

2024 Lancaster County Middle School Envirothon

Aquatics Study Materials

Eastern Garter Snake
Eastern Spadefoot Toad
Eastern Gray Tree Frog
Spotted Turtle
Fairy Shrimp
Eastern Hellbender
Eastern Red-spotted Newt
Spotted Salamander
Jefferson Salamander
Redback Salamander
Four-toed Salamander
Predaceous Diving Beetle
Vernal Pools/Ponds
Natural history of salamanders



VERNAL POOLS/PONDS: Have you ever walked through the woods in spring and found an immense puddle that wasn't there over the winter? You may have discovered one of the most ecologically important habitats to be found among Pennsylvania's woodlands. Vernal pools or ponds are temporary wetlands that fill after the snowfall of winter. They become the seasonal breeding and feeding grounds for many intriguing amphibians and insects, as well as the reptiles,

birds, and mammals that depend on them for food. With the rapid population declines of so many amphibian species, these often unnoticed habitats must be recognized and protected.

Vernal ponds/pools are formed seasonally in shallow ground depressions from spring snowmelt, precipitation, and rising water tables. Generally drying up in late summer, these ponds are only temporary woodland reservoirs. Blackened, compressed leaf litter, gray soil, watermarks on surrounding tree trunks, and the presence of moisture-tolerant vegetation all suggest an area that collects water part of the year.

Vernal ponds/pools themselves are generally less than 40 yards in diameter and no more than 4 feet deep. Much of the topography that makes Pennsylvania's vernal ponds possible was first formed during the last glacial period and is the result of 10,000 years of irreplaceable geologic history.

The forest canopy provides essential shade for regulating pond temperatures, and slows the loss of water from the pond by evapotranspiration. In addition, the forest canopy helps to maintain a cool, moist environment in the surrounding forest, a necessity for many amphibians.

NATURAL HISTORY OF SALAMANDERS

Salamanders are often confused with lizards because of their similar body form. Instead, salamanders have moist glandular skin that is permeable to water and unlike frogs, they have tails and teeth in both jaws. They rely on moisture to survive and can disappear when there is no rainfall. There are only two continents on which salamanders do not occur: Antarctica and Australia. Most species of salamanders are found in North and South America.

Salamanders are crucial to humans both culturally and scientifically. From a scientist's point of view, salamanders are key in understanding an extraordinary phenomenon that would revolutionize medicine: limb regeneration. Salamanders are the highest order of animals capable of regenerating body parts, including their tails, upper and lower jaws, and eyes.

Salamanders prefer a cool and stable microclimate because they breathe through their skin. Habitat loss is the primary threat to salamanders. Human actions contribute to habitat loss including logging, road building, mining, recreation, and dam construction. Salamanders are protected in the state of Pennsylvania and can not be kept as pets.



Springtime fairy shrimp (Eubbranchipus vernalis)

FAIRY SHRIMP: Fairy shrimp are crustaceans that are found exclusively in vernal pools. They are exquisitely adapted to this environment. They have no external shell, two compound eyes, and two sets of antennae. Their abdomen terminates with a pair of tail-like cercopods. They swim 'upside-down' on eleven sets of swimming legs that are also used to take up oxygen. They can withstand very low oxygen levels.

In order to avoid the increasing number of predators that find the pool by summer, fairy shrimp hatch in late winter and early spring. They can be seen swimming under the surface of ice-encrusted pools. Female fairy shrimp can produce two types of eggs; summer eggs hatch in the same season they were laid, while winter eggs fall to the bottom of the pool and remain there after the pool dries up. The

winter eggs are hard-shelled, withstand freezing and drying, and require a period of dryness in order to hatch. They hatch the following spring when the pool refills.

Fairy shrimp serve as an important link between primary producers and predators. They feed on bacteria, detritus, and microzooplankton. They are preyed on by a number of organisms, including salamanders, beetles, and insects.



EASTERN HELLBENDER: The hellbender, a member of the Giant Salamander family, is one of two large salamanders inhabiting Pennsylvania. (The other is the mudpuppy, although it belongs to a different family than the hellbender.)

Eastern hellbenders are the largest salamander in Pennsylvania (and the United States), measuring up to 11-20" long. They are gray or olive in color with heavily wrinkled skin. Their eyes are tiny and they have a rudder-like tail. The hellbender loses its external gills by the time it reaches 4-5" in length, although gill openings may be seen on the side of the neck.

They live in fast-moving streams with clear water and boulders or large stones. Eastern hellbenders are completely aquatic animals, often hiding under rocks or submerged logs. Because they need clean water, they are good indicators of stream health. There is even a movement to get them named as the state amphibian for PA.

Hellbenders are primarily nocturnal and feed on crayfish, small fish, other hellbenders, tadpoles, toads, and water snakes. Very little is known about the predators of hellbenders. It is suspected that larvae and juveniles could be prey to snapping turtles, water snakes, and large predatory fish.

Unlike our other salamanders, the giant salamanders fertilize their eggs externally. In fall, males make a nest chamber beneath a rock. Females deposit long strings of eggs in a mass onto the nest bed. Males fertilize the eggs and guard them until they hatch.

The number of Eastern hellbenders has been decreasing because of habitat destruction and pollution. They are a species of special concern in PA. Some people think they have a venomous bite, but they do not. They are sometimes called “snot otters”. In 2021 the Eastern hellbender was named Pennsylvania’s state amphibian.



EASTERN RED-SPOTTED NEWT: The red-spotted newt inhabits ponds, lakes, slow-moving streams and creeks, and vernal pools. They are common throughout Pennsylvania and the northeast U.S.

The red-spotted newt is actually the adult stage of an amphibian that progresses through a unique life cycle. At hatching, the larva is greenish-yellow with gills. Larvae eat aquatic insects, crustaceans, and the larvae of other salamanders. Two to three months into the larval stage, the forelegs and hind legs are developed, the gills are lost and the skin becomes rough. Next is the land-dwelling red eft stage, or sub-adult stage. The body becomes a brilliant orange-red. A row of black-bordered, round red spots appears on either side of the back; the belly is yellow. The red eft's bright color serves as a warning to predators that they produce a poisonous toxin that can kill small predators like mice. Toxins are produced throughout their life stages, but is at its strongest during the red eft stage. Red efts’ diet includes insects and snails.



Top: sub-adult (eft), Bottom: aquatic adult

After the red eft stage, it re-enters the water to breed and live out its life as an adult. The skin becomes smooth and the tail fin develops. Its color now is olive to yellowish

brown or dark brown. The belly remains yellow with black spots. It still has the rows of red spots, bordered with black.



SPOTTED SALAMANDER: The spotted salamander is the most common mole salamander in Pennsylvania and is found throughout the eastern U.S. Adult spotted salamanders have bright yellow spots on a dark black to bluish-black background. There are 12 costal grooves (see figure II-6.) These grooves seem to be to help keep the skin moist by channeling water over the surface of the body. They also increase the surface area of the skin for water absorption. Adults are large, averaging 4.5-9.5”.

The mole salamanders spend most of their lives underground. They are found in moist forests and use animal burrows and other natural underground openings

or passages. They hibernate in burrows or crevices underground during winter.

Adults return to breeding pools in early spring and egg masses are deposited in the water by the females. The egg masses may look milky-white or be clear. The larvae hatch in the vernal pools and eat zooplankton, insect larvae and, in

times of low food availability, each other. The larvae are preyed upon by crayfish, frogs (both adults and tadpoles), snakes, birds, predaceous aquatic insects, turtles, and even other salamanders.

The diet of the terrestrial juvenile and adult may include earthworms, snails, slugs, spiders, millipedes, centipedes, isopods, and insects. Juveniles and adults are preyed upon by chipmunks, snakes, squirrels, raccoons, skunks, turtles, and opossums. A milky toxin secreted from glands on the back of their tails functions to repel and disgust predators.



JEFFERSON SALAMANDER: A large member of the mole salamander family, this salamander reaches 4-7" as an adult. It is long and slender with a wide snout. Its toes are proportionately longer than those of most other salamanders. They are brownish gray with a lighter underside. Small, bluish marks speckle the body but tend to disappear with age. They have 12 costal grooves on each side.

Jefferson Salamanders will hybridize with the similar-looking blue-spotted salamander. However, the blue-spotted has only been found in a few locations in PA.

Jefferson salamander eggs are laid and hatch in temporary or permanent ponds in forested areas. Adults live underground in steep, rocky areas and under cover of plant litter and logs. They feed on insects, slugs, worms and other terrestrial and aquatic invertebrates. As a defense, they can produce a milky, noxious secretion on their tail.

This amphibian was named for Jefferson College in Pennsylvania. (The college is named in honor of Thomas Jefferson.)

The Jefferson salamander is listed as a species of special concern in PA. It is highly sensitive to pollution, changes in pH, habitat disturbance, and habitat destruction. Like other salamanders, they are also killed by vehicles on roadways during the spring migration to breed in vernal pools.



Unstriped Morph and Striped Morph

REDBACK SALAMANDER: The eastern redback is a member of the lungless salamander family. (Instead of breathing with lungs, these salamanders take in most of the oxygen they need through the skin. They also have a vertical slit between the nostril and upper lip, known as the "nasolabial groove" that aids in chemoreception. See figure II-6.)

There are two common color morphs that occur within most redback populations- the striped morph (red-backed) and the unstriped morph (lead backed). In a third color phase, the entire body, except for the belly, is red. Regardless of the color phase, the belly is always mottled in a distinctive pattern of black and white. They have 18 to 20 costal grooves and adults reach 2-4" in length.

Unlike many amphibians, red-backs do not return to water to lay eggs. Instead, they find a suitable spot among the damp leaves under a stone or in a rotting log. The young hatch as tiny, well-formed red-backed salamanders —

miniatures of their parents — and live under the same logs and debris until they finally crawl off to colonize other areas of the local woods.

Redbacks eat insects and their larvae, mites, spiders, and slugs. Other forest animals like birds, shrews and snakes, will prey on this salamander.

A red-back salamander has the ability to shed its tail if it is grabbed or it feels threatened. The tail then continues to wriggle for several minutes. This is thought to keep a predator's attention while the real meal escapes. Though it's not quite the same, the tail regenerates, leaving the salamander almost as good as new.

They are one of the most abundant woodland species, found throughout PA and the northeastern U.S.



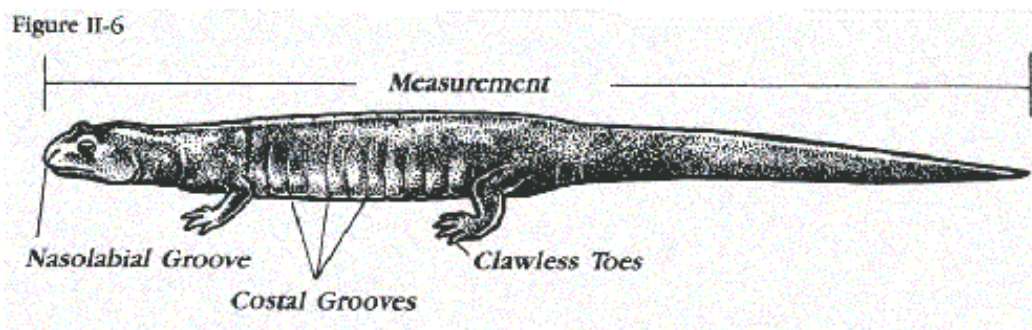
FOUR-TOED SALAMANDER: Only four toes appear on each hind foot (most other salamanders have five toes). Adults reach only 2-3.5". The belly is marked with large, bold black spots that stand out against an almost pure white. The back of the four-toed salamander is reddish brown to yellowish tan. Its sides tend to be gray. Each side has 12 to 14 costal grooves. They are in the lungless salamander family, breathing through their skin and the tissues lining their mouths.

The thick tail is marked near its base with a constrictive ring, indicating the point at which it would separate if threatened. A new tail is then regenerated.

Four-toed salamanders are strongly associated with sphagnum moss and are found in forested areas that have bogs, marshes, or woodland pools. Females nest in moss that overhangs or is near the edge of standing water. The eggs hatch and fall into the water for the larval stage. The redback diet includes aquatic invertebrates, ticks, beetles, arachnids, ants and snails.

Four-toed salamanders occur throughout Pennsylvania but are found in very spotty, localized areas due to their strict habitat requirements. Four-toed salamanders often overwinter inside of rotting logs, sometimes in large groups. Like so many other reptile and amphibian species, the four-toed salamander suffers from habitat loss primarily due to various human activities including farming, industrialization, and suburban sprawl. Wetland preservation is the key to conserving this unique little amphibian. It's listed as a species of special concern in PA.

Figure II-6:



PA Fish and Boat Commission



PREDACEOUS DIVING BEETLE: This diving beetle is a fierce predator with amazing adaptations. Their body is streamlined, and oval, with a narrower end at the head. When swimming, they kick both hind legs simultaneously.

Though they live in water, they are descendants of land beetles and are still able to breathe air and fly. Both the larvae and adult beetles breathe air. They act like a scuba diver by taking air at the water surface and storing it in its windpipe returning to the surface when they need more. Having air stored in their body makes their body buoyant and they swim ineffectively. When they release the air in their body they blast forward a bit in the water.

A second adaptation to swimming makes these beetles water permeable. If they are out of the water for too long, they become somewhat waterproof. When this happens, they may become trapped on the surface, unable to break the surface tension. A specialized gland on their abdomen produces a wetting agent chemical that makes the exoskeleton permeable to water again, and helps the beetle to become submerged.

Also known as a water tiger, they feed on insects, snails, tadpoles, and fish during the day. At night, they fly. They search for moonlight reflections which would indicate other bodies of water for them to take up residence.



EASTERN GARTER SNAKE: The adult eastern garter snake grows to 18 to 26 inches long with ridged scales and variation in their coloration and patterns. Their backs are dark brown, green, or olive colored with a distinct yellow or white stripe running down the center. The center stripe is often paralleled by two less distinct stripes. The area between the stripes is often a checkerboard pattern of black or green. The snake's unmarked belly is cream colored.

The eastern garter snake eats during the day and consumes earthworms, millipedes, spiders, insects, salamanders, small fish, frogs, and toads. It can be

prey upon by hawks, skunks, raccoons, larger snakes, and bullfrogs. They will hibernate in larger numbers during winter. Unlike most snakes, garter snakes do not lay eggs. Female eastern garter snakes give birth to a litter of 10 to 40 live young in summer. Young are 5 to 9 inches long at birth. Eastern garter snakes typically live 3 to 4 years. They are protected in the state of Pennsylvania and can not be kept as a pet.

Eastern garter snakes are non-venomous, but can defend themselves if they feel threatened with a strike and bite. If handled or attacked, they will release a foul smelling musk. They take shelter in hollow logs, or piles of rocks.



EASTERN SPADEFOOT TOAD: Although the shape of the eastern spadefoot toad's body, the wart on its back, and its burrowing nature are toadlike, and the word "toad" is often included in its common name, it is a primitive frog. This amphibian is rather small, up to 2 ½ inches and stout. It can be identified by two light wavy stripes that start behind the eyes and run down its back in an hourglass pattern. Its most distinctive adaptation is on its hind feet. Its hind feet are equipped with sharp edges that can be used as digging tools, hence the name 'spadefoot'. This adaptation makes it a champion burrower, digging and then dropping from sight into the earth below.

The eastern spadefoot is the most elusive. Scientists in Pennsylvania have documented it spending 109 days in a burrow without surfacing. It is nocturnal and will emerge sporadically to forage for insects on warm, humid, and rainy nights from March to October. It will generally remain within 5-10 yards of its burrow. Its favorite habitat includes vernal pools in forested areas.

Females lay 1,000 to 2,500 eggs over submerged twigs and grasses. Depending on the water temperature, the eggs will hatch in 24 hours to 7 days. Pennsylvania's eastern spadefoot is in trouble. The amphibian is listed on the endangered species list, due to habitat destruction. In addition to loss of habitat, the spadefoot's long-term survival is in jeopardy due to factors like barriers to travel and climate change. It is a beneficial amphibian to humans. They eat harmful and pesky insects and serve as environmental barometers, with their decline signaling problems that may affect us as well.



EASTERN GRAY TREE FROG: The eastern gray tree frog is nocturnal. They hide in tree holes, under bark, in rotten logs, under leaves, and under tree roots. At night, they search for insects, spiders, snails, and slugs in trees, where they can climb vertically or move horizontally with specially adapted toe pads. Their lifespan is 7-9 years. Male eastern gray tree frogs emit a loud, musical call usually after dusk, for as long as four hours. He uses this call to establish a territory.

Access to trees and a water source is common to all habitats it occupies. When a gray tree frog is young and newly metamorphosed, it usually remains near the forest floor. As it

ages, it may transition to living in the forest canopy.

The upper surfaces of the frog's legs feature a dark, banded pattern, which contrasts starkly with the bright yellow or orange undersides of the legs. Scientists believe the bright coloration serves as a warning for predators not to attack. The gray tree frog has webbed hands and feet. The tip of each digit produces an adhesive fluid that allows this species to better grip trees and improves its climbing abilities.

The gray tree frog hibernates in the winter by taking refuge in trees. It survives freezing temperatures by producing glycerol to freeze itself while maintaining internal metabolic processes at a very slow rate.



SPOTTED TURTLE: The spotted turtle is a small species that rarely exceeds 5 inches in length. It prefers shallow water bodies like vernal pools. It basks on logs, stumps, and grass mats. Its population in Pennsylvania is small, it is an endangered species. Spotted turtles feed on algae, soft aquatic plants, worms, insects, and amphibian eggs. Male spotted turtles have been known to live up to 65 years while female turtles live up to 110 years.

The small spotted turtle has a smooth carapace that is slate gray or black with a number of bright yellow spots, which can disappear in older turtles. The underside of the shell is yellow or orange with wide black smudges. Males and

females differ in size and color: males have brown eyes with a longer thicker tail, while females have orange eyes, and a narrow tail.

Feeding begins once spring temperatures reach about 60 degrees. It can be preyed on by raccoons and muskrats. They will dive into water and bury themselves in mud to protect themselves. Female turtles lay 1-8 eggs. Temperature determines whether the egg will hatch a male or female turtle. Cooler temperatures produce male turtles, warmer temperatures produce female turtles.

Sources:

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Scientific Names and Photo Credits:

FAIRY SHRIMP

Two species of fairy shrimp found in Pennsylvania are the eastern fairy shrimp (*Eubbranchipus holmani*) and the springtime fairy shrimp (*E. vernalis*). The most frequently encountered species in Pennsylvania is the springtime fairy

shrimp.

Photo: Springtime fairy shrimp, Jack Ray, PA Natural Heritage Program website

EASTERN HELLBENDER *Cryptobranchus alleganiensis alleganiensis*

Photo: Tom Diez, PA Herps Website

EASTERN RED-SPOTTED NEWT *Notophthalmus viridescens viridescens*

Photos: Top: Sub-adult (eft), Jason Poston, PA Herps website, Bottom: Aquatic Adult, PA Fish and Boat Commission

SPOTTED SALAMANDER *Ambystoma maculatum*

Photo: Bob Hamilton, PA Herps website

JEFFERSON SALAMANDER *Ambystoma jeffersonianum*

Photo: Jason Poston, PA Herps

REDBACK SALAMANDER *Plethodon cinereus*

Photo: Unstriped Morph and Striped Morph, Kyle Loucks, PA Herps website

FOUR-TOED SALAMANDER *Hemidactylium scutatum*

Photo: Bob Hamilton, PA Herps website

SPOTTED TURTLE [Spotted Turtle – PA HERP IDENTIFICATION \(paherps.com\)](http://paherps.com/Spotted-Turtle-PA-HERP-IDENTIFICATION)

EASTERN GRAY TREE FROG [Gray Treefrog – PA HERP IDENTIFICATION \(paherps.com\)](http://paherps.com/Gray-Treefrog-PA-HERP-IDENTIFICATION)

EASTERN SPADEFOOT TOAD [Eastern Spadefoot – PA HERP IDENTIFICATION \(paherps.com\)](http://paherps.com/Eastern-Spadefoot-PA-HERP-IDENTIFICATION)

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