

Rain Gardens

Overview: Rain gardens help collect stormwater to reduce runoff, providing numerous environmental benefits. They are excellent tools for teaching students about the water cycle, storm water drainage, water quality and the broad environmental impacts of urbanization. This lesson provides instructions for designing your own rain garden.

Grade Level/Range: Grades 9 to 12

Objectives: Students will research the issue of stormwater runoff and the impact of water pollution on the environment. They will design a rain garden to further understand the ecological impact of stormwater and why rain gardens are an important solution.

Time: 1- 2 hours to discuss and design

Materials:

- graph paper
- pencil
- tape measure
- long handle shovel
- ruler
- hose or watering can
- *Water Cycle: The Rain Garden Handout*

Background Information:

Rain gardens provide a perfect setting to teach about water quality, habitat creation and the impact of our actions on protecting our natural resources. A rain garden is a garden planted in a depressed area to encourage water collection. This design enables rain gardens to trap stormwater before it becomes runoff and filter it before it's absorbed into the soil. The plants in a rain garden have high tolerance for excess moisture and the increased levels of nutrients often found in stormwater. Rain gardens are most useful if situated downhill from impervious surfaces, such as rooftops and roads, and are designed to collect runoff from those surfaces. They slow down the flow of stormwater by collecting it in the sunken garden area and allowing it to absorb into the soil rather than cause erosion and carry pollutants into our waterways.

Why are rain gardens beneficial? To understand the importance of rain gardens, students must first learn how the urban environment impacts the natural water cycle. In nature, rain falls directly onto vegetation and is evenly distributed over the land's surface. The plants slow the velocity of raindrops and also help decrease the volume of water reaching the soil, which helps with absorption (approximately 50% of the rain will be absorbed by the soil) and decreases runoff (approximately 10% of rain will run off to local waterways).

In suburban and urban settings, however, much of the rain that falls hits impervious surfaces such as roofs, parking lots and roads, where it cannot be absorbed. It becomes runoff, moving across the ground to areas where it can be absorbed or into local waterways, either directly or via storm sewers. In urban settings as little as 15% of the water may be absorbed where it falls and up to 55% will runoff. Not only does this result in lower groundwater reserves which endangers drinking water supplies and can ultimately cause cities to sink (subsidence), it also creates a significant amount of water to deal with above ground. To prevent flooding of houses and roads, cities install drainage systems to move storm water to municipal water treatment facilities or to streams, lakes and rivers.

Although rain is an important contributor for recharging local waterways, the problem with runoff from urban environments is what the runoff is carrying. As the water moves across surfaces such as streets, parking lots, and roofs, it picks up all sorts of pollutants, from nutrients like nitrogen and phosphorous that fuel algal blooms to pesticides, herbicides, oil, grease, heavy metals, and harmful bacteria, . These pollutants can kill water life and interfere with the delicate balance of the aquatic ecosystem. Scientist estimate that 70% of the pollution in streams, rivers and lakes is from stormwater runoff.

To decrease the amount of runoff flowing directly into local waterways, some is diverted into treatment facilities to remove the contaminants and then deposited into waterways or used for drinking supplies. However it is not feasible for treatment facilities to catch and process all storm water. Rain gardens are another solution.

Rain gardens help catch storm runoff and then aid in absorption and filtration of the water. Benefits of installing rain gardens include:

- decreased amounts of polluted stormwater runoff reaching local streams, rivers and lakes
- increased absorption of water to recharge groundwater supplies
- filtration of pollutants by soil and plants helps improve water quality in groundwater supplies
- installation is less expensive than other drainage techniques
- an attractive addition to your landscape and a low maintenance alternative to lawns
- creation of a habitat for birds and butterflies.

Laying the Groundwork:

Begin this lesson with an observation activity. If weather cooperates, ask students to observe a rain event from a safe location (such as from a window or covered pathway). If this is not possible, there are numerous videos online that can be viewed. As they watch the rain, ask them to observe how and where the rain falls. Ask, what do you think happens to the water once it hits the ground? How do you know?

Visit your schoolyard right after a rain event and create a map showing areas of flowing and standing water. Return after an hour and document and compare your findings. Repeat after two hours. Ask, *how well does our schoolyard manage rainwater? Are there any areas that need help?*

Exploration: Planning a Rain Garden

1. You begin your rain garden by identifying a good location. Use your from the Laying the Groundwork determine the natural patterns of runoff. In order to capture rainwater, the garden must be planted down slope from buildings and other surfaces that increase stormwater run-off, but up slope from municipal storm drains and natural waterways. If you don't find a good spot along the current travels of runoff, you may need to install drains to help move the water to the location of your rain garden.

The garden must be located at least 10 feet away from a building foundation and should not be placed over a septic system. Also, avoid locations under mature trees, because the digging of the garden could cause serious damage to their root systems.

Also, since the ground of a rain garden is intended to become water-logged, it is important to plan for maintenance and student access around the perimeter to avoid soil compaction.

2. Once you identify a possible site, test the drainage of the soil. It is important for the garden to contain well-draining soil so that the collected water dissipates within two to four days. If water sits for too long, plant roots will suffocate and insect breeding will become a problem. Ideal rain garden soil is comprised of:
 - 20-25% leaf mulch or compost
 - 50% sandy soil
 - 25-30% topsoil

To test the drainage of the soil in each a potential rain garden location:

- Dig a hole 6 inches wide and 18 inches deep in each location
- Fill each hole with water and measure depth with a ruler.
- Check on water depth every hour and record results.
- If all the water drains within a few hours, the site has excellent drainage. If the water drains within 24 hours, then it is still an acceptable site for a rain garden. If the water has not drained in 48 to 72 hours, then you should choose a different location.

3. After a location is identified, call your local utilities hotline to have them mark any underground lines on the property. Your soil will need to be cultivated by a tiller or by hand 1 to 2 feet deep to break up any existing soil compaction and you want to make sure to avoid any unnecessary entanglements.
4. The next step will be to design your rain garden. As mentioned earlier, gardens can vary greatly in size, shape and types of plant material. However as a general rule rain gardens include the following components: (from the Virginia Department of Forestry Rain Garden Guide):
 - Ponding area or depression. To help capture runoff, the garden base should be shaped like a saucer with the middle deeper than the edges. The grading between the middle (generally 6" deep) and edges should be gradual though so that water is spread out throughout the garden. Because of this shape, the edges of the garden will usually be drier than the middle which will need to be considered when selecting plant materials.
 - Well-draining soil. Well-draining soil is important to ensure quick absorption of runoff. During planting and maintenance, it is important to avoid compacting the soil, which will decrease its effectiveness.
 - Tough plants. Plants chosen for the rain garden must be able to tolerate extremes of wet and dry soil. Rain gardens are typically planted with shrubs and perennials. Because the rain garden functions better with deep rooting plants, annuals are not part of the usual design. Although native plants are not mandatory, they are often the best choices, as long as they are adapted to the conditions your site offers because they will be well suited to the environmental conditions of your climate and do not need additional fertilizer.
 - Mulch. Mulch is needed to protect the soil from erosion and insulate the garden from extreme wet and dry conditions. Shredded bark mulch is preferable because it does not wash away as easily as lighter bark chips.
 - A grass buffer strip. A grass buffer strip around the garden is important to slow the speed at which the runoff enters the garden and to decrease soil erosion.
 - A berm. A berm made from at least six inches of soil or rocks helps to keep the runoff in the garden long enough to allow it to be absorbed into the soil. Make sure that if your garden does overflow, the overflow will head to storm drains rather towards structures.

Use the handout "Water Cycle: The Rain Garden" for further instructions.

Making Connections:

- Dig in! If resources allow, turn your rain garden plans into a reality. Use your new design to gather support and resources for your new space. Your rain garden will serve as a living laboratory to teach young gardeners about the importance of protecting and conserving water resources.
- Visit a local water treatment facility to learn more about the sewer and storm drains in your community. If a field trip is not possible, invite a staff member from the facility to the class for a presentation.

Branching Out:

Science - Learn about other ways to protect water resources in your area. Check out the EPA's water resources to get started.

Science - Research good rain garden plants for your area. Native plants adapted to varying amounts of water are best. Create a brochure or presentation to share your findings with parents and community members.

Social Studies - Bring in magazine and newspaper articles focused on water quality or quantity. Ask students to evaluate and debate current issues related to water.

History - Lead students in researching the Clean Water Act. Discuss the role of government in protecting natural resources.

Winter Bird Observation

Overview: Bird feeders are lively places during the winter months and their presence is important. Though many bird species can handle the hardships of winter, with natural food sources becoming fewer due to the loss of habitats, feeders can help fill a food void. Feeding winter birds can be a fun and educational activity for students; they can learn about different species while also learning about their habitats, diets and winter survival tools.

Grade Level/Range: Grades 3 to 8

Objective: Students will:

- Observe bird feeding sites to learn more about their habits and habitats.
- Discuss the challenges of the winter season for animals and related adaptations.

Time: 4 to 6 weeks

Materials:

- Bird Observation Handout
- Clipboards and pencils
- Online or printed bird identification guide

Background Information:

There are lots of common birds in North America that stick around for winter. Many of these are colorful favorites that evoke a winter feeling. Each has a unique lifestyle and story to tell. Ten of the best for students to easily recognize are:

The Northern Cardinal

Probably the most well-known and beloved of all American winter birds, the northern cardinal inhabits much of eastern and midwestern North America, from Quebec, Canada all the way down to Central America. The male birds have bright red plumage, black faces and orange beaks, as well as a cheery red crest on their heads. The brownish red females are less colorful, which camouflages them when they are protecting their spring nests. These birds favor shrubby, forested areas, and they eat seeds and fruits in winter, with a supplement of insects in the summer months. Their call is a clear or trilled whistle.



Blue Jay

Distinctive blue, white and black markings and a blue head crest decorate this relatively large bird. Blue jays naturally exist in forest edges and wooded city areas across eastern North America. They are adaptable, somewhat aggressive birds with varied sharp, crow-like calls. (Sometimes they mimic the calls of hawks to frighten other birds!) The ground foraging birds have a varied diet, eating everything from small mice to grains, seeds and insects, but in the winter they rely mostly on a diet of seeds. You might even see them snatching pieces of pet food from the bowl if you feed your pet outside!



Cedar Waxwing

The beautiful cedar waxwing is a master flyer capable of acrobatic turns in the sky. Its plumage is tawny brown on the head and chest, fading to blue-gray on the wings, with a pale yellow belly. The crested birds have red markings on the wing tips, yellow markings on the tail tips, and a narrow black face mask bordered in white. The woodland natives also like wooded neighborhoods and can be found throughout the U.S. down to the northernmost tip of South America in winter and in the northern half of the U.S. and most of Canada in the summer breeding season. Cedar waxwings primarily eat fruit and enjoy dining on overripe berries on winter shrubs and trees. While they don't usually visit feeders, you may be able to attract these fruit lovers to platform feeders with orange slices, grapes and raisins. Their call is a high-pitched trilled whistle.



American Goldfinch

Brilliant gold plumage with black markings makes these birds nearly impossible to miss. Finches of all types are small, seed-eating birds that frequent feeders. The American goldfinch is found across much of North America and northern Mexico; it's a seasonal winter visitor in the Southwest and along the Gulf Coast but a year round resident in most other areas. Goldfinches favor open fields, parks and lowlands – anywhere where thistles, asters and sunflowers are common. Their chirpy, melodic song patterns are variable but distinctive. Females have lighter yellow bellies but otherwise look like males.



Tufted Titmouse

A small, silvery gray bird, the tufted titmouse has a smart little tufted head crest, a whitish belly and tawny or rusty patches flanking the wings. It is found only in the eastern United States and adjacent Canada where it lives in lower elevation forests and wooded neighborhoods. Its varied diet consists of insects, nuts, seeds and small fruits. This species nests in tree holes and forages in tree canopies and among tall plants for winter food. Sometimes tufted titmice use their fast, repetitive whistling calls to rally in groups and attack threatening predators like hawks.



Downy Woodpecker

One of the most common and adaptable of the woodpeckers, downy woodpeckers are a relatively small birds that are easily distinguished by their black and white checkered wings, white back, and black striped head accented with a patch of red in the back. They are found across North America from Alaska to Florida, where they live in open woodlands, scrubby areas and wooded neighborhoods. These insect eaters relish suet at winter feeders. They make a loud, percussive “rat-ta-tat-tat” when pecking trees and have a shrill, whinnying call.



White-breasted Nuthatch

Long beaks, attractive gray, black and white markings, and white bellies accented with reddish-brown are the key identifiers of the white-breasted nuthatch. Native to much of North America, these forest dwelling birds survive on a diet of insects, nuts, and seeds. Their long, strong silvery beaks can easily wedge open nuts. The call of the nuthatch is a loud, rapid, nasal “yank-yank-yank”.



Mourning Doves

Ground-foraging mourning doves are tawny gray with flecks of black on their wings. These common North American birds mate for life and are often seen in pairs. They are very prevalent in open wooded areas, fields, and yards where they can be seen scouring the ground and low-lying plants for seeds and berries. They emit mournful coos and nest in trees.



Carolina Wrens

In fall you can hear the “tea party, tea party, tea party” songs of defensive Carolina wrens staking out their winter territories. Found across the eastern United States down into adjacent Mexico, these small birds have cinnamon brown plumage and perky tails that stick upwards. They like spots with dense vines and bushes where they can forage on insects and small vertebrates. In the winter they switch to a diet of fruits and seeds.



Carolina Chickadee

A common bird across the southeastern United States, the Carolina chickadee is a small bird with a distinctive black cap and chin, gray and white wings, buffy tan body and little beak. (The similar looking black-capped chickadee is found across the northern half of the country.) It inhabits shrubby forests and wooded neighborhoods where it forages for insects, seeds, and nuts. Spiders are also a favorite treat! The males do most of the singing with a high-pitched, two to three note “fee-bee” whistle.



Laying the Groundwork: Ask students, why are birds important in our ecosystem? Some answers may include: they spread plant seeds, eat pesky insects, feed on decaying matter, and just in general are fun to watch and observe (bird watching is one of the most popular hobbies in the United States). Ask students to consider the question, what do birds eat? Are all of these items available in nature during the winter? If not, how do they survive the winter months?

Exploration

Explain to students that you plan to create a bird observation center in your schoolyard by setting up bird feeder stations. You can build your own from recycled materials such as milk cartons, recycled jugs or pine cones or purchase pre-made bird feeders.

Next decide what type of bird seed you want to use. Introduce students to some of the common birds in your area and explain that they each have different food preferences. Here is a list of favorite winter bird foods for the 10 most common birds.

Favorite Winter Bird Foods

Bird	Millet	Cracked Corn	Sunflower Seed	Wild Fruits	Thistle Seed	Suet
American Goldfinch	x		x	x	x	
Blue Jay			x	x		x
Cardinal	x		x	x		
Carolina Wren				x		x
Cedar Waxwing				x		
Chickadee			x	x		x
Downy Woodpecker						x
Mourning Dove	x	x	x	x		
Nuthatch		x	x	x		x
Tufted Titmouse			x	x		x

You can select your seed to attract a certain species of bird or offer a variety to attract different bird species.

Set up your bird feeders and schedule time for students to observe them. Placing feeders by a window for indoor viewing is an excellent idea for those cold winter days. You can use the sample Bird Observation Worksheet to collect data or younger students can create a chart on a whiteboard or large sheet of paper so they can check off birds they see on the playground or at the classroom birdfeeder. Make sure to alter the observation times so that students can determine if their visitors change throughout the day. If you have multiple feeders offering different types of seed, make sure students record which birds visit which feeders, as certain types of birds have preference for particular kinds of seeds.

After a couple of weeks, compile your observations looking for patterns in birds observed at your feeders at different times of the day. Discuss the results.

Making Connections:

Use your bird observations to discuss the challenges of the winter season for animals and related adaptations. You may want to ask:

- How has urbanization impacted other animals' ability to survive the winter months? *Loss of habitat has decreased food sources during winter months and available shelter.*

- What are other adaptations do birds have to help them survive winter months? Dense down feathers lining their bodies helps to store heat, and they put on fat reserves, eat frequently, and seek protective shelter. Plant cover is the most common type of shelter, but some winter birds nest in tree holes and others may seek refuge under the warm eaves of buildings. Dedicated winter birders may even put up protective roosting boxes to give their birds shelter in winter.
- Many other birds survive the winter months by migrating to warmer climates. Discuss migration and research which birds migrate, where they go and why and how they do it.

Branching Out:

Science – Study additional bird adaptations. For example, different birds have different types of beaks (also known as bills) which influence their food preferences. For example, hummingbirds have long slender beaks that allow them to delicately probe flowers in search of nectar. Short, thick, cone-shaped beaks, such as those on cardinals, sparrows, and grosbeaks, are ideal for cracking hard seeds. Swallows and others that gather insects in flight can open their beaks wide to get a mouthful. Some birds that find insects in logs and twigs, such as warblers, have small sharp beaks while others, like woodpeckers, have long and chisel-like beaks for boring deep. Birds of prey have sharp hooked beaks for tearing into meat. The common crow has a multipurpose beak suitable for eating fruit, seeds, insects, and fish. Some ducks and other water birds have bills that act like strainers to gather tiny plants and animals. Herons have spear-like bills for fishing.

Once students have investigated beaks, you might want to bring in or challenge them to find tools that have functions similar to bird beaks and try using them to access different food sources. (A hummingbird’s beak acts like a straw, for instance. A nutcracker functions like the beaks on seed-eating birds. The beaks of many water birds function much like strainers.)

Your keen observers might notice or question whether birds have teeth. (They don’t.) How do they handle those hard seeds? Birds have strong acids in their stomachs that help digest food. From there, hard foods, such as nuts, seeds, and grains, go into the gizzard (a muscular part of the stomach) where it is further ground up. Many birds actually swallow small stones or grit, which help break down the food!

Social Studies - Many species of our feathered friends are in decline. Scientists believe this may be due, in part, to habitats being lost or fragmented due to land clearing, development, and building on wetlands. Other factors, such as house cats, pesticides, and oil spills threaten birds. Ask students conduct research to learn more about these factors and then consider how they might take constructive action. For instance, they could make nesting boxes, continue feeding birds throughout year, garden for the birds, or donate time or funds to efforts to improve habitats locally and nationally.

Music - Encourage students to notice differences in birds’ songs. There are many different recordings available online. Research some of the meanings behind those songs. Inspire inquiry by asking: are bird songs different during different times of year? Who does the singing? (Males do most of the singing to attract females or tell other males to stay away. Also watch for displays such as thumping and strutting.) In addition to a melodious song, most birds also have shorter call notes to warn others. Many bird guides mention words or phrases that birders employ to identify certain bird songs. Robins, for instance, sound as though they’re “saying” cheery, cheerio. Some, like chickadees, are said to say their own names. Students may want to make up their own words or other devices to help them identify bird songs in the schoolyard or neighborhood.