch Land Trust](#). I left consulting to work for PEC in 1998. That opened up an entirely new world, and I became involved in a variety of programs including land conservation, trail/greenway planning, brownfields and grayfields redevelopment and remediation, rivers conservation planning and implementation, establishing watershed associations and river kayak events and festivals. It was great!

The other experience that I derived from my past and I took wholeheartedly into DCNR was a "field view" of work. With the kind of work I did, I personally was the one in the field next to the drill rig taking soil and groundwater samples; I was the one taking shallow soil samples with a hand auger; I was the one trying not to get too tangled up in twine as I hand-baled monitoring wells (I think there are pumps for that now, but not then!); I was the one going to umpteen municipal or community meetings talking about the benefits of trails or sustainable site reuse on minelands or why certain lands should be conserved. Because of this, I have a healthy respect for the field. When I came here I asked a lot of questions so I could understand what was being done and why. I asked those questions of everyone, from executive to field staff to understand all perspectives. It was truly enlightening and provided me with a foundation for informed decision-making in my time at DCNR.

Dan: Currently I am deputy secretary for parks and forestry, which means I am responsible for directing the bureaus of State Parks, Forestry, and Facility Design & Construction. It has been a long journey in the natural resource field that led to being selected for the deputy secretary position. I actually started my career on the faculty at [Penn State](#) as a research associate working on the potential use of marginal crop and forest lands. I then took a position with the US Department of Interior [Bureau of Indian Affairs](#) where I was responsible for the management of the 56,000 acre Grand Portage Indian Reservation. From there I joined the Pennsylvania DER Bureau of Forestry as a wildlife biologist and worked there for a decade. I was then promoted to the chief of planning in the Bureau of Forestry where I worked on developing state forest resource management plans, strategic plans, and project plans for the next decade. After that I was promoted to assistant director and then director of the Bureau of Forestry for seven years.

Wild!Notes: *We know you both are busy people, and your jobs require a lot of your time. But, what do like to you do when you're not in the office? Favorite hobbies?*

Ellen: I like spending time with my kids, doing whatever we can come up with, hiking, kayaking and pretty much being outside. I love all aspects of conservation – from the ground up and stand amazed at how well Pennsylvania has done all these years. I like to travel and, as secretary, I get to travel to our beautiful forests and parks and to the places our partners hold dear. I even get to travel into limestone mines, thanks to our Topo Geo staff!

Wild!Notes: *Wow, that's quite a journey. What about you Dan? Tell us about your experiences.*

Dan: Aside from my work life, I am married to a wonderful lady and have two great kids. I like to hunt and fish and have five hunting dogs (four of which actually hunt). I love to garden and usually can several dozen jars of hot peppers a year to hold me over until the next crop comes in.

Wild!Notes: *Sounds like you both have found great ways to balance work and leisure. Can you tell us about your involvement with WRCP? What's your favorite thing about your role with WRCP?*

Ellen Ferretti and Dan Devlin (continued)

Ellen: I've been involved with WRCP since I came to DCNR, although I had heard of the program prior. I bought one of the early Wild Resource Conservation Fund license plates and that otter's friendly face is still on my car! I serve on the WRCP board as secretary of DCNR, along with the directors of Fish and Boat and Game commissions and the minority and majority chairs of the Senate and House Environmental Resources and Energy committees. The secretary of DCNR takes recommendations from staff and the board regarding grants and is responsible for the final determinations. My favorite thing about my role with WRCP, as a scientist by trade, is the diversity and quality of research funded under this program and how the program has and continues to evolve to better integrate that research into our work and programs here at DCNR and at our partner resource agencies.

Dan: My history with the WCRF actually dates back to its beginning. I was the agency representative at the very first meeting of the Wild Resource Conservation Board and was involved either as an agency representative or alternate board member for the first 20 years of the program. It's nice to come full circle and again be involved in the program and be an alternate board member.

Wild!Notes: *Wow, you both have very important roles in WRCP. How exciting! What do you think is important about WRCP, what do you want readers to know?*

Ellen: WRCP is important because it provides opportunities for a wide diversity of researchers and research topics while, at the same time, allowing that research to be integrated into our work here at DCNR. I think it's most important for the *Wild!Notes* readers to know that we are expanding how we make this

research available to anyone who would like to use it via the WRCP website. Just click on "Grant Reports" and you can scan all the research that's been funded since the start of the program. That's exciting!

Dan: The WRCP has accomplished a great deal of conservation work over its history. Aside from all the projects that have been funded over the years (of which there were many) the WRCP has been a great forum for the natural resource agencies in the state to work and collaborate together on issues and studies that concern many of the most critical species in Pennsylvania.

Wild!Notes: *That does sound great. Any other tidbits you'd like to share with readers, anything you would like them to know?*

Ellen: Well, I'm thankful to Governor Corbett for [Enhance Penn's Woods](#). This investment is the largest short-term funding commitment to state park and forest infrastructure in the history of the



Ellen, Dan and DCNR staff celebrate Smokey Bear's 70th birthday.

Commonwealth. The foundation of our state parks and forests was failing and our staff has put their heads together to use every penny of this funding wisely, where it's needed to improve infrastructure in our parks and forests for current visitors and generations to come. **Enhance Penn's Woods** includes the addition of conserved lands to our state forests and parks as well! I'm also excited about **Kids in Nature**, our effort to elevate the great work being done at DCNR to engage children, their families and educators in nature and the outdoors. I recently participated in Eco-Camp at Nescopeck State Park as part of **Kids in Nature**. This event and the others we have done convince me that children are indeed going outside and enjoying themselves. Our role is to give them more opportunities!



Isotopes – Too Small to See, But Helping us See the Big Picture

by Greg Czarnecki, WRCP Director



Most people like a good detective story, and these days that often means watching one of the many CSI-type television shows. They're great at showing how forensic science and technology can be used to help solve crimes by piecing together different lines of evidence. One of those forensic technologies, isotopic analysis, is also being used by scientists in the conservation field.

In case you've forgotten what an isotope is, let's start with a little refresher from high school chemistry class. Atoms are composed of three basic subatomic particles – protons (positively charged), electrons (negatively charged), and neutrons (no charge). There are around 92 different atomic elements that occur in nature, each identified by the number of protons they contain. The lightest element is hydrogen (H), with one proton, and uranium (U) is the heaviest, with 92 protons. While the number of electrons equals the number of protons, many elements occur with different numbers of neutrons. These variants are called isotopes.

Let's look at hydrogen as an example. The most common form of hydrogen has no neutrons, but it also occurs in small amounts with one and even two neutrons. The isotope with one neutron is called deuterium. When deuterium is incorporated into a water molecule (H₂O), the molecule's mass increases, thereby yielding what's known as "heavy water." Heavy water was a top secret component of the [Manhattan Project](#) and was used in the earliest atom bombs and nuclear power plants.

Deuterium is a stable isotope, which means it doesn't readily lose its neutron, so there's always a small amount floating around in the environment. Some isotopes, however, aren't stable and readily lose their neutrons. The hydrogen isotope with two neutrons is a good example. Tritium, as it's known, is very unstable and readily reverts to a more stable form via a process known as [radioactive decay](#). Unstable isotopes are a key part of the reactions that occur within a nuclear power plant.

Because the ratios of an element's isotopes often vary in predictable ways from one place or time to another, they can serve as good forensic tools. Isotopic analysis, which looks at the ratios of specific isotopes using a process called [mass spectrometry](#), is now a commonly used forensic tool. Among the most commonly used are

isotopes of oxygen (O), nitrogen (N), carbon (C), hydrogen (H), and sulfur (S).

Isotopic analysis is being used in a lot of interesting ways. It can be used to determine whether sugar was made from sugar beets or sugar cane. It's used to determine if wine and vegetable oils are what they claim to be on the label. It can even be used to determine if birds being sold in pet shops are captive bred or were caught in the wild, which is an important consideration for some rare species. Isotopic analysis has also been important in documenting the role of fossil fuels in climate change, because the isotopic ratios of geologically-derived carbon are different than other atmospheric carbon sources.

Isotopes can also be used to prove that old adage, "you are what you eat." When you eat an apple or a hamburger, any molecules that aren't broken down for energy or eliminated as waste are incorporated into your tissues. This includes any stable isotopes that happen to be present.



Dr. Ned Fetcher of Wilkes University collects a grass sample from a meadow in Nescopeck State Park. His study hopes to shed light on the relationship between grassland productivity, warm- and cold-season grasses, and biodiversity.
(photo: Greg Czarnecki)

Under the right conditions those isotopes can be used to help identify what you ate, when you ate it, and where the food came from. This type of analysis has been used to determine the [diets of polar bears](#) throughout the seasons. By sampling different types of tissue, which grow at different rates, scientists can determine the isotopic ratio at different points in time. The bear's fur and claws grow continuously and deposit cells, so they provide a chronological history of its diet. Blood samples generally reflect the isotopic composition of the food the bear ate one to two months ago. ➡

Scientists can even measure the isotopic ratios in the bear's breath, which reflects the ratios found in the food or fat stores that it's metabolizing at that moment. This type of analysis is especially important in helping scientists monitor changes in the bear's diet and nutritional status as changes in climate patterns has made their primary food source, seals, harder to come by due to the loss of sea ice.

One of WRCP's grantees is also using this technology to better understand one of the state's least common, yet important, habitats – grasslands. Since the turn of the 20th century, grasslands, including meadows and savannahs, have been declining across the state and along with them many of the species that live there. To better understand these ecosystems, [Dr. Ned Fetcher](#) and his students at Wilkes University are using isotopic analysis to study species diversity and food webs in state park and state game lands.

Native grasses can be broken into two categories. Warm-season grasses which prefer hotter, drier sites are generally larger than those in the second category, cool-season grasses. Grasslands in Pennsylvania may be dominated by one, the other, or have a mixture of both.

Like all plants, both types of grasses convert carbon dioxide from the atmosphere into sugars through the process of photosynthesis, but they use slightly different chemical pathways to do it. Warm-season grasses use what's called the C4 photosynthetic pathway, while the cool-season grasses use the more common C3 pathway. These different pathways result in different, and predictable, carbon isotope ratios.

Animals, such as insects that ate the plants or birds that ate the insects that ate the plants, incorporate the isotopes into their bodies in the same ratios. Dr. Fetcher is thus able to determine which of the plants is contributing most to the food web and species diversity by measuring the isotopic ratios found in the bodies of the critters that live there. Based on this work he hopes to develop habitat restoration recommendations regarding which type of grassland yields the highest biological diversity.

These are just a few examples of how isotopic analysis can be used to study the natural world and contribute to conservation. See why it was important to pay attention in chemistry class? ✓



Wilkes University students take measurements and collect blood and feather samples from a bird they've caught in a mist net for isotopic analysis. (photos: Tara Czarnecki and Greg Czarnecki, respectively)



These students are collecting insects using sweep nets in a grassland in Nescopeck State Park. The net in the center is a malaise trap, which collects flying insects (photo: Greg Czarnecki)

A Wilkes University student sets up a pitfall trap to collect ground-dwelling insects in a state game land in Carbon County. (photo: Greg Czarnecki)

Surprising Pennsylvania Residents

by Greg Czarnecki, WRCP Director

Here are a few plants and animals that most people associate with other places and are surprised to learn are found in Pennsylvania too.



Wilson's snipe (*Gallinago delicata*)

(photo: Wikimedia Commons)

Contrary to what you may have heard, the snipe really does exist. It closely resembles the American woodcock in both appearance and behavior. In Pennsylvania it's found primarily in the wet meadows and marshes of the formerly glaciated northern tier of the state.



Northern coal skink (*Plestiodon anthracinus anthracinus*)

(photo: Charlie Eichelberger, Pennsylvania Natural Heritage Program)

Many people are surprised to learn that there are lizards in Pennsylvania. This species, which is found primarily in the northwest part of the state, is relatively rare here. Like most skinks, they lose their tails when attacked by predators, re-growing a new one within a few months.



Eastern spotted skunk (*Spilogale putorius*)

(Trail cam photo: Greg Turner, Pennsylvania Game Commission)

This primarily southern species is even more striking in appearance than the more common striped skunk. It has just recently been seen again in south-central PA after a 20-year period with no reliable observations.



Sandhill crane (*Grus canadensis*)

(photo: Steve Emmons U.S. Fish and Wildlife Service, Wikimedia Commons)

The only crane found in Pennsylvania, this species is relatively new to the state. The first recorded breeding pair was in 1993, and today they are known to nest in a handful of sites in both western and eastern Pennsylvania.



Snowshoe hare (*Lepus americanus*)

(photo: Tim Rains, National Park Service)

Named for its large furry feet, this member of the rabbit family changes color with the seasons, turning white in the winter. In Pennsylvania they're found primarily in younger, high-altitude forests with a dense understory.



Prickly pear cactus (*Opuntia humifusa*)

(photo: Andrew Rohrbaugh, DCNR)

Not all cacti live in the desert. The prickly pear is found throughout the eastern and mid-west U.S. There are only about 30 occurrences in Pennsylvania, primarily in the southern counties growing on shale barrens and rocky slopes and cliffs.



Carnivorous Plants of

Pennsylvania

by **Greg Podniesinski**, Director of the Pennsylvania Natural Heritage Program

Deep in the bogs and lakes of Pennsylvania live carnivorous plants. Unlike the man-eating plant in “Little Shop of Horrors,” our carnivorous plants satisfy themselves with the occasional fly, mosquito or any other insect that happens to wander their way.

Pennsylvania is home to 14 species of carnivorous plants, including sundews, pitcher plants and bladderworts. Each of these groups has a unique method of catching and consuming their prey, but why do they catch and eat insects in the first place?

The reason for their meat-eating becomes clear when we look at their habitat, bogs and pristine lakes. [Bog habitats](#) are typically acidic, with pH values sometimes less than 4.0 (compared to your tap water which has a pH of about 7.0), and since the pH scale is logarithmic, it means bogs can be up to 1000 times more acidic than your drinking water. Under those conditions, many nutrients are scarce, in particular certain elements like calcium and especially nitrogen. Nitrogen is critical for plants to make [amino acids](#), the building blocks for proteins and enzymes that are essential for all organisms.

In order to address the scarcity of these nutrients, bog plants resort to a variety of strategies. Many bog plants just grow very slowly, adapted to low nutrient levels. Others retain their leaves (evergreen trees and shrubs) to avoid having to expend nutrients to grow new leaves every spring. In the case of our carnivorous plants, insects are like nature’s energy bars, packed full of nitrogen-rich protein, minerals and other nutrients. However, you should remember that while our insect-

eating plants enjoy their live food, they still get most of their energy the old-fashioned way, from the sun using photosynthesis.

Now that we know why these plants have a carnivorous diet, let’s take a closer look at some of our native carnivorous plants.

Sundews

Pennsylvania is home to two native species of sundews, the spatulate-leaved sundew (*Drosera intermedia*) and the round-leaved sundew (*Drosera rotundifolia*). World-wide, there are over 90 species of sundews, with the majority occurring in Australia and South Africa.

These plants get their name from the appearance of their leaves and attached tentacles which are covered with glistening droplets reminiscent of dew on grass at mid-day. However, these glistening droplets are actually a mixture of sticky adhesive and digestive enzymes secreted by the delicate tentacles that cover the surface of the leaves. When a hapless fly or other small insect lands or walks across the sundew’s leaves, the “dew” clings to the insect. In response to the insect, nearby “hairs” and the leaf itself will bend toward the area of the leaf where the insect is caught, and further secure the insect in the “dew.”

The enzymes in the dew will then begin to dissolve the victim, reducing it to a soup of proteins, amino acids, and nutrients that can be readily absorbed by the plant. Once the meal is complete, the leaf will re-open and the tentacles will reset themselves.

Sundews are readily available at most plant nurseries and are not



Greg Podniesinski,
Director of the
PA Natural Heritage
Program



Round-leaf sundew
(*Drosera rotundifolia*) leaf
(photo: Petr Dlouhy,
Wikimedia.com).



Spoon-leaved sundew
(*Drosera intermedia*),
(photo: David G. Smith,
delawarewildflowers.org)



Carnivorous Plants of Pennsylvania (continued)

difficult to keep, provided they are kept in near full sun, are watered with rain water or distilled water (the minerals in tap water will quickly kill them), kept in humid environment (such as a terrarium) and are never fertilized (again, high mineral content in fertilizer will lead to their quick demise).

Pitcher Plants

Pennsylvania has only one species of pitcher plant, the purple pitcher plant (*Sarracenia purpurea*).



Pitcher plant (*Sarracenia purpurea*),
(photo: Geoff Gallice, Wikimedia.com)

World-wide, there are over 100 species of pitcher plant, most of which occur in tropical regions. The genus *Sarracenia*, to which our species belongs, only has about 8 species, all of which are limited to North America.

The pitcher plant leaf consists of a hollow tube that opens at the top, where two “ear-like” wings form a “hood.” The inner surface of the hood and the upper portion of the tube is covered with minute, stiff, downward pointing hairs.

These hairs help the pitcher plant trap unsuspecting insects by creating a slippery surface that causes insects to tumble and fall into the tube portion of the leaf. The downward pointing hairs also prevent the insects from crawling upwards and out of the tube. There, the unfortunate insect finds itself swimming for its life in a watery “soup” of digestive enzymes that will eventually dissolve it. The plant will slowly absorb all of the nutrients from the insect.

The digestive soup of the pitcher plant is an inhospitable environment, but not to all creatures. One species of



Close up of hairs on the hood of a pitcher plant (*Sarracenia purpurea*),
(photo: Peter M. Dziuk, Wikimedia.com)

mosquito (*Wyeomyia smithii*) is immune to the digestive enzymes and as a larva, it happily flicks about the tube until its ready to metamorphose and fly away. Another denizen of pitcher plants is a carnivorous larvae of midge (*Metriocnemus knabi*), which will eat the larvae of non-native mosquitoes, but not those of *Wyeomyia smithii*.

Pitcher plants also have a variety of smaller organisms living in their tubes including mites, small protozoans, and bacteria, which feed on the decaying bodies of insects, and each other, creating an entire ecosystem in a single plant leaf.

The leaves of the pitcher are not long-lived, surviving one and occasionally, two years. The leaves themselves can be quite striking visually, and vary in color from deep purple to a light yellow green with deep purple veins. The hood in our species is unusual for North American pitcher plants in that it is open, and allows rainfall to enter the tube. In all other *Sarracenia* species, the hood bends over the tube, letting insects in, but keeping rain out.

Pitcher plants, like sundews, are popular in the horticultural trade and can often be found in nurseries, usually as small, young plants, and they can be kept in a manner similar to sundews. Because many of the North American pitcher plants will interbreed, plant breeders have created a number of interesting hybrid pitcher plants over the years, which are available to the pitcher plant aficionado.

Bladderworts

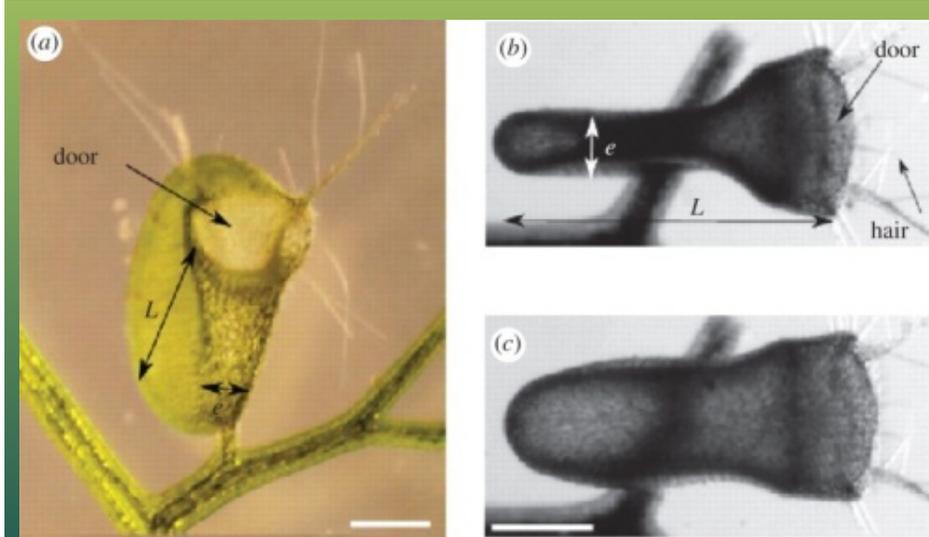
Bladderworts (genus *Utricularia*) are probably the most overlooked of our native carnivorous plants, probably because they feed on [microscopic zooplankton](#) and their “traps” typically require a good hand lens to clearly see. Pennsylvania has 11 species of bladderwort, of which five are considered rare.



Flower of horned bladderwort (*Utricularia cornuta*),
(photo: Bob Peterson, Wikimedia.com)

Worldwide, there are 233 species, occurring in freshwater and wet soils across every continent except Antarctica. Whether in freshwater or wet soil, bladderworts tend to occur in acidic conditions with low nutrient levels, similar to sundews and pitcher plants. In fact, sundews, pitcher plants and bladderworts are often found side-by-side in many Pennsylvania bogs and other acidic wetlands.

Under aquatic conditions, bladderworts are free-floating aquatic plants with finely dissected leaves to which are attached many small "bladders." These bladders consist of a pouch that is partially collapsed under negative pressure relative to the surrounding environment, a trapdoor that seals the opening of the pouch, and trigger hairs around the trapdoor.



Trap of *Utricularia inflata*. (a) Frontal view of the trap. The light green disc is the door of the trap. (b,c) Top view of a trap. The two extreme states of the trap are displayed. In (b), the trap is in the deflated, capturing configuration. The fine threads are the trigger hairs. In (c), the trap has just fired and is inflated. Scale bars, 500 μm . (photo: Coraline Llorens, M d ric Argentina, Yann Bouret, Philippe Marmottant, Olivier Vincent. Journal of the Royal Society Interface. 2012 9 76 3129. A dynamical model for the Utricularia trap.)

the wet soil surface. In these cases, the only time of year they can be identified is when they flower, typically with a yellow or sometimes purple flower. While many of our species are aquatic, worldwide 80 percent of bladderwort species occur in wet soils.

Unlike the sundew and pitcher plant, the bladderwort does not have an attractive appearance (except perhaps when it briefly flowers), and

When a small aquatic organism approaches the bladder and brushes against a trigger hair, the trapdoor abruptly opens and the bladder, which was under negative pressure, inflates, sucking in anything in front of the trap door, including the aquatic organism. The entire process occurs in only 10-15 thousandths of a second. Once inside the bladder, digestive enzymes are released and the organism is consumed.

Depending on the species, the bladders can be quite small (0.2 mm) to large (1.2 cm). Species with large bladders can consume larger prey, including aquatic insects, young fish, and even young tadpoles. The trapping mechanism of the bladderwort is considered the most sophisticated among carnivorous plants.

When bladderworts occur in wet soils, they tend to depend on carnivory less. The bladders appear less frequently and green photosynthetic leaves grow on

tends not to lend itself to cultivation, so it typically won't be found in nurseries. It is best left alone in its native habitat.

Carnivorous plant conservation

Our native carnivorous plants live in fragile habitats. Bogs and associated peatlands are very susceptible to disturbance and can easily be "loved to death" by plant enthusiasts tramping through them. The best way to view them is at parks and nature preserves where boardwalks have been installed to limit the impact by visitors. Another important consideration regarding carnivorous plant protection is protecting water quality, especially controlling nutrient pollution from agricultural, residential and industrial practices. Nutrient pollution can rapidly turn a pristine bog into a weedy wetland full of invasive plants, from which the sundews, pitcher plants and bladderworts will quickly disappear. ✓



"Information for the Conservation of Biodiversity"

Pennsylvania Natural Heritage Program

The Pennsylvania Natural Heritage Program (PNHP) is a member of NatureServe, an international network of natural heritage programs that gather and provide information on the location and status of important ecological resources (plants, vertebrates, invertebrates, natural communities and geologic features). Its purpose is to provide current, reliable, objective information to help inform environmental decisions. PNHP information can be used to guide conservation work and land-use planning, ensuring the maximum conservation benefit with the minimum cost. To learn more about what we do, and about species of special concern, visit us on the web at www.naturalheritage.state.pa.us.

Guess Who Used to Call Pennsylvania Home?

by Greg Czarnecki, WRCP Director

Believe it or not, each of these species once lived in Pennsylvania, but have since disappeared from the state due to causes such as habitat loss and overhunting.



Moose (*Alces alces*)

(photo: Hagerty Ryan, U.S. Fish and Wildlife Service)

Exactly when the moose disappeared from Pennsylvania is unknown, but there are numerous accounts of these large animals from as recently as the late 1700s. They were known to occur across the northern half of the state and were prevalent throughout the Alleghenies between Altoona and Pittsburgh.



Bison (*Bison bison*)

(photo: Stefan Didam – Schmallenberg)

While never common in Pennsylvania, the plains bison did once occur here in small herds. They were most common in the Ohio, Monongahela, and Allegheny River watersheds. It is believed that the last bison in the state was killed around 1800 near Lewisburg.



Eastern gray wolf (*Canis lupus lyacon*)

(photo: D. Gordon E. Robertson, Wikimedia Commons)

When European settlers arrived in North America, wolves roamed all of the future 48 contiguous states. By the late 1800s, however, they were gone from Pennsylvania due to habitat loss and extermination. Today the largest wild canid in the state is the [eastern coyote](#). Our coyotes here are much larger than their western cousins, it's thought, because they are hybrids that contain wolf DNA.



Wolverine (*Gulo gulo*)

(photo: Wikimedia Commons)

This tenacious predator of the northern [boreal forests](#) was never common in Pennsylvania. While still found throughout western North America, the last known record of a wolverine in Pennsylvania is from Potter County in 1858.



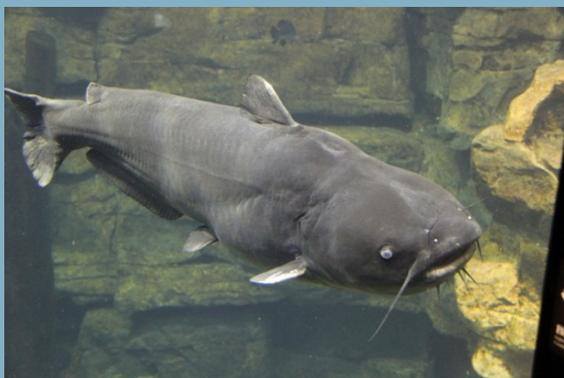
Passenger pigeon (*Ectopistes migratorius*)
(photo: Greg Czarnecki)

Thought to have comprised as much as 40 percent of the wild bird population of the U.S. when Europeans arrived, the last passenger pigeon died in captivity 100 years ago. They were common throughout the Commonwealth and nested in great numbers in the northwestern part of the state. The last report of a living passenger pigeon in Pennsylvania was in 1906. The bird in this photo is in the [State Museum in Harrisburg](#).



Heath hen (*Tympanuchus cupido cupido*)
(Wikimedia Commons)

This sub-species of the Greater prairie chicken, which is found in the grasslands of the Midwest U.S., was once found in scrub oak and blueberry barrens on the [Pocono Plateau](#). It's believed to have disappeared from the Commonwealth by the early 19th century, but persisted on the islands of Martha's Vineyard until 1932.



Blue catfish (*Ictalurus furcatus*)
(photo: Wikimedia Commons)

The largest catfish in North America, the blue catfish can reach lengths of greater than six feet and weigh up to 150 pounds. It's a southern species that occurs within the Mississippi River drainage basin, and there are records of this fish being caught in the Monongahela River in the late 1800s.



Christmas mistletoe (*Phoradendron leucarpum*)
(photo: Patrick Mackie, Wikimedia Commons)

This parasitic plant, which was considered sacred by the druids in medieval Europe and is still steeped in tradition today, used to be found in the southeastern part of the state. It's still relatively common in the southern U.S. ✓

Red Spruce Restoration in Pennsylvania

by Carolyn Mahan, Professor of Biology and Environmental Studies, Penn State Altoona



Red spruce is a component of the glacial relict montane forest community associated with the high elevations of the Appalachian Mountains. Red spruce is a conifer and thus retains its needle-like leaves all year. Due to this “evergreen” characteristic, conifers provide shaded habitat that cool streams in the summer while providing shelter for wildlife during winter months.

In Pennsylvania, red spruce is found on the Allegheny and Pocono plateaus typically above 2000 feet in elevation. Red spruce forests in Pennsylvania and throughout the Appalachians have experienced a dramatic decline from their original range perhaps as great as 85-90 percent in some areas of the Appalachians. These declines are historically related to land development, clearing and logging.

Red spruce forests provide habitat for a variety of wildlife species typical of more northern areas such as fisher, snowshoe hare, saw whet owl and goshawk. Additionally, the state-endangered northern flying squirrel is associated with red spruce throughout its range in the Appalachians. A diverse community of fungi –a major food source for northern flying squirrels—grows in the soil under red spruce stands and large trees provide cavities for shelter especially during the winter months.

Aside from mammals, a variety of warblers including blackburnian, blackpoll, and black-throated blue, breed in mixed conifer stands that contain red spruce. The decline of another conifer species—the eastern hemlock—has provided an opportunity to restore red spruce throughout its former range in Pennsylvania. The eastern hemlock is declining in the state due to infestation by a non-native insect, the [hemlock woolly adelgid](#). The expansion of red spruce could help ameliorate the loss of this eastern hemlock from our forests.

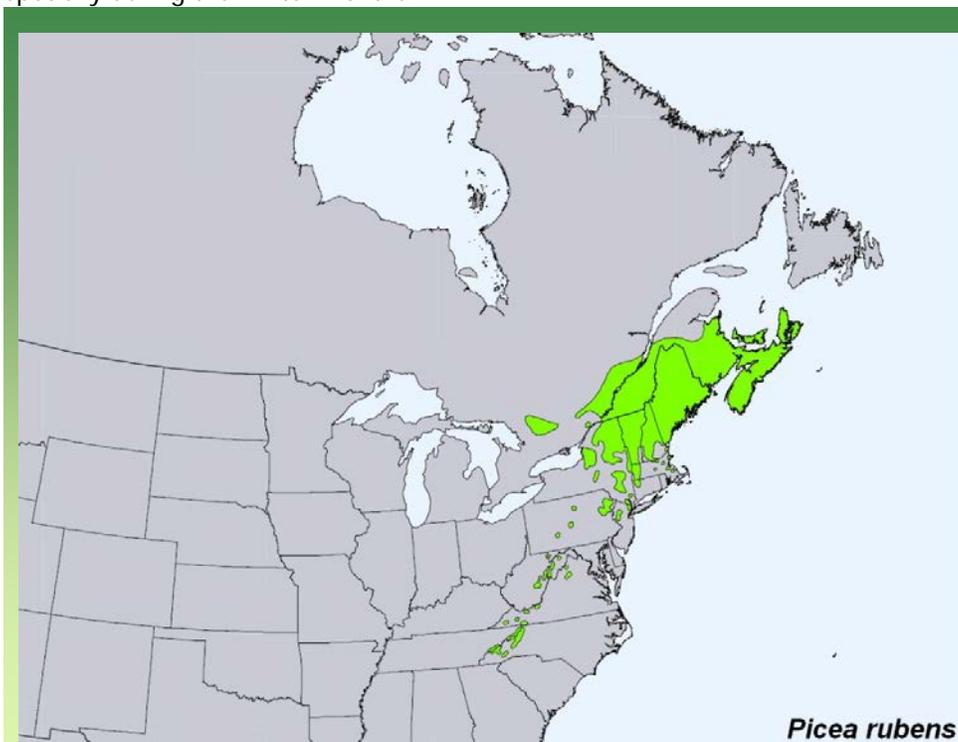
In 2012, a cooperative effort to restore and expand red spruce within the range of the northern flying squirrel was initiated. The [project was funded](#) by the Wild Resources Conservation Fund with matching funds and services provided by [Penn State Altoona](#), [Wilkes University](#), and the [Pennsylvania Game Commission](#). As part of this project, 2,500 red spruce seedlings were planted on State Game Lands 127 and 129 in Monroe and Carbon Counties in May 2012.

The seedlings were planted in forest stands where eastern hemlock had died, in a recent clear cut, and understands of red spruce to encourage and ensure regeneration of the those stands. The seedlings were obtained from West Virginia where researchers have been

studying and implementing red spruce restoration for over a decade. By obtaining the seedlings from West Virginia, we were ensuring that an Appalachian red spruce ecotype was being used.

According to Dave Saville of the [West Virginia Highlands Conservancy](#), an ecotype is a “particular population of plants within a species which, due to genetic differences, has a

The range of red spruce in eastern United States
(U.S. Forest Service)



Picea rubens

Red Spruce Restoration in Pennsylvania (continued)

different physical form (leaf size, height, etc.), resistance to diseases/pests, hardiness, or reproduction time that is



Red spruce branch with cones

(photo: U.S. Forest Service)

adapted to certain environmental conditions of a particular area.”

The Game Commission is working to develop a Pennsylvania red spruce ecotype for planting in 2015. The Pennsylvania ecotype

was established by harvesting red spruce cones, removing the seeds, and growing seedlings from this seed source at state nurseries. These seedlings, however, were not large enough to be planted for our project.

During summer 2013, we permanently tagged and monitored a random sample of five percent of these seedlings at each of our study sites. To date, the red spruce seedlings are doing quite well. Red spruce seedlings had a 98.6 percent survival rate in our study sites one-year post planting. Approximately 10 percent of our surviving spruce seedlings had a damaged apical stem and 28.6% had their apex browsed by white-tailed deer.

This browsing rate is similar to rates found in red spruce/balsam fir forest stands in other portions of eastern North America. We hope to monitor the red spruce seedlings again in two years to better

understand the best conditions for establishing and restoring red spruce. The Game Commission also will plant the Pennsylvania red spruce seedlings in state game lands in northern Pennsylvania, and we hope these combined efforts will help maintain conifer communities in the state and support the wildlife that use this habitat type.



Red spruce seedlings used in our restoration efforts; (photo by West Virginia Highlands Conservancy)



A northern flying squirrel captured in northeastern Pennsylvania is fitted with a telemetry device to track its movements.

(photo: G. Turner, PA Game Commission)

Answers to Wild Words on page 21.



Unexpected Visitors

by Rebecca Bowen, Editor of *Keystone Wild!Notes*

Birds have an inner-compass to direct them when they are migrating, and lots of birds travel astounding distances. But what happens when a hurricane or storm hits? Sometimes they get blown off course, and end up somewhere other than their destination. Birds can also accidentally be transported with cargo (although international laws try to prevent this from happening). Some just wander farther away than the rest of the flock. Below are some instances when Pennsylvania got unexpected visitors.



Kermadec petrel (*Pterodroma neglecta*)

(John Gerrard Keulemans, Wikimedia Commons)

Kermadec petrels are South Pacific sea birds. One was seen circling at [Hawk Mountain](#), Berks/Schuylkill counties in 1959 after Hurricane Gracie.



Greater flamingo (*Phoenicopterus ruber*)

(photo: Charles J. Sharp, Wikimedia Commons)

Normally tropical birds, flamingos are common in Florida but they may wander north along the east coast or escape from zoos or collections. A flamingo was observed in 1949 at a pond in Bucks County, but appeared to be “naturalized” and an escapee from a zoo.



White-tailed tropicbird (*Phaethon lepturus*)

(photo: Marion Scheider and Christopher Aistleitner, Wikimedia Commons)

The white-tailed tropicbird, a bird of the tropical and subtropical open oceans, breeds in Bermuda and the Caribbean. After Hurricane Hazel, birds were collected in 1954 from Luzerne County and near Gettysburg.



Magnificent frigatebird (*Fregata magnificens*)

(photo: Adnrew Turner, Wikimedia Commons)

The magnificent frigatebird of the Florida Keys is a high-flier with a large wingspan. One was observed after Hurricane Flossie in 1956 in Westmoreland County.

Unexpected Visitors (continued)



American white pelican (*Pelecanus erythrorhynchos*) (photo: John Foster, U.S. Fish and Wildlife Service)

The white pelican, a giant black-and-white bird with the distinctive pouch, is normally found along the Gulf Coast and in California, but has been seen in several locations in Pennsylvania dating back to 1926.



Eurasian jackdaw (*Corvus monedula*) (photo: Dick Daniels, Wikimedia Commons)

This Eurasian jackdaw (a relative of our American crow) is thought to have come to Pennsylvania via shipping cargo, not a storm. It lives in Europe and Asia, but a pair was observed attempting to nest in 1985 in Union County. The pair tried to raise a family for several years, but it is not clear if they were successful.



Brambling (*Fringilla montifringilla*) (photo by Pierce Dalous, Wikimedia Commons)

One male brambling was reported in 1978 at a feeder in Allegheny County. This bird is a Eurasian species that breeds in Scandinavia, Russia, and Siberia; it migrates through Alaska, Canada and northwestern U.S. It spends winters in the British Isles.

So, keep your binoculars handy and your camera or phone...you never know what visitors may show up at your house! ✓

Answers to ColorMe Wild!

- 4 **Pitcher plant** (*Sarracenia purpurea*)
- 6 **Moose** (*Alces alces*)
- 5 **Sandhill crane** (*Grus canadensis*)
- 1 **Round-leaved sundew** (*Drosera rotundifolia*)

- 3 **Eastern Spotted Skunk** (*Spilogale putorius*)
- 2 **Bison** (*Bison bison*)
- 8 **Yellow-fringed orchid** (*Platanthera ciliaris*)
- 7 **Prickly pear cactus** (*Opuntia humifusa*)

Scientist Profile—

Rebecca Bowen

I am actually a native of Maryland, born and raised in Forest Hill, Harford County, where the Susquehanna crosses into Maryland and eventually reaches the Chesapeake Bay. I grew up playing in the woods, down at the stream, and collecting wildflowers from the fields. I used to go down to our pond and watch the frogs and damselflies. I kept a notebook of what happened at the pond, when frogs laid eggs, when the wood ducks nested and drew sketches of what I saw. Other little girls my age played house...I played scientist.

So it makes sense that I now work in the conservation field. I am currently the Ecological Services section chief in DCNR Bureau of Forestry. The biologists in my section provide botany and wildlife expertise on state forests. My day-to-day work is mostly in the office, but I do get to get out to the great Pennsylvania state forest system a lot for meetings, habitat management and species survey work. What I like best about my job is that I feel like I am making a difference for some key areas in Pennsylvania. I get to work with great people too.

I knew I wanted to be a biologist from middle school. Being so close to the Chesapeake Bay, I learned a lot about the environment and ecosystems. I attended Frostburg State University in Frostburg, Maryland and received a bachelor's degree in Biology. Then I worked seasonally for three years as the herpetile technician in North Carolina for Tall Timbers Research Station, checking pitfall traps around four vernal pools. The project studied the effect of seasonal burning in longleaf-wiregrass ecosystems, and the study sites were located on Fort Bragg Military Reservation. The ecosystem there was so different from what I was used to. However,

I gained an appreciation of how diverse forest ecosystems were. It was also a different world—you didn't know when a tank was going to be passing by, or artillery whizzing overhead. It was quite an experience! And it solidified my desire to pursue conservation biology. Then I attended Shippensburg University and built upon my vernal pool experience, studying larval amphibians in vernal ponds in the Michaux State Forest.

I came to DCNR as an environmental review specialist, doing Pennsylvania Natural Diversity Inventory reviews (PNDIs) for private lands development projects. That experience gave me a better understanding of Pennsylvania's diverse landscape and habitats. It also let me learn more about its unique plant life.

Many people don't know that DCNR is the jurisdictional agency with authority over plants in PA. People in my division work to protect and benefit native wild plants through several ways: the PNDI system where we review projects with potential impacts to plant species, the Wild Plant Sanctuaries program (both private and public), and maintaining the list of state-listed species. We also have a very useful invasive plants program that provides landowners information on combatting invasive species on their property. In my position, I also help to determine the priorities for the WRCP grant requests. This is an important source of funding for wild plant research in Pennsylvania. We are able to utilize this funding to target species that need further study. WRCP is important because it serves a critical source of revenue for scientists doing research that does not fall under other grant opportunities.

As for hobbies, I enjoy travelling and camping with my husband. We enjoy our two dogs and one cat. I also love drawing, painting and writing. I considered going into arts when I was

**Ecological Services
Section Chief,
Bureau of Forestry**



Vernal pond survey



**Rebecca and Eco Services
staff take a break during a
bog survey**



**Planting potatoes in my
garden**

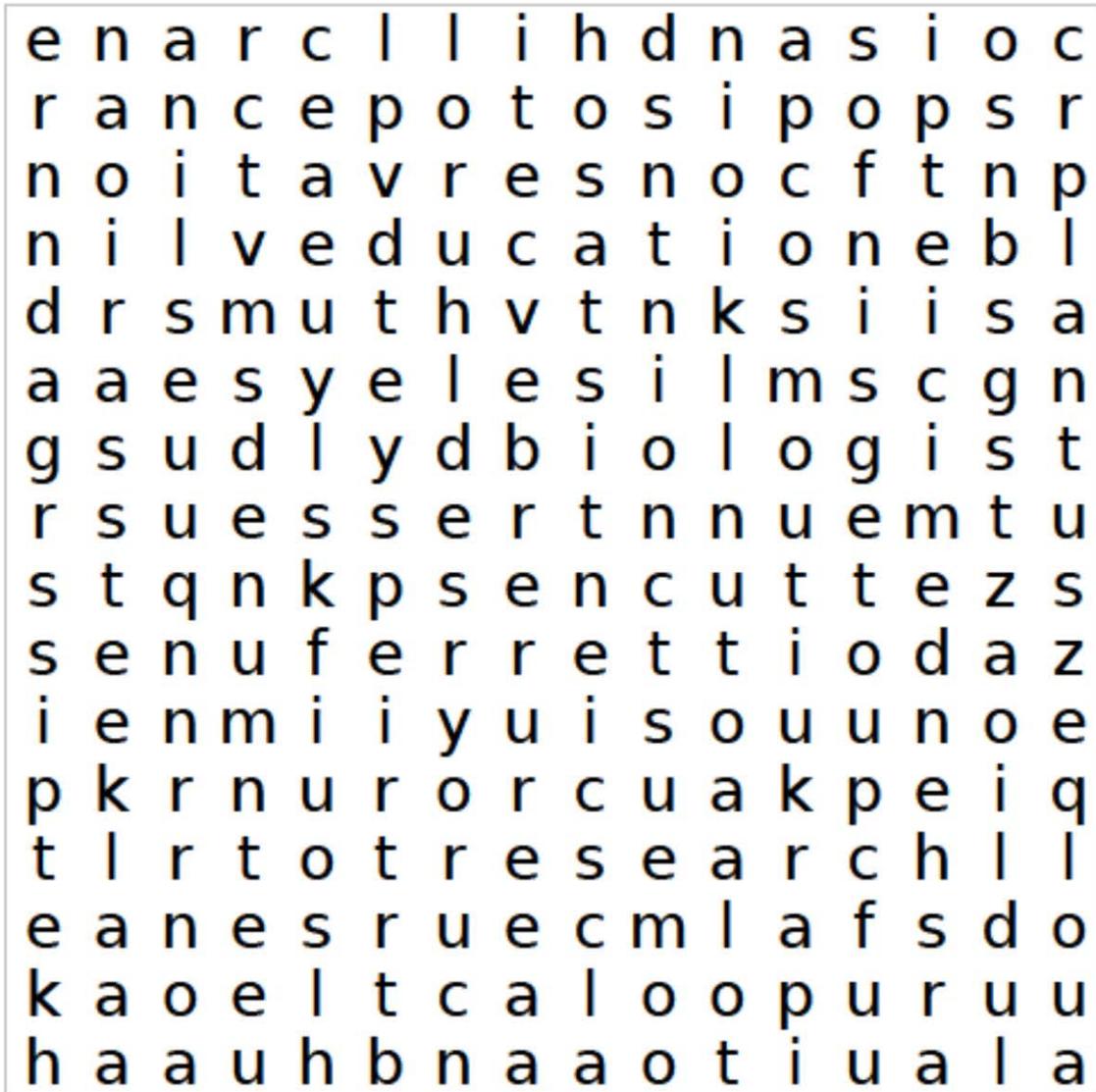
in high school, but decided that I loved it too much to do it for a job. I also am a vegetarian and love food and cooking, and enjoy all the veggies that come out of the garden my husband and I tend in our backyard.

I am excited to serve as the new *Keystone Wild! Notes* editor, and look forward to the new experiences it will bring!



Wild! Words

Search for key words from this issue's articles!



autumn
cosmo
Ferretti
Pennsylvania
sandhill crane
study

biologist
Devlin
isotope
plant
scientist

bison
education
kudzu
redspruce
spotted skunk

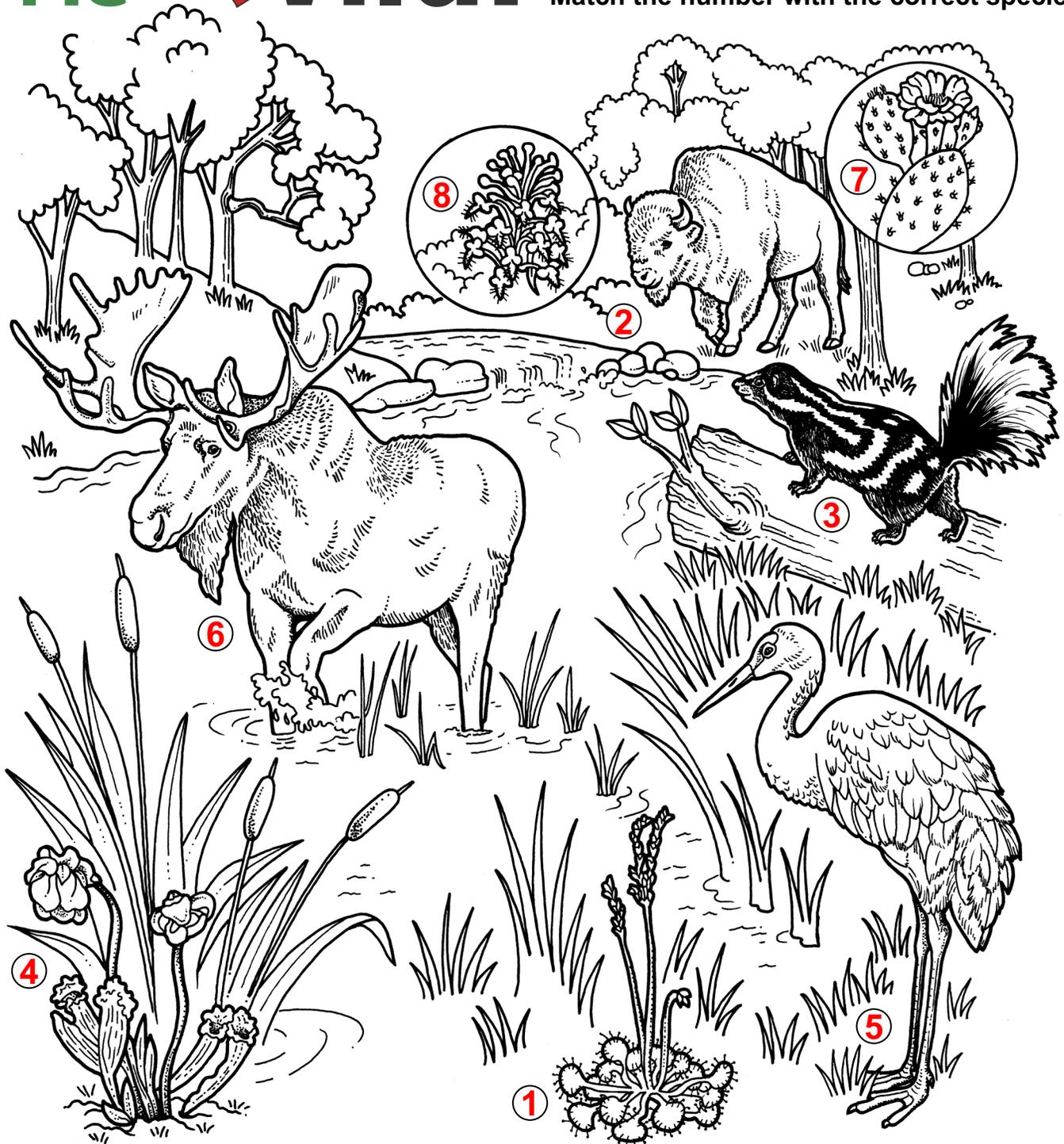
conservation
endemic
park
research
squirrel

Answers on page 17.

Color Me Wild!

Things You Probably Didn't Know Live in Pennsylvania

Match the number with the correct species



- _____ Pitcher plant (*Sarracenia purpurea*)
- _____ Moose (*Alces alces*)
- _____ Sandhill crane (*Grus canadensis*)
- _____ Round-leaved sundew (*Drosera rotundifolia*)

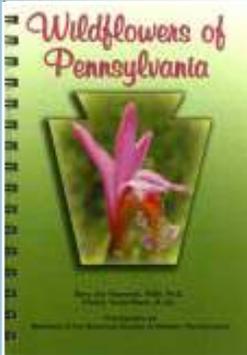
- _____ Eastern Spotted Skunk (*Spilogale putorius*)
- _____ Bison (*Bison bison*)
- _____ Yellow-fringed orchid (*Platanthera ciliaris*)
- _____ Prickly pear cactus (*Opuntia humifusa*)



Wild! Buys

Show Your Wild Side!

Read All About It—In Wild! Books



WILDFLOWERS OF PENNSYLVANIA

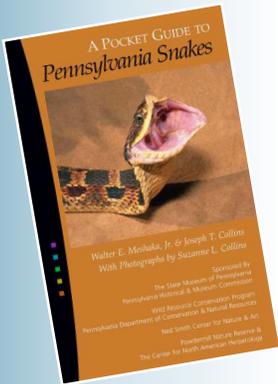
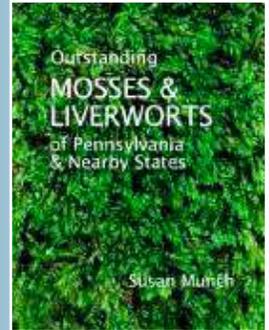
This book is for all who enjoy nature and would like to become more acquainted with wildflowers. It will help the observer to identify the plants seen on a spring, summer or fall hike in a natural area. The book uses photographs of the plants, as photos reveal much more detail than can be found in drawings.

Price: \$20 (+ \$1.20 tax)

OUTSTANDING MOSSES AND LIVERWORTS OF PENNSYLVANIA

Botanist Susan Munch brings us the first full-color field guide for mosses in the Mid-Atlantic region. The guide's 89 pages contain detailed color photographs allowing for easy ID of many of the most common, yet striking, mosses and liverworts. No microscope is necessary. The guide is suitable for both professionals and non-botanists.

Price: \$20 (+ \$1.20 tax)



POCKET GUIDE TO PENNSYLVANIA SNAKES

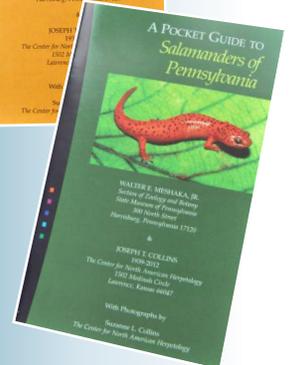
WRCP teamed up with the State Museum to produce this affordable and informative little book that provides photos and natural history information about all of the state's serpents.

Price: \$4.72 (+ \$.28 tax) each

NEW! POCKET GUIDE TO SALAMANDERS OF PENNSYLVANIA AND POCKET GUIDE TO LIZARDS AND TURTLES OF PENNSYLVANIA

Once again WRCP has teamed up with the State Museum to create affordable and informative mini books that provide photos and natural history information about all of the state's turtles, lizards and salamanders.

Price: \$4.72 (+ \$.28 tax) each





Wild! Buys

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Greg Czarnecki, Executive Director
Wild Resource Conservation Program



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Rebecca Bowen, Editor
Design/Layout, DEP Graphics & Desktop Publishing



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Keystone Wild! Notes is the official online publication of the Pennsylvania Wild Resource Conservation Program. Its goal is to inform people about the activities of the program, which supports research and protection efforts for the state's natural heritage—its unique collection of native nongame animals and wild plants. The program is funded by the Pennsylvania Department of Conservation and Natural Resources and by public contributions: voluntary checkoffs on the state income