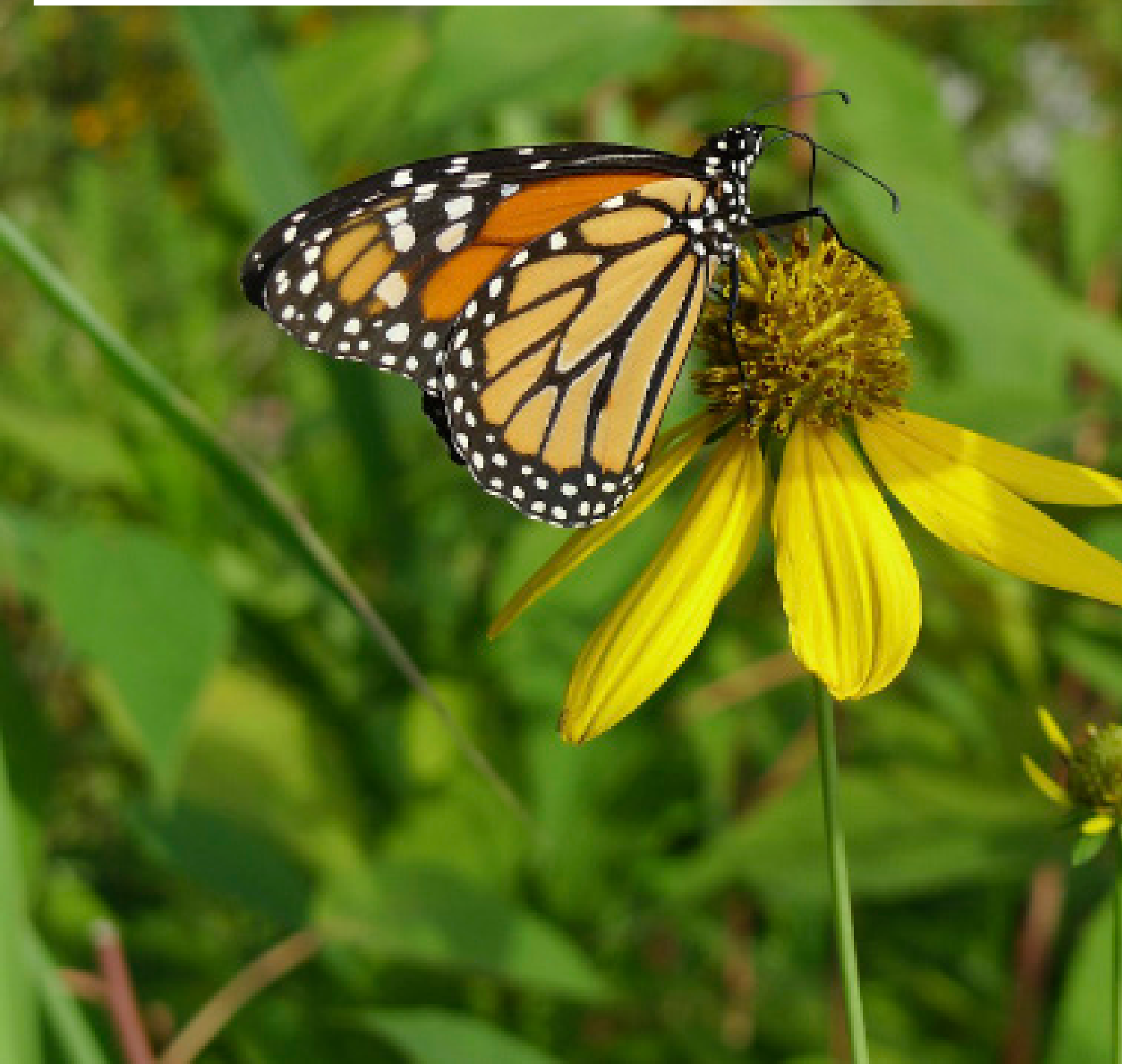
LANDSCAPE FOR LIFE™

Based on the principles of the Sustainable Sites Initiative™

Student's Manual

www.landscapeforlife.org

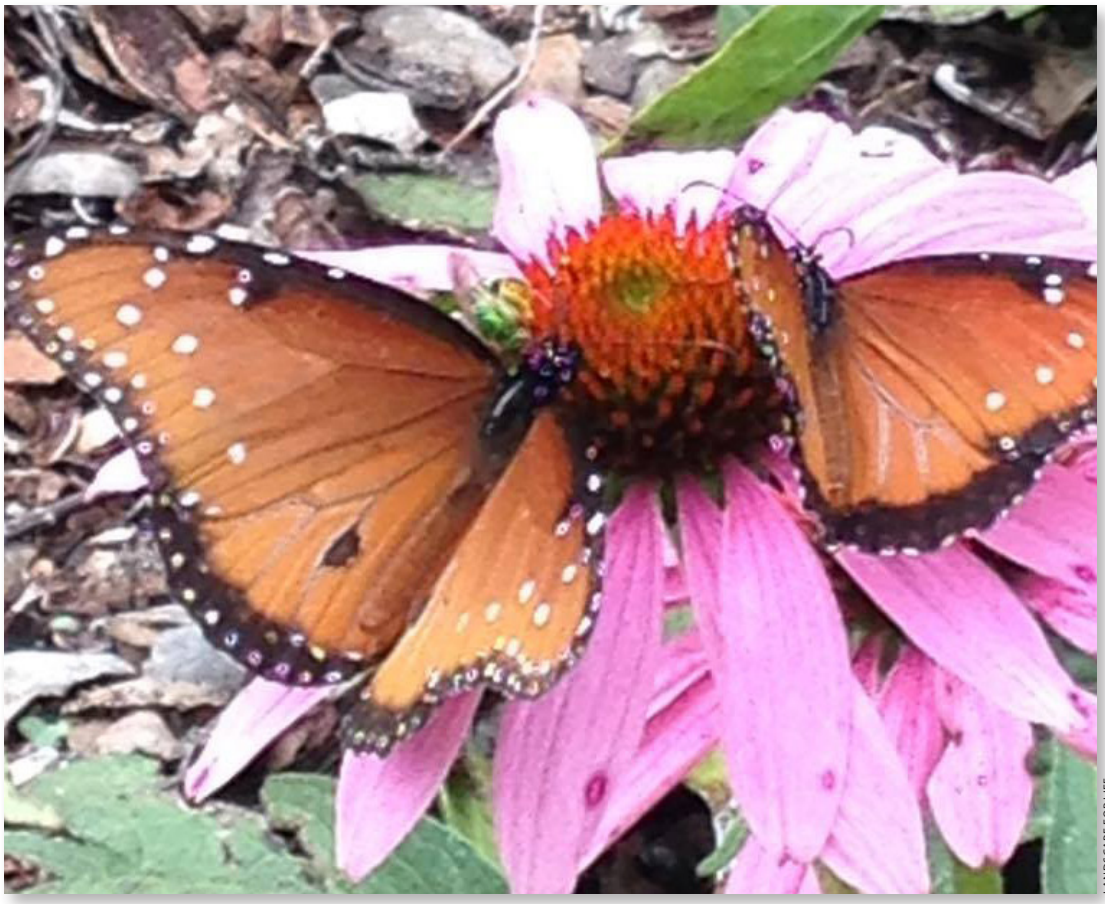


Lesson 11
The Role of Pollinators in Sustainable Gardens

Learning objectives

After completing this lesson you will be able to:

- ☐ Provide a basic explanation/ overview of common pollinator species
- ☐ Provide examples of ecosystem services provided by pollinator species
- ☐ Compare and understand unsustainable and sustainable gardening practices and effects on pollinator health
- ☐ Explain how home gardens and the larger pollinator network interact



LANDSCAPE FOR LIFE

Overview

According to a 2012 study by the United States Department of Agriculture Economic Research Service, residential areas in the United States are estimated to make up a total of 103 million acres of land. That's an area of land equal to the entire state of California. While these landscapes provide for an array of services for humans, pollinator species also make use of these landscapes by finding food, water and shelter, and in doing so they help maintain many essential functions necessary for the health of human habitats and our ecosystems at-large. Without these insects and other animals, the vast majority of plants that provide food, clean our air and water, stabilize our soil, sequester carbon and do many other valuable ecosystem services could not survive. Therefore, home gardens have a tremendous amount of potential for fostering pollinator habitats and ensuring the health, safety and future populations of pollinator species.

Two types of pollination occur in plants, abiotic and biotic. Abiotic refers to the type of pollination that takes place without the involvement of other organisms. In this situation plants are pollinated primarily by wind or water, and it most often occurs with plants like grasses, sedges, conifers and many deciduous trees. Biotic pollination, which is more commonly found in the plant kingdom, requires the assistance of pollinator species to transfer pollen from one plant to another.

It is estimated that about 90% of wild flowering plants depend on biotic pollination, such as that provided by bees, butterflies, wasps, moths, birds, bats and many other animals. Beyond that, approximately 100 different food crops produced in the U.S. depend primarily on biotic pollination, as well as 25% of birds and some mammals that also depend on the fruit and seed provided by these flowering plants. Yet, there has been a significant population decline of pollinator species in the past three decades due largely to habitat loss and degradation. The primary stressors of such include the loss of breeding habitat due to agriculture and other land conversions, including both rural and urban developments, logging and deforestation at overwintering sites (particularly for Monarch butterflies), pesticide and fertilizer use and extreme weather conditions. Although we may not all be directly associated with any one of these stressors, we all are indirectly connected and thus must take responsibility and action to implement solutions.

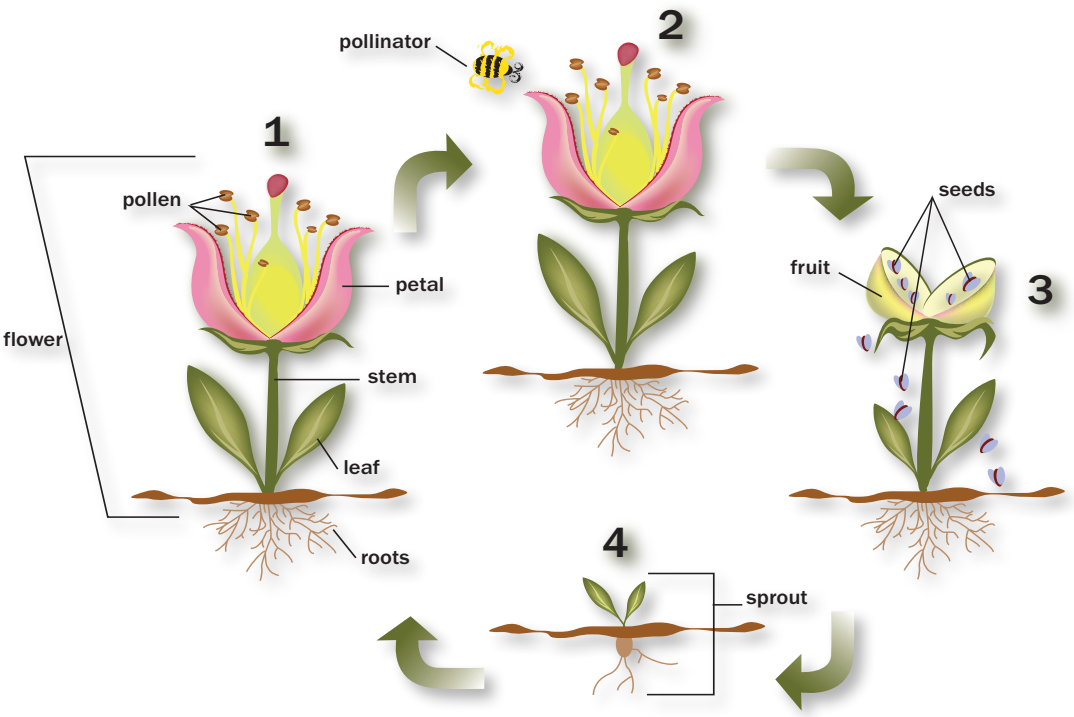
This lesson is focused on the role of pollinator species and how their needs can be met in relation to the needs of flowering plants, and in tandem can equip home gardens to provide an essential role in the health and protection of pollinator species, particularly those that migrate. We will discuss what's necessary to attract pollinator species to a home garden, the ecosystem services pollinators provide to you and your community and how you can foster the conservation and restoration of pollinator habitats.

"MONACRCH BUTTERFLY" via flickr.com Paul VenDerWerf

The importance of creating pollinator gardens and habitats

Pollination is a biological process that the majority of plants undergo for reproduction. The process involves the transportation of pollen grains from one flower's anthers to another flower's stigma. If fertilization occurs, seeds will be produced. Since plants are non-modal, they have developed two primary ways to pollinate: wind pollination (abiotic) and animal pollination (biotic). The United States Department of Agriculture states about 90% of all flowering plants and over three-quarters of the primary food crops (i.e. staple crop plants) rely on pollinators. The reason is because animal pollinators can carry pollen on their bodies while traveling from one plant to another, a more efficient way for the plant to get fertilized (compared to wind pollination, where many pollen grains are lost in the scatter shot and do not make it to their intended destinations).

Natural habitat areas necessary to support pollinators and this important pollination process have decreased significantly due to land development, reliance on lawns, and monoculture farm crops. Residential gardens and landscapes are critical to providing pollinators the essential elements of habitat, food, water, cover and places to raise young. Providing these elements in a sustainable, chemical free manner is key. Plants provide food resources they need to survive. For example, in the case of bees, the animal gets protein from the pollen it eats and in the process of foraging, incidentally transports pollen from one flower to another. Bees also rely on nectar; a sugary secretion produced by the plant. Nectar is utilized as an energy source, though bees are not as dependent on it as much as other pollinators, such as wasps, butterflies, moths, or hummingbirds.



POLLINATOR PARTNERSHIP

Pollinators rely on plants to provide them nutrients for their survival, while the plant species rely on pollinators to deliver pollen and ensure their long-term survival.

This symbiotic relationship provides many foundational ecosystem services in our natural environment. Beyond the key ecosystem service role of providing a nutritious supply of fruits, vegetables, and nuts to the world's population, pollinators help maintain native plant communities, which provide a variety of other ecosystem services, such as:

- Carbon sequestration
- Water filtration
- Erosion control
- Ecological biodiversity
- Soil health
- Urban heat island reduction

BRUCE LEANDER

Unsustainable vs. Sustainable Gardens: How They Compare POLLINATORS

Unsustainable Gardens	Sustainable Gardens
Plant diversity is minimal, and nonnative and ornamental invasive plant species are used in the garden.	*Diverse flowering native plant species and communities make up the garden*
All soil is heavily covered with mulch or planted.	*Among planted areas, bare soil is unaltered and left as nesting habitats or mud sources for pollinator species.*
Pools or dishes of drinking water are not provided.	*Many intentional water sources are provided, such as birdbaths, ephemeral pools, shallow dishes and puddling places, and the water is replenished regularly*
Thickets or hedges are frequently maintained as uniform shapes, requiring maintenance practices that affect pollinator activities, such as seeking shelter or nesting.	*Native plants are used as thickets or hedges to act as wind-blocks, nesting habitats and protection from predators, and are not cut back during pollinator activity.*
Lawns are large expanses of single species grass, highly maintained, irrigated and fertilized.	*Lawns are reduced in size, diverse in plant species, including some flowering ground cover or forbs that are beneficial to pollinator species.*
Lawn area is fertilized and chemically treated to remove weeds and other unwanted pests, which can be toxic to pollinators.	*Unwanted weeds and pests are removed by hand or other non-chemical procedures. Chemical spot treatment may occur, but is infrequent and rare.*
New plants introduced to the garden have been grown in the nursery using neonicotinoids or other harmful pesticides, which can be absorbed into plant tissue and can be present in pollen and nectar, making them toxic to pollinators.	*New plants are purchased from nurseries that use less detrimental practices to treat plants during production.*

Pollinator syndromes

Pollinator syndromes are the various traits that flowers have evolved in response to natural selection by pollinator species. In order to attract a particular pollinator, plants have developed certain syndromes, such as flower type, shape, size, color, odor, pollen or nectar and the amount. The types of syndromes vary throughout the plant kingdom, and can be identified as a predictor of what type or types of pollinators will visit the flower. For example, red, tubular flowers with generous amounts of nectar attract hummingbirds, while red or bright orange flowers with flat petals attract butterflies because they offer a landing platform for the pollinator to rest while gathering nectar and pollen. Pollinator syndromes are often defined by the pollinator species that visit the flower. These syndromes are an indication that plants continue to evolve in order to attract the most effective pollinators to aid in plant reproduction. In particular, native plants have evolved to provide efficient syndromes to attract particular pollinators native to the same locale. The most common pollinators are bees, wasps, butterflies, moths, birds, bats and flies, and many of their pollinator syndrome preferences are described below. Science is still studying pollinator syndromes and why different pollinators are attracted to varying syndromes, however, for the most part these syndromes have evolved as a means for most efficiently attracting a pollinator for plant reproduction while simultaneously providing the food and energy needs for the health and livelihood of the pollinator that visits the plant. Let's take a closer look at some of these common pollinators and compare the pollinator syndromes they are attracted to so you can more easily plan your garden for these valuable helpers.

Pollinator Syndrome Traits Table

Trait	Bees	Butterflies	Moths	Birds	Bats	Beetles	Flies
Color	*Bright white, yellow, blue or UV*	*Bright, including red and purple*	*Pale and dull red, purple, pink or white*	*Scarlet, orange, red or white*	*Dull white, green or purple*	*Dull white or green*	*Pale and dull to dark brown or purple; flecked with translucent patches*
Nectar Guides	*Present*	*Present*	*Absent*	*Absent*	*Absent*	*Absent*	*Absent*
Odor	*Fresh, mild, pleasant*	*Faint but fresh*	*Strong sweet; emitted at night*	*None*	*Strong musty; emitted at night*	*None to strongly fruity or foul*	*Putrid*
Nectar	*Usually present*	*Ample; deeply hidden*	*Ample; deeply hidden*	*Ample; deeply hidden*	*Abundant; somewhat hidden*	*Sometimes present; not hidden*	*Usually absent*
Pollen	*Limited; often sticky and scented*	*Limited*	*Limited*	*Modest*	*Ample*	*Ample*	*Modest in amount*
Flower Shape	*Shallow; have landing platform; tubular*	*Narrow tube with spur; wide landing pad*	*Regular; tubular without a lip*	*Large funnel like; cups, strong perch support*	*Regular; bowl shaped – closed during day*	*Large and bowl-shaped*	*Shallow; funnel like or complex and trap-like*

US FOREST SERVICE AND POLLINATOR PARTNERSHIP

Common pollinators

NATIVE BEES AND HONEYBEES – In the United States, there are more than 20,000 types of native or "wild" bee species. Native bees are considered to be the most vital pollinators because of their proliferation and ability to perceive, discriminate between and remember the characteristics of flowers. All bees are attracted to bright white, blue, yellow or light colored flowers, but are also able to see ultraviolet light, making them more efficient at finding the center of the flower. This ultraviolet pattern apparent in many flowers is called a nectar guide. The nectar guide benefits both the flower and the bee by directing the bee to the center of the flower to deliver the transported pollen to its reproductive parts, which also happens to be where the bee can more rapidly collect the nectar it needs. Native bees are very important to the pollination of many plants; specifically native wildflowers, shrubs and flowering trees, but some beekeepers use domesticated native bees for food crop pollination. Native bees are widely varied in their shape, size and colors, and their life styles, nesting habits and seasons of activity are just as varied. Most often going unnoticed or ignored, native bees play a large role in maintaining native plant communities, which contribute to a variety of valuable ecosystem services.

BRUCE LEANDER

Honeybees, on the other hand, while still attracted to the same pollinator syndromes as native bees, are largely used in the agricultural industry and are critically important for the pollination of the many fruit, vegetable and nut-producing plants. In fact, a 1999 Cornell University study documented that the contribution made by managed honeybees hired by U.S. crop growers to pollinate crops amounted to just over $14.6 billion. There are over 2 million colonies of honeybees in the United States, most of which travel the country each year pollinating crops and producing honey and beeswax.

WASPS – Wasps are important pollinators because of their proliferation and variation in size and shape. They are also closely related to bees and ants, however, since wasps are generally not as abundantly covered with fuzzy hairs like bees and some ants, they are less efficient in pollinating flowers because pollen is less likely to stick to their bodies and be transported from one flower to another. Wasps are still able to transport pollen from one plant to another that is collected on their bodies during the hunt for nectar, but their yield is not as great as that of a bee. Although wasps often come with a fear factor stigma due their presence and harsh, unfortunate sting, they do play another important role in the garden. Because they are a predatory species, wasps feed on aphids and other insects in the garden that might otherwise destroy the crops of vegetables, fruits and other flowers. When left alone or untampered with, wasps are diligent workers in the garden pollinating plants and keeping other pests away.

Wasps have very high-energy needs, similar to those of bees; therefore they need a large quantity of pollen and nectar to sustain their survival. Wasps are attracted to highly fragrant flowers and those that produce large quantities of nectar. Also similar to bees, wasps are more attracted to flowers of blue, white and yellow colors and generally tend to avoid red flowers.

BUTTERFLIES – Butterflies provide a flurry of activity in a garden during the day, visiting numerous species of native wildflowers and other nectar producing plants. Although a garden favorite, because of their long, thin legs they don't pick up and carry as much pollen on their bodies, which makes them a less vital pollinator. However, butterflies have better color perception than bees, which makes them attracted to bright red, orange and purple flowers, and in turn they provide pollinating services to many different plants not often pollinated by bees or other common pollinator species.

Butterflies play another significant role though, serving as an indicator of biodiversity and ecosystem health simply by their presence in the garden or landscape. In the case of Monarch butterflies, much of their life is spent completing an annual migration over the course of multiple generations. This migration happens either across North America between Canada and Mexico (southern migration), or between the Rocky Mountains and groves in California (western migration). Because of their ability to travel long distances, butterflies provide pollination coverage to a larger scale and in more equal amounts for many types of flowering plants. When an area or an ecosystem is devoid of butterfly presence, it is largely due to land conversion for agricultural uses, urban and suburban development, logging or use as grazing lands; practices that eliminate necessary habits – primarily food sources – for these pollinators.

MOTHS – Moths, along with bats, take the night shift when it comes to providing pollinating services. The majority of moths are nocturnal, pollinating nocturnal flowers that are pale or white and easier to see at night, are strongly fragrant and easier to locate in dark conditions and offer an abundance of nectar. Moths activate the garden in the evening and provide pollination for many plants that have long, tubular, pale colored flowers, or other plants that do not offer a landing platform. Moths have the ability to hover and their long proboscis allows them to access the nectar deep inside a tubular flower. Moths are often found inside a tubular flower, where their hairy bodies collect pollen and transport to another flower, but the tubular flowers also offer protection to the moth from predator species like birds or bats that hunt at night. Moth pollination is much more prevalent in the South, where temperatures and climates are more conducive to offering warm evenings.

"HUMMINGBIRD" via Flickr.com gardener41

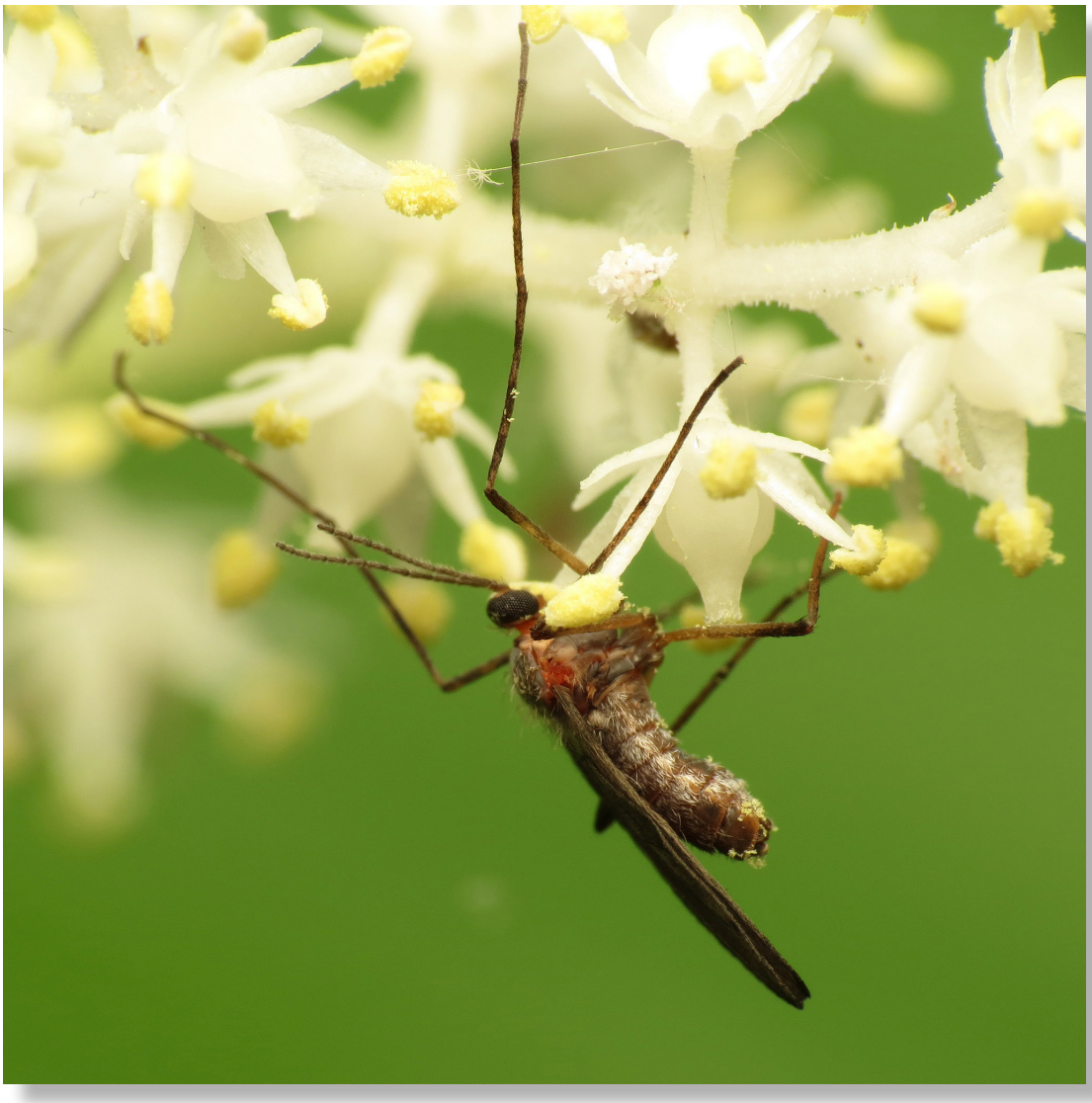
HUMMINGBIRDS – Hummingbirds are one of two types of non-insect pollinators, and are also considered vital pollinators because they are feathered, allowing large quantities of pollen to stick to their bodies and be transported from one plant to another. Hummingbirds are key in wildflower pollination, particularly for plants that produce curved, tubular flowers that are more difficult for butterflies or moths to pollinate. Because hummingbirds most often visit long, tubular flowers with the nectar far at the base of the flower, as the hummingbird enters and exits the flower they collect pollen on their heads and necks and transport it to the next flower. Interestingly, hummingbirds have a keen sense of sight for color, but generally a poor sense of smell. Therefore, they are highly attracted to bright orange, red or yellow flowers because these colors are more vibrant in the landscape. Hummingbirds are not known for pollinating food-producing crops, but without their services many other plant species would be in danger of extinction.

BATS – The other night shift workers, bats are important pollinators in tropical and desert climates. Over 300 different species of fruit depend on bats for pollination; the most common of these is the banana. As bats seek large quantities of nectar produced by certain plants, their faces and heads become covered in pollen that is then transferred on to the next flower. Bats also pollinate plants that are used in everyday products, such as fibers, timber and other cultural and economic purposes. And, just like hummingbirds, bats are able to carry pollen over a great distance.

BEETLES - Although bees take the prize for being the most prolific pollinators, beetles can claim the throne as being the most numerous of all pollinators. In fact, the U.S. Forest Service estimates beetles are responsible for pollinating 88% of the 240,000 flowering plants globally. Beetles are everywhere! Beetles are also among the oldest known pollinator species; dating back to the Mesozoic period (about 200 million years ago). Without the service of beetles, many of the world's ancient plants, such as magnolia and spicebush, would not exist today. Beetles are known to be "mess and soil" pollinators; meaning, they often chew their way through petals and other parts of the flower and then roll around and defecate within the flower as they enjoy a tasty meal of the pollen inside. This is not necessarily harmful or problematic for the plant, other than beetles will leave a flower garden unsightly after they chew their way through flower petals and other flower parts. Unlike many other pollinators, beetles search for pollen rather than nectar, and they do not require the assistance of a nectar guide. Beetles rely on their sense of smell for feeding and finding a place to lay their eggs, and they are drawn to flowers that have a sweet, spicy, or fermented scent regardless of color or flower shape.

"POLLEN BEETLE ON A CELADINE" via Flickr.com Abdy Murray

FLIES – Although largely considered by many to be a nuisance rather than an asset, flies provide essential pollination services similar to many other pollinators. Flies also contribute other services such as they provide pest control of smaller insects, they serve as food for birds and fish, when they die they decompose and condition the soil health and they can serve as indicators of water quality, most notably the presence or lack of pollution in water bodies. Flies prefer nectar from flowers; and, in environments where bees are less active, such as alpine or arctic habitats, flies are the chief pollinator species. Flies are most active in orchards, where they pollinate a variety of fruit crops that are commonly seen in produce sections, such as apples, cherries and peaches, and one particular tiny fly known as a midge is the chief pollinator of cocoa trees and are responsible for the production of chocolate. Flies are also drawn to flowers that emit a strong putrid or rotting smell, a syndrome that some plants have evolved in order to attract a biotic pollinator to aid in reproduction.



"MIDGE" via Flickr.com Katja Schulz

This page intentionally left blank

Lesson 12
Successful Pollinator Garden Practices

Lesson 12

After completing this lesson you will be able to:

- ☐ Provide examples of pollinator-friendly garden features
- ☐ Identify gardening practices that contribute to pollinator species decline and alternatives that reverse species decline
- ☐ Provide resources on pollinator species, ways to improve pollinator health, and tips for creating pollinator gardens
- ☐ Provide appropriate regional plant species for a pollinator friendly garden

"POLLINATOR GARDEN" via U.S. Department of Agriculture

Overview

In this lesson homeowners will learn how to work in their gardens to create or improve areas to attract and host pollinators in the garden. This lesson discusses various types of pollinator gardens, the basics of what every pollinator garden needs, strategies for working in or enhancing existing gardens and strategies for working in new gardens, as well as a few pollinator conservation strategies.

Types of pollinator gardens

In Lesson 11 we learned there are many types of pollinators, each with their own preference of plants – or pollinator syndromes – that attract them to a garden or landscape. Depending on the type of pollinators you want to attract, understanding these syndromes is helpful in planning a new garden or working with an existing area to be more pollinator-friendly. However, another part of the planning process is determining the type of garden space that will be utilized. Each of the following types of pollinator gardens has its benefit and can be easily adapted for the space available. One other important thing to remember when planning for the desired kinds of pollinators in a home garden is planning for the needs of the plants that attract the pollinators. That is to say, ensuring that the needs of the pollinators are met without compromising the needs of the plants (e.g., soil conditions, water, sunlight).

CONTAINER GARDENS – Container gardens are gardens that exist in a container of any type. These may vary from salvaged materials, such as an old bucket or scraps of wood reused or repurposed into something new, to new materials like an ornate flowerpot or window box from a home improvement or garden store. The varieties of materials that can be used to create a container garden are virtually endless. Also, container gardens can be a single container or many containers of different shapes, sizes and materials. Perhaps the best benefit of a container garden is the ability to move it around, either to different areas of the landscape or to completely different locations, allowing you to provide a space for pollinators regardless of where you live. Keep in mind container gardens often require more water and nutrient inputs than in-the-ground gardens, and they are more susceptible to harsh weather conditions like freezing or extreme heat. However, unlike in-the-ground gardens, the only commitment with a container garden is the container itself, which presents more flexibility than a plant in the landscape that may live there for years to come.

Another benefit to container gardens is the relatively small amount of space they occupy. These are perfect for apartment or condo dwellers, or people who only have a small patch of green space in their landscape; again allowing a gardener the ability to provide habitat for pollinators. Also, for colder climate dwelling gardeners, container gardens can be brought inside when the weather is not so favorable for outside gardening.
In essence, container gardens allow anyone to enjoy growing plants, and attracting pollinators to the garden, in places they may have thought to be impossible or unlikely. Elderly people or those with disabilities prohibiting from working in the landscape may find container gardening to be an easy substitution for gardening and allow them to enjoy the many benefits of gardening at ease. Of most importance, proper soil, water and sun requirements must be provided for the plants that will be planted in the containers, but once those are met the gardener is only limited by their creativity when it comes to designing and planning a container garden.

"VIEW FROM THE BACK DOOR" via Flickr.com Faith Goble

MIXED BORDERS – Mixed borders represent a type of garden where your love of plants can run wild yet still maintain some order in the landscape. Typically these types of gardens surround a patch of lawn or delineate a border near a driveway or sidewalk and contain a large mass and variety of plants. In terms of attracting pollinators, mixed borders allow you to plant a range of different plants that vary in size and spread, height, color, bloom time and bloom color. Providing a range of plants with many different pollinator syndromes that bloom during several seasons can be provided to attract a wider multitude of pollinators through spring, summer and fall.

You may also find a mixed border to be a great place to provide host plants for pollinators to lay their eggs and foster the larval stage of a pollinator's life. Because plants in a mixed border are often planted in masses and repeated throughout the entire border, several areas can contain host plants among the nectar and pollen producing plants, which provides closer proximity to necessary resources for larvae as well as a variety of nesting areas, limit competition among pollinators and protect against predators.

Primarily, mixed borders expand the notion of a flowerbed, from something that may only be a narrow strip of flowers that are changed out seasonally to something that is planned and refined over and over through each season. Keep in mind, from a sustainability standpoint, it is important to only plant a limited amount of annual plants each year; due to the additional environmental and energy footprints associated with the production, growing and transportation of annual plants. Nevertheless, a mixed border should have showcase flowers and plants that are admired, as well as flowers that can be cut, plants with berries, seed heads, vines, small trees and evergreens. Also, the mixed border should change on its own throughout the seasons as the ebb and flow of flowering plants varies over the growing months and into winter.

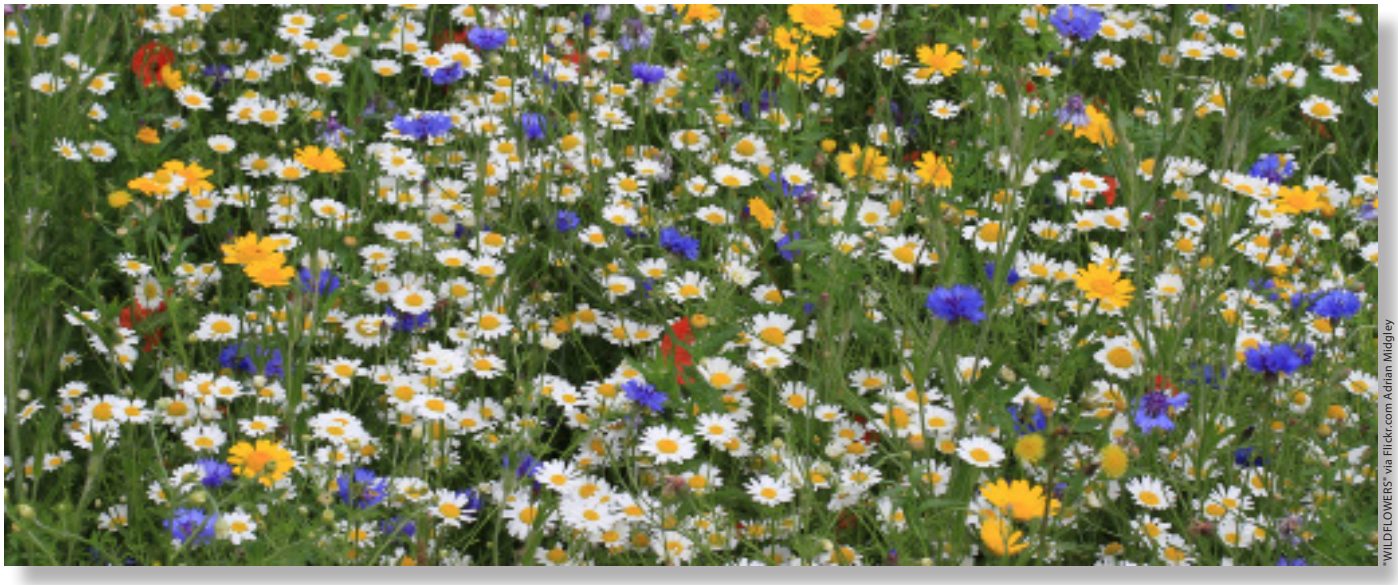
"MIXED BORDER" via Flickr.com finella_c

Typically, mixed borders are sized larger than standard flowerbeds. This can be daunting at first for most beginning gardeners. However, to achieve continuous interest from early spring through fall and into winter, this sizing is necessary. By providing more space for larger masses and greater varieties of plants, you can provide more and greater habitat for pollinators.

WILDFLOWER MEADOWS – Wildflower meadows are characteristically large, providing potentially acres of plants for pollinators. However, a home gardener can achieve a wildflower meadow on a smaller scale by borrowing some design fundamentals from the mixed border concept –such as massing and repetition of plants – but keeping the plant palette limited to wildflowers and some grasses rather than including small trees, vines, specimen plants or cutting flowers. This type of pollinator garden also requires an understanding of ecological succession and a fair amount of perseverance and patience as the garden matures over the years.

Wildflower meadows are best located in places that receive a great deal of sunlight and not a lot of haphazard traffic, although cutting a strip or two through the wildflower meadow makes for a more enriching experience for the user. Alternatively, the same effect of a wildflower meadow can be achieved in a woodland garden planted with shade-appropriate flowers for those living in more wooded regions. Often wildflower meadows are located in transition between a manicured lawn and a forest edge, or as an edge around a body of water, but before starting it is recommended you check the local regulations that may prohibit a wildflower meadow, such as your home owner's association documents.

Wildflower meadows are beneficial to pollinators much in the same way as mixed borders. Wildflower meadows offer a wide range and diversity of plants that provide a food source for many different pollinators, and they provide other necessary means of habitat such as shelter and a place for reproduction. For the home gardener, wildflower meadows do not require a tremendous amount of maintenance, though this does not mean they are completely maintenance-free. Wildflower meadows need periodic checks for soil health and that the plants are receiving enough water. Once the wildflower meadow is established they can typically survive on the amount of precipitation in the area as long as the right plants for the area are selected and sown in the garden. Monitoring of any invasive plant species propagation is critical. Regular visits to the wildflower meadow will allow you many opportunities to perform necessary maintenance of the garden, yet still be able to admire and appreciate the efforts that went into creating a home wildflower meadow.



"WILDFLOWERS" via Flickr.com Adrian Midgley

WAYSTATIONS – A waystation garden, or waystation, is the term most used when describing gardens for migrating butterflies (specifically, Monarch butterflies) or moths. Waystations are key areas of habitat that provide both the host plant during the larval stage and the nectar producing plant during the adult stage. Many of the previously described gardens could serve as waystations, however, in order to provide an appropriate amount of host plants and nectar plants, a waystation garden should be no less than 100 square feet in area and should be included in or located nearby a mixed border or other similar garden bed. Knowing the pollinators that migrate through your area is the first step in planning a waystation garden. From there, it is a matter of providing the right resources for those pollinators and maintaining the waystation garden to continually provide for the pollinators' needs through all stages of their life-cycle. Most importantly, pollinator habitats and food supplies are constantly under threat from land development, so providing these spaces – even in a small-scale setting – can be a tremendous asset for the conservation of many types of pollinators.

CATERPILLAR/LARVAL HOST GARDENS – Because butterfly and moth caterpillars have voracious appetites, they can be viewed as less desirable in the garden during the larval stage. Therefore, it is important to understand that providing a habitat for either includes having a tolerance for caterpillars to munch on plants, which may leave unsightly aesthetics in the garden. It is best you reserve a less visible area in your garden specifically for this purpose, and allow the full life cycle of butterflies and moths to take place in an area that offers protection from severe weather or predators. This kind of garden can also be densely planted with other types of attractive native flowering non-host plants to provide the larvae cover from predators and may also camouflage the damage done to the nearby host plants.

When female butterflies and moths visit a garden, they flit around the garden looking for nectar while also scoping out an area to rest and lay their eggs. Since most young caterpillars are not capable of traveling great distances in search of food, it is up to the adult butterfly or moth to find the right host plant that the caterpillar needs. If the eggs are not placed on the correct plants, the caterpillar will not survive. There are a variety of plant forms that can serve as hosts, such as milkweeds, wildflowers, herbs, vines, bushes, trees and even some groundcovers. When planning a host garden, it's important you research the types of butterflies and moths in your area and what types of host plants are needed to support the larval stages.

When planning a pollinator garden, in the end it comes down to three important factors: "What types of pollinators do I most desire in my garden? What are the food sources they need throughout their life cycle?" And, "What type of space do I have available?" There is obvious overlap among the types of pollinator gardens described in this section, and ideally there should be. Successful pollinator gardening includes providing all the resources pollinators need, which is discussed in the following section, but should not be limited to one type or size of pollinator garden.

"CATEPILLAR OF THE CINNABAR MOTH" via Flickr.com Leonora Enking

Pollinator gardening is a fun and much-needed activity for the conservation of pollinators, plants and the larger ecosystem, but planning a garden based on pollinators also brings another level of livelihood to the garden by attracting a variety of wildlife and providing them a home. This provides an endless amount of entertainment to the gardener, and allows you to foster pollinators that play a vital role in providing the needed ecosystem services for the conservation of the environment.

How to attract pollinators – the basics of food, water, shelter and places to raise young

In 2014, The White House issued a Memorandum and formed the Pollinator Health Task Force to develop the ***National Strategy to Promote the Health of Honey Bees and Other Pollinators (Strategy)***. The resulting "Strategy" outlined three main goals: a) Reduce honey bee colony losses during winter, b) Increase the Eastern population of the monarch butterfly, and c) Restore or enhance 7 million acres of land for pollinators over the next five years. This last goal is where home gardeners have an incredible opportunity to participate in achieving the goals of the Strategy. In addition, the Million Pollinator Garden Challenge was launched as a private sector effort to rally all private property owners to plant pollinator habitats nationwide. Across the country, people are planting and registering their gardens and encouraging others to do the same. It's also worth mentioning all the Citizen Scientist programs available across the country that you can participate in to track pollinators, invasive species (flora and fauna) and other animal species such as birds or fish.

By selecting any of the aforementioned pollinator garden types, you can instantly be involved in the efforts to restore or enhance land for pollinators. To do so, four main components are needed in every garden type; food, water shelter and places to raise young. All living things need to eat and have drinking water to survive; these two components are critical for any wildlife habitat. Wildlife also need places of shelter to protect them from weather extremes like heavy rain or intense summer heat, as well as places of shelter to protect them and their young from predators or to provide cover for predators to catch prey. A well-thought out garden will provide these needs and easily be able to attract pollinators.

FOOD SOURCES

- **SELECT PLANTS THAT ARE BENEFICIAL TO THE POLLINATOR POPULATION.** Selecting plants that provide a food source is the key strategy in attracting pollinators to a home garden. By providing the right food resources, a home gardener can be successful in attracting pollinators and ensuring their continued survival.
- **PLANT NATIVE PLANTS** Pollinators depend directly on plants for their food sources, especially native plants. Planting a variety of native plants that flower at different times of the growing season can provide a continuous supply of pollen and nectar for local and migrating pollinators. Also, when selecting unfamiliar plants from the nursery, it is very important to you check and make sure the plant is not mislabeled as a native, which could cause exponential negative effects later in the life of the garden.

› **REGIONAL PLANTING GUIDES** These guides provide guidance on choosing the right nectar plants for year-round planting throughout the United States. Resources like the Lady Bird Johnson Wildflower Center's Native Plant Information Network (NPIN) or the Pollinator Partnership's Ecoregional Planting Guides offer a tremendous amount of information available on native plants in your area. Or, more specifically, the Regional Monarch Nectar Guide, developed in partnership with the Monarch Joint Venture and National Wildlife Federation, offers evidence-based, monarch-specific nectar plant guides for gardeners, landscape designers and land managers who are implementing large-scale monarch restoration projects.

ECOREGIONAL PLANTING GUIDES via Pollinator Partnership

Example Ecoregional Planting Guides www.pollinator.org

- **MINIMIZE THE USE OF NON-NATIVE PLANTS** Non-native plants can be an alternative source of food for pollinators when there are little to no native plant species available, however non-native plants should not be used exclusively in the garden. At times, non-natives can help in extending the availability of pollen and nectar sources for longer periods across the seasons, but they should be planted intermittently among native plants, and you should use caution planting them as food sources for pollinators, especially for migrating pollinators. Because some non-native plants offer an extended food source, like a tropical milkweed rather than a native milkweed, this can delay the migrating pattern of pollinators and create a wider gap in available food sources between migrations, as well as lead to disease among migrating populations.
- **THINK BEFORE PLANTING CULTIVARS** Cultivars are plants that have a variation that has been deliberately bred by humans for a specific desirable trait, such as a certain color, stature, or form. When this happens, oftentimes other traits, such as seed production, pollen or nectar production can be extremely limited. While cultivars can provide a unique variety in the garden, they do not provide the same amount of resources available from the true species of plant, and are not as attractive to pollinators. In some cases the important syndromes that attract pollinators can be bred out of the cultivar form entirely. Therefore, it's best to avoid hybrid cultivars, double-flowered cultivars, and those that have a drastic change in color or shape of flower. When selecting plants for the pollinator garden, the plant label can typically identify cultivars. For example, the label will show the plant name in italics, and the cultivar will be displayed in quotes or capital letters.

"OSU ANNUAL CULTIVAR TRIAL" via Flickr.com Becker1999

WATER SOURCES

- **PROVIDE WATER IN A VARIETY OF APPLICATIONS FOR A VARIETY OF POLLINATOR TYPES.** It's easy to not think about something as small as a bee or a butterfly needing water, but all living creatures need water for survival. Water sources can be of a variety of shapes, sizes, depths and locations, and should always be refreshed regularly. Refreshing the water may be one of the most important components because this not only provides fresh, clean water to the pollinators, but it also drastically minimizes the potential of mosquito habitat creation.
- **CREATE PLACES FOR WATER TO SEEP** Seeps are places where water oozes or flows out through a small hole or porous material. Typically, seeps pertain to natural features where groundwater comes out, but they can be replicated in the home garden with a little thought and ingenuity.
- **USE MULTIPLE WATER FEATURES** Birdbaths, shallow dishes, bubblers, fountains, ponds or small streambeds can be utilized in the garden as water features for a variety of pollinators. These provide a variety of drinking water sources, and many different types should be used in the garden. Make sure to vary their size, depth, height and location, such as placing some in open areas and others in more protected areas, and replenish the water source often so clean, fresh water is available and the possibility of unwanted pests (e.g., mosquito larvae) is reduced.
- **LEAVE AREAS FOR PUDDLING** Puddling areas provide a safer area for pollinators like butterflies and moths to find their hydration needs. An easy way to create a puddling area is to use a small dish, fill it with dirt (non-potting soil) or sand, place flat stones in the dirt or sand for a landing area, locate it near the butterfly plants in the garden and fill it with water. Natural rainfall will keep the puddling area wet, but between times of rain it will need to be replenished regularly.

"CALIFORNIA SISTER PUDDLING" via Flickr.com Edward Rooks

SHELTER SOURCES

- **INCORPORATE AREAS FOR SHELTER AND PROTECTION FOR POLLINATORS** Pollinators need places to hide, feel safe or be protected from inclement or hot weather. While vegetation can provide many shelter needs, there are several kinds of human interventions that can provide more adequate shelter needs.
- **USE DEAD OR DYING TREES AND SHRUBS, AND DORMANT GRASSES FOUND ON SITE** Natural materials provide excellent shelter sources, which replicate many shelter sources found in nature. Using natural materials as a shelter source is a great reuse of materials that may otherwise be composted or discarded in some other manner. Bushy leaves, thorny twigs or branches with holes or cavities provide places to nest, perch, rest or hide.

PLACES TO RAISE YOUNG

- **RESERVE SPACE FOR HOST PLANTS** Host plants, such as milkweed (spp. Asclepias L.), provide a source of food for butterfly and moth larvae. Butterflies and moths have evolved to only rely on one or a limited number of plant species for their larvae to feed on. There are only specific host plants for specific larvae, therefore you should research into the types of butterfly and moth pollinators in your area and the host plants their larvae depend on when planning the garden. A quick way to do this and discover which host plants are native to specific butterflies and moths in your area, visit the Native Plant Finder on the National Wildlife Federation's website and enter your zip code. This will allow you to research the types of butterfly and moth pollinators in the area and the required host plants needed to support their larvae.

"MOARCH CATERPILLAR ON ASCLEPIAS" via Flickr.com mwms1916

› **ALLOW AREAS OF BARE SOIL** Patches of bare soil are potential nesting habitats for ground-nesting bees. These types of bees construct nest tunnels under bare ground, which are pretty easy to recognize because of the conical pile of dirt with a large hole in the middle that serves as the entrance to the burrow. While it's tempting to mulch every bare area of the garden to conserve soil moisture or reduce weedy plants, this practice also inhibits the ability of ground-nesting bees to start their nests. Approximately 70% of the native bees in the United States are ground-nesting bees, therefore providing areas of bare soil for their nesting habitats is essential in providing them with adequate habitat resources. These areas do not need to be very large, usually no more than one to three square feet in area, but for aesthetics and safety, you should choose areas behind a row of shrubs or in more isolated portions of your garden to leave as bare soil for nesting bees.

› **CREATE NESTING BOXES/ INSECT HOTELS** Nesting boxes can provide an alternative nesting habitat for bumblebees, as well as for the approximately 30% of native bees that aren't ground nesting. These boxes mimic beetle tunnels, snags or other small holes that would naturally be found in the wild that the bee would use for nesting. Nesting boxes can also be made for butterflies, birds and even bats. Building a nesting box takes some consideration to research the needs of the pollinator, but otherwise can be easily built and placed throughout the garden.

"BUG HOTEL" via Flickr.com she_who_must

Insect hotels are unique elements in the landscape or garden that are part art piece and part habitat shelter for a variety of nesting pollinators. Typically made of natural materials and compartmentalized into different sections, insect hotels provide nesting space for a variety of pollinators, particularly during winter, and provide visual interest to any home garden. Insect hotels can be built with just about any kind of materials found or salvaged, and make for a fun garden project.

Strategies with existing gardens

Home gardeners have numerous opportunities to increase the number of pollinators that visit an existing garden. By observing the garden throughout the season, changes can be implemented very easily that will attract more pollinators to the garden for the following seasons.

- **EXPAND BLOOM TIMES** A large majority of plants in the U.S. bloom in the middle months of the growing season; late May through the end of August. However, there are a large variety of plants that bloom in the early spring and through the middle of fall. To attract more pollinators to an existing garden, home gardeners should research plants that are early or late bloomers, that provide the food sources needed by pollinators and that grow in their region, and then begin incorporating those plants in the garden. Some plants, particularly native wildflowers, can be planted as layers along with existing plants so that when one plant begins to fade out of its bloom time another plant is just beginning its bloom time. Keeping a simple journal or notebook of what kind of pollinator visits what kind of flower (e.g., what pollinator syndromes are offered) is a great start to adjusting bloom times and adding more bloom diversity to an existing garden. Also, regular visits to nearby botanical gardens, other pollinator gardens or nurseries will provide valuable insight into plants that bloom in early spring or late fall.
- **PLAN MAINTENANCE ACTIVITIES** You should develop a maintenance plan for your garden that is specific to the needs of the garden as well as the pollinators that visit. A maintenance plan should incorporate items such as how frequent maintenance will be performed (e.g., weekly, monthly, semi-annually), what types of maintenance will be performed (e.g., cutting, mowing, weeding), what types of tools will be used to perform the maintenance and how the maintenance will affect pollinator habitat in the garden.
- **USE POLLINATOR-FRIENDLY ALTERNATIVES** If you want to attract more pollinators to your garden, you should resist the urge to have a perfectly manicured lawn. Many of the turf grass species used in the U.S. offer little to no habitat resources for pollinators, yet lawns make up the majority of green space in a home landscape and oftentimes depend on pesticides and fertilizers that can be harmful to pollinators. Rather than using a monoculture turf grass species, home gardeners should allow the lawn to return to more diverse plant species that offer pollinator resources, such as the common practice in English lawns with diverse cultures of clover throughout. Low-growing flowering groundcovers can be used in place of turf grass species, or areas of lawn can be minimized and maintained for recreational needs. Larger expanses of lawn can then be converted to perennial borders, thickets or corridors of perennials, shrubs and trees that provide shelter to pollinators as they move through the garden.

Strategies for new or redeveloped gardens

Planting and growing a pollinator garden is a rewarding endeavor, providing resources for the pollinators that visit and activating the garden for the gardener's enjoyment. The success of the pollinator garden depends on the preparation and planning by the home gardener – taking into account all of the previous lessons on successful soil, water, plants and material practices – and incorporating appropriate pollinator strategies for the region.

- **EXPERIMENT WITH GARDEN SIZES** There are no rules to the size a pollinator garden must be. As discussed earlier, pollinator gardens can be as small as a few container gardens or can be large acreages of wildflower meadows. What's important is to provide the right food resources (e.g., nectar, pollen and host plants), water resources and shelter resources.

mi·cro·cli·mate the climate of a very small or restricted area, especially when this differs from the climate of the surrounding area.

- **CREATE MICROCLIMATES IN THE GARDEN** Creating microclimates is a practice many experienced gardeners experiment with, but even the newest gardener can begin making small strides to create microclimates in a new pollinator garden. Microclimates are small areas that differ from the climate of the surrounding area. They can be produced by small changes in topography, moisture, wind, soil conditions or vegetation. Areas like the shaded spot produced by a large tree, or one that is warmed by an adjacent brick or concrete wall that absorbs and radiates the sun's energy are examples of microclimates. In the pollinator garden, small gestures like offering small areas of shade to protect pollinators from direct sun exposure, growing a thicket to protect pollinators from high winds or creating small depression areas for water to pool can create microclimates that will allow the pollinator garden to attract pollinators and provide other beneficial habitat resources.
- **USE UNDERUTILIZED SPACES** Along with being any size or being any type, pollinator gardens can also be located anywhere space is available. Underutilized space between a house and fence, a side yard, an area in an alleyway, the small strip of green space between the street and the sidewalk (sometimes called a 'hell strip') or even on a rooftop of a house or shed building are all great places to begin creating a pollinator garden. Since these spaces are often less trafficked, they present excellent opportunities to fill up the space with pollinator-friendly plants and allow the pollinators to be protected as they perform their pollinator duties.

- **PLANT IN MASSES** Planting in masses ensure pollinators can practice flower constancy. For example, bee pollinators prefer to collect pollen and nectar from a single species of flower during each outing, therefore planting a series of repetitive plant species allows the bee to be more efficient at gathering pollen. Massing plants can be done in several ways. For example, plant one species of plant in mass of an irregular shape to create a mosaic, or drifts of that plant, similar to how drifts of plants would be found in nature. Another way is select two or three plants that bloom at the same time in a similar color to create a mass of color. Alternatively, a mass of plant types, like a variety of grasses or several different evergreen shrubs grouped together make a strong impact and help define the areas of the garden that are reserved for flowering plants. When defining mass in the garden, it helps to consider a ratio of the size of the mass to the size of the overall garden. In general, a contiguous mass planting should not exceed more than 25 percent of the total garden size. If non-contiguous, this percentage can be adjusted slightly higher. This ratio should be used as a guide to achieve aesthetic balance in the garden; such that, if one species goes dormant or dies back in an untimely manner, the garden will not look devoid and unsightly, or conversely, if overplanted by one species the garden will not look heavy and dominating in one area or overall.
- **INCORPORATE DIVERSITY** Like we discussed in previous sections, adding diversity to the pollinator garden is a sure way of attracting more diverse pollinators. Following the characteristics learned from the various pollinator syndromes, you can plan for a diversity of plants that provide those syndromes, bloom at various times of the year to extend the bloom time, vary in height, color and flower shape and can also be used as host plants. Additionally, you should research pollinator migration routes and if any occur for their area. If so, research the types of migrating pollinators and the food sources needed by those pollinators, then research what plants provide those resources – including appropriate host plants – and plant them in the garden.

  Adding diversity to the pollinator garden makes the activity more engaging and allows you opportunities to monitor the pollinator garden over many seasons and note which plants are more favored by visiting pollinators. This feedback is essential for future success of the pollinator garden, and in turn makes gardening for pollinators a continuous learning practice.

"LURIE GARDEN" via Flickr.com Daniel X. O'Neil

Pollinator species conservation strategies

Home gardeners can participate in the critical efforts to conserve pollinators. As noted, residential areas in the United States are estimated to make up a total of 103 million acres of land. Therefore, it is easy to see the important role your home gardens play in the effort to restore or enhance 7 million acres of land for pollinators over the next few years since the goal was set by the 2015 National Strategy to Promote the Health of Honeybees and Other Pollinators (2015-2020).

Many of the stressors or threats to pollinators include chemical controls for pests and pathogens in the garden, especially the use of neonicotinoids in nursery operations, and the reduction or loss of habitat due to land development that in turn results in a lack of nutritional resources and the loss of overwintering sites for many species. However, if home gardeners participate in pollinator conservation efforts, many of these stressors and threats can be mitigated and the health and survival of pollinators will be continue.

Below are a few strategies to begin and maintain pollinator conservation efforts in the home garden

- **USE NATIVE PLANTS** Native plants provide many of the nutritional resources that pollinators need to survive. Pollinators prefer finding nutritional resources (nectar and pollen) from native plants, and using true native plant species rather than cultivars will ensure pollinators visit the garden. Native plants are also well adapted to local soils and climates, so the amount of inputs you have to provide (e.g., fertilizers, pesticides, irrigation) is much less, as well as the amount of maintenance needed.

- **MINIMIZE THE USE OF PESTICIDES AND FERTILIZERS** The most harmful pesticides to pollinators are neonicotinoids, which are a host of several insecticides. Widely used in agricultural industries, neonicotinoids are making their way into the nursery trade where they are used on young plants to limit insect damage during early stages of growth. The problem with these insecticides is they are absorbed by the plants' tissue and can be present in pollen and nectar, making them highly toxic to pollinators. When selecting plants to put in the garden, you should take extra precaution to source plants that have not been treated with any variety of neonicotinoids. Other fertilizers or pesticides used on plants, particularly fruit and vegetable gardens, may also limit the appearance of pollinators to the garden. Unfortunately, it is not always easiest or most efficient to completely eliminate chemical pesticides or fertilizers from the garden. However, if they are to be used, be sure to research of the chemicals are a neonicotinoids and limit the application of pesticides and fertilizers during times of pollination.

- **INCREASE HABITAT AND REDUCE LOSS OR FRAGMENTATION** Urban and suburban development will continue to increase, resulting in loss and fragmentation of habitat for pollinators. Planting pollinator gardens in home gardens and expanding pollinator gardens into neighboring homes, residences and undeveloped areas, can mitigate habitat loss and fragmentation. Providing these pathways for pollinators that are full of nutritional resources, water and shelter are steps that will increase habitat in developed areas.
- **ADOPT SUSTAINABLE MAINTENANCE PRACTICES** Being proactive in the garden and planning for required maintenance allows you to begin adopting more sustainable maintenance practices. There are many sustainable maintenance practices that you can begin to adopt easily that are not necessarily actions in the garden, such as, knowing the plants' requirements for water and soil conditions, knowing the best times for pruning or cutting back vegetation or knowing which pests or pathogens may affect the plants and how to best care for plants without pesticides or fertilizers. You should also keep a journal or calendar of maintenance practices to be performed in the garden, as well as keep a journal of what pollinators visit the garden and when. Then, plan maintenance practices around those times that do not interfere with pollinators' activity.
- **PLAN FOR CLIMATE CHANGE** Temperature plays a key role in the timing of plant and pollinator development. Small shifts in temperature can mean a shift in the timing of plants and their flowering stage, as well as in the timing of pollinators and their first emergence stage. Due to increasing warmer weather and extreme weather events like heatwaves or drought, these two timing stages can get out of sync. This can result in reduced availability of food for pollinators and, at the same time, a reduction in pollinator visitation to the plants that depend on biotic pollination services. Therefore, it is vitally important for home gardeners to provide a variety of flowering plants and work to diversify bloom times that extend the flowering season so that more pollinators can have access to the food sources they depend on for future survival. A resulting benefit is the ability to maintain pollinator populations and maximize the benefits pollinators provide to the natural world.

Polinator syndromes identification (see Assignment p.77

Activity

The assignment for this lesson is to take the *Site Assessment – Plants* performed in Lesson 6 and identify specific pollinator syndromes present in the plants mapped in the homeowner's garden. Encourage students to use the ***Pollinator Syndrome Traits Table*** found in Lesson 11.

In a separate chart, begin to classify the plants existing in your garden according to one of the traits found in the ***Pollinator Syndrome Traits Table***. For example, classify all your plants based on color or odor. Once classified, begin to identify the pollinators that may visit the flowers that exhibit those traits.

1. What is the most common pollinator trait in your garden?
2. What kinds of pollinators are attracted to that trait?
3. What pollinator syndromes are not present?
4. What types of native plants for your region will provide those missing pollinator syndromes?

Use this information as you continue to explore pollinator-friendly design strategies for your home garden.

Resources: Pollinators

Publications

National Strategy to Promote the Health of Honey Bees and Other Pollinators
Presidential Memorandum
The White House (2015)

A comprehensive approach to tackling and reducing the impact of multiple stressors on pollinator health.

Pollinator Partnership Action Plan
The White House (1998)

An action plan to amplify the many Federal actions advanced under the Presidential Memorandum through complementary state and private-sector actions.

Ann and O.J. Weber Butterfly Garden Trail Guide
Lady Bird Johnson Wildflower Center (2002)

A technical field guide for the Ann and O.J. Weber Butterfly Garden at the Lady Bird Johnson Wildflower Center in Austin, Texas.

Webinars

U.S. Fish and Wildlife Service
National Conservation Training Center
Monarch Butterfly Conservation Webinar Series
https://training.fws.gov/topic/online-training/webinars/monarch-conservation.html

Lisa Zander's Pollination Station
https://vimeo.com/123237959

Useful Websites

Pollinator Partnership
Pollinator Friendly Plant Guides
http://www.pollinator.org/
http://pollinator.org/guides

This website provides ecoregional native planting guides focused on selecting plants that attract pollinators.

Million Pollinator Garden Challenge
http://millionpollinatorgardens.org/
A campaign to register a million public and private sector gardens and landscapes to support pollinators.

The Xerces Society for Invertebrate Conservation
"How Neoniotinoids Can Kill Bees
xerces.org/neonicotinoids-and-bees

A report on the science behind the potential of insecticides in the role of harming bees.

The Xerces Society for Invertebrate Conservation
"Think about nesting as you prepare for winter - November 2015"
xerces.org/in-your-pollinator-garden-november-2015
An instructional guide for over-wintering your garden to allow for nesting bees

"Nests for Native Bees"
www.xerces.org/wp-content/uploads/2008/11/nests_for_native_bees_fact_sheet_xerces_society.pdf
A fact sheet for how to provide nest sites for native bees.

U.S. Department of Agriculture
Pollinator Syndromes
https://www.fs.fed.us/wildflowers/pollinators/What_is_Pollination/syndromes.shtml
A brief overview of pollinator syndromes.

Dave's Garden
"Beetles and Their Role in Pollination"
davesgarden.com/guides/articles/beetles-and-their-role-in-pollination
An online resource for the roles of beetles in pollination.

University of Illinois Extension
Successful Container Gardens
"How to Select, Plant and Maintain
https://extension.illinois.edu/containergardening/
An online index of information for container gardening, including information about pollinator attracting container gardens.

Other Website Resources

American Beekeeping Federation
Pollination Facts
www.abfnet.org/page/PollinatorFacts

Water Quality/Macroorganisom List
https://scioly.org/wiki/index.php/Water_Quality/Macroorganism_List

"Border Design 101"
www.whiteflowerfarm.com/mas_assests/theme/whiteflowerfarm/pdfs/gardener_Perennial-border-design.pdf

"How to Grow a Wildflower Meadow"
www.veseys.com/us/en/guide/wildflower

"Create a Monarch Waystation"
www.gardeners.com/hot-to/monarch-waystation/8603.html?SC=XNET9465

GrowVeg
"Insect Hotels - Encourage Beneficial Insects Into Your Garden"
https://www.growveg.com/guides/insect-hotels-encourage-beneficial-insects-into-your-garden/"

"Native Cultivars vs. Native Plants & Thier Attractiveness to Pollinators"
https://www.ecobeneficial.com/2014/04/native-cultivars-vs-native-plants/

"Climate change impacts on pollination"
https://www.nature.com/articles/nplants201692