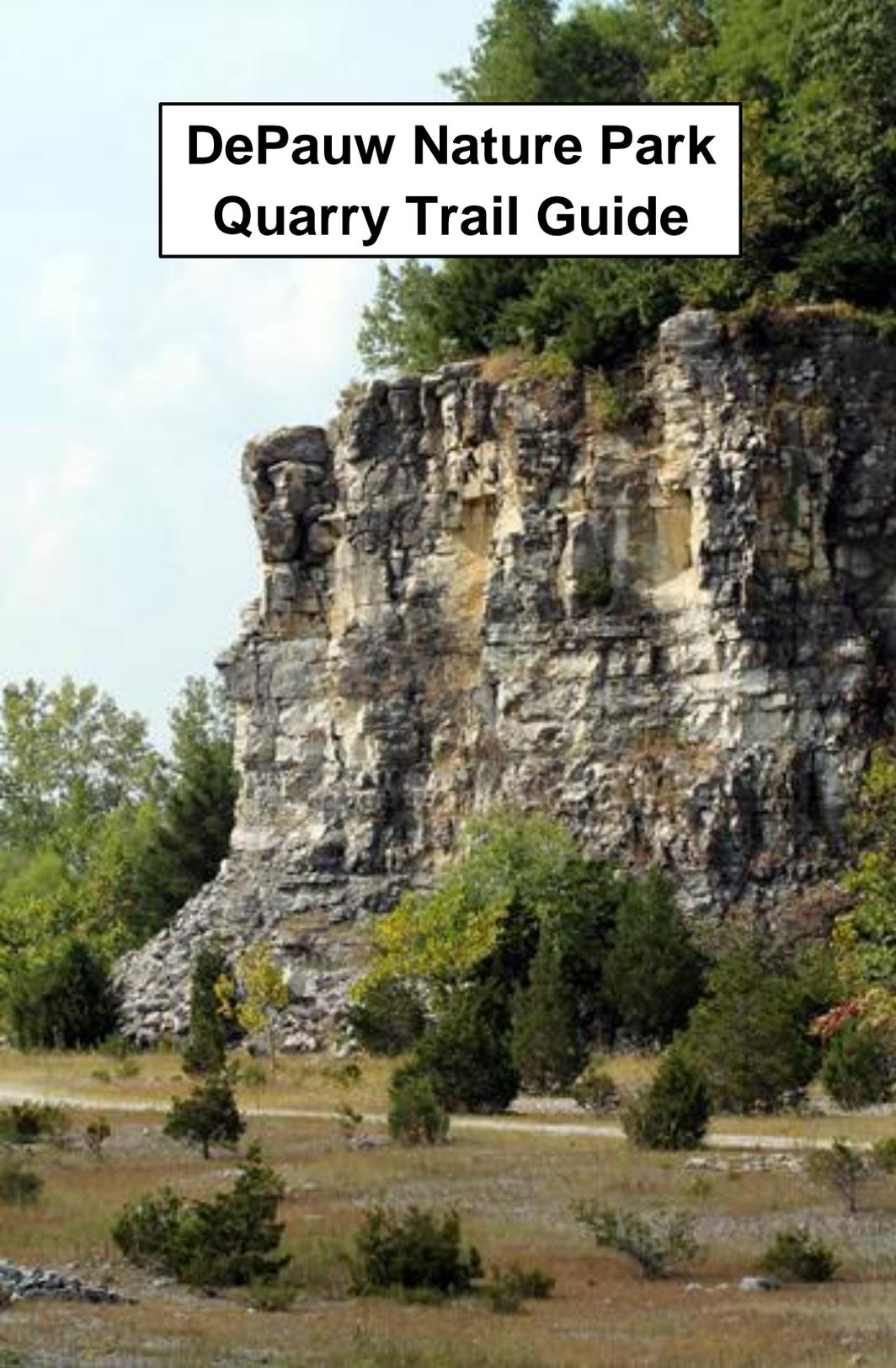


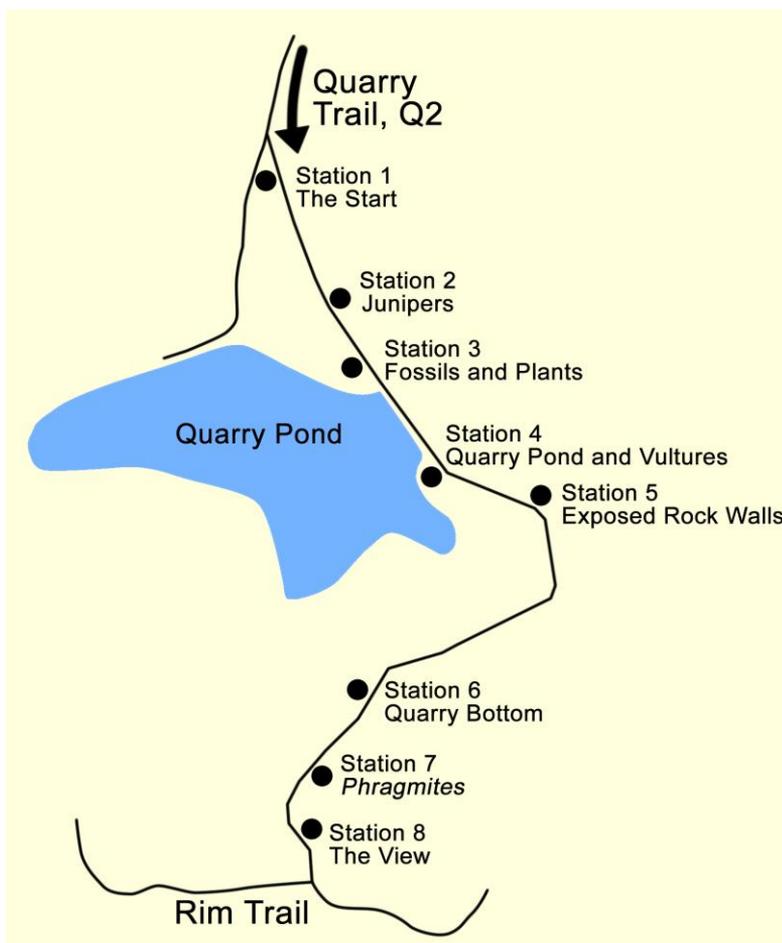
DePauw Nature Park Quarry Trail Guide



DePauw Nature Park

Quarry Trail Guide

Welcome! This trail guide takes you along marked stations on the Quarry Trail. There are 8 stations on the trail. Each station is marked with a numbered sign. The trail is just over ½ mile long and takes you through the abandoned limestone quarry. Along the way, you will see trees, wildflowers, rock walls, fossils, and an exposed groundwater aquifer. You may see and hear frogs, songbirds, waterfowl, and vultures. We hope you enjoy your walk!



Station 1: The Start

Station 1 is located at the intersection of the Q1 and Q2 trails. At the fork, follow the trail to the left. This is the Q2 trail. As you approach the abandoned quarry, keep in mind that you are entering a world that was formed 350 million years ago.



In 1917, the DePauw Nature Park was the site of an active limestone quarry operated by the Hanson Aggregates Mining Company. The quarry was closed in 1977. The land in the Nature Park was donated to DePauw University in 2003. The Nature Park officially opened in 2004. The park covers more than 500 acres of land with over 10 miles of trails.

Station 2: Junipers

Station 2 is located on the left side of the trail and is surrounded by **juniper trees**. Juniper trees are Indiana's most abundant native evergreen tree. The juniper's leaves are small and scaly, and its bark is reddish and peels off of the tree.



Many plant species have both male and female parts within the same individual plant. However, juniper trees have separate male and female individuals. An individual juniper tree is male or female, but not both.

Female juniper trees produce seeds in small blue cones. The blue cones have fleshy scales that are fused together to look like berries. The cones take about 6 months to reach maturity. Birds and other animals eat the fleshy scales of the blue cones and disperse the seeds in their feces.



Male juniper trees produce small brown cones during early spring. If a tree doesn't have blue cones on it, it's probably a male tree. The male cones produce pollen. The pollen is dispersed by wind from the male tree to the female tree during early spring.



Questions for thought...

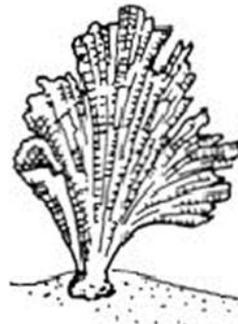
- What is the advantage of having separate male and female individuals from the perspective of a plant?
- How old do you think the junipers are?
- What is the advantage of having small scaly leaves?
- What is the disadvantage of having small scaly leaves?

Station 3: Fossils and Plants

Look for rocks on the ground about 3 feet to the left of the sign for Station 3. The rocks contain several kinds of **fossils**. You can see fossils of fan-shaped bryozoans, crinoids, and brachiopods.



Fan-shaped bryozoans were colonial animals. A colony was composed of thousands to millions of individual animals. Each animal secreted an external skeleton composed of calcium carbonate. The external skeleton of the fan-shaped bryozoans has a fan- or mesh-like structure.



Crinoids were marine animals that looked like flowers. Each crinoid had a long stem or stalk and a series of tentacles that looked like petals. The stalk kept the animal attached to the ocean floor and the tentacles extended out and filtered food particles from the water. Most of the crinoid fossils are small circles (as shown in the photo below). The circles are cross-sections of the crinoid stems.



Brachiopods were marine animals that looked like clams. Each brachiopod had a soft body enclosed in two hard outer shells. The shells were lined with ridges. The brachiopod was anchored to the ocean floor with a fleshy muscular stalk. It opened and closed its shell to filter food particles from the water. Brachiopods are also referred to as “lamp shells” because they look similar to antique oil lamps.



How did the fossils form? Indiana was covered with a shallow sea 300 million years ago. The seawater contained large quantities of calcium carbonate. The brachiopods, crinoids, and bryozoans used the dissolved calcium carbonate in the seawater to form their skeletons and shells. Fossils formed when the shells and skeletons were buried without being broken into smaller pieces. Over time, the shells and skeletons were replaced with limestone.

On the left side of the trail is a patch of **smooth sumac**. Sumac is a large shrub or small tree and has a distinct appearance. Its leaves are arranged in a spiral around the tip of the plant's stem. Each leaf consists of 20 or more leaflets. The leaflets are arranged in a feather-like pattern on the branches. The leaflets are shiny and dark green in the summer and turn bright red in the fall.



Smooth sumac also has separate male and female individuals. Male plants produce pollen and female plants produce flowers, seeds, and fruit. The fruit is a large cluster of dark red berries at the top of the stem. The plant produces the fruit during late summer and fall. The berries remain on the plant throughout the winter and are eaten by various animals.

Smooth sumac is in the same plant family as **poison ivy**, but smooth sumac is not poisonous. However, another species of sumac, **poison sumac**, is poisonous. Fortunately, there isn't any poison sumac growing in the Nature Park. It is also easy to tell the difference between smooth sumac and poison sumac. Poison sumac produces white berries and leaves with smooth edges. Smooth sumac produces red berries and leaves with toothed edges.

Questions for thought...

- What living animals look similar to bryozoans, crinoids, and brachiopods?
- What is the advantage of being a poisonous plant, such as poison ivy or poison sumac?
- Do you see any wildflowers blooming? What color are they? Do you see any pollinators?

Station 4: Quarry Pond and Vultures

Station 4 is located at the edge of the quarry pond. The quarry pond is an exposed **groundwater aquifer**. Imagine digging a hole in your back yard – eventually you would hit water. This is what happened in the quarry. The water in the quarry pond was completely underground and was exposed when the miners dug deep enough.



There are many fish in the quarry pond, including **bluegill** and **largemouth bass**. But the pond isn't very deep. It is only about 6 feet deep at its deepest point. Many years ago, the miners excavated an underground cave between the quarry pond and Big Walnut Creek. The cave is too narrow to be explored, but it is wide enough to drain water from the quarry pond to Big Walnut Creek. The miners excavated the cave to prevent the quarry from filling up with water.



When you look up to the top of the rock walls, you can usually see vultures soaring in the sky or perching on the edge of the cliffs. There are two species of vultures: turkey vultures and black vultures.

How do you tell the difference between a turkey vulture and a black vulture? The **turkey vulture** (below left) has a longer tail and longer wings; its wings are 6 feet long. The **black vulture** (below right) has a shorter tail and shorter wings; its wings are about 1 foot shorter than the turkey vulture. The black vulture also flaps its wings more frequently during flight. On closer views, you'll see the turkey vulture has a red head and the black vulture has a gray head.



Turkey vultures and black vultures do not build nests. Instead, they lay eggs on a flat surface, usually in a cave or rock crevice. They are very secretive around their nests and may abandon their nest if you disturb it. The female usually lays two eggs. Both parents incubate the eggs and the young hatch after 5 to 6 weeks. The adults feed the chicks by regurgitating food. The young leave the nest after 9 to 10 weeks.

Both turkey vultures and black vultures feed on dead animals. They are referred to as “nature’s janitors” and play an important role in the ecosystem by disposing of dead animal carcasses. The turkey vulture finds dead animals by smell. Black vultures don’t have the ability to smell dead animals but follow turkey vultures to carcasses.

The flying conditions in the Nature Park are ideal for turkey vultures and black vultures. The sun heats up the bottom of the quarry, and the hot air rises and creates thermals. The **thermals** are columns of rising air. The vultures take advantage of the thermals to soar effortlessly over the quarry bottom.

Questions for thought...

- Do you see any fish in the pond? How do you think the fish colonized the pond?
- Do you see any Canada geese on the pond?
- Do you hear any frogs calling?
- How many vultures do you see? Why do you think there so many vultures in the Nature Park?

Station 5: Exposed Rock Walls

At station 5, you can see the steep rock walls left by the quarrying operation. The rock walls are about 50 feet high and are composed of limestone. Limestone consists mainly of **calcium carbonate**. The limestone rock in the DePauw Nature Park was formed 350 million years ago when this area was covered with a shallow sea. The seawater contained large quantities of calcium carbonate. The calcium carbonate precipitated out of the water and eventually solidified into limestone



The Nature Park was the site of an active limestone quarry operation from 1917 to 1977. The steep rock walls were exposed by blasting. Most of the rock is unstable, as you can see by the piles of fallen rocks at the bottom of the walls. The limestone from this quarry was too hard and brittle to use for buildings or monuments. This limestone was used to make **crushed gravel**. We use some of the leftover piles of crushed gravel to cover the trails in the Nature Park.

Three-quarters of the way up the rock walls, you can see a thick whitish-yellow layer. This is a layer of **oolitic limestone**. Oolites are spherical grains of carbonate that look like small white marbles. The oolites were formed by strong tidal activity. Small pieces of carbonate rolled back and forth on the sea floor. The rolling action caused the carbonate to form the marble-like structures.

You can also see diagonal lines in the layer of oolitic limestone. The diagonal lines in the rocks are indicative of tides. The tides caused formation of sand dunes. The diagonal slopes of the sand dunes were reserved when the limestone was deposited.



Questions for thought...

- Each vertical foot of limestone takes about 300,000 years to form. The rock walls in the Nature Park are about 50 feet tall. How long did it take for the rock walls to form?
- What evidence indicates that this area was covered by a shallow ocean 350 million years ago?

Station 6: Quarry Bottom

Station 6 is located in the middle of the excavated quarry. The quarry is basically a big hole in the ground. When you look up at the top of the rock walls surrounding the quarry, you can see where the ground level used to be. Everything below the top of the rock walls represents the area that was excavated by the mining company. The miners used dynamite and heavy equipment to dig the hole, and they removed the limestone to make gravel.

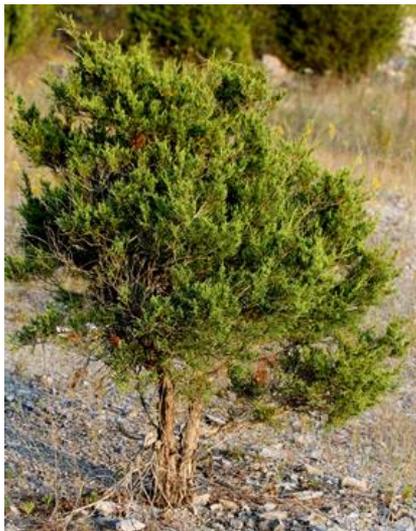


What was left behind after the quarry was abandoned? The bottom of the quarry was bare rock. It was a stressful place to live. There was no shade, water, soil, or plants. Now we see a few trees, grasses, small herbaceous plants, and mosses growing in the quarry bottom. How did these plants become established in the quarry bottom?

The process of colonization of a site such as the quarry bottom is referred to as **primary succession**. Primary succession occurs in an environment where no vegetation or soil is present, such as after a volcanic eruption. The bare rock surface is gradually broken down and organic matter slowly accumulates in the cracks and crevices between the rocks. The wind blows small seeds and spores to the site. The seeds and spores germinate and plants start to grow.

The first plants to live in the quarry bottom are **pioneer species**. Pioneer plant species are tolerant of stressful conditions. Their roots continue to break down the bare rock surface. More organic matter and water accumulate in the cracks and crevices. Eventually, conditions improve and other plant species move in and replace the pioneer plants.

Juniper is an example of a stress-tolerant plant species. There are many juniper trees growing in the quarry bottom. The juniper trees growing at Station 6 are smaller and more spread out than the juniper trees growing at Station 2. But the juniper trees are gradually improving the conditions for future inhabitants of the quarry bottom. Eventually, the junipers will be replaced by other tree species as conditions continue to improve in the quarry bottom.



You can often hear and see **killdeer** in the quarry bottom during spring and summer. The killdeer is a medium-sized shorebird. It is named for its loud call, “*kill deeeeer, kill deeeeer.*” The adults have a brown back and wings, a white belly, and a white breast with two black bands (see image below left). When the birds are flying, you can see their reddish-orange rump and white wing stripes.

The killdeer nests on bare ground or gravel. It doesn't build a nest. The female lays her eggs in a slight depression on the ground (see photo below right). Her eggs are well camouflaged among the bits of gravel. How does the killdeer protect their eggs and young? The adults frequently use a “broken wing act” to distract predators from the nest or young. If you are near a killdeer's nest or young, the adult will walk ahead of you dragging its wing as though it is injured. This behavior is intended to entice you – or a predator – to follow the adult instead of trying to find the nest.



Questions for thought...

- What did the quarry bottom look like when the limestone quarrying operation ended in the 1970s?
- How has the quarry bottom changed since then?
- What special characteristics do pioneer plants have to survive and reproduce in the quarry bottom?
- Why do pioneer plants such as juniper get replaced by other plant species when conditions improve?

Station 7: *Phragmites*

There is a large patch of tall grasses on each side of the trail at Station 7. The scientific name of the grass is *Phragmites australis*. *Phragmites* has long hollow stems and can grow up to 20 feet tall. Its leaves are 2 feet long and its flowers are produced in dense clusters, also about 2 feet long. Each cluster of flowers produces hundreds to thousands of seeds.



Phragmites is notable because it is a non-native invasive plant species. It is native to Europe and has successfully colonized wet areas of the quarry bottom. It is considered to be a pest because it outcompetes and displaces native plant species such as cattails. *Phragmites* probably arrived from the wind carrying its seeds. Once the plants germinated and became established, they started spreading rapidly. The plant grows clonally, and can spread 15 feet per year by horizontal runners. The runners put down roots at regular intervals. All of the plants in one patch are usually clones of each other. There may be thousands of genetically identical *Phragmites* plants in one patch.



It is very difficult to eradicate *Phragmites*. Its roots are deep and strong. Repeated application of herbicides or fire could be used to kill the plants. But recent research suggests that goats could be used to control the plants. At Duke University in North Carolina, biologist Brian Silliman has spent 20 years trying to figure out how to get rid of *Phragmites*. He says, "I took a holiday to the Netherlands where the plant comes from and saw it wasn't a problem there because it was constantly being grazed by animals. In experimental trials, Silliman found that goats were very effective. In one trial, 90 percent of the *Phragmites* was eliminated. Silliman says, "I think all land managers should take up this method. It's cheaper, less polluting, better for the environment and goat farmers get paid."

But *Phragmites* can be useful. Its thick vegetation provides habitat for nesting birds. Its leaves and stems can be used to make roofs, mats, and baskets. Some parts of the plant can be prepared as food. The young stems and thick roots can be dried, pounded, and roasted and the wheat-like seeds can be ground into flour.

Questions for thought...

- What should we do about the *Phragmites* growing in the quarry bottom? Should we try to remove it or should we leave it alone?
- Do you know of any other species of non-native invasive plants or animals that live in Indiana?
- Do you know any other species of plants that have both good and bad characteristics?

Station 8: The View

Look down into the quarry and you can see different trees and other plant species.

Sycamore trees grow in the quarry bottom next to juniper trees. Sycamores usually grow in wet areas but they can also tolerate the stressful conditions of the quarry bottom. Sycamore leaves are large with 3 to 5 short lobes and coarsely toothed edges (see photo below). The bark is brown and peels off in irregularly-shaped patches, exposing a smooth white trunk underneath. Sycamore trees also have plentiful brown seed balls hanging from their branches, like Christmas tree ornaments.



There is a series of small ponds in the quarry bottom. The ponds are formed by seepage of groundwater into shallow depressions. The ponds fill with rainwater during spring and dry up during the summer and fall. Amphibians and insects breed in the ponds. They complete the aquatic portion of their life cycle before the ponds dry up in the summer.

The northern cricket frog is one of the amphibians that breeds in the small ponds in the quarry bottom. It has a distinct call that sounds like two steel balls clicking together, slowly at first, then faster, “gick-gick-gick.”

Questions for thought...

- Why do some amphibians require water for breeding?
- What do you see from this view that you couldn't see before?
- What was your favorite part of the Quarry Trail?



You are now at the end of the guided portion of the Quarry Trail. You may return the way you came or continue up to the quarry rim and follow the Rim Trail back to the parking lot.

Thank you for visiting the Nature Park!



About the trail guide

This trail guide was originally created and written by Megan Michael '06, Shayla Williamson '07, and Dana Dudle, professor of biology, as part of a project for a conservation biology class taught at DePauw University. The trail guide was later modified and edited by Vanessa Fox, ecologist of the DePauw Nature Park.

For more information

Visit the DePauw Nature Park web site at www.depauw.edu/about/campus/naturepark/



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