

Help! My Home is in Danger!

Plants and their Habitats

Building Rock Outcrop Habitat Garden Solution
Pits and Growing Annual Outcrop Wildflowers
from Seed

Essential Questions:

What is a seed?

How does a seed break dormancy?

How do scientists get clues about growing plants from studying a plant's life history and habitat?

What is an outcrop and what are solution pits?

How is being an annual wildflower an adaptation for survival?

Background Information:

These directions are specific for rock outcrop plant species – focusing here on creating solution pit gardens and not the vernal pools that are like small ponds in the winter. (Vernal pools - Another unit, another day with federal permits.) We recommend that your students sow annual rock outcrop plant species directly into your rock outcrop habitat garden solution pits, sowing them in the spring. You can grow the perennial rock outcrop plant species indoors following the directions for growing native wildflowers and medicinal plants. Annual rock outcrop species can be grown in doors as well for observation and study only. They will not transplant well to your habitat garden.

Contact EPSN Headquarters any time you have questions or need help.

Background Information:

Material for this text was contributed by Suzzanne Tate as part of her master's thesis, "Effects of stratification on the germination of six Piedmont rock outcrop species and development of a model Piedmont rock outcrop habitat garden," The University of Georgia Department of Horticulture, 2005.

Note to Teachers:

Outcrops offer wonderful fodder for teaching conservation issues and concerns, plant adaptations, and biodiversity.

Location: outdoors

Objectives: *Learners will:*

- 1) Observe and document the life cycle of a rare plant species.
- 2) Explore how conservation horticulturists design a propagation protocol by observing a plant species in its natural habitat.
- 3) Learn what seed dormancy is and different techniques for breaking dormancy.
- 4) Grow rare plant species from seed.
- 5) Create a rock outcrop habitat garden with solution pits at varying depths.
- 6) Study the reasons plant species are threatened and develop strategies to help those species recover.

Grades: K - 12

Skills: communication, analysis, measuring, observing, data collecting

Supplies:

- shade cloth at least 7' x7'
- 1 cubic yard crusher run (granite rock gravel and sand mix – or finer mix if available)
- shovels
- scissors
- work gloves or plastic gloves (very important!)
- water from a hose
- sand (1 bag playbox sand or equivalent in granite or river sand)
- 12" rocks or bigger
- rock outcrop seeds from EPSN seed exchange
- wheel barrels – 2 or 3 if you can borrow them.
- garden soil (1 bag of compost or other garden soil)
- yard stick ruler
- camera through entire process

Subjects: science, horticulture, history, botany, phenology

Time: 30 minutes a day for three days

And likely, most students in the South have had some exposure to outcrops by visiting or seeing Stone Mountain Park, or one of the many other outcrops in the Atlanta area. Outcrops also lend themselves well to cultivation and display at schools. Most of the species bloom during the school year with the first species germinating outdoors in January; the majority of outcrop species are annual and will self-seed back into dish-garden displays; and outcrops are drought tolerant. Most southern states have experienced severe droughts in the last decade and most county governments have watering restrictions. The outcrop displays actually perform best when they receive no additional watering. They thrive on neglect! And yet there is room for active maintenance in the display, as children can hand propagate the species in their classroom, planting out the individuals they grow themselves. Students can observe and study the special adaptations of rock outcrop plant species when they are at their peak of flowering - during the months of the school year.

What is a rock outcrop?

Granite rock outcrops are ancient and unique habitats found in the Piedmont of the southeastern United States from Alabama to Virginia. While the composition of the bedrock changes from site to site, the flora is similar among outcrops yet remarkably different from that of the surrounding forests. These islands of exposed rock have more than 100 characteristic plant species; 34 of these are restricted, or very nearly so, to this plant community type. The outcrop flora is unusual and diverse, and is composed mainly of flowering annuals and perennials with very few woody plants. These wildflowers form a dramatic carpet within pits and crevices, deeper holes in the rock house rare aquatic plants, and the surrounding rock is exposed and fringed by colorful mosses and lichens.

It is estimated that the rock outcrop habitat, when pieced together like a puzzle, composes approximately 8,000 acres total with about 6,000 of those acres falling within the state of Georgia. Usually the outcrops are either “flatrocks”, whose topography nearly matches that of the surrounding area, or “mountains” reaching 656 feet or more in height. They can be quite small, measuring a few hundred square feet, to rather large covering several hundred acres. Outcrops vary in rock type being composed of granite, gneiss, or quartzite, and are high in silica and aluminum and low in iron and magnesium.

The environmental conditions on the outcrops are quite different than those encountered in the surrounding mosaic of oak/hickory/pine forest. The Piedmont region is characterized by warm summers averaging between 72-81°F, cool winters averaging between 41-50°F and rainfall of over 39 inches annually. The high light environment and the heat absorbing capacity of the rocks results in temperatures that can surpass 122°F during the summer months. Rainfall runs off at an extraordinarily high rate. Not surprisingly, outcrop vegetation has unique plant species that are very different from the surrounding woods of the forest. And rock outcrops have a high number of plant species that are endemic to outcrops, living only on outcrop habitats. Dr. Robert Wyatt, Ecologist with the University of Georgia compares the piedmont outcrops to an “archipelago” of desert islands in a “sea” of otherwise moist forest conditions.

What are solution pits?

Irregular weathering of the rock face creates a moonscape of potholes called **solution pits**. These shallow depressions contain soil ranging in depth from 2-50 cm. Different plant species or groups of species tend to grow in different specific soil depths.

Dominant Vegetation Type Soil Depth:

Annual herbaceous plant species	2-9 cm
Lichen-moss-annual herbaceous plant species	7-15 cm
Annual-perennial herbaceous plant species	14-41 cm
Herb-shrub-small tree species	40-50 cm

Often all of these miniaturized plant communities can be observed in concentric zones within a single depression or solution pit. They are usually irregularly shaped but can be nearly round with rings of color round the circle for each flowering plant species. And some solution pits will have and sustain only one outcrop species for perhaps hundreds of years. Crevices in the rocks and talus piles of exfoliated rock also allow for soil to accumulate to various depths. The larger and deeper soil deposits tend to discharge excessive rainwater gradually creating seepage areas where aquatic or semi-aquatic plants can survive.

What are vernal pools?

Shallow vernal pools are deep depressionas (1-2 feet) on the rock that fill with water. They are found on some outcrops, but not all outcrops, and they provide an additional specialized habitat for some of the most critically rare aquatic plants like the tiny *Isoetes* (Quillworts) and *Amphianthus* (Poolsprites). Vernal pools are deep solution pits that look a lot in form like play swimming pools for young kids – and are sometimes used by young kids as play pools as well much to the dismay of the endangered species living there. Vernal pools fill with fall and winter rains, holding the water through the season. The species inside germinate, flower, and reproduce before all the water evaporates from the pool. In this exercise, we are not creating vernal pools. We are instead creating shallow solution pits.

What are *annual rock outcrop plant species seeds* like?

Annual rock outcrop seeds are tiny like dust. The annual wildflowers put a lot of energy into making lots of seeds in hopes of securing the next generation. Avoiding drought conditions altogether is also an effective strategy if you are a plant trying to survive on rock that gets to 122 degrees in the summer. The winter annual life cycle is a very common drought avoidance technique for piedmont rock outcrop species. By germinating in the fall, winter, or early spring and then flowering and setting fruit before summer begins, plants survive the hottest and driest months of the year as dormant seeds.

(Question to ponder: If many species of outcrops survive as seeds most of the year, what happens to the seeds and the species when people walk or play in solution pits?)

As an EPSN educator, seed will arrive in an envelope. This seed has already been cleaned (removed from fruit) and is ready to be sown. Outcrop seeds are mailed in the spring and fall annually. Annual outcrop species should be sown immediately into your rock outcrop habitat garden in the spring. Sowing in the fall is second best and will have a lower

percent germination. If you have not built this garden yet, you can store these seeds in a paper envelope. Place this paper envelope in a sealed plastic container and put it in the refrigerator. Sow your seeds as soon as you can during the warm months so that they receive exposure to the warm months before the cold months set in.

What is germination?

Germination is the act of a seed waking up from its dormancy. Seeds wake up in the wild after they receive clues from the environment that the time is right to wake up and grow. These clues include changes in temperature, water, and light. In the Southeastern United States most plant species' seeds germinate in the spring after a cold, wet winter. There are species who germinate at other times (waking up in the winter) or from other clues (being exposed to the acids and scraping in a bird's crop or heat from fire). But most species tend to germinate in the spring. So their clues may be a combination of cold and wet for specific amount of time and then warm. When germinating seeds, we give them a cold, wet period called **stratification** followed by a warm period to help break the seed out of dormancy. Stratification is a pre-treatment for seeds to help wake the embryo up from its dormancy. Stratification tries to mimic natural conditions that the seed would experience in its natural habitat. So, studying plants and observing them in their natural habitat is important for learning how to grow plants from seed.

But observing annual rock outcrop species in the wild, we notice the seeds germinate in the late winter or very early spring, often when temperatures on the rock are freezing. Research and observation in the classroom has shown that most outcrop seeds need a warm period, a warm/wet stratification treatment, first to mimic the warm summer months the seeds are exposed to the wild. Then the seeds receive a cold/wet stratification treatment, and finally they are returned to the Grow Lab. Your students may observe the seeds germinating in the refrigerator in the cold. Make certain your students check seed trays while they are in the refrigerator and make notes and drawings on what they discover.

How do we know when an annual outcrop seed has germinated?

Germination is recognized when the seed-root (the **radicle**) emerges from the seed. When a seed is buried under the soil, you cannot see this happening. Most of the time, we know a seed has germinated when we see the **cotyledons** (seed leaves) emerge from the soil. But if you sow large seeds on top of wet sand in a Petri dish wrapped in plastic wrap or better still parafilm, you can watch seed coats split and radicles emerge as the seeds germinate. (*Tip: This is a great experiment to do with larger seeds like lima beans or sunflowers. Use a jar and wet sand or a plastic ziplock bag and wet paper towels to observe germination in detail. Have students draw pictures of what they observe.*)

But when working with rock outcrop species, especially the annual species, the seeds are as tiny as dust. (*Tip: Get a microscope or a hand-lense and look at annual outcrop seeds. Do they have hairs, knobs, silver color? Why are they so tiny? Hint: Adaptations to life on the hot rock, perhaps?*) When the seeds germinate in the solution pit garden, students will see their cotyledons, but not usually their radicles. Have the students draw and take pictures of the cotyledons with something in the image for scale (e.g., coin). With some

observation and experience, students will be able to identify different plant species by looking at their cotyledons alone.

But if we want to grow annual outcrop plants indoors how do we do it?

Watching annual outcrop species seeds germinate is tricky at best because of their small size, but their cotyledons are easy to see and identify. If your students do want to observe this indoors in their classroom, they can sow the seeds on wet filter paper in a Petri-dish. Seal the edges of the Petri-dish with parafilm all the way around. Place the dish on top of a refrigerator for four weeks and then inside the refrigerator for four weeks and then into your grow lab. Look carefully with a hand-lense to catch the tiny seeds waking up.

Students can also sow annual outcrop seeds like they would any other wildflower species using propagation soil mix:sand:composted pinebark, 1:1:1. Sprinkle the seeds on top of the soil. Don't cover the seeds with soil. Don't worry about trying to sow the seeds in a grid-like pattern to track exact percent germination, just sprinkle the seeds across the top of the soil, avoiding the very edges of the pot. Put the pots (soil, seeds, and all) in a non-drain tray and under a humidity dome and follow the "top of fridge, into fridge, into Grow Lab" stratification pattern every four weeks (four weeks warm, four weeks cold, back to warm treatment).

Wait – We're building a rock outcrop garden with granite sand from destroyed outcrops?!

Yes, it is a moral dilemma. And it is an opportunity for discussion with your students. The bad news is that yes, granite sand in crusher run comes from rock quarries, most likely rock outcrop habitat that has been destroyed. Crusher run is the bedding material used under most asphalt roads and parking lots. The good news is that the crusher run comes from a quarry of rock outcrop that is already in process. ("No new outcrops were destroyed in the creation of this outcrop habitat garden.") If a new quarry was started because of building these outcrop gardens at schools across the SE US, then we'd have to stop promoting this habitat garden as a teaching tool.

We chose crusher run because it is easily available and inexpensive. The mix does have large chunks of granite that will need to be picked out and tossed aside for use in a driveway or water run-off site. If you can find and afford a finer mix, we say go for it.

Getting Ready

1. Order the crusher run and have it delivered or have a parent pick it up in a strong truck. If using a parent's truck, bring a tarp to lay in the bed, under the crusher run. If a truck is delivering it, have them dump it on a tarp near where you will build the outcrop garden – or in a gravel driveway or rain runoff place where the extra can be left behind.

2. Everyone will need to wear gloves while handling the crusher run granite gravel and granite sand mix. It can be sharp and can scratch up your hands like fiberglass. Don't let children play in the pile or throw it to get in their eyes.

3. Divide students into teams while working – digging (outcrop bed), hauling (off soil), loading (wheel barrels with crusher run)... And switch off so every team gets a turn at each job. This is hard work, so make sure everyone takes their time.

4. Review safety with your students. Adults need to be reminded of these rules even if they are avid gardeners.

- Always lay tools down with the sharp edges pointing down, into the ground, out of the way of foot traffic.
- Load wheel barrels with small loads. Crusher run is rock, and it is heavy. Heavy wheel barrels can easily tip over onto someone, possibly breaking a leg. It is better to have several wheel barrels going with small loads that are easy to manage.
- Wear those work gloves while handling the crusher run.

5. Check the weather before you sow your seeds. If a thunderstorm is predicted – or even heavy rains – wait until this weather passes before your students sow the seeds into the outcrop garden. Storms can rain all they want on your outcrop garden before you sow your seeds, so if you are scheduled to build your outcrop before a storm, go for it and observe how the water washes over your garden and how it pools in your solution pits.

6. Have your camera ready. Take lots of pictures each step of the way. You will be telling a great story with your images. Call the local press and have them run a story on your students and their outcrop projects.

Procedure:

Choosing the Site:

1. Sun

Your rock outcrop habitat garden is going to need full sun. Walk outside on your school site with your students and check out potential locations. Watch out for shadows cast by your building and neighboring trees and be mindful of how shadows change orientation in the different seasons.

2. Foot traffic

Choose a site that is a good location for visibility for your project, but watch out for “anthropological trails” – footpaths created as people cut across areas. In an area is used by students to cut across from the sidewalk to the soccer field, this may not be the best place for your garden. Your garden will be dormant during the summer months, and you don’t want people walking through the solution pits where your annual seeds are waiting, lying dormant.

3. Water

You will need to water your garden in when first building it and after sowing seeds. And if we experience an extreme drought over the fall and winter months, watering your solution pits will ensure your annual seeds get another generation through. Locate your garden with your outdoor classroom near a spigot.

4. Water run-off

Check out how water moves in this area you are considering for your outcrop garden. Does water collect during a rain and wash through the area like a small river? You do not want water washer over your garden and washing away your seeds.

5. Pollution

Look for pollution sources. Don't put your outcrop garden down slope from a parking lot (source of oil and other chemicals) or down slope from a well-maintained football field (if they spray herbicide and fertilizer there). You don't want these chemicals washing into your rock outcrop garden – or into any of your outdoor classroom garden beds or habitat gardens.

6. Aspect (slope)

You want to build your rock outcrop garden in a flat area. A gentle slope is ok, but nothing over 1 inch every three feet. We want the water to run off most of the rock and pool in our shallow solution pits until it evaporates out.

Digging the Hole

1. Stay small

You are going to build a small rock outcrop garden with solution pits. Remember children have little arms, and most of these plant species are small. You want students to be able to get right up close to these species, and you can pack a lot of diversity into a 1-meter garden. Our plans here are for an outcrop that is 5'x5' with solution pits throughout.

2. Dig out a slice of earth – not a hole

Dig out a circle of soil 5'x5' that is 5" deep throughout. Now choose one spot within this circle and dig a smaller circle that is at least 24" deep and 24" across with gently sloping sides. This spot will be your deepest solution pit with perennial species. Let's call this the "deep perennial pit."

3. Get rid of the dirt

You do not need the soil you dug up while creating the "slice" or hole for your garden, so move it to another location. Don't leave this dirt near your outcrop where it can wash over the garden during a storm.

Lay the Liner

Remove any rocks or sticks from your hole. Unfold your shade cloth and lay it in and across the hole. If you could not find liner that was wide enough, lay the shade cloth in sections over the hole, overlapping the edges at least one foot.

Fill the Hole*Wear gloves!!!**

***Everyone will need to wear gloves while handling the crusher run granite gravel and granite sand mix. It can be sharp and can scratch up your hands like fiberglass. Don't let children play in the pile or throw it to get in their eyes. Once the crusher run is in and settled, it will not be a problem to touch through casual use.

1. Shovel in the crusher run to the top throughout the hole – except in the "deep perennial pit." Shovel in two inches here on the bottom and all sides as best you can.

2. Remove all bigger chunks of granite across the surface. Pick these out and use them somewhere else on your school site like in an erosion area.

3. Now choose six areas throughout the hole and dig or scrape back out the crusher run in circles that are 10” across and two” deep. These will be your solution pits for the annual outcrop species and will be filled back up with sand either to the top, half way, or quarter of the way.

Water the Outcrop

Use a garden hose and water-in your outcrop. The crusher run mix will compact some as the air holes are filled. Keep adding water until you see water running off. Water should pool in your solution pit areas.

Let the outcrop garden settle for 24 hours.

You may need to add more crusher run mix after it sits and settles. Carefully check your deep solution pit and see if more mix can be added to the sides and bottom of that hole so that all of the shade cloth is covered.

Fill the Pits

In the deep solution pit, mix garden compost and sand 1:1 and fill the hole to the top. Water it in and add more soil until it is flush with the outcrop level.

In the annual solution pits, fill half (3) of these with garden compost and sand 1:1 half way (one inch). These pits will hold Sandwort (*Arenaria uniflora*), Talinum (*Talinum teretifolium*), and Candyroot (*Hypericum gentianoides*). Water these pits in carefully and let settle.

Fill the final three pits with one inch of sand. These will be your Elf Orpine (*Diamorpha smallii*) pits. Water these pits in carefully and let settle.

Draw a map of your outcrop garden labeling which pits are which so there is no confusion later when you need to sow the appropriate seeds in the correct pits.

Other pits can be added in the future for additional outcrop species as you wish but digging or scraping crusher run out and filling it with an appropriate mix and amount of soil.

Cut the Shade Cloth

Cut away any shade cloth that is hanging out or exposed around the edge of your outcrop garden.

Lay the Rocks

Collect larger 12” rocks from around your school site. Or! Better yet, see if a quarry will let you take some of the cast off pieces of granite. Place these rocks around the edge of your outcrop garden. This will give students a place to kneel and sit and will help slow down water that is rushing over the outcrop during a heavy rain. Do not use railroad ties or pressure treated wood to line any areas of your habitat garden (or any other food gardens) because they leach noxious chemicals into the soil.

Sow the Outcrop – In the Spring if possible – fall is second choice but ok

In the spring, direct sow seeds of granite rock outcrop annual species directly onto the surface of the appropriate solution pits. Check the map you drew earlier to remember which pits are for which species. Remove any weeds that have settled into your outcrop garden. Remove all leaves that have fallen onto it as well.

In the three annual solution pits with soil:sand, 1:1, one inch deep – sow Sandwort (*Arenaria uniflora*), Talinum (*Talinum teretifolium*), and Candyroot (*Hypericum gentianoides*) each in their own individual pit. Do not mix the species. Sprinkle a dash of sand over the pit. Water by hand, very carefully until water pools and let settle. You may be able to get a plant label to stand in this pit, but likely students will be relying on their map to recall the species locations during dormant periods.

In the three annual solution pits with one inch of sand - sow Elf Orpine (*Diamorpha smallii*) pits. Sprinkle a dash of sand over the pit. Water by hand, very carefully until water pools and let settle.

In the deep pit, you can direct sow *Viguiera porteri* (Stone Mountain Daisy) and you can plant other outcrop species that you may have grown indoors *Aster*, *Crotonopsis*, *Solidago*, and *Coreopsis*. Because there is soil in this deep solution pit, you can label each plant species.

Outcrop Garden Care

1. Don't water

You should not need to water the solution pits of your outcrop garden – except perhaps on occasion the deep pit with perennial species. If we have a drought during the fall and winter, water the solution pits gently and letting the water evaporate out will give your annual seeds a better chance of germination. But normally, you will not need to water the annual pits at all.

2. Cut back the vegetation in the perennials but not the annuals

In the late fall you can cut back the dead plant material from your deep solution pit. Collect any seeds you'd like to try indoors or scatter them back in the deep pit. Do not cut back or remove any dead plants from the annual species in the annual solution pits. These species scatter seeds throughout the fall and winter months and the old roots help prevent seeds and fine soil from washing away. Also, the dead plants of *Diamorpha smallii* hold the seeds through the summer up off the rock to protect the seeds from extreme heat. If students pick these out, they could pick out viable seeds.

3. Pick fallen leaves off

Carefully lift off any leaves that have fallen onto your outcrop garden. These can bury your annual species, limiting germination. They can also produce moist areas where weed seeds will settle.

4. Weed carefully

If you see plants that you know are not supposed to be in your rock outcrop habitat garden, pull them out gently. Always be careful not to disturb the annual solution pits and weed in there only very, very carefully and gently. If you are not certain something is a

weed, leave it and see how the plant matures. Or take a picture of it and send the image to EPSN Headquarters for help.

5. Let them self sow and order extra seed from EPSN

Let all of your annuals self sow in their solution pits – and wherever else they settle in your outcrop garden. Unless each solution pit is filled to the brim, edge to edge with plants, order more seeds from EPSN to bolster and replenish your pits.

Discussion/Assessment:

Describe a rock outcrop habitat garden?

Why are outcrops described as extreme and harsh habitats?

Name three rock outcrop plant species.

Name three adaptations rock outcrop plants have for survival on the rock.

What is an annual species?

How can you help rock outcrop plants?

Digging Deeper:

Visit a local rock outcrop. There are several state and county parks available with organized field trips through the rock outcrop habitat.

Learn about the lichens and mosses unique to rock outcrops. Be sure to check out how you can write with water on Grimmea moss.