

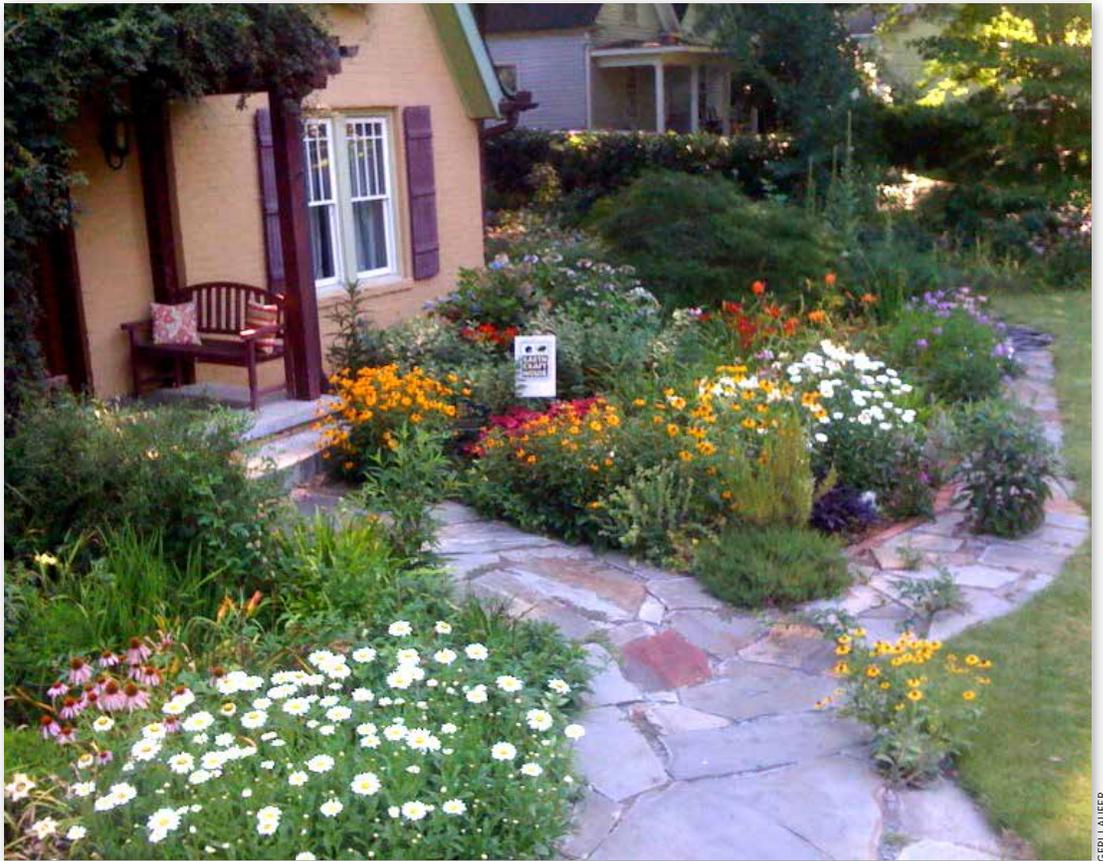
Lesson 6

The Role of Plants in Sustainable Gardens

Learning objectives

After completing this lesson you will be able to:

- Provide examples of the benefits vegetation can provide to homeowners and the surrounding community
- Explain how gardens and the larger ecoregion interact
- Identify site conditions, including hardiness zones and macroclimates that should be considered in plant selection



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Overview

Vegetation is a key component of sustainable gardens. The environmental benefits that plants offer, including clean air and water, temperature regulation, and erosion control, are essential to the functioning of both healthy home gardens and surrounding landscapes. Additionally, plants can provide a variety of economic and social benefits, including reduced energy use/ costs and increased wellness through the creation of restful settings. This lesson focuses on the important role plants play in garden sustainability. It discusses how to select vegetation for the home garden in a way that enhances the environmental, economic, and social benefits for not only the homeowner, but also the surrounding community.

The role of plants in sustainable gardens and surrounding landscapes

Plants play an integral role in providing the ecosystem services that are required for the functioning of home gardens and surrounding landscapes. Homeowners can enhance ecosystem services and the overall function of their garden by using sustainable plant selection and design practices.

Some ecosystem services provided by vegetation:

- › **MITIGATE THE URBAN HEAT ISLAND** Plants cool the air by providing shade and evaporating soil moisture.
- › **REDUCE ENERGY USE AND COSTS** Properly placed vegetation can reduce energy use and costs by shading a house during summer and providing insulation during cold winter months.
- › **CLEANSE AIR AND WATER** Vegetation removes pollutants from air and water.
- › **PROVIDE OXYGEN** Through the process of photosynthesis, vegetation sequesters CO₂ and releases oxygen.
- › **CONTROL EROSION** Plants reduce the intensity of rainfall hitting the ground, increase the absorption of water into the soil, and help hold soil together.
- › **PROVIDE HABITAT** Vegetation provides refuge, breeding, and nursery habitat for wildlife both above and below the ground.
- › **PRODUCE FOOD AND RENEWABLE NON-FOOD PRODUCTS** Plants provide resources such as wood, cloth fibers, oils, fruits, and vegetables.
- › **CREATE RESTFUL AND PEACEFUL SETTINGS** Trees and other vegetation create settings that allow us to refresh our minds, relax, and better manage stress.

Selecting plants

When selecting vegetation for sustainable gardens, homeowners should work with nature and select plants that are adapted to the conditions of the site. Vegetation that is well suited to the growing conditions of the garden will maximize benefits and minimize the need for fertilizers, pesticides, and irrigation. Exploring the **ecoregion** in which a garden is located can provide valuable insight about the environmental characteristics of the site and the basic type of plants or plant communities that may have adapted to survive in a particular area. To address environmental changes and/or irregularities that can occur across a garden, homeowners should consider the regional climate and **microclimatic**, including **hardiness zone** and sun/shade requirements, before selecting vegetation. Additionally, a careful review the soil, water, and remaining plant lessons should be completed before a homeowner incorporates new vegetation into their garden.

Unsustainable vs. Sustainable Gardens: How They Compare	
PLANTS	
Unsustainable Gardens	Sustainable Gardens
<i>Often includes invasive plants that threaten natural ecosystems.</i>	<i>Vegetation is carefully selected to avoid the use of invasive species. Existing invasive species are removed from the garden.</i>
<i>Often requires potable water, fertilizers, and pesticides to sustain vegetation.</i>	<i>Includes plants that are adapted to the conditions of the site and can thrive without potable water, fertilizers, or pesticides.</i>
<i>Often has low diversity and minimal wildlife habitat.</i>	<i>Includes plants that are both beautiful and useful as food or refuge for wildlife.</i>
<i>Not designed to improve home energy efficiency.</i>	<i>Uses vegetation to reduce the heating and cooling requirements of the home and surrounding buildings.</i>
<i>Provides minimal long-term savings.</i>	<i>Can save homeowners money over the long run by cutting water, heating, and cooling bills.</i>

Ecoregion

Ecoregions denote areas with general ecosystem similarities and the type, quality, and quantity of environmental resources. Learning about your ecoregion can support a deeper understanding of the environmental characteristics of your garden and what types of vegetative communities these characteristics tend to support. The EPA has developed level IV ecoregion maps for most of the US. The maps can be found at <http://www.epa.gov/wed/pages/ecoregions/ecoregions.htm>. Additional resources include the local branch of the EPA, local parks and wildlife agencies, The Nature Conservancy, and land grant universities.

Below is an example for the Edwards Plateau region of Texas:

ELEVATION Measurements range from 600 feet above sea level in the eastern canyons to 3,000 feet above sea level in the ridges of the central and western regions.

PRECIPITATION Levels vary from 23 to 35 inches per year.

TOPOGRAPHY The features are round, often with rolling hills. It is thought of as a southern extension of the Great Plains.

SOILS Most of the Edwards Plateau contains mottled yellowish clay or clay loam surface soil with rocky clay or solid limestone rock layers underneath. Erosion has left much of the region with top soils of less than 10 inches.

VEGETATION DESCRIPTION The Edwards Plateau is characterized by a combination of tall, medium, and short grasses, including little bluestem, sideoats grama, switchgrass, Indiangrass, Texas wintergrass, and three-awn often intermixed into a woodland setting with hardwood trees such as escarpment live oak, Texas oak, honey mesquite, and with coniferous Ashe juniper. Protective canyons, especially on the eastern and southern portions of the plateau, provide for a great diversity of other hardwood species, such as Texas madrone, escarpment black cherry, Texas mountain-laurel, Mexican plum, Carolina basswood, lacey oak, and bigtooth maple. Springs and creeks found in these canyons are typically lined with bald cypress, sycamore, and black willow.

IMPACTS OF FIRE Prior to heavy settlement, fire played a major role in shaping the vegetation on the Edwards Plateau. Fire occurred on much of the land every 2-10 years. During this interval, Ashe juniper was kept out of most uplands by fire and dense grass competition. Other trees such as escarpment live oak and honey mesquite were kept more isolated among the grasses. Concentrated livestock grazing reduced the cover of grasses which suppressed wildfire and allowed trees to begin moving into the grasslands. Protected canyons and moist, north-facing slopes reduced the number and intensity of damaging fires, allowing many trees to persist prior to human settlement.

HISTORICAL INFORMATION Bison were known to frequent the Edwards Plateau. Their migration in great numbers undoubtedly affected the landscape, plant communities, and the cultures of early human inhabitants. Later settlement brought primarily German farming communities and the adventurous livestock ranchers which have since been identified with Texas.

Ecoregion maps and descriptions should only serve as background or preliminary information. Additional environmental information and/or testing should be gathered before selecting vegetation. The next two sections will provide plant selection strategies based on regional climate and garden-level microclimate.

Regional Climate

The climatic conditions of a region are largely determined by geographic factors including latitude, terrain, distance from bodies of water, prevailing winds, and elevation. The regional climate takes into account long-term temperature and precipitation patterns and has a significant impact on the types of plants a particular area can support. Hardiness zone classifications are tools that were created to help map geographic climate bands. They provide gardeners with an easy way to determine their regional climate and select appropriate vegetation.

Hardiness Zone—Most plants available for sale at nurseries or through online suppliers have been assigned a hardiness zone that correlates with a hardiness zone map. These are among the most basic tools have been used by gardeners for decades to determine if a particular plant can survive winter in their area. Probably the most widely-used map in the eastern two-thirds of the country is produced by the US Department of Agriculture (USDA). The most recent USDA map, www.planthardiness.ars.usda.gov published in

2012, divides the country into 13 color-coded bands or zones. Each successive zone represents a 10-degree Fahrenheit difference in average annual minimum temperature; higher zone numbers correspond to warmer gardening temperatures.

In 2006, using the same basic zone structure as the USDA, the National Arbor Day Foundation produced a map (www.arborday.org/media/zones.cfm) for the US that is also useful.

Gardeners in the West generally use the system of 24 climate zones first published by the Sunset Publishing Corporation in the *Western Garden Book*. The Sunset zone maps factor in not only minimum winter temperatures but also summer highs, growing season length, humidity, and rainfall patterns. The zones correlate to a series of regional maps of the West. Zone 1 represents the harshest growing conditions, zone 24 the mildest.

In 1997, Sunset published its first national garden book. Applying the same range of climatic criteria to areas of the United States and Canada east of the Continental Divide, it added 21 new climate zones (zones 25 to 45). Most gardeners in these regions, however, continue to use the USDA map.

Local Microclimate

It is important to recognize that every garden is influenced by not only the regional climate but also microclimates, which are formed when the prevailing climate of a region interacts with objects in the garden. For example, planting beds located on the south side of a house or garden wall receive more sunlight and are typically warmer than those on the north side. Low areas of the garden may be cooler at night due to pockets of cold air pooling in the depressions. When the cold air drops below freezing, frost pockets will form and can cause damage to plants. Homeowners should select plants that are best suited to each particular microclimate within the site.

Sun and Shade Conditions—Plants need sunlight to photosynthesize and make their food, and only some can tolerate low light levels. Conversely, those that have evolved for shady conditions will often fail if planted in full sun. Plant labels, nursery catalogs, or gardening books typically identify the needs of many plants commonly expressed in degrees of sun or shade.

Definition of common terms:

- › **FULL SUN** Six to eight hours of direct sunlight a day
- › **PARTIAL SUN OR LIGHT SHADE** Generally refers to an area that gets full sun for all but a few hours of the day
- › **PARTIAL** Also known as medium shade, it is an area that gets sunshine for roughly half of the day and shade for the other half
- › **FULL SHADE** The sun is obstructed for most of the day
- › **DENSE SHADE** Near-total shade, which is too dark for all but the most shade-tolerant species

Identifying plants commonly grown in the area

Activity

Familiarize yourself with plants commonly grown in the area. This can be done by visiting a local botanic garden, nursery, or garden club demonstration. If the weather is not conducive or a trip to one of these locations is not possible, you can also conduct research online. The Native Plant Information Network (NPIN), available at <http://www.wildflower.org/explore/>, is a good resource for identifying common plants by region.

Site Assessment — Plants

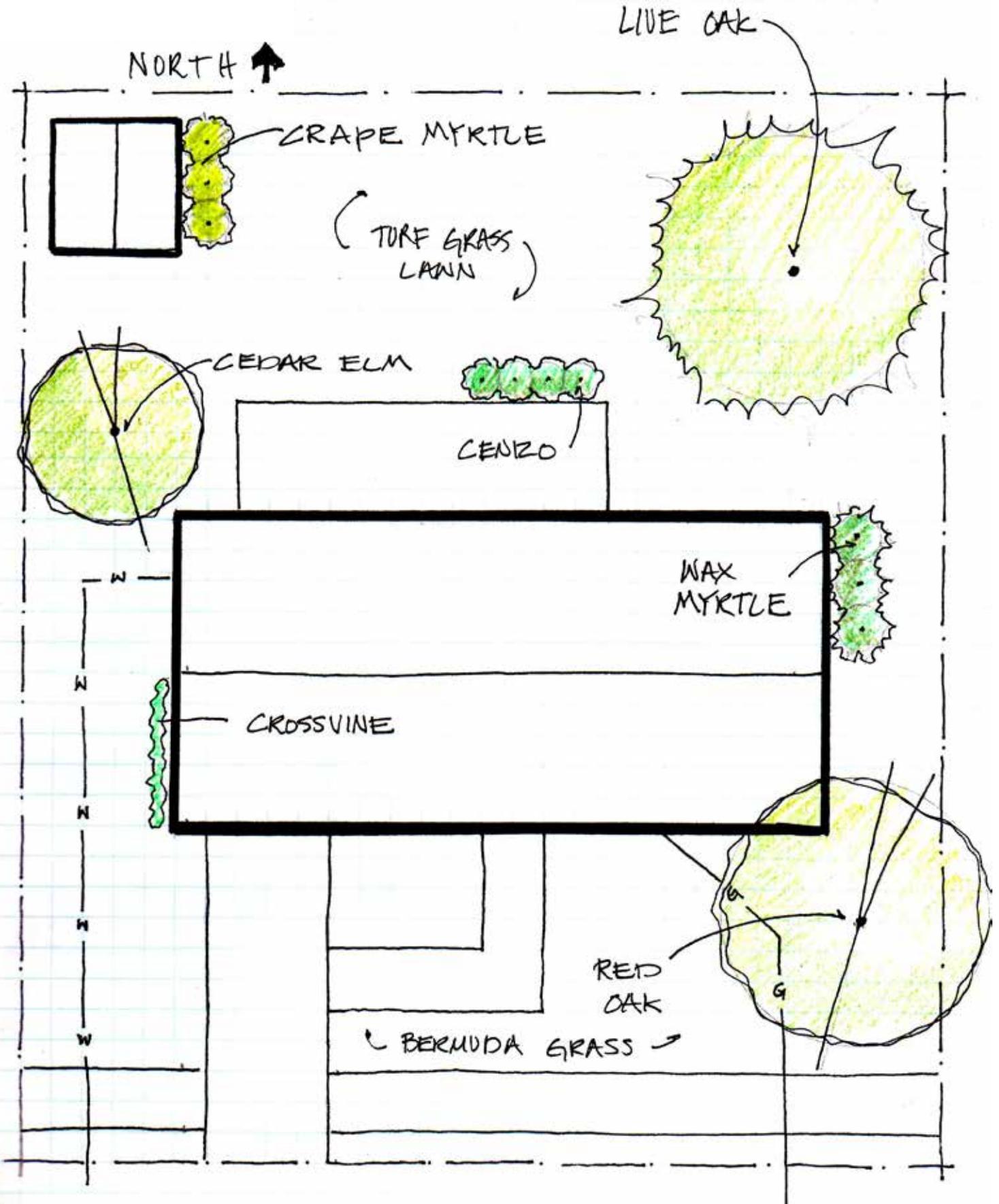
Assignment

Site Assessment — Plants

The assignment for this lesson is to map and identify the plants in the homeowners' garden. On a copy of the site analysis base map, locate large trees, shrubs, lawn, and other significant vegetation. The canopy area of each plant should be outlined along with the name, general size, and health of the plant. Encourage students to bring in photos or samples of vegetation they cannot identify.

On a separate sheet of trace paper, outline the sun and shade patterns of the site. Note areas that receive sun all day, areas that receive morning, midday, or afternoon sun only, and areas that are shaded all day.

Example: Plants Assessment



Lesson 7

Successful Plant Practices

Learning objectives

After completing this lesson you will be able to:

- Explain why it is important to remove and stop the spread of invasive species
- Identify invasive species common to the area
- List vegetation that is well suited to the site conditions
- Explain the benefits of using native plants in the garden
- Describe garden features that are beneficial to wildlife



Overview

While incorporating the right vegetation into your garden can provide a wide-array of benefits, planting the wrong vegetation may cause significant economic and environmental damage. In this lesson, homeowners will learn how to stop the spread of invasive species, as well as select vegetation that optimizes benefits such as attracting desirable wildlife and increasing the energy use efficiency of their home.

Plants gardeners should include in their garden

Native Plants

Native plants are species that exist in a region without human introduction. About 20,000 native plant species grow in the United States from the tropical rainforests of Hawaii to the deserts of Arizona. Unfortunately, native plants are disappearing at an alarming rate. Botanists are concerned about the survival of one in every five of this country's native plants, which provide critical habitat for countless other creatures. To help prevent the further loss of these plants, many can be attractively incorporated into our home gardens.

Native plants can add beauty to a garden, just as they do in natural areas. The great variety of regional natives provides gardeners with options that can support any garden design. In addition to enhancing a garden's aesthetic appeal, native plants also do much more.

Some benefits of using native plants:

- ▶ Native plants that are well suited to the site conditions do not require soil modifications or fertilizers and, once established, can thrive without regular watering. Ultimately, they reduce maintenance costs associated with **irrigation**, fertilizers, and pesticides.
- ▶ Native plants are the foundation of the ecological **biodiversity**. For example, they can nurture important pollinators like bees, butterflies, and hummingbirds.
- ▶ Native plants create a distinctive sense of place, preserving the natural character of a region.

Growing natives can be as simple as adding a regionally native shrub or wildflower to an existing flowerbed or border. Larger projects may include protecting an area of native habitat—a **fragment** of prairie or forest, for example. Homeowners may also choose to restore or recreate the native habitat that once existed on their sites. Even a tiny yard can be restored to include a small native patch of meadow or a woodland glade.

Native plants can provide a variety of benefits to homeowners and the surrounding area, but in order to be successful, they must be well suited to the growing conditions of the site. As with all plants, gardeners should consider the soil type, pH, sun and shade requirements, and watering needs of native vegetation before planting.

Non-native Appropriate Plants

Appropriate plants can be thought of as plants that are not native to a region, but can adapt well to site conditions. They do not possess invasive qualities (e.g., abundance of seed or dense rhizomatous roots) and can be sustainably maintained without the addition of regular input or resources.



HOLLAND YATES

Meadow designed using yarrow and grasses

Plants gardeners should avoid

Invasive Species

An **invasive species** is a non-native plant or animal species that causes or is likely to cause economic or environmental harm. Studies have shown that at least half of the invasive plants in the US were introduced for horticultural use. Invasive plants are often able to outcompete and displace native vegetation when the natural checks and balances that existed in their native range are no longer present in the new environment.

Most invasive plants are habitat **generalists** and able to survive in a wide range of conditions. However, they are more likely to invade ecosystems that have been disturbed or are degraded. Over time they can further degrade or change the characteristics of an ecosystem, altering important natural processes like hydrology, fire, and nutrient flow.

Many invasive plants are still being sold for garden use, despite their documented ability to degrade natural areas. No system is yet in place to effectively screen plants for their potential invasiveness, and new plants from around the world are constantly being introduced.

Certain traits are associated with invasive plant species and should be approached with caution when developing a home garden. For example, rhizomatous roots, large quantities of seed, or fleshy fruits aid many invasive plants in rapid dispersal. Non-native plants bearing these traits should be carefully selected and monitored. It is also recommended that homeowners avoid planting any species found escaping into vacant lots or roadsides, even if they cannot be found on any official invasive species list.

Identifying native and non-native appropriate plants

Activity

Familiarize yourself with native and appropriate plants of the area. This can be done by visiting local botanic gardens, nurseries, or garden club demonstrations. If the weather is not conducive or a trip to one of these locations is not possible, you can also conduct research online. The Native Plant Information Network (NPIN), available at <http://www.wildflower.org/explore/>, is a good resource for identifying native plants.

The most prudent prevention measure is to select regionally native plants. Homeowners who grow plants that are native to their region are helping to prevent the spread of invasive species, preserving the natural character of the region, and supporting the complex interrelationships that have coevolved between native plants, and the insects, birds, and myriad of other creatures belonging to the area.

Examples of Invasive Species Introduced for Horticultural Purposes

Purple Loosestrife (*Lythrum salicaria* L.)

Purple loosestrife is an ornamental herbaceous perennial that is native throughout Eurasia. It was first introduced to the northeastern US and Canada in the 1800s for ornamental and medicinal purposes. Loosestrife tends to invade natural and disturbed wetlands, forming dense, homogeneous stands or monocultures. These stands displace native wetland plant species, reducing habitat of several federally endangered orchids and waterfowl species in the US. Loosestrife now occurs in 48 states across the US and has an estimated cost of \$45 million per year in control and forage losses.



STEVE DEWEY

Purple loosestrife (*Lythrum salicaria* L.)

Salt Cedar (*Tamarix spp.*)

Salt cedar is a large ornamental shrub native to Eurasia. It was introduced to the US in the 1800s for its attractive flower, low maintenance requirements, and ability to prevent stream bank erosion. Despite these advantages, this invasive shrub can significantly degrade or alter an ecosystem by absorbing large quantities of water, restricting river access, and changing the chemical profile of the soil by depositing salt above and below ground. These salt deposits can inhibit other plants from growing and displaces native habitat. By 1998 salt cedar had successfully invaded nearly every drainage system in the southwestern US to occupy over 1 million acres. Efforts to remove salt cedar and restore native habitat can be quite costly. For example, direct costs for restoring areas along the Middle Pecos River, New Mexico were estimated at around \$2.2 to \$6.4 million.



Salt cedar
(*Tamarix spp.*)

STEVE DEWEY

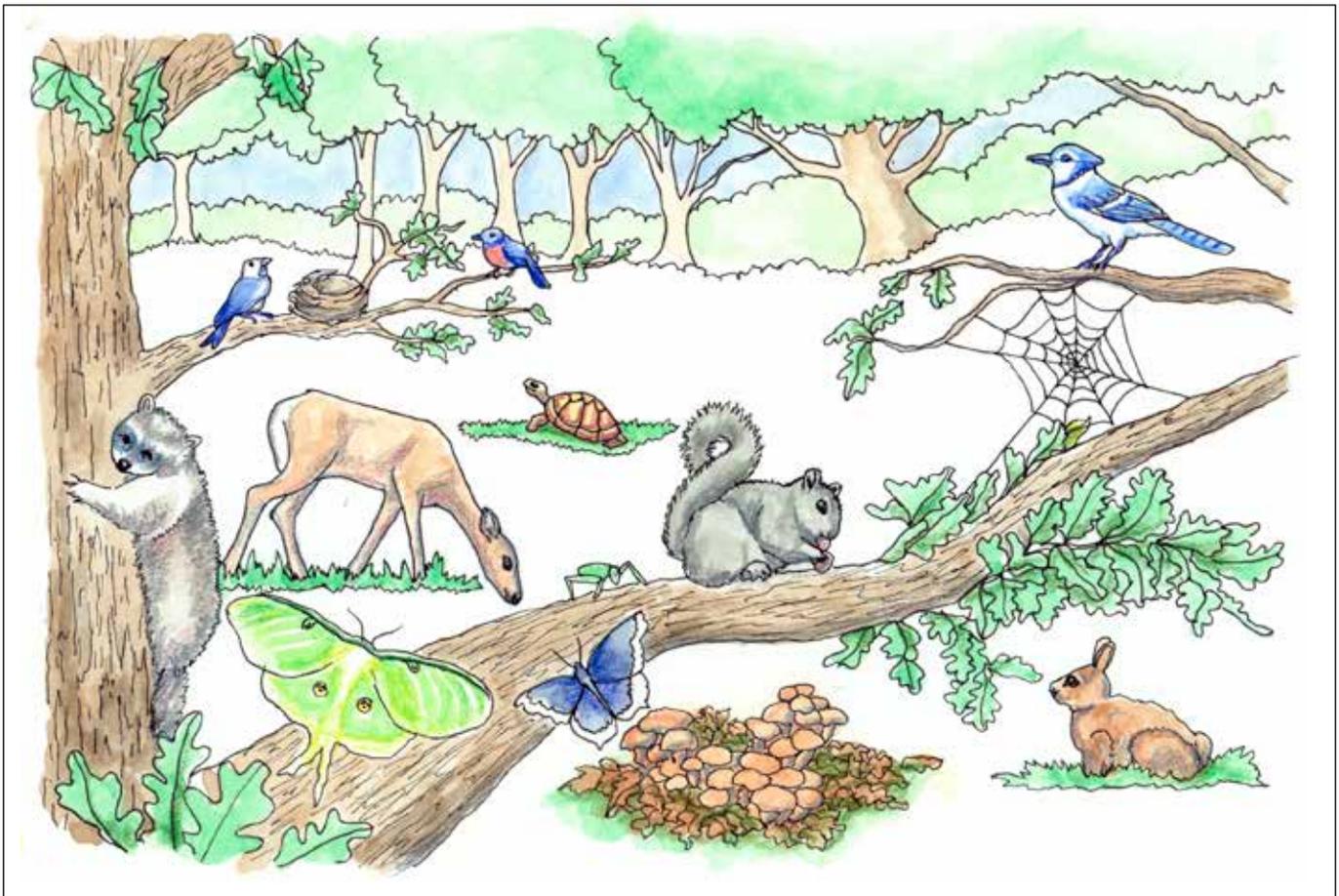
Identifying and controlling common invasive species found in your area**Activity**

Familiarize yourself with invasive plants of the area and methods of controlling these invasives. Resources for learning more about the invasive species in your region include www.naeppc.org, www.invasiveplantatlas.org, the USDA Natural Resources Conservation Service, the Center for Plant Conservation, The Nature Conservancy, state natural resources departments, state conservation departments, and state forestry departments.

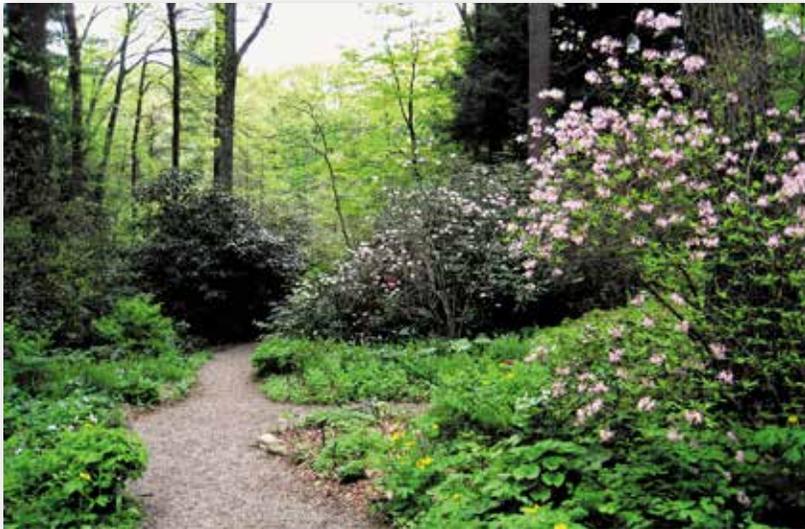
Gardening for wildlife

As wilderness areas become more fragmented and urban landscapes expand, butterflies, songbirds, and other creatures are left without **habitat** or the places and resources needed to live. New development continues to consume 2 million acres of quality wildlife habitat each year—an amount equivalent to the size of Yellowstone National Park. Invasive plants, the overuse of polluting fertilizers and pesticides, and other unsustainable gardening/agricultural practices further threaten wildlife habitat.

Creating sustainable residential gardens can help offset the loss of critical wildlife habitat. The first step in creating sustainable gardens for wildlife is to determine the priority species. Next, gardeners should identify habitat needs including food, water, and shelter for each species. Below is an overview of habitat essentials.



*Since space is limited in most home gardens, it makes sense to select native plants that support the greatest wildlife diversity possible. In Doug Tallamy's book *Bringing Nature Home: How Native Plants Sustain Wildlife in Our Gardens*, native oaks are found to be one of the best plants in supporting wildlife diversity, providing habitat for more than 534 species of butterflies and moths alone. These trees also provide food and shelter for many birds, mammals, and reptiles.*



WIKIMEDIA COMMONS

To enhance wildlife biodiversity, use natural areas as a model in recreating vertical layers of vegetation in the home garden.

Food

The best food source is often a diverse selection of native plants. For the vast majority of native wildlife, most of the non-native plants that have been incorporated in our gardens for more than a century do not provide sufficient food. When you plant native trees, shrubs, and herbaceous plants, you provide wildlife with the nectar, pollen, fruits, leaves, seeds, and nuts—and associated insects—that have nourished them for millennia.

Water

All wildlife needs water for drinking, bathing, and regulating body temperature. Water can be scarce in arid areas and in cities. Nature provides water to wildlife in a multitude of ways that the homeowner can replicate such as a shallow in-ground pool or pond, a water-barrel, or a birdbath. Homeowners should work to ensure that water is clean, accessible to wildlife, and does not serve as a breeding ground for mosquitoes.

Cover

Native trees, shrubs, thickets, grasses, brush piles, and artificial wildlife houses provide cover or places for wildlife to hide, rest, and nest. For birds, all trees and shrubs provide cover, but none are better than evergreens. The seeds in **conifer** cones are an important source of food for many avian species. Regionally native pines and other conifers are more likely to host the native insects upon which birds depend.

Homeowners should avoid the use of pesticides, which can harm birds and other wildlife directly or contaminate the flowers or vegetation that serves as an important food source. To provide habitat **niches** for the widest array of wildlife, it helps to recreate various vertical layers of vegetation—trees, shrubs, flowers, and grasses—found in nearby natural areas.

All native plant communities consist of vertical plant layers. However, these layers tend to be more distinct in forested regions. The canopy, the tallest layer of a forest, is composed of mature trees. Canopy trees typically reach heights between 30 and 100 feet. The next layer down, or the understory, is composed of saplings of canopy tree species as well as smaller flowering trees such as dogwoods and redbuds. The understory layer extends from about 12 to 30 feet above the ground. The shrub layer is the lowest layer of woody vegetation occupying the height between 3 and 12 feet. The lowest aboveground layer of a forest, below 3 feet, is called the ground layer. In this layer, wildflowers, ferns, grasses, and sedges grow in often spectacular combinations. Plants in the ground layer also partition their environment vertically. Spring ephemeral wildflowers bloom first, typically raising

their foliage only a few inches above the leaf litter. When they go dormant, taller ferns and wildflowers overtop them.

Prairies and other communities dominated by herbaceous plants also have distinct vertical layers. The earliest plants to emerge in spring are low to the ground. Each successive emerging plant overtops the next, culminating with the tallest grasses and late-blooming asters and other composites that end the growing season. The layers also extend below the ground, from fibrous-rooted grasses to wildflowers with deep taproots. In general, the more vertical layers there are, the more complex the vegetative structure and the more habitat is created for a wider array of animal life.

Using vegetation to increase the energy efficiency of your home

Collectively, US households consume around 22 percent of the country's total energy. About half of this is devoted to heating and cooling. A properly designed garden can make a home significantly more energy efficient by utilizing trees, shrubs, groundcovers, and vines to provide cooling shade in the summer and insulation against heat loss in winter. An energy-efficient garden also provides a variety of other benefits, which includes cutting heating and cooling bills by as much as 40 percent and adding significant aesthetic value to a home. A windbreak, for example, can define the space in a yard or patio and provide privacy while blocking blustery winds. Using plants as living air conditioners or insulating blankets, homeowners can soften a house's architectural edges with foliage and flowers while improving its energy performance.

Basic energy efficiency strategies by climatic region

Basic energy-saving strategies for buildings are in large part determined by geographic location. The US Department of Energy had divided the US into four climate regions—cool, temperate, hot and arid, and hot and humid—and has recommended the following landscaping strategies for each zone.

Cool

The cool climate region is characterized by very cold winters and hot summers. Temperatures throughout the year are known to vary widely, ranging from about -30 degrees F to 100 degrees F during hot summer months. During the winter, days are short and the sun is low, limiting the amount of solar radiation available for warming. Prevailing winds tend to blow from the northwest to the southwest.

Energy conservation strategies for the cool climatic region:

- › Use windbreaks to protect buildings from cold winter winds.
- › Avoid planting tall vegetation on the south side of the house that may prevent the sunlight from reaching walls or windows.

Hot and Arid

The hot and arid climate region has long summers that are characterized as being dry and hot. Nighttime temperatures drop dramatically. Winds vary between night and day, but tend to blow from east to west.

Energy conservation strategies for the hot and arid climatic region:

- › In summer months, provide shade to cool roofs, walls, and windows
- › Plant around your home so that it is cooled by evapotranspiration, the release of water vapor from the soil and plant surfaces into the atmosphere
- › Funnel summer breezes toward your home if it is cooled naturally and does not rely upon an air-conditioner unit
- › Deflect wind away from houses that are air-conditioned

Hot and Humid

The hot and humid climate zone is characterized by being warm and wet for most of the year. Winds are variable and can blow from any direction.

Energy conservation strategies for the hot and humid climatic region:

- › Direct summer breezes toward the house
- › Make the most of summer shade with trees that still allow low-angle winter sunlight to warm the home
- › Avoid locating planting beds close to the house if they require frequent watering

Strategies for using vegetation to reduce energy consumption during the summer

Warm summer temperatures can increase the need for cooling and significantly raise a household's energy use. This is especially true in urban areas where temperature is already elevated by buildings, asphalt, sidewalks, and other built surfaces that absorb and slowly release heat. Properly placed vegetation in a home garden can significantly reduce energy use by shading buildings, appliances, and other structures that absorb and/or emit high levels of solar radiation.

- › **SHADE A/C UNITS** An easy way to get quick results is to shade the air conditioner. According to the US Department of Energy, this can increase a unit's efficiency by as much as 10 percent. Be sure that shrubs or vines planted near the compressor do not obstruct the airflow or impede access for repairs.
- › **SHADE ALL WINDOWS THAT RECEIVE DIRECT SUNLIGHT** A building gains substantially more heat through windows than insulated walls, making the shading of windows a priority in the summer.



ED CASTRO LANDSCAPE

Vines can help shade a home, while adding aesthetic appeal.

› **SHADE WALLS AND PARTS OF ROOF THAT RECEIVE THE MOST SUN** In the northern hemisphere, the location of the sun is shifted slightly to the north in the summer, making the building surfaces that receive the most sunlight the roof and east- and west-facing walls. Overheating early in the day can be prevented by shading east and southeast building surfaces, whereas shade on the west and southwest walls and roof can significantly reduce peak indoor air temperatures and accelerate cooling in the afternoon and evening hours. In the southern hemisphere, the location of the sun is shifted slightly to the south in the summer, the building surfaces that receive the most sunlight are still the roof and east- and west-facing walls. Overheating early in the day can be prevented however by shading east and northeast building surfaces, whereas shade on the west and northwest walls and roof can significantly reduce peak indoor air temperatures and accelerate cooling in the afternoon and evening hours.

› **SHADE DARK-COLORED DRIVEWAYS, ROADWAYS OR PATIOS** Dark paving and roofing materials, such as asphalt roads, roofs, and driveways, absorb and radiate significant amounts of heat. The resulting warm air can influence the inside temperature of a home and the comfort of people who utilize the garden. Shading these surfaces, particularly during summer months is an important strategy for mitigating the urban heat island that will benefit not only the site but also the surrounding area.

Selecting Vegetation to Increase Shade and Improve Energy Efficiency

Vines—Because trees often grow slowly, homeowners can more efficiently moderate solar radiation by planting fast-growing vines on strategically placed trellises. Permanent structures like trellises are most appropriate in hot climates, where blocking solar heat gain in winter is not counterproductive. Where wetness and humidity are a problem, keep the trellis at least a foot away from the house to allow for air circulation. In these areas, air should be allowed to flow around the home, keeping the structure and surrounding soil dry to prevent mildew and rot. Arbors or pergolas are a better choice in temperate regions because they allow winter sun to penetrate the windows and warm the house.

Annual Vines—grow quickly and can cover a large area by mid to late summer. Homeowners can make shading devices twice as functional by growing vines that provide not only shade but also fruits or vegetables. Edible vines, such as scarlet runner beans, winter squashes, and luffa squashes are both vigorous and fast growing. Ornamental vines are also good candidates. For example, cypress vine and scarlet creeper provide nectar for hummingbirds, while moonflower attracts moths. At the same time, homeowners can plant perennial vines, which may take two or more years to cover an arbor or trellis as tall as the home's walls. Avoid planting these in cooler climates where solar heat gain is desirable during the cold months unless they don't block the sun in winter or can be cut back drastically at the end of the season.



PROJECT LIVING PROOF

Trees planted near a home should accommodate shade as well as spacing needs, when possible.

Trees and Shrubs—Large trees and shrubs take longer to fill in but provide the best cooling shade. The air temperature can be as much as 25 degrees F cooler under trees than around nearby asphalt lots. As is true for vines, in cool and temperate climates the placement of trees is more complicated than it would first appear. Trees can reduce summer temperatures significantly, especially when they are located on the south and west sides of the house. Large specimens that shade the roof and walls from the afternoon sun can reduce indoor temperatures by as much as 8 to 10 degrees F. Trees should be located close enough to the house to cast shade but far enough away (typically about 15 feet) that their roots will not damage the foundation. Homeowners should also consider how wide the trees will become when mature, and space them accordingly.

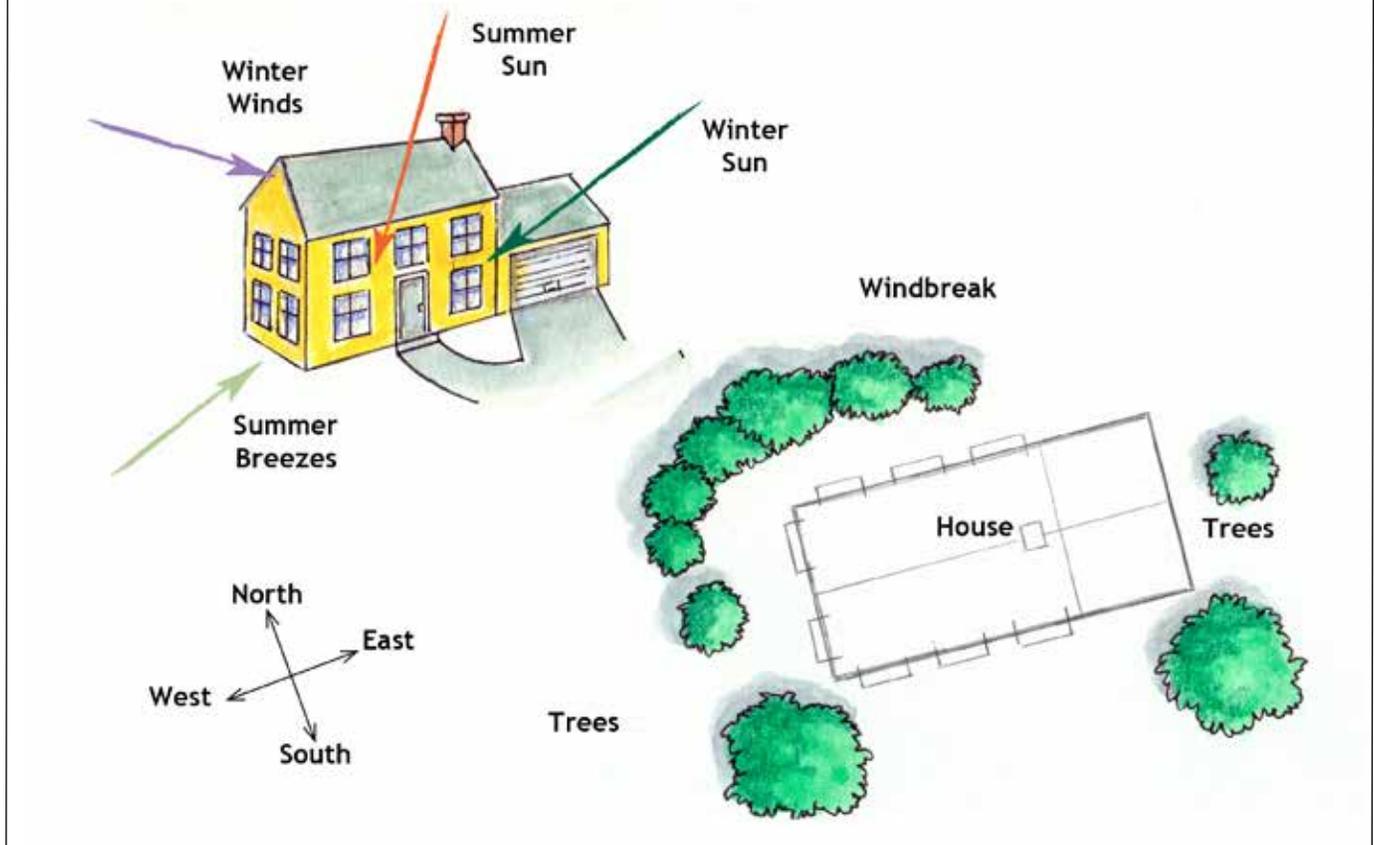
On small city or suburban lots, the optimum location for a shade tree may be in a neighboring yard. Homeowners should work with neighbors to create a larger garden plan that enhances energy conservation and lowers costs for everyone. If this is not an option, homeowners can use shrubs and vines to shade the walls, windows, and air conditioners. Deciduous trees provide shade in

summer and then drop their leaves in autumn, allowing the sun to warm the home during the winter. Tall trees with broad leaves and a high, spreading crown (e.g., maples) are ideal for this purpose. As few as two or three properly spaced trees with wide crowns may suffice, depending on the size of the house. Prune lower branches for maximum heating of walls and roof by the low winter sun. A 6- to 8-foot deciduous tree planted near a home will typically begin shading windows the first year. Shading the roof of a home will typically take between five and ten years depending on the tree species and the height of the home. Smaller trees and shrubs can also play a role in helping to conserve energy. Species with branches lower to the ground can be planted closer to the house than tall shade trees and used for shading east and west facing walls and windows from the lower morning and afternoon sun. For the greatest ecological benefit, select species native to the region that offer food and shelter for pollinators and other wildlife. Shrubs planted close to the house can fill in rapidly and shade walls and windows relatively quickly in wet and humid areas. Avoid planting them right up against the house so air can circulate freely.

Using Vegetation to Reduce Energy Consumption During the Winter

Winds make winter cold significantly worse, however it is possible to keep a house warmer in winter by blocking the chilling effect of wind. The most effective way is to plant a windbreak perpendicular to the prevailing winds. If a property is small, homeowners can plant evergreen shrubs next to the house to create a dead air space that can help insulate the home. Evergreen shrubs can also be strategically located near the house to help shelter doors exposed to the wind.

Garden Plan to Enhance Home Energy Efficiency



A simple garden plan can help you devise the most effective strategies for an energy-conserving garden. Note which areas of your home are affected by the sun and wind (upper left) to determine the best placement of plantings (lower right). The plan above is for a home in the eastern states, where winds generally come from the north and west.



A standard multiple row windbreak consists of an upwind row of dense conifer trees and shrubs, interior rows of tall broadleaf trees, and downwind rows of shrubs or conifers. How far apart the trees and shrubs should be planted depends upon the size and shape of the species when they reach maturity, but there should be no gaps between the plants when they are fully grown.

Site Assessment — Energy Efficiency

Assignment

Site Assessment — Energy Efficiency

This assignment focuses on investigating the site conditions that impact a home's energy efficiency. On the site analysis basemap, locate the following:

- › All windows, doors, and skylights in the house
- › A/C units
- › Solar collectors or photovoltaic arrays

On a separate sheet of trace paper, note the following:

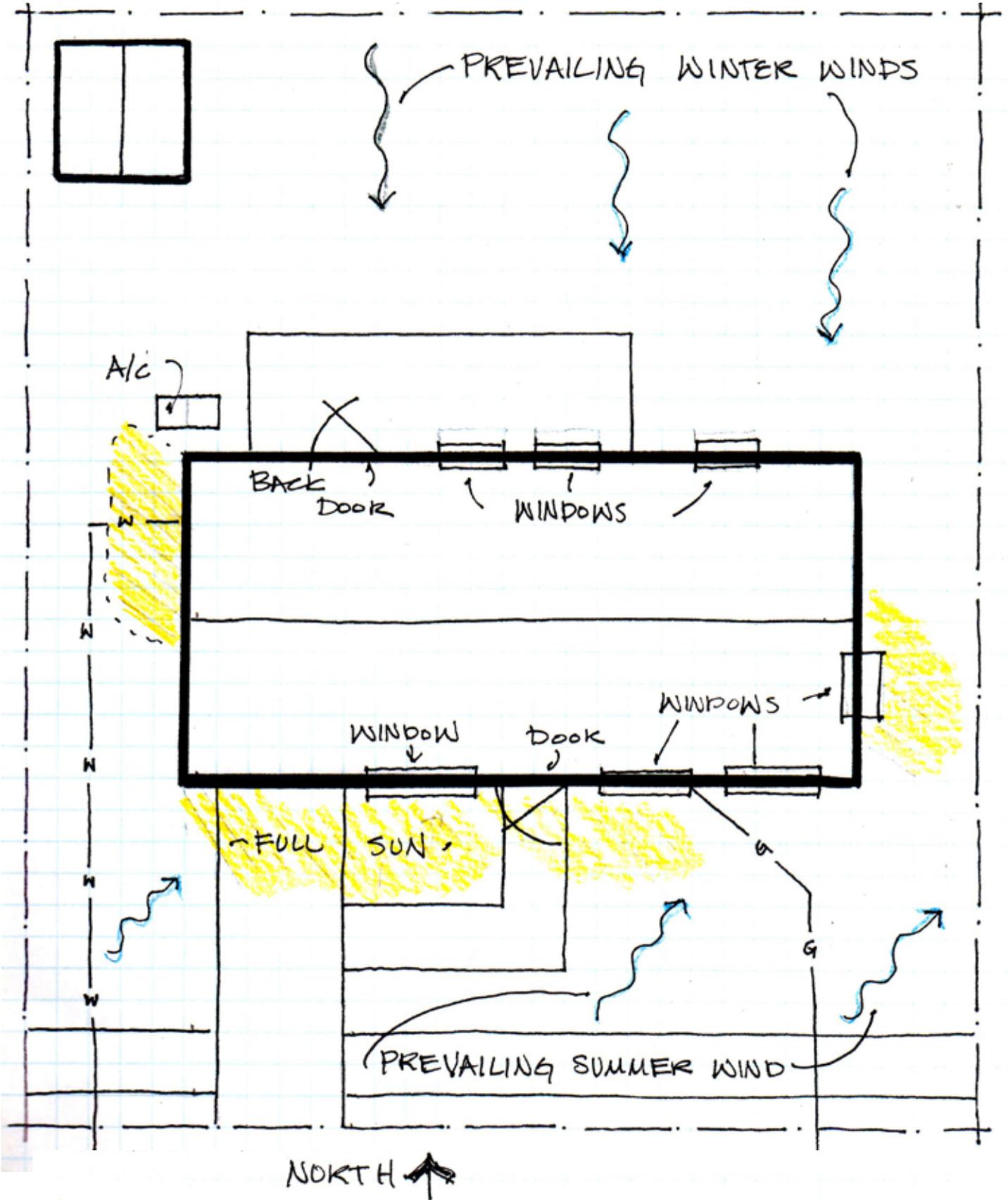
- › Direction of prevailing winds in the winter and summer
- › Portions of the home that receive sunlight in the morning, afternoon, and evening during the summer and winter

Creating an Effective Windbreak—To be most effective, a windbreak should meet certain height and length requirements. For the greatest protection, homeowners should plant windbreaks at a distance from their house of about two to five times the height of the mature trees. That means that if the trees being planted grow to 40 feet, homeowners should plant them at least 80 feet upwind from the house. Windbreaks should be located so that it does not prevent sunlight from reaching the house, particularly on the south facing walls between the hours of 9 am and 3 pm.

A good windbreak provides protection in more than one direction. A study in South Dakota found that placing windbreaks on at least three sides of the home (i.e., west, north, and east) can cut fuel consumption by an average of 40 percent. Houses with windbreaks planted only on the windward side—the side of the prevailing winds—only averaged 25 percent less fuel consumption when compared to unprotected homes.

The best windbreaks block the wind close to the ground as well as up high, so homeowners should be sure to include species that have low crowns, such as spruces and firs. Evergreen and deciduous trees and shrubs can also be combined with a wall, fence, or berm to lift the winds up and over the house. Some air should be able to pass through the windbreak. Impenetrable barriers create a strong vacuum on the protected or leeward side, causing some of the wind to hit the house instead of lofting over it. Windbreaks composed of trees and shrubs allow some of the wind to penetrate, making them a more effective option.

Example: Energy Efficiency Assessment



Resources: Plants

Publications

Bringing Nature Home: How You Can Sustain Wildlife with Native Plants

Douglas Tallamy
Timber Press, Inc. (2007)

A book about using native plants to create habitat for local wildlife.

Edible Estates: Attack on the Front Lawn, Expanded 2nd Edition

Fritz Haeg
Metropolis Books (2010)

A well-illustrated book that showcases edible gardens across the US.

Energy-Wise Landscape Design: A New Approach for your Home and Garden

Sue Reed
New Society Publishers (2010)

This book demonstrates how homeowners can use plants and other standard landscape materials to reduce energy use.

Native Alternatives to Invasive Plants

C. Colston Burrell
Brooklyn Botanic Garden (2011)

This handbook provides recommendations for a variety of beautiful, regionally native, trees, shrubs, vines, herbaceous plants, and grasses that can replace commonly planted invasive species.

Trees in the Urban Landscape: Site Assessment, Design, and Installation

Peter Trowbridge and Nina Bassuk
John Wiley and Sons, Inc. (2003)

A well-illustrated guide to successful planting in urban landscapes, from design conceptualization to daily maintenance.

Useful Websites

ACTrees

Alliance for Community Trees
<http://actrees.org/what-we-do/>

This organization provides resources geared at creating healthy urban and community forests.

Casey Trees

<http://caseytrees.org/>

This organization provides information on how to install, select, and care for trees in urban areas.

Celebrating Wildflowers: Gardening for Pollinators

US Forest Service
<http://www.fs.fed.us/wildflowers/pollinators/gardening.shtml>

This website provides basic tips and a list of additional resources about using wildflowers to attract pollinators.

Growing Green Lawns

Community IPM Network

www.growinggreenlawns.org/

A resource that provides integrated best management practices for residential landscapes, lawns, gardens, and home pests.

Invasive and Exotic Species of North America

Center for Invasive Species and Ecosystem Health

www.invasive.org/

A comprehensive resource for invasive species identification and control.

Least Wanted: Alien Plant Invaders of Natural Areas

Plant Conservation Alliance's Alien Plant Work Group (PCA)

<http://www.nps.gov/plants/alien/factmain.htm>

Illustrated, easy-to-read fact sheets on invasive alien plants with native ranges, plant descriptions, ecological threats, US distributions and habitats, background of introductions, plant reproduction and dispersal, management approaches, alternative native plants, and other useful information.

National Tree Benefit Calculator

Casey Trees and Davey Tree Expert Co.

<http://www.treebenefits.com/calculator/>

Calculates the environmental and economic value trees provide on an annual basis.

Native Plant Information Network (NPIN)

Lady Bird Johnson Wildflower Center, the University of Texas at Austin

<http://www.wildflower.org/plants/>

The largest native plant database in North America.

North American Native Plant Society

<http://www.nanps.org/>

This organization provides information and resources on the cultivation and conservation of native plants.

PLANTS Database

Natural Resource Conservation Service (NRCS)

<http://plants.usda.gov/java/>

This database provides standardized information about vascular plants, mosses, liverworts, hornworts, and lichens of the US and its territories. It includes names, plant symbols, checklists, distributional data, species abstracts, characteristics, images, crop information, automated tools, and references.

Pollinator Friendly Plant Guides

Pollinator Partnership

<http://www.pollinator.org/>

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

Protecting Native Plants and Animals: Taking on Invaders

The Nature Conservancy

www.nature.org

A resource for learning more about invasive species and how to control their spread.

Vibrant Communities: Trees are the Key Online Toolkit

Sustainable Urban Forests Coalition

<http://vibrantcities.org/>

An online resource center and communication toolkit with a variety of materials that can be used and/or adapted to provide education on the benefits of city trees.

*Information on water testing can be found through a local Cooperative Extension Office. A list of offices by state is provided in Appendix 2 of this manual.