Section II

# Gardening for Wildlife

This section provides a general introduction to ecological concepts, which will assist you in the process of creating your Schoolyard Habitats site and the use of the site for instruction. Also included is practical, easy-to-use information on the concept and practice of gardening for wildlife.

- Ecology 101
- Introduction to Native Plants
- Habitat Basics
- Butterfly Gardening
- Restoration Projects
- Soil
- Composting
- Container Gardening

# Ecology 101

The survival of individual species of animals and plants relies on the health of their habitat. Today, more than 900 types of plants and animals in North America have been designated as endangered. To prevent the extinction of these species and to conserve the amazing diversity of living things on this continent, people must work together to protect and restore habitat for wildlife. Schoolyard Habitats projects provide the opportunity for students, teachers, and community volunteers to act as wildlife biologists and restoration ecologists as they work on a small scale habitat project on their own schoolgrounds.

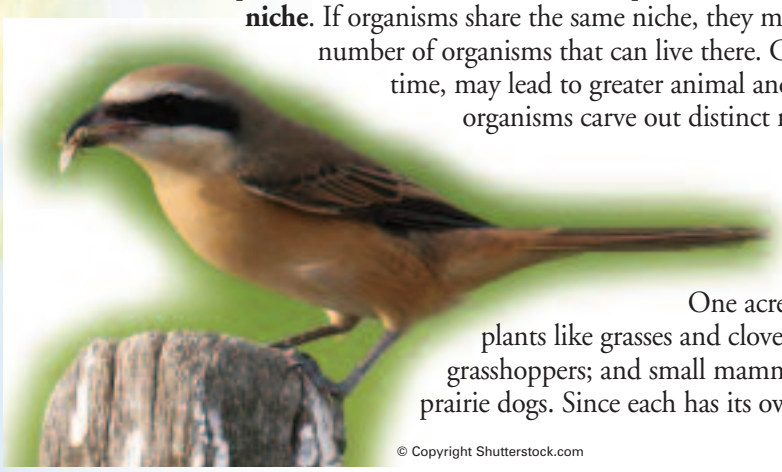
## Every living species has specific habitat requirements.

**Habitat** is the arrangement of living and non-living things which together supply an organism's basic requirements for life. These essential components include sources of food, water, cover, and safe places to raise young.

Each species' habitat has a characteristic physical environment, including climate, and often a characteristic type of vegetation. Eastern temperate forests tend to have cold winters and wet, hot summers. Broadleaf trees like oak and maple live well in these conditions; Eastern forests are defined by the mix of oak, maple, birch, and other trees that grow there. These trees create a canopy that shades the forest floor and provides habitat for many creatures, such as gray squirrels, white-footed mice, white-tailed deer, blue jays, and more. Deserts, on the other hand, receive little rain throughout the year and can only support plants able to tolerate dry conditions such as cacti and sagebrush, which in turn characterize the habitat for many other plants and animals.

In forests and all other habitat types, plants and animals living there are **adapted** to their environment (they have inherited characteristics that enable them to survive in that location). Most plants and animals have one kind of habitat that suits them best, although they may be able to survive in several others. Other living things can survive in only one kind of habitat.

Even when two organisms live in the same area, their needs and how they meet these needs may be distinct, allowing them to share the same space without **competition.** Two birds, for instance, might live in the same tree but eat different foods, have different predators and have different tolerances to temperature. The birds live in the same place, but do not fill the same role, or **niche**. If organisms share the same niche, they may compete and limit the number of organisms that can live there. Competition, over a long time, may lead to greater animal and plant diversity as organisms carve out distinct niches.





Organisms of different species can coexist in the same type of habitat while having separate niches. One acre of prairie is home to plants like grasses and clovers; insects like beetles and grasshoppers; and small mammals like deer mice and prairie dogs. Since each has its own niche—diet, foraging or

hunting habits, needs for shelter and places to raise young—many species can live there.

Scientists who study the interaction between an area's physical environment and living things are called **ecologists** ("eco" is derived from the Greek "oikos" meaning home). They divide their studies by scale, from smallest to largest. The smallest unit ecologists study is an individual organism of one species, including its habitat and niche. Ecologists may also study a **population** of **organisms** of the same species. The populations of plants and animals that live near each other in a particular habitat make up the living **community**. An **ecosystem** encompasses all living things interacting with one another and with the non-living environment, including air, water and soil.

## North American Habitats

Trace the 39th Parallel across a map of the United States. Traveling from coast to coast along this latitude, you would pass through a surprising variety of North American habitats. The journey would lead you through California's chaparral and the sands of the Mojave Desert, on to the evergreen forests of the Rocky Mountains and the mid-western prairies before finally arriving at the broadleaf forests of the East Coast. All of these ecosystems contain an array of habitats, which, in turn, support an incredible diversity of living things.

The 39th Parallel only provides a glimpse at the diversity of habitats found in North America. North of that latitude lie the wet evergreen forests of Washington and Oregon. South are the deserts of Arizona and New Mexico, the wetlands of Louisiana, and the subtropical marshes of Florida's Everglades. On the western shore, rocky tide pools mark the meeting of land and sea, while the East Coast boasts sandy beaches, salty estuaries, and barrier islands. Aquatic habitats are found in North American ecosystems, including open oceans, lakes, ponds, rivers, and wetlands. Although we rarely think of urban areas as 'wild places', cities are ecosystems, too. Rare and delicate ecosystems may sometimes be found alongside an abandoned railroad track, under the roaring jet engines of an airport, and in between city blocks. In the city, a park may be a squirrel's habitat, where it finds acorns to eat, water to drink, and a hole in a tree to hide and raise its young. Across town, a skyscraper may provide a nesting place for a peregrine falcon, while the park may provide it with food and water.

What creates this diversity in habitats? The diversity results from unique combinations of the physical environment and the living community. Physical factors play a key role, since the amount of rain, sunlight, temperatures, and the type of soil largely determine the kinds of plants that can survive in an area. These factors change from north to south and with the presence of mountains or sea, among other features. In addition, all animals depend directly or indirectly on certain plants for food and shelter, and the presence or absence of these plants





influences an animal's survival in a given habitat. Plant and animal species also affect each other and the physical environment. Decomposing leaves may change the chemistry of soil or water while a bee that pollinates a flower helps the flowering plant to reproduce.

## The Physical Environment

Species are adapted to live in a habitat with a certain range of physical and chemical conditions. This includes weather (rainfall and temperature), soil (both the chemical nature and the supply of air and water available to plant roots), exposure to sunlight (sun or shade), and the composition of air. Other parts of the non-living environment are also important in determining whether a plant or animal can survive in a given habitat. These include: wind, salinity (the amount of salt in the soil or water), geologic forms (such as mountains or rivers, which influence weather, and caves or rocks, which some animals use for shelter), fire and other disturbances, the amount of air dissolved in water (in aquatic habitats), and whether the soil, water or air has been polluted by significant levels of toxic substances.

Plants need sunlight, water and carbon dioxide gas to survive in their habitats. In

addition, they require nutrients such as nitrogen and phosphorous to grow. Without sufficient amounts of these non-living factors, a plant would weaken and eventually die. All habitats must have both a suitable physical environment and the organisms on which animals depend.



Many parts of the physical environment can become **limiting factors** when in short supply or in excess. Within a habitat, each species has factors that limit its growth or reproduction. In a desert the lack of water is a serious limiting factor to plant growth. Add water with irrigation, and plants grow more quickly. Stop irrigation, and growth returns to normal. For a tree seedling on the shaded forest floor, amount of sunlight may be what most limits the seedling's growth. Other examples of limiting factors include temperature, supply of minerals in soil, land for territory and the availability of food and nutrients. Temperature and other factors become limiting to growth and/or reproduction when they approach the limits of what a living thing can tolerate.

## Food Chains and Food Webs

Within a habitat, most organisms depend on other living things to meet their needs for food and often for shelter. Taking in food is critical to survival. From food, living things get the energy they need to go about the business of being alive. Plants get their energy from the food they make through the process of **photosynthesis**, and animals get their energy by eating plants and other animals. The path through which energy and nutrients pass from one living thing to another is called a food chain. All living things are part of at least one food chain, which includes species that live in the same or overlapping habitats.

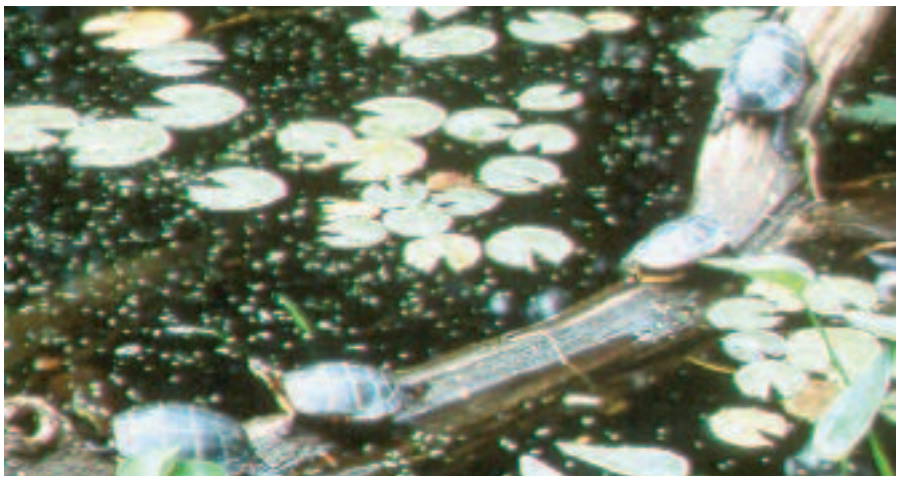
Green plants represent the first step in most food chains. During photosynthesis, plants (and a few types of bacteria) absorb energy from sunlight and use that energy to turn water and carbon dioxide gas into food. Plants are considered producers in an ecosystem because they produce the food that supports other living things in a food chain. All animals rely, either directly or indirectly, on plants for food.

Animals that eat primarily plants are called **herbivores**, or primary consumers, and represent the next link in the food chain. Animals called **carnivores**, or secondary consumers, eat herbivores and form the next level of the food chain. Some animals eat both plants and animals and are called **omnivores**. Many food chains end with a tertiary consumer, or a top **predator**, which eats secondary consumers.

Few food chains contain more than six species, since a large percentage of energy is lost at each transfer from eaten to eater. For example, a rabbit feeds on grass for energy and then spends most of this energy digesting, moving and controlling its body temperature. The fox that eats the rabbit gets only a small fraction (about 10 percent) of the original energy stored in the grass. Because relatively little energy is passed from one link in the food chain to the next, food chains aren't usually that long.

Energy loss also explains why those at the top of the food chain, top predators, are rare. Top predators like wolves and sharks must eat many smaller animals to get enough energy, and so a large population of wolves would not be able to find enough food. A food chain pyramid shows how the population of each species in a food chain decreases further up the chain. Primary consumers are much more common than secondary consumers, which are in turn more common than tertiary consumers.

Organisms are rarely part of just one food chain. A collection of food chains in a community form a living network called a **food web**. **Decomposers** are a part of all food webs and include microbes, fungi, insects, and animals that break down dead plants and animals, returning essential nutrients to the soil. This process ensures that nutrients are available again for use by plants and microbes.



## Predator and Prey

Beyond providing food-energy for the predator, predator-prey relationships help keep populations of both species in check. When a predator is removed, prey populations may grow out of control, beyond the ability of the habitat to support them. For example, in Arizona in the early 1900s, hunters killed huge numbers of wolves, mountain lions, and coyotes; all of these were top predators in the area of mule deer. With the decline of predators, the mule deer population grew from 4,000 individuals in 1907 to more than 100,000 in 1924. The huge population of deer stripped their habitat of all the leaves, plants and other greenery they used as food. With food scarce, many deer starved and fewer were able to reproduce. By 1939, the deer population had declined to just 10,000 individuals.

## Other Interactions

Food webs aren't the only kind of interaction between living things in a habitat. Although you may not think about it, each time you seek shade under the boughs of a tree, you interact with the tree. Plants and animals in a community depend on each other to meet needs other than food, such as shelter, places to raise young, pollination, and the distribution of seeds.

For an example of these other kinds of relationships, just look a saguaro cactus. In the desert, mice and rabbits help disperse the seeds of the saguaro cactus to new locations. During its first years of life, a saguaro cactus needs shaded habitat. To meet this need, the cactus depends on other plants, such as a mesquite tree, to protect it from the hot sun while the root system develops. Later in life, the cactus provides shelter (and food) to many other organisms. Gila woodpeckers build nests in it; once vacated, the nest may provide a home for elf owls, lizards, insects, or spiders.

Like the saguaro cactus in the Sonoran Desert, prairie dogs are important species in their short grass prairie ecosystem. They live in 'towns' made up of hundreds of underground burrows and tunnels in the grasslands of the American Midwest. Burrows are built with chambers set aside for sleeping and storing food. Abandoned burrows provide shelter for many other prairie critters, including prairie rattlesnakes, black-footed ferrets, and burrowing owls.



## Life Cycles and Habitat

Butterflies look drastically different as adults than they did when they were young caterpillars. The types of food, water and cover they require also change. Many organisms have different needs as they go through the stages of their life cycle, especially organisms like butterflies that undergo metamorphosis. In these cases, the life requirements of the young, or larval stage, of a species can be extremely different from the needs of an adult. In this way, some species may have more diverse needs within their habitat than others.

## Specialists and Generalists

Scientists consider the members of a species **generalists** if they can live in a wide range of habitat types and eat a wide variety of foods. **Specialists**, on the other hand, include species that live in a narrow niche and can live only in one or very few types of habitats. Relatively, generalists are better able to adjust to changes in the environment by finding a new source of food or cover. Populations of specialists grow when the resources they rely on are available, but may not be able to survive if changes threatens their only food, cover or nesting resource.

What is the quintessential generalist? The raccoon! They are generalists found in many different habitats. Raccoons live in habitats as diverse as woodland, grassland, wetland, desert, and seashore, not to mention the alleys of inner cities and suburban lanes. They live throughout North America—from Canada to Panama. What are their secrets for success? For one, they eat a varied diet, and can find nutrition from many different sources. Raccoon diets include plants, nuts, fish, rodents ,or the leftovers

found in garbage cans. This flexibility means that if one source of food disappears, raccoons are still able to find another. For cover, they do not have specific needs. Any hole or crevice will do. Raccoons have been known to make hideouts in pipes, tree holes and small rock hollows.

By contrast, monarch caterpillars depend on a single group of plants—the milkweeds—for food. These caterpillars have evolved the ability to eat this plant that most other insects find poisonous. As a result, there exists less competition for milkweed leaves. But this same specialization makes monarchs vulnerable. If milkweed disappears from one area, monarchs may have to move to a new habitat. If anything threatens the plant over a larger area, or if the butterfly is forced into habitat where milkweed cannot grow, the butterfly population will be threatened.

## Adaptations

An **adaptation** is an inherited trait that helps an animal or plant survive in its habitat.

Diet, behavior, physical anatomy and even physiology (internal mechanisms), are ways animals adapt to their surroundings. Many living things have evolved unique ways of dealing with the problems of survival. An animal's adaptations—such as an eagle's keen sense of sight or a hummingbird's long beak—develop over a very long time and can be passed on to offspring.

Animals have adapted to even the harshest environments. Some aquatic insects have evolved a way to survive extremely cold temperatures. They can freeze while remaining alive. When the air warms up, these insects thaw and return to normal shape and activity. Similarly, plants and animals who call the desert home have adapted over thousands of years to life in a place that gets fewer than 10 inches of rainfall each year. These adaptations allow organisms like the kangaroo rat (which gets all the water it needs from plants it eats) and the saguaro cactus (which stores enough water to survive years) to thrive in the desert environment.





But adaptations are useful only in the habitat for which an animal is adapted. A freshwater newt, adapted to living in or near water, wouldn't survive long in the desert.

People often confuse adaptation with adjusting or responding to a change in environment. Adjustment happens, for example, whenever humans climb to high altitudes. On top of a 15,000-foot mountain, it feels colder and there is less oxygen to breathe. Humans adjust through behaviors such as wearing warm clothes and staying inside a tent. Within a short time period, humans go through a reversible physiological change, which allows them to breathe in a low-oxygen environment. Once climbers return to sea level, they return to normal. This is a temporary change that is not passed on to children. Adaptations occur over long periods of time and are passed on from one generation to the next.

## Limiting Factors

Just as some species require specific spatial requirements to meet their needs, other species have very specific food or cover requirements. If one of these critical elements or factors is missing a species cannot survive. These most specific habitat needs are called limiting factors because their absence limits whether a species can live.

For example, many decades ago the North American wood duck was disappearing. Scientists had to determine why this species was declining alongside other flourishing duck species. The answer was simple once the situation was examined by looking at the habitat requirements for wood ducks. Wood ducks require snags (old dead trees) with holes in them to raise their young. Wood ducks were loosing their habitats because wetlands with old dead trees were being destroyed for development. Resource agency and conservation organizations worked together to restore the habitat by placing wood duck boxes on posts or in living trees near wetlands. The wood duck boxes simulate the holes in trees wood duck require to raise its young. Thanks to the placement of wood duck boxes the species is thriving and its habitat restored. The loss of suitable places to raise young was the limiting factor for the wood duck.

## Habitat Size

Animals differ in the size of habitat they require. In general, large animals need more food-energy to survive and so need to hunt or forage within a larger area than does a small animal. For the larvae of the longhorn beetle, a small area inside a single oak tree may be sufficient. Beetle larvae live below the tree's bark, creating tunnels as they feed on wood and hide from hungry predators. A squirrel might find cover in the same oak, but its habitat, which includes its entire foraging range, stretches over 3 to 4 acres. One kind of warbler bird may require up to 7,000 acres of forest habitat for a breeding pair, while a black bear needs as much as 40,000 acres for its home range.

Other factors influence habitat size. An organism's feeding habits, mobility, nesting preferences, and territoriality can all play a role in determining its required habitat size. A bee, which has the mobility of flight and needs to find food with a high sugar content, has a much larger habitat than an ant. Plant-eating grazers like buffalo need only a quarter the habitat that carnivores such as wolves require. Leaves and grass are relatively common and easy to find for buffalo. By contrast, prey animals are much harder to find than grass, so their predators need to search a larger area to find them.



## Biodiversity and Endangered Species

Today, habitat loss is the leading threat facing wilderness, wildlife and biodiversity in North America. The term **'biodiversity'** refers to the variety of species of plants and animals in a given area. One way to measure the biodiversity of a given area is to count the number of types of species living within that area.

Biological diversity has been recognized as an important measure of an ecosystem's health. All members of food webs, including humans, rely on healthy ecosystems to provide food and materials needed to live. The more diverse an ecosystem, the greater chance that some species will be able to survive sudden disturbances in the system caused by climactic change, human impacts or the loss of a key species.

Tropical rainforests face the greatest threats to declines in biodiversity, but much of North America has also suffered serious declines. In 1973, concern over the loss of wildlife led to the creation of the U.S. Endangered Species Act, which aims to protect the rarest species from extinction. To date, over 1,100 plants and animals in the United States are rare enough that they have been listed on the federal **endangered** and threatened species list. An endangered animal or plant has so few individuals left that it has been officially identified as close to extinction. Threatened species are not in such dire situations but have suffered rapid declines in their populations. The Endangered Species Act provides for active conservation and management of these species.



The sheer number of endangered, threatened and vulnerable species, along with high costs involved in their protection, has made conserving these species a challenging task. More recently, conservationists and federal managers have shifted their focus from individual species to the habitats of endangered and threatened species. Focusing on critical habitats, home to a diverse group of plants and animals, seems the most effective method to save wildlife. In saving the habitat of an endangered species, managers will also be able to save the many unique organisms that share that habitat.

## Habitat Loss

In some cases, human alteration of the environment can endanger plants and animals in a given area. For example, scientists linked the seaside sparrow's extinction in 1987 directly to the loss and fragmentation of its habitat. In a little over two centuries, vast portions of the North American landscape have been altered by human activities, including development of housing, roads and cities, farming, resource extraction, pollution, and hunting. Noteworthy examples include:

- ✔ Prairies once covered 40% of the lower 48 states. Much of this Mid-Western grassland habitat has been lost to farming, development and overgrazing. In addition, periodic fires that

grasses depend upon have long been suppressed, allowing other species to flourish. Wild grazers like bison, which also played an important role in the grass ecosystem, were over-hunted long ago. Scientists estimate that 99% of tall grass prairies, which once stretched over 90 million acres on the Eastern edge of the prairie states, have been lost to development and farming. Prairie loss has led to steep declines in many species' populations, including black-tailed prairie dogs and the now very rare black-footed ferrets.

- ✔ More than 90% of old-growth forests of the Pacific Northwest have been disturbed by development and logging. Many species, such as the endangered northern spotted owl, need a mature forest habitat to survive.



- ✔ Over 50% of wetlands in the lower 48 states have been cleared, drained, filled, or destroyed. Many of those remaining face problems with inadequate water supplies (due to upstream dams and diversions), polluted run-off from agriculture and industry, and continued pressure for development. In California, only 10% of original wetlands remain, most lost to agriculture and development. Especially notable has been the shrinking of wetlands in Florida, where the Everglades once reached from above Orlando to the state's southern tip. The loss in wetlands there has contributed to a 90% drop in the number of waterfowl in the area. A full one-third of endangered plant species grows in wetland habitats throughout the U.S.
- ✔ Although beginning to recover, more than 80% of New England forests were cut when Europeans settled the region and the land was converted to farmland. As agriculture has moved to the mid-west, Eastern forests are slowly re-establishing themselves. Acid rain, a by-product of modern industrial emissions, still poses a threat to the health of these ecosystems.
- ✔ The Southeastern United States was once covered in longleaf pine forests, which stretched from Virginia to Texas. Only about 3% of these historical ecosystems still exist, resulting in endangerment of birds like the red-cockaded woodpecker. The rest has long since been converted to cities, farms and tree plantations or has lost key habitat features due to logging, fire suppression and use of adjacent lands.
- ✔ Riparian ecosystems face the greatest threats from dams, diversion of water, and pollution. Most major rivers in North America are dammed to provide energy, control flooding, and divert water for irrigation and other uses. Inadequate river water threatens wildlife that needs flowing or deep water.

## Human Impacts

As human populations continue to grow, more and more natural areas are developed or converted to cropland to meet increasing human demands for housing and food.

Development—the building of new houses, streets, highways, offices, schools, shopping centers and parks, and the clearing of land often associated with new construction—is a leading cause of habitat loss. Building on wild land can destroy or seriously degrade wildlife habitat. The extraction of natural resources from certain areas can impact habitat quality and species viability as well.

Conversion of wild habitat into farmland increases with our need to grow food for greater numbers of people. It also drastically changes the habitat. While some organisms, like migratory cranes on the Platte River who feed on waste corn from the year's harvest, can live with farms, others, such as many of the native grasses of the prairie, cannot.

Run-off from farms, such as fertilizers and pesticides, can create problems in downstream habitats. If too much fertilizer washes into a pond, for example, the amount of available nitrogen and phosphate can completely alter the physical environment of the lake, creating huge algae blooms, which deplete oxygen and seriously harm or even kill other wildlife living there.

Pesticides also harm birds, butterflies and other insects. Birds of prey, for example, suffer enormously from pesticides even though they may not consume them directly. Each animal they consume may have a small amount of the toxic substance in its body, and these amounts can accumulate in the bird's body over time.

To protect wildlife, we need to better balance human needs with conservation and restoration of habitats. Sometimes, unexpected consequences of human activity harm a habitat. For example, pollution (such as fertilizer in a lake or toxic levels of chemicals) may render a habitat unsuitable for life.

## Natural Impacts on Habitats

Catastrophic natural events can also spell disaster for habitats over the short-term. But even after a severe flood or fire, most ecosystems can recover. In most cases, the habitat develops back into a healthy community similar to the pre-fire or flood habitat over time.

Other powerful natural impacts can come from disease, extremes in weather and climate change. Disease



can destroy a population of one species, which may impact the lives of others. Some 250,000 ducks on Great Salt Lake appeared to have died from botulism, a bacterial disease, in 1932. While the local population of ducks was decimated, ducks from other areas eventually moved in and repopulated the Lake. Even extremes in weather (an especially cold winter or long drought) may become lethal to many. Hurricane Hugo destroyed many older longleaf pine trees that endangered red-cockaded woodpeckers rely on for cover.

Some habitats, such as mid-western prairies or longleaf pine forests of the south, actually rely on periodic natural disturbances, such as fire, to stay healthy. Yellowstone National Park is a good example of such an ecosystem and a place where fires have long been suppressed to protect property and people in the area. When large wilderness fires erupted in Yellowstone, the burning did cause some tragic losses of wildlife and park facilities. But within a few short years, the many benefits of a natural fire (often started by lightning) became apparent. The park experienced an ecological re-birth, with greater plant and tree diversity, leading to greater animal diversity and a healthy, stable ecosystem.

While most ecosystems have the resiliency to bounce back after a severe natural event, some changes may be too great. Climate change, as evidenced in ice ages that regularly occur on Earth, may permanently alter the group of species able to grow in a habitat. Human activity also may change ecosystems irreversibly. For example, when a new species is introduced to a habitat, the entire structure of the place may change, never to return to its original state.



## Introduced Species

Some species are intentionally or accidentally introduced into a non-native habitat from elsewhere. The impacts of particularly aggressive species can be enormous, altering the entire structure of an area or ecosystem.

For example, the nutria, a small beaver-like mammal, was imported from South America and released into the wild in a number of habitats earlier this century. Fur farmers wanted them for their pelts. They are now found in 15 states and have caused much habitat havoc. In Louisiana, 20 animals were released in 1938. There are now 20 million living in the bayous and wetlands of that state. Their voracious appetite for wetland plants, added to their constant digging, has resulted in 100,000 acres of marsh turned into open water, destroying the winter habitat of waterfowl. Aside from alligators in the southeast, there are no natural predators to keep nutria in check.

The weedy and shade-loving English ivy plant is another example of a non-native species that has caused many problems for habitats it invades. The ivy is native to Europe and Asia and was introduced into landscaping and gardens by some of America's early colonists. It has escaped from gardens into many forests, where it creates dense cover on the forest floor and lowers plant diversity in the forest. Little sunlight reaches below ivy and the shade stops native wildflowers, trees and shrubs from sprouting and growing. These native plants are the ones wildlife rely on for food, cover and places to raise young. No animals appear to use ivy to meet their needs, save the European starling, another introduced, non-native species.

## Habitat Fragmentation

Habitats are increasingly divided into smaller and smaller areas because of development or other land uses, such as roads, housing, parking lots, and lawns, until many islands of unconnected fragments remain. Habitat fragmentation can lead to huge losses of wildlife because it affects overall habitat size, creates more edges, and isolates species from other members of their population.

Some habitat fragments are just too small to provide for all the needs of a species. A black bear that needs 40,000 acres of forest habitat to survive, will not survive in a 2,000 acre fragment. Even for species with a smaller habitat range, the fragment may be too small to support enough



individuals for a healthy breeding population.

Carving up a habitat creates more edges and changes the qualities of a habitat. Many bird species, for instance, live in the interior of a forest and have a hard time thriving along edges, where they are more vulnerable to attacks by predators. Physical factors along edges differ too—without the shade of the forest canopy, more sunlight reaches the ground and allows a thick understory to grow. Some birds need a relatively sparse area of forest floor to successfully forage for food.

Fragmentation also isolates populations or individuals by creating barriers to movement. Without forest cover, it may be harder for young to disperse to new areas. New individuals from other populations may no longer be able to reach those living in the habitat fragment, meaning that the genetic diversity of the population may decline. Studies show that decreases in the size of the habitat fragments directly correlate with declines in species diversity.

### The Good News

Many conservation efforts have been successful in managing wildlife species and in setting aside larger tracts of wilderness so that wildlife can continue to thrive in these areas. Many people are beginning to make wiser decisions about the ways in which land is developed and are joining in efforts to restore local habitat. It is even possible to restore degraded habitats. Many schools across the country are making their contribution through Schoolyard Habitats projects. From Florida to Alaska, schools are creating wildlife habitat and restoring wetlands, prairies and forests on their schoolyards. Schools are engaging in Schoolyard Habitats projects to restore biological diversity in their communities by removing invasive exotics and planting native species. They are providing much needed temporary habitat for migratory birds and butterflies on long journeys, and year-round habitat for numerous local residents. The work of schools is helping to open the eyes of the larger community to the important issue of habitat loss, and showing communities that by working together, we can make a difference.

# Introduction to Native Plants

A native plant is a species that naturally occurs on a site and has not been introduced from another region or country. Native plants thrive in their natural setting without disrupting natural ecological processes because they are perfectly adapted to the conditions of that locale. Native plants provide the best diversity of habitat elements for wildlife. Wildlife species have evolved to rely upon native plants as food, cover, and sometimes even for water. **The National Wildlife Federation strongly encourages the use of native plant species in all new plantings.**

### *By choosing native plants for your Schoolyard Habitats site, you will:*

- provide the best overall food sources for wildlife
- require less water and overall maintenance
- provide excellent support to local wildlife species
- help maintain the diversity of plant species in our communities

The wildlife in our communities flourish amid locally native plants. However, there are hundreds of species of exotic plants available for sale, which are originally from Asia, Europe, Africa, or Australia and now call the landscapes of North America home. These plants do not sustain local wildlife as well as native plants do. Though these plants may offer birds fruit, squirrels nuts, and hummingbirds and butterflies nectar, they do not provide the full range of seasonal habitat benefits that appropriate locally native species provide. If we want to attract wildlife and to restore the critical, often unseen small pieces in our ecosystems, we need to bring back locally native plants.

An equally important reason to use locally native plants is to reduce the possibility that exotic plants from our landscapes will run wild. Native plants do not become invasive; that is, they will not reproduce rampantly, invading and impoverishing the diversity of our remaining natural habitats (as an increasing number of exotic plants now do). Non-native plants often reproduce quickly, depleting the diversity of remaining natural habitats. When a non-native species is planted in a new place, it is isolated from its original region or country and the controls present there: insects and diseases that limited its spread in its place of origin. This lack of controls in a new area often allows the plant species to spread unchecked in its new environment.



Rapidly growing and reproducing exotics often displace native plants that cannot compete with them. Consequently, animals that depend on native plants to provide a





particular habitat component may not find a suitable replacement among the non-native species. Exotic plants that have been popular in formal landscaping but which have been particularly invasive in many parts of the U.S. (and therefore should not be planted) include: purple loosestrife, multiflora and Cherokee roses, Asiatic bush honeysuckle, Japanese honeysuckle, nandina, privet, autumn and Russian olive, and burning bush euonymus, among many others. NWF and your local native plant societies can provide region-specific plant lists to assist with your plant selections.

Locally native plant species meet virtually any landscaping need. By choosing native species, you will replace the monotony of the few exotics that so dominate our landscapes and the spread of exotic invasives which are choking out the diversity of local plants in woodlands, roadsides, meadows, and natural ecosystems.

Our landscapes, carefully planted with locally native species, can be effective instruments in restoring native plants to our communities and open spaces.

Most local nurseries and plant centers sell native plants, whether they know it or not. Since some nursery staff may not be familiar with native plants and their benefits, educating yourself about the plants you would like to purchase prior to visiting the nursery is helpful. Many nurseries are willing to special-order plants that they do not normally stock. If possible, request your plants by species name rather than common name, as one common name is often ascribed to many different species. The best sources of finding reputable native plant suppliers are your state native plant or wildflower society.

# Habitat Basics

All wildlife needs an appropriate combination of food, water, cover, and places to raise young. Therefore Schoolyard Habitats sites must include these four essential habitat elements specific to the local wildlife they seek to support and attract. Some areas of the schoolyard might already be visited by wildlife; these areas may naturally provide some or all essential habitat elements. If so, consider enhancing or restoring habitat that already exists. **It is just as important to restore and conserve existing habitat areas as it is to create new habitat on the schoolyard.**

Providing a wide variety of appropriate habitat elements will attract a diversity of wildlife to your schoolyard. After learning about habitat basics, use the Site Inventory activity to evaluate your schoolyard and determine how it can be enhanced to better support local wildlife.

Following are a few brief suggestions on how to provide food, water, cover and places for wildlife to raise young on your schoolgrounds. Accompanying each habitat component is a preview of the corresponding portion of the Schoolyard Habitats Application which your school will eventually be completing.

## Food

The ideal Schoolyard Habitats plan uses vegetation to supply as much food as possible to meet the year-round needs of many local species. Shrubs, trees, and other plants produce foods, such as acorns, nuts, berries, and other seeds. Leaves, buds, catkins, nectar, and pollen are also important food sources.



Locally native plants are the basis for the natural food chain in any given ecosystem. Therefore, it is important that any Schoolyard Habitats plantings consist of locally native plant species that include trees, shrubs, perennials, and annuals. Contact a Cooperative Extension office, local garden center, state non-game wildlife program, nature center, or the National Wildlife Federation field office closest to you for recommendations about the best locally native wildlife plants.

While plants are maturing, and in areas with cold winters, natural food sources can be supplemented with food for birds. The best foods for feeders are sunflower, safflower, proso millet seed, niger seed, and suet. In warm months, sugar water in regularly cleaned humming bird feeders supplements the nectar and insects that flowers provide. Feeder maintenance is an excellent ongoing student project.

## Water

Throughout the year, wildlife needs water for drinking, bathing, and in some cases, breeding. Water can be supplied in a birdbath or other shallow dish, a small pond, a shallow wetland, or stream. While vegetation holds droplets from rain or morning dew, a more constant, reliable source of water is needed by many wildlife species and therefore is recommended in Schoolyard Habitats sites.

Butterflies, birds, frogs, and toads often prefer to use shallow, puddle-like water sources. Create puddles by filling a shallow basin with clean sand; sink the basin into the ground in a sunny spot within your garden. Keep it flooded so that some of the water and sand spill over the edge at different times of the season.

An elevated birdbath may protect birds from cats and other predators, and can be an attractive addition to your Schoolyard Habitats site. Place birdbaths near an overhanging branch or a nearby bush to provide a quick escape route for songbirds from predators but not so close that predators have a good hiding place within pouncing range. The bath

## Basic Steps for Building a Pond:

1. **Check Local Regulations.** Many schools are concerned with the liability issues of having open water on their campuses. Before planning pond construction, check school district and municipality guidelines. These are usually easy-to-follow regulations regarding the size, depth, and location of schoolyard water features.

2. **Observe the natural flow of water on the property.** The best time to do this is right after it rains. The ideal site for the pond may be where water naturally accumulates on the schoolyard. Make sure that the site does not receive excess nutrients from compost piles, fertilizers placed on lawns, or street runoff.

3. **Choose Pond Structure.** One of several options available for creating pond structures is to use a commercially available flexible liner. Create a basin by excavating the soil and providing a gradually sloping beach area so that amphibians and other wildlife species can leave and enter the pond easily. Many schools choose to provide an overflow "wetland" area next to the pond (a place for water to flow during excessive precipitation), to support additional types of plants and wildlife, and to thereby provide greater educational opportunities.

4. **Install. Before laying the liner, pad the hole with a layer of sand or some old carpeting, and then put the liner in place.** Secure with rocks. Before filling pond with water, check to see if the local municipality uses chlorine or chloramine. Chlorine will dissipate after one week, but a neutralizer is necessary in order to adjust chloramine levels.

5. **Add Water and Vegetation.** Cover the surface of your pond with a layer of leaves. These will sink to the bottom and form an organic layer and provide habitat for microorganisms. Place plenty of plants, rocks and tree branches in the pond as emergent structures so wildlife have places to sun and to seek cover. A good way to mimic nature's recipe for a healthy pond is to add a bucket of water from a nearby natural pond. Do not stock the pond with fish. Wildlife will eventually find the pond on their own. If aquatic plants are added, be sure to add only native species—these will offer the maximum benefits to local wildlife. Avoid exotic ornamentals.

6. **Take Safety Precautions.** Address safety concerns by educating students about potential risks. Student-made educational signs posted close to the pond are a great way to call attention to the presence of water. Another way to slow foot traffic and create a boundary between the pond and a playground area, for instance, is to install low fences or benches around the pond. Small ponds may also be created in courtyards where students are always visible. Another solution is to create a deep basin, and back-fill much of the basin with large rocks. This type of pond will support small aquatic species while remaining quite shallow (which will allay fears of potential danger to students).

should be no deeper than 3" and have gently sloping sides, with water less than 2" deep. In summer heat, be sure to replace water regularly and to keep birdbaths clean. In winter, if temperatures drop well below freezing, use a birdbath heater or remove ice in the morning and refill with water daily.

If a creek, stream, pond or wetland already exists on the schoolyard, consider enhancing or restoring that area. If a water body is not present, many schools choose to create a pond as part of their Schoolyard Habitats project. Ponds not only help support a greater diversity of wildlife, but expand opportunities for hands-on teaching and learning. Students with schoolyard ponds learn directly about everything from aquatic insects to water quality to physical science. A small pond built into the ground can provide water for drinking and bathing as well as cover and reproductive areas for small fish, amphibians, insects, and reptiles. Many birds and amphibians rely on insects that spend part or all of their life in the water. Observing naturally occurring local ponds will help students learn about the characteristics and life requirements of locally native aquatic plants and animals.

Some people are hesitant about creating a pond because they associate ponds with mosquitoes. Though some may see them as a nuisance, mosquitoes do help support many natural predators such as bats and dragonflies. In healthy ecosystems with plenty of native vegetation, mosquitoes usually do not pose any problems. If mosquito larvae are a concern, eliminate standing water by installing a small circulating pump.

Many certified National Wildlife Federation Schoolyard Habitats sites have installed ponds on their schoolgrounds. Whether they have removed a concrete courtyard, or simply converted an unused corner of grassy lawn, they are all now enjoying the wildlife that visit and make their homes in these ponds, and the instructional possibilities the pond provides.



## Cover

Wildlife needs protective cover from heat, cold, wind, rain, and predators. Many plants that offer food can also provide valuable escape cover for wildlife. Densely branched shrubs, evergreens, grasses, as well as hollow trees—upright and fallen—rock piles, brush piles, and stone walls can all provide cover for many animal species.

The ideal wildlife habitat area includes plants ranging in size and density from low ground cover to tall, mature trees. Arranging plants in groups that mimic the growth of plant communities (rather than in isolated islands) will increase the amount of cover provided. Increasing the diversity of plant species will increase the diversity of wildlife that is supported; this variety of plant life provides birds and other animals with a wide array of appropriate cover for feeding, hiding, courting, and nesting activities.

To add to the types of cover on the schoolyard, students can construct and erect nesting boxes for the resident or migratory songbirds, ducks, and bats that live in the area (these structures are also available commercially). Each type of wildlife nesting box has specific requirements; it is important to identify the overall box size, entrance size, design, and placement needed in order to successfully attract specific species. Following these specifications will both ensure that the box is usable by the intended species, and that the box is not unduly vulnerable to that species' predators.

### Resources for Nest Box Plans and Information:

- The U.S. Fish and Wildlife Service maintains an excellent list of how to attract and support 13 bird species through nest boxes: http://migratorybirds.fws.gov/pamphlet/pamplets.html
- Bat Conservation International provides detailed plans on its website for constructing bat boxes, bat conservation issues. Videos, books, and many other resources can also be ordered online: www.batcons.org
- The North American Bluebird Society provides thorough information about bluebirds and supporting local populations through bluebird boxes: www.nabluebirdsociety.org



## Places to Raise Young

To be complete, habitat areas must include safe places in which wildlife can raise their young. Examples include appropriate areas for nesting, specific plants upon which butterfly larvae depend, and the security of pond water for tadpoles.

Consider providing places to raise young through both vegetation and human-made devices. Attach birdhouses and nesting shelves to posts, trees, or buildings. Maintain as many snags (dead, standing trees with hollow cavities) as possible. Plant dense pockets of shrubbery to provide safe areas for many species of wildlife.

Some of our most interesting animals require a body of water as a safe haven for their young. Many salamanders, frogs, toads, and insects, like dragonflies and water boatmen, begin life in water and are unlikely to prosper on the schoolyard without the safe, healthy water environments that a clean stream or small pond can offer.

## Sustainable Gardening

A sustainable garden works in harmony with nature. In sustainable systems, plants are grown without depleting natural resources or contributing to pollution. And, in order for anything to be sustainable, it should continue for a long time. This means that it should sustain itself as much as possible, without constant inputs from you.

There are many techniques that can improve the health of the garden and minimize any negative impact on the environment.

### Mulching

Mulch helps keep water in the soil and available to the plant, rather than evaporating into the air. This can help **reduce water consumption.** As mulch breaks down, it provides nutrients to the soil, which can help reduce or eliminate the need for additional fertilizers. Be sure to use mulches that are from sustainable forestry practices (not Cypress tree mulch), and that are free from pests and diseases. Your cooperative extension office can help you find sources of mulch in your local community.

### Reducing Lawn Areas

Grass lawns often require chemicals and frequent maintenance. Gas-powered lawnmowers produce high amounts of greenhouse gases, which contribute to the air pollution that causes global warming. Since lawns are often made of only a few types of plants that most animals do not consume, they do not provide a lot of value for wildlife. **Replacing grass lawn** with native wildflowers, bushes, and trees provides the food, shelter, and cover that help to maintain healthy, natural ecosystems and reduces your time and labor working on the lawn!

### Xeriscaping

Xeriscaping is an approach to landscaping that minimizes outdoor water use while maintaining soil integrity through the use of native, drought-tolerant plants. This is a common practice in drier areas, such as the West and Southwest, where water supplies and water quality are in very short supply.

### Removing Invasives and Restoring Native Plant Communities

**Native plants** are better for the environment than exotic plants, generally requiring less fertilizer and other additives, less water, and less effort in pest control. They are especially important to native wildlife, such as pollinators, that may have coevolved with a particular species. Pollinators often rely on a certain type of flower as a source of food, while the flower depends on the pollinator to transport its pollen to other flowers for reproduction.

When **non-native plants** are used, they often times upset the delicate balance of a local ecosystem and sometimes even out-compete native species to the point of extinction. Wildlife benefit more when native plant communities remain intact, or are restored to their natural habitats, providing the best source of food for wildlife.

# Butterfly Gardening

Once the habitat basics of food, water, cover, and places to raise young are understood, it becomes much easier to identify and provide for the needs of local wildlife. Engage students in learning about the specific needs of various local species. Because so many schools decide to attract and support butterflies as part of their Schoolyard Habitats project, following are suggestions for creating butterfly habitat.

A butterfly garden is a great addition to any habitat project, no matter how large or small. Beyond the beauty butterflies bring to a schoolyard, they also play a key role in ecosystems by pollinating plants. Studying butterflies is an excellent way to teach concepts of life cycles, the importance of biodiversity, and interdependence of species in a hands-on way. Butterfly gardens can be created in a small area; many schools plant butterfly gardens in courtyards or close to windows so that their activity can be easily observed. In order to attract butterflies, your Schoolyard Habitats site will need to provide places for them to sun, sources of nectar, food sources for caterpillars, and access to water.

Butterflies are often found resting in sunny patches: they use the sun for orientation and to regulate body temperatures. Like all insects, butterflies are *ectothermic* (they do not produce their own body heat). They fly best when their body temperature is between 85-100°F. (Students may notice that butterflies are not very active on cloudy days).

To provide sunning spots for butterflies, place large, flat stones in the schoolyard. If necessary, remove a little soil to stabilize the rock. Also make sure the selected vegetation is planted in an area that receives sun for most of the day.



Minerals are an essential part of male butterflies' diet. These minerals are readily available dissolved in water, especially water existing in puddles. The large surface area-to-volume ratio of shallow water allows for greater evaporation, which concentrates the dissolved minerals in the remaining water. Butterflies do not need a large amount of water; in fact they quickly expel most of the water they uptake, primarily retaining dissolved minerals.

Students can make one or more butterfly puddles by creating a small depression in the ground and allowing them to fill with water. As part of ongoing site maintenance, students should check on the puddle during dry periods, and spray periodically with a hose.

Another way to provide water is to dig a hole in the ground to accommodate a container. Place the container in the hole, level the ground to the top of the container and fill with rocks and soil. Fill with water until the soil becomes saturated and there is standing water at the surface. Be sure to check for water periodically.

When selecting plants for a butterfly garden, be sure to choose locally native plants that provide both nectar plants for the adult butterfly, and leafy host plants for eggs and caterpillars. Overlap the blooming time of the flowering nectar plants; butterflies require a nectar source throughout their adult lives. Be sure not to use chemical or biological pest controls on or around the plants in the butterfly garden, as these can be fatal to butterflies and their larva. Plant the vegetation in a sunny spot that is protected from the wind.



Butterflies visit and pollinate hundreds of flowers. Common nectar plants include: aster, joe-pye weeds, milkweeds, black-eyed susan, phlox, butterfly-weed, purple coneflower, sweet pepperbush, sunflowers, cardinal flower, goldenrod, and many, many more. Your local nursery or native plant society will be able to recommend plants appropriate for your region.

The chart below summarizes common butterflies that have ranges throughout most of the U.S. and the plants that are required for their respective caterpillars.

Many lessons can be learned from observing the life cycle and changes of butterflies. The importance of biodiversity is illustrated by different plant requirements of the larva, and adult stages. The relationship between plants and butterflies is a great example of interdependence; the plants need butterflies for pollination and butterflies need plants as food sources and places to lay their eggs.

There are two formal international programs that support butterfly monitoring by students; see *Monitoring Projects* (p. __) for more information.

**Butterfly Caterpillar Food Source**

| | |
|---|---|
| American Painted Lady | cudweeds, everlasts, antennarias |
| Cabbage White | many plants in the mustard family and nasturtium |
| Clouded Sulphur | clovers |
| Gray Hairstreak | many pea and mallow family members; many others |
| Monarch | milkweed family, esp. swamp milkweed and butterflyweed |
| Mourning Cloak | willows, American elm, quaking aspen, paper birch, hackberry |
| Painted Lady | thistles, mallows, nievitas, yellow fiddleneck |
| Pearl Crescent | asters |
| Red Admiral/ White Admiral | wild cherries, black oaks, aspens, yellow and black birch |
| Spring Azure | dogwoods, wild black cherry, viburnums, staghorn sumac, others |
| Viceroy | willows, cottonwood, aspen |

# Restoration Projects

Many schools with larger amounts of land focus their Schoolyard Habitats efforts on restoring local ecosystems and enhancing these areas. School communities across the U.S. have joined together to restore prairies, wetlands and forests on or adjacent to school property.

Those with intact ecosystems on site can study these areas and identify ways in which these areas can be enhanced to improve the habitat value for local wildlife. As with all Schoolyard Habitats projects, tapping into community resources and expertise is essential.

## A Teacher's Story: Engaging Iowa Youth in Schoolyard Prairie Restoration by Michael Blair

(Excerpted from Habitats Newsletter, NWF, Summer 2001)

In 1991, after working for four years in Honduras, I decided to return to Des Moines to teach. I was assigned to a 7th grade science position at Hoyt Middle School. Drawing on my experiences in Central America, I expanded on the standard tropical rainforest unit and engaged the students in fund-raising activities to buy acres of rainforest. Around that time, I learned that 200 years ago, 85% of Iowa was covered in prairie but that today, less than 1% of the original prairie is left. It occurred to me one day: What if someone in Brazil started buying up Iowa farmland and turning it into prairie? I created an open-ended lesson on the effect this would have on Iowa. After the lesson, many students felt strongly that we needed to take care of our environment before we started telling others what to do with theirs.

Together, we decided that reconstructing a prairie was the best way to understand one; by doing so we would also be giving future students an outdoor laboratory. For me, there is no other way to teach than to have the students experience things first hand and to make it relevant to them. I had no prior experience with prairie restoration but learned along with the students.

During the following year, my at-risk students in our School-Within-A-School program researched prairie reconstruction methods. One group studied the kinds of plants that grew locally 200 years ago; a second researched the best ways to prepare the land and to plant the seeds; and the third group raised money and kept track of the finances. The principal obtained donations and the teachers adapted their curriculum to focus on the prairie across the disciplines. Although I was transferred

*continued*

***A Teacher's Story—continued from page 36***

a year later, the teachers that followed me expanded the prairie to three times its original size.

At my current school—Roosevelt High School—my students and I have established the 3,600- square-foot "Sunflower Prairie." The students help to maintain the prairie and use it in the fall and spring for a variety of activities: biology classes can be found studying the plants and animals in the prairie, while English classes read prairie literature under the sunflowers.

The prairie projects have given me a greater awareness of how much we have lost in Iowa over the years. My students and I are learning new things virtually every day. Through these projects, the students and community have become aware that a prairie is not just a weed patch but something of great value and beauty. Former students continue to feel a sense of stewardship; they tell me they stop by the prairies to see how they are doing. One day, a year after I left Hoyt Middle School, I stopped by to see how the prairie was progressing. Before I got to the prairie, I saw two little girls jump off their bicycles and run into the prairie to play hide-and-seek. I knew from that point on that this prairie would have the support of future generations of students.

# Soil

Soil is the basic building block of any Schoolyard Habitats project, it is needed to provide plant material with micronutrients, air, and water. Soil is composed of living and non-living material. It is about 25% water, 25% air, 45% mineral (rock particles), and 5% organic matter. Organic matter is made up of decaying plant and animal matter. Bacteria and fungi live in this orgainic matter and change it; along with the minerals, air and water into forms that plants can readily use to become healthy food and cover sources for wildlife.

## Soil structure

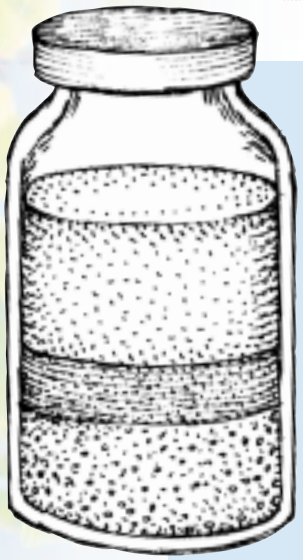
The ideal soil for your project site is loam. It is dark in appearance, crumbly to touch, slightly moist. Loam contains less than 52% sand, between 28-50 % silt, and 7-27% clay.

All soil is composed of sand, silt, and clay. These distinctions are made by particle size only, with sand being the largest and clay the smallest. The particle size of soil components determines the soil structure, which affects how well water is retained, how much air is in the soil and how easily minerals are released for uptake. Younger students can collect soil samples from the schoolyard, and create charts indicating what they find in their sample on close inspection (i.e. pine needles, rocks, worms, etc.). Basic information about soil structure can also be gained by conducting the Squeeze Test or Jar Test. (See boxes p. X)

## pH

Most plants thrive in soils with a pH between 6 and 7. The pH of the soil greatly affects the activity of soil organisms and the availability of nutrients. For example, when the pH is lower than 6 some nutrients become less water soluble, therefore less available for uptake by plants.

Engage students in testing the pH of the soil. Prepare a soil slurry with some distilled water and soil in a clean dish. It should have the consistency of thick mud. Let the slurry stand for one hour. Then put a strip of litmus



### Jar Test

A test for determining soil composition is the glass jar test. Obtain one cup of soil; remove any pebbles, debris, leaves, or roots. Break up any lumps. Place the soil in a glass jar with a tight fitting lid. Add 1-2 cups water. Shake the jar vigorously until the soil is suspended. After one minute measure the amount of soil that has settled with a ruler, this is the sand content. After one hour measure the amount of soil that has settled, subtract the amount of sand. This is the silt content. 24 hours later measure the total amount of soil settled, subtract the amount of sand and silt. This is the clay content of the soil. Divide the depth of each layer by the total depth of the soil, and then multiply by 100 to get percentages of soil components. Ex: .5"/3" x 100 = 16.6 % sand/silt/clay.

### Squeeze Test

Grab a small handful of soil. Make a fist and release. If the soil falls apart and feels gritty, it is sand. Sandy soil has quick drainage and low nutrient levels, requiring frequent watering and fertilization. If the soil has a slippery texture and slides apart, it has a high percentage of silt. Silty soil has poor drainage and moderate ability to retain nutrients. If the soil retains it shape after it is squeezed and is sticky when wet it is mostly clay. Clay is rock-hard when dry; it can store nutrients, but roots and water have difficulty penetrating it. Loam is a mixture of all three of these particles. It has a crumbly texture with some grittiness and some stickiness.



paper in the slurry and leave it there for one minute. Rinse off the paper and compare the changed color to the kit's litmus chart to determine the pH.

## Nutrients

The three nutrients that plants use most are nitrogen (N), phosphorous (P), and potassium (K). Nitrogen is responsible for leafy growth and the dark green color of leaves. Phosphorus encourages plant cell division. It is necessary for flower and seed formation, helps roots grow, and protects plants from disease. Potassium also encourages root growth and protects against disease. It is an important nutrient for the process of photosynthesis.

Micronutrients, while used in smaller quantities, are equally important to the growth of healthy plants. There are 10 micronutrients that are derived directly from minerals and decaying plant matter: calcium, magnesium, sulfur, iron, copper, manganese, boron, chlorine, zinc, and molybdenum. Carbon, hydrogen and oxygen are essential for plant growth, but these nutrients are found in the air spaces in the soil structure, not the physical soil itself.

# Composting


A great way to enhance the richness of soil and to add nutrients and micronutrients is to apply compost at least once a year. Composting food scraps and yard waste also reduces the amount of solid waste going to landfills. An estimated 3/4 of solid waste produced in the U.S. is comprised of organic material that could easily be composted.

Composting will also save your school money that may otherwise be spent on fertilizers and soil. Composting can be a great illustration of concepts such as nutrient cycling and decomposition. For information on constructing or purchasing a bin, see the Resource section at the end of this section.


Materials for composting are split into two groups: greens and browns. Greens are materials that are high in nitrogen and browns are high in carbon. An ideal ratio for an optimal compost pile is 30 p carbon to one part nitrogen. The closer to this ratio, the higher the temperature of the pile and the more quickly materials will decompose. This figure is based on weight, not volume. Generally, if you have equal amounts of greens and browns by volume, the pile should operate well. High nitrogen materials, such as fresh cut grass, should be used in a smaller ratio (40:60).

| GREENS (nitrogen) | BROWNS (carbon) |
|---|---|
| fruit | straw |
| vegetables | fallen leaves |
| hair clippings | shredded newspaper |
| tea/ coffee grounds and filters | dried prunings |
| fresh yard clippings | corn stalks |

**Materials that should not be composted**

| | |
|---|---|
| meat | dairy products |
| oils (butter, mayonnaise) | pine needles |
| bones | dog or cat manure |
| barbecue ashes/coal | forks, knives, etc. |

Shred coarse material before placing in the bin, this will increase the surface area of the material and lead to quicker decomposition.

Some schools collect their "greens" (fruits and vegetables) in the school cafeteria, which both reduces the amount of school waste, and helps create more compost. After educating the school community about the purpose of composting, and



exactly what can and cannot be added to the compost, consider placing a bucket with a tight fitting lid (pickle buckets work well) next to the trashcans in the cafeteria to collect melon rinds, vegetable scraps, etc. The contents of these buckets should be added to the compost pile daily to avoid any unpleasant odors.

Locate the bin in a shady, well-drained area. The bin should either be placed on top of, or the bottom should be made of wooden slats, leaving spaces for air to flow through the pile. The micro- and macro- organisms living and working in the compost pile need air to survive and work efficiently. Allowing airflow will also reduce unpleasant odors, but take care not to leave holes that are large enough for rodents to get in. Some composters in urban areas use wire mesh to make or line compost bins to prevent rodent visitors.

Begin the pile with a layer of browns at the bottom; moisten this layer. A compost pile should consistently be as "wet as a squeezed out sponge." Add a green layer. Build as many layers possible with your materials. The layers should be spread out well and not too deep. Always make sure the top layer is made of browns and that it completely covers the lower layers. This will discourage odors and pests. Mix the pile thoroughly every week or two. The compost is ready for use when the materials have all broken-down into a crumbly soil texture.

## Worm Bins

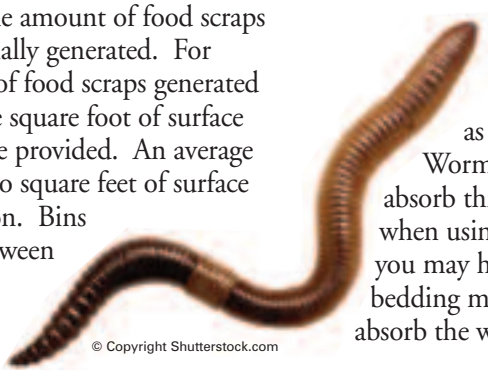
Vermiculture is both the art of worm composting and the resulting worm castings, which are the best fertilizer available. Vermiculture is a popular way to compost in a school setting because it can be done inside in compact containers. It is also a great way to demonstrate on a small scale how to provide habitat for creatures. For a worm bin to work you will need to understand and provide the proper food, water, cover and places to raise young that the worms and microorganisms require to survive in your classroom.

To determine the size of the worm bin, survey the amount of food scraps that are normally generated. For every pound of food scraps generated per week, one square foot of surface area should be provided. An average estimate is two square feet of surface area per person. Bins should be between 10-18 inches deep with a tight-fitting lid and holes in the bottom or side for ventilation. Keep the holes 1/4" or smaller to keep bugs out. There are many low-cost, pre-made bins on the market (see Resources p. x).

Make a worm bed by placing 1" strips of newspaper or shredded cardboard or peat moss in the bin, filling it 1/3 to 3/4 of the way full. Moisten the bed and add a few handfuls of soil.

You will need to get some red wigglers (*Eisenia fetida*). Red wigglers are the worms that can often be found just at the soil's surface eating leaves or manure. They are the best for worm bins because they can withstand warmer temperatures than other earthworms. These worms can be obtained from a bait shop, a friend's vermiculture bin, or by mail order. General guidelines are 1 pound of worms to every 3.5 pounds of food. Place the worms in the bin and give them about 1 pound of food scraps initially. Leave them alone for a few weeks; allow them to get used to their new home. After the first few weeks, the worms should be able to handle about 1 pound of food scraps per square foot of surface area per week. Always bury fresh food scraps under the bedding to eliminate fruit fly problems.

Keep the bedding moist, but not wet. Apply the same rule as for other compost piles—as wet as a squeezed out sponge. Place the bin where it will not freeze or overheat. Temperatures over 84°F are fatal to red wigglers.





The kitchen scraps that are added to the bin will add moisture as they decompose. Worm bins should be able to absorb this excess moisture, but when using plastic or metal bins you may have to add some more bedding material periodically to absorb the water. If the bins are

located outside, holes can be drilled in the bottom for drainage. The bin will give off a mild odor if it is too wet. Adding shredded newspaper will eliminate this problem.

The worm bin should be harvested at least once a year. It can be harvested as quickly as 2-3 months after the bin is set up. To harvest, simply reach in and scoop out the compost worms and all. Sprinkle the compost around (but not covering) the base of plants, 1/4" to 1" thick. Or blend the compost into soil using no more than 20% compost.

When adding new plants to the schoolyard, add compost or vermiculture to the habitat's existing soil; be sure to add less than one-half the volume of the existing soil. If you place the "good" stuff only around new plants the roots may refuse to spread into the pre-existing, untreated soil.

## Suggested Resources

**Acorn Naturalists**
17821 East 17th Street, #130
PO Box 2423
Tustin, CA 92781-2423
1-800-422-8886
www.acornnaturalists.com

Supplies many teaching tools including worm bins and vermiculture and composting books.

**Let's Get Growing**
1900 Commercial Way
Santa Cruz, CA 95065
1-800-408-1868
www.letsgetgrowing.com

Supplies materials for composting, soil studies, and general gardening resources.



**Mastercomposter.com**
Online organization that serves as a clearinghouse for composting information. Directory for local programs, places to buy tools, bins, worms, and much more.
www.mastercomposter.com

**University of Missouri Cooperative Extension**
www.muextension.missouri.edu/xplor/agguides/hort/g06956.htm

Comprehensive site with technical information.

# Container Gardening

Limited space is a reality for many schools, and a large-scale Schoolyard Habitats project may therefore be impossible. Some schools simply have limited property, while others have dedicated much of their land to parking areas or playing fields. The common problems of limited space and/or poor soil can be overcome by maximizing the small strips of land which are available, and by complementing these areas with wildlife-attracting plants in containers. Growing plants in containers is also a good way to curb competition from weeds. Many schools have grown thriving habitats on top of asphalt, rooftops, and paved courtyards in this way.

## Container Selection

In selecting containers, there are many options including the traditional clay or plastic pots available at any nursery. When buying plastic containers, avoid dark colors that will absorb sunlight, and overheat the plants' roots. Containers must have drainage holes which are large enough for water to drain through, but small enough so that soil is not lost through the openings. If the container has holes that are too large, place a layer of gravel over the opening. This will prevent soil from washing out of the container.

The size of the container should be appropriate to the size and number of plants that will be placed in it. Plants are ready to be transplanted to a larger container when they become root bound. Carefully hold the container upside down and gently slide the plant out. If the roots are crowded along the sides and bottom of the plant, it is ready to be transplanted. Plant in a container that has a circumference about two inches larger than the current pot. Fill the container part way with quality soil. Place the plant in the center, keeping the soil level about two inches below the top of the container. This will prevent the soil from washing away during watering. Fill in the sides of the container with more soil, and pack the soil down lightly.

Another option is to build your own wooden planter boxes. When selecting lumber, choose wood that naturally resists the damaging effects of water, such as cedar and redwood. Avoid wood treated with preservatives containing pentachlorophena or arsenic. This chemical is toxic to plant life. Containers holding large trees should be built so they are easy to take apart (i.e. with nuts and bolts) for periodic root maintenance.



To make containers accessible for those in wheelchairs, mount the containers on sawhorses or wooden legs. Raised beds should have 27" clearance from the ground to the bottom of the bed to be wheelchair accessible. For more information on accessible gardens, visit the American Horticultural Therapy Association's website at www.ahta.org .

*"Our Roof Garden location was selected because it is our only possibility for green space. The nearest park is a gated one, and therefore, we have no access to natural spaces without hopping on the bus or subway. Our location is so man-made, that I find it imperative to connect students with the natural, living world; with the growing loss of community gardens in New York City, we are forced, not unhappily, to look skyward for green solutions."*

*--School of the Future, New York, NY*

## Soil and Water for Container Plants

Soil drainage is important in all gardening, and especially so in container gardening. Make sure your containers allow excess water to flow through, since water trapped at the bottom of the plant can harm, and eventually kill, some plants. To ensure proper drainage, buy pots with drainage holes or drill holes into your containers and planter boxes.

A mix of organic matter, vermiculite and peat moss will provide good soil structure and proper drainage. Contact your local nursery or cooperative extension office in choosing the proper mix for your plants. These supplies can usually be purchased in bulk quantities at garden centers or nurseries. Since plants grown in containers live in limited amounts of soil they dry out quickly and need to be watered often. Frequent watering, though necessary, leaches nutrients out of the soil. Replace the lost nutrients by supplementing the soil with compost, manure, or another natural fertilizer at the start of each growing season.



## Rooftop Gardening

If your school has limited land to use for creating a wildlife habitat and outdoor classroom, consider creating a garden on the school rooftop. Be sure to include the maintenance facilities personnel in early discussions. Roofs must be checked for stability and leaks. Some roofs also need to be protected from foot traffic. Plants will be exposed to more wind and sunlight on the roof than they would be at ground level. To compensate for this, choose hardier plants. Simple structures such as wooden trellises or burlap screens can provide some wind protection and areas of shade.

## Suggested Resources

To learn about the City of Chicago's efforts to reduce energy demand and improve air quality through **rooftop gardens**, visit:
www.ci.chi.il.us/Environment/html/RooftopGarden.htm
Also visit the Rooftop Garden Resource Group at
www.interlog.com/~rooftop

**National Gardening Association**
Online catalog offers several containers and kits for easy-to-construct planter boxes.
www.kidsgardening.com.