Habitat Gardening for Wildlife

Photo by Carol Heiser

Photo by Ed Dorsey

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Landscaping for wildlife is both an art and a science. Whether we use plants creatively as a form of artistic expression or we design the landscape as merely a utilitarian space, we can sustain the biodiversity around us by planning our gardens with an ecological function in mind. When we plan our surroundings in a way that supports complex interactions between plants and animals, we become more fully connected to nature ourselves.

Habitat gardening is an enjoyable way to more fully appreciate nature while improving the available food, water and cover for birds, amphibians, mammals and other wild creatures in our landscape. Applying the principles of good vegetative structure and horizontal layering as we add plants to the landscape will provide wildlife with beneficial food sources as well as much needed cover from predators, winter winds and summer sun. Nest boxes, water features, brush piles and other amenities will enhance the habitat's value and can be planned as attractive focal points in the garden.

However, as one assesses the existing habitat and makes choices about what plants and amenities to add, care must be taken in the placement of those enhancements, in order to minimize the possibility of attracting "unwelcome" wildlife species. There are no "nuisance wildlife" species; rather, we create the conditions in our landscape that attract wildlife, and sometimes our unwitting choices set the stage for certain wildlife species to become a problem. Therefore, we must plan the habitat garden in a way that balances our need for aesthetics and beauty with the reality of how wildlife will likely use the space as we've designed it.

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Introduction

Habitat Loss and Declining Wildlife Populations

The **decline of wildlife species** is occurring at an alarming, accelerated rate. In 2005, the Virginia Department of Game and Inland Fisheries published a Wildlife Action Plan which identified 925 species of greatest concern, classified into four groups or 'tiers' that describe varying degrees of population declines attributed to habitat loss. Of these, 290 species or 31% are insects, which are an essential part of aquatic and terrestrial food webs.

Wildlife Groups in Virginia (Total Species in Parentheses)	*Number of Species of Greatest Conservation Need*
Mammals (96)	24
Birds (390)	96
Fishes (210)	97
Reptiles (62)	28

Wildlife Groups in Virginia (Total Species in Parentheses)	*Number of Species of Greatest Conservation Need*
Amphibians (82)	32
Mussels	61
Aquatic Crustaceans	61
Aquatic Insects	148
Terrestrial Insects	142
Other Aquatic Invertebrates	34
Other Terrestrial Invertebrates	202
[List does not include marine wildlife, except 1 regularly nesting sea turtle species]	**TOTAL 925 Species of Greatest Concern**

Habitat loss is caused by many factors. The most obvious is development and fragmentation of forest, meadow and wetland habitats, as we continue to grow the economy by building commercial and residential sites. This development brings with it a host of factors that adversely impact the remaining or surrounding habitats, and these

factors include but are not limited to a prevalence of impervious surfaces that contribute to increased erosion and runoff, which carries chemicals and sediments with it, and the extensive use of lawn and other non-native plants in the landscape for ornamentation. There are adverse impacts occurring in the more rural or agricultural areas, too, including the routine use of herbicides and pesticides and 'clean' farming practices that remove hedgerows and large expanses of vegetation, in order to maximize production. In addition, as more land disturbance occurs across all these areas—urban, suburban and rural—we've seen a concomitant proliferation of invasive exotic plant species that compete with native plant communities.

The additive effect of all these factors or pressures on the environment is an overall reduction in the quantity and quality of aquatic and terrestrial habitats, which is the single most important reason that wildlife populations are in decline, across multiple genera and species. The 2015 revised edition of the Wildlife Action Plan therefore places even greater emphasis on habitat conservation by providing summaries of priority actions that local Planning District Commissions can apply on a regional scale.

What can Master Gardeners do at the local level to support the Wildlife Action Plan? Master Gardeners are in a unique position to influence the trajectory of habitat loss by increasing public understanding of this issue. Oftentimes, homeowners and landowners are either completely unaware of or only vaguely familiar with the connection between their landscape practices and the effects of those practices on habitat quality. Continued emphasis in our education outreach programs about good conservation landscaping practices is essential for raising awareness. If we provide consistent, clear messages and simple guidance about how to improve or restore habitat in our communities, then the resulting actions by the public should help to slow—and ultimately, one hopes, to reverse—the trend of declining wildlife species. Conservation begins at home and in the neighborhood, and habitat gardening is a good first step to restoring and sustaining biodiversity.

Habitat Principles

What Wildlife Needs: Vegetative (Biotic) Components

In order to fully understand what wildlife needs, we must begin with plants. Each plant species in a given geographic area has a total number of individual plants that make up a **population**, and the collection of plant populations found in that area form an assemblage known as the **plant community**. A diverse, healthy plant community provides multiple ecological services, such as interception of rainfall, which helps to recharge the groundwater and reduce flooding and erosion. Plant communities also contribute to nutrient cycling, oxygen exchange and carbon sequestration processes. Perhaps one of the most crucial functions of a plant community, in addition to these many benefits, is the life-sustaining support it provides to an associated community of wildlife species. The plant community provides organic matter for a variety of organisms, such as bacteria and fungi, and the plants also provide food and cover for wildlife, including birds, mammals, reptiles, amphibians and insects.

Plant and animal communities live and interact together in varying compositions and in distinct, often complementary relationships to each other. These biologically diverse communities, when combined together with the other non-living (abiotic) elements of the surrounding environment, such as soil, water and sunlight, form a functional system of continuous energy exchange called an **ecosystem**. Forests, wetlands and prairies are examples of ecosystems that contain thousands of plant and animal populations that interact with each other in the context of other landscape components.

Together, these interdependent populations of plants and animals make up countless communities within ecosystems, which give an area its species richness and genetic diversity. **Biodiversity** refers to the variety of genes, species and ecosystems in the aggregate, across the larger landscape.

A habitat is the area within an ecosystem where an animal is able to secure the food, water, cover and space it needs to survive and reproduce. Every wildlife species has specific habitat requirements; but because there are often overlaps of habitat features within a system, there are usually multiple wildlife species that can live in a given habitat. Salamanders, for example, require moist soil and rich organic matter that can be found in forest, riverine and wetland ecosystems. Each of those ecosystems contain multiple habitat components—the tree canopy, boggy low areas, rocky outcrops, etc.—and other wildlife species like frogs and birds will be found in association with the habitats in those ecosystems, too. This means that if we want to restore and sustain biodiversity in the landscape around our home or on our property, we simply

need to "put back" an assemblage of many of the plant species and other elements that would naturally have occurred there, and arrange the plants and those elements in such a way that many wildlife species will be able to take advantage of them and meet their needs for survival.

Habitat gardens are therefore most successful when they support a broad diversity of wildlife species, and the easiest way to achieve wildlife diversity is to choose a variety of plant species that most closely mimic the vegetative structure of a natural system. Plants are the living or biotic component of the landscape, and vegetative or **vertical structure** refers to layers of plants that provide a level of complexity and functionality in their arrangement such that they sustain a broad array of wildlife species.

For example, on the ground plane of an eastern deciduous forest, the first component is the mulch layer, which forms a humus blanket that maintains soil temperature and can protect the ground from erosion. The mulch layer is critical for the decomposition process and supports many insects such as sow bugs, beetles and millipedes. These insects then become food for predatory insects such as centipedes and also serve to feed other wildlife, such as spiders, salamanders, toads, lizards, turtles, small mammals and birds. As the leaf litter and woody debris are broken down through the chewing and shredding of insects, along with the associated decay that's wrought by fungi and bacteria, nutrients are released back into the soil, where plants can take them up again. This continuous recycling of organic matter and replenishment of soil is a most valuable aspect of the mulch layer. Therefore, one of the very first steps in establishing a habitat garden is to retain the leaf litter in the landscape, so as to support a rich assortment of organisms that will form the foundation for a complex food web.

The next layer in our forest example is the **herbaceous layer.** These are plants with green, mostly non-woody stems, and they include species that form the groundcover layer. Groundcovers are plants that creep along the mulch or grow in clumps or masses and provide a protective covering for the soil below. Foamflower, wild ginger, striped wintergreen, sundrops, woodland phlox, columbine and bluebells are some wildflowers or "**forbs**" we might see in the forest setting. In addition to these groundcover plants, the herbaceous layer may also contain a variety of ferns as well as vines, such as crossvine, pipevine, trumpet vine and Virginia creeper. Of special note is that groundcovers in nature are typically much taller than the two to three inches in height we're accustomed to seeing in a conventional lawn. Hence, the herbaceous layer in a productive habitat garden is not likely to be a short carpet but rather a diverse composition of plants of varying heights that simply cover the ground.

Standing above the herbaceous layer but below the taller trees is the **shrub layer** or "sub-canopy" layer. This layer is comprised of flowering shrubs that grow in a wide range of sizes, from as small as two feet for huckleberry or lowbush blueberry; to medium heights of six to 12 feet for deerberry, spicebush, and viburnums; and as tall as 15 or 20 feet for American hazelnut, witch hazel, and rhododendrons.

Overhead is the canopy formed by the tallest plants, the **tree layer**. Some trees are small, only 20 to 35 feet in height, such as pagoda dogwood, paw paw, and redbud. Others grow within a range of 30 to 60 feet in height, such as serviceberry, flowering dogwood, and American holly. The largest trees, such as oaks and hickories, can attain heights of 80 to 100 feet.

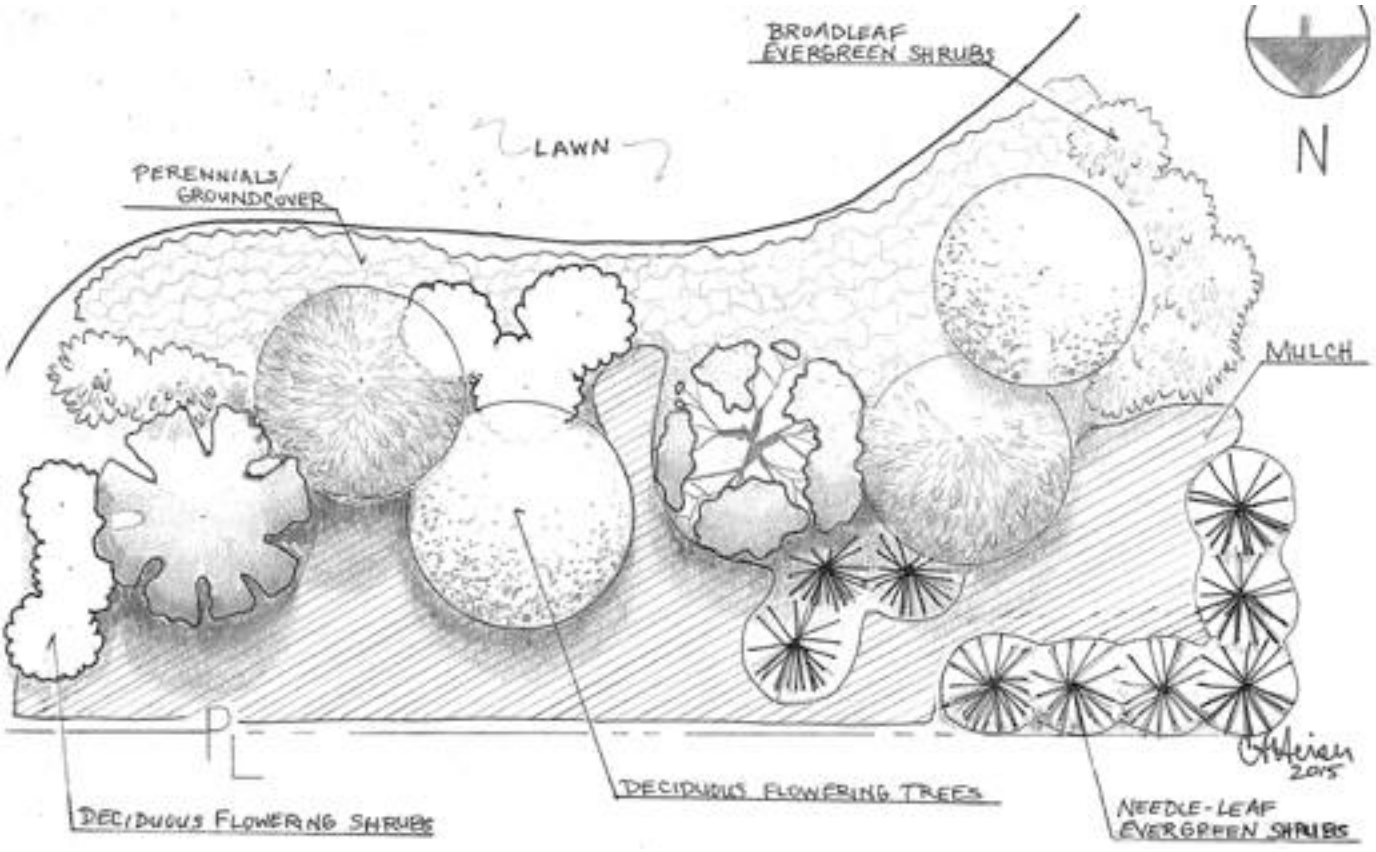
Since most of our built landscapes are typically missing one or more vegetative layers, we can easily support more wildlife species by taking our cues from nature and choosing a palette of plants appropriate for our particular site conditions. For example, if the landscape is primarily wide open lawn, which is devoid of vegetative layers and diversity, we could bring life back to the scene by emulating a meadow habitat made up of sun-loving native grasses and flowers. If our landscape has some tree cover but little else, we could add a shrub layer and herbaceous ground covers. A very wet, boggy area in the yard that's difficult to mow and maintain could be transformed into a mini-wetland with the addition of common elderberry and buttonbush to make up the shrub layer; moisture-loving plants like Joe pyeweed, cardinal flower, and swamp milkweed would form an herbaceous layer.

Another habitat principle we can apply in our landscape planning is **horizontal structure**. Over the course of time, plant species within a given community will naturally change, if there are no interventions such as mowing, grazing or burning. Each stage of change occurs in succession after the one before it, and this process of succession is why a plant community that starts out as a meadow will gradually be replaced with woody species and eventually become a forest in the final stage. The arrangement and interspersion of these different

successional stages in proximity to each other is what provides horizontal structure. We can use basic gardening and maintenance methods to improve horizontal structure by encouraging the growth of particular vegetative types that will mimic different successional stages, which in turn will support different wildlife species. For example, if we stop mowing an area, we can allow woody shrubs and trees to gradually take over and provide a forest-type habitat. If, on the other hand, we already have a woodland and want to attract wildlife species that require grasses and other flowering herbaceous plants, we can create an opening in the canopy and plant perennials and grasses, then keep the successional changes in check by mowing every two to three years, which will prevent woody vegetation from becoming re-established there.

We can also enhance the places where two habitat types come together, referred to as an **edge**. This transition zone is made up of plants from each of the habitats juxtaposed to each other and therefore contains wildlife species from both habitats as well. The greater the number and variety of plant species along an edge, the higher the abundance of wildlife found there. In a landscape setting, we can maximize this edge effect by increasing the number of plant species in the space between where two different vegetative types occur. For example, where a lawn abuts a stand of trees, we can add a shrub layer alongside the trees, to soften the edge. We could even take the edge one step further by adding a layer of herbaceous flowering plants next to the shrub layer. Hence, even a very small space like a townhouse yard can greatly increase its habitat potential by simply adding layers that improve both vertical and horizontal structure.

Similarly, the edges of small creeks and streams that run through the landscape can be enhanced or protected with vegetation. An edge of shrubs and trees planted along a waterway will provide a sheltering buffer for wildlife



HABITAT STRUCTURE: Adding layers of plants to the landscape is a very effective way of increasing available food and cover for wildlife. Flowering perennials form an herbaceous groundcover next to shrubs and small trees of varying heights and texture. Placement of a shrub border is ideal along an edge where the grouping will be adjacent to taller trees. Look for places throughout the property to increase vertical structure, such as along fences, property lines, walkways and driveways. Shrub beds can also be situated in the middle of a lawn to create a habitat island. Arrange the plants in large clusters or groupings, which will maximize the depth of the bed and the interior structure for greater cover, rather than installing a single row of plants.

from human activity, and the roots of the plants will hold the soil and filter runoff that enters the stream – thus improving the aquatic habitat within the stream, too.

Choosing Plants for Wildlife: Interrelationships and Biodiversity

Now that we know how to put a habitat together—arrange it in layers, with lots of structure and diversity—the next step is deciding which plants to use. There's an important case to be made for selecting native plants for wildlife whenever possible.

What's a native plant? According to the Plant Conservation Alliance, a native plant is "…one that occurs naturally in a particular habitat, ecosystem, or region of the U.S. and its territories or possessions, without direct or indirect human actions." The U.S. Fish and Wildlife Service defines native plants this way: "With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem."

Mounting scientific evidence indicates a strong correlation between the use of native plants in the landscape and insect biodiversity. Dr. Doug Tallamy of the University of Delaware has conducted research that illustrates this correlation. In his landmark book Bringing Nature Home: How You Can Sustain Wildlife with Native Plants [2009 edition, Timber Press], Tallamy cites the following research results:

"In a survey of insect herbivores found eating woody native and alien species in Oxford, Pennsylvania, native plants produced over four times more insect biomass than alien plants produced. This difference resulted entirely from the inability of insects with chewing mouthparts to eat alien plants. (p. 328)

"In a comparison of the diversity of herbivorous insects on native and alien woody plants in Oxford, Pennsylvania, more than three times as many insect species were associated with native plants as with alien plants. (p. 329)

Tallamy also explains that because 96% of songbirds feed their young insects, and 37% of all animals on earth are herbivorous insects (pp. 21-24), the choice of plants we make in our landscape not only impacts the biodiversity of insect populations but also multiple bird populations as well.

Further, Tallamy and other scientists have found that not all native plants are equally productive. Some plant species support far greater biomass or numbers of organisms than others. For example, native plants in the Lobelia genus (such as cardinal flower) only support four species of Lepidoptera (butterflies, moths, and skippers), while plants in the Carex genus (the sedges) support 36 species of Lepidoptera [http://udel.edu/~dtallamy/host/index.html].

As gardeners, then, we have a wide range of choices before us when selecting plants for habitat improvement. The initial decisions we make for habitat gardening will likely be the same as for any other project, based on three primary factors: 1) how we plan to use the site; 2) the current site conditions; and 3) what plant species are most appropriate for those site conditions and the geographic region we live in. (Budget is typically a fourth factor, but will not be addressed here.) Although it's true that the more native plant species we use, the better the wildlife diversity will be, it's important to find the right balance to suit our specific site, which is an individual choice that will depend on our own particular needs. Ultimately, the degree to which one is able to improve habitat and sustain wildlife will be unique to each situation and dependent on individual preference.

In addition, there are many other reasons to use native plants besides the benefit of providing food and cover for wildlife. Whenever we choose "the right plant for the right place," we ensure a more successful outcome, especially if we select those best adapted for drought- or water-tolerance. And although native plants are not maintenance free—contrary to popular opinion—they can substantially decrease long-term maintenance requirements over time, once established. In general, native plant landscapes use less water, help reduce energy costs, and can increase property value because of their intrinsic aesthetic appeal.

Conservation Landscaping and Habitat Gardening

Conservation landscaping refers to landscape principles that apply best practices for conserving water, soil, and existing native plant communities. The Chesapeake Conservation Landscaping Council [www.chesapeakelandscape.org] has developed simple guidelines that can help homeowners, landowners, landscape professionals and municipal decision-makers take action to improve the health of the Chesapeake Bay watershed. However, these guidelines can certainly be

applied to other areas of the state that are outside the Bay watershed, because conservation practices help improve environmental quality no matter where we live. The "Eight Essential Elements" listed below are useful for making informed landscape choices.

A conservation landscape:

1. Is designed to benefit the environment and function efficiently and aesthetically for human use and well-being;

2. Uses locally native plants that are appropriate for site conditions;

3. Institutes a management plan for the removal of existing invasive plants and the prevention of future nonnative plant invasions;

4. Provides habitat for wildlife;

5. Promotes healthy air quality and minimizes air pollution;

6. Conserves and cleans water;

7. Promotes healthy soils;

8. Is managed to conserve energy, reduce waste, and eliminate or minimize the use of pesticides and fertilizers.

Conservation landscaping is therefore a systematic approach that integrates the use of native plants and wildlife habitat into our built environment while simultaneously reducing the need for mowing or for using fertilizers, pesticides, herbicides, water and fossil fuels. With this approach, plants are selected not just for their ornamental appeal but for their function in providing the highest habitat value for the site, in order to sustain multiple wildlife species. There's much less emphasis on using turfgrass as the predominant cover type, because turfgrass supports very little biodiversity. Instead, the principles apply greater emphasis on replacing lawn with assemblages of native plants that would be found locally in the natural environment. In essence, a conservation landscape sustains life and conserves resources in a way that traditional landscaping often does not. Yet, conservation landscapes can provide as much—and many would say they provide more—beauty and aesthetic appeal to the human eye.

Other Habitat Amenities: Structural (Abiotic) Components

After the vegetative components have been chosen and the various layers of plants have become established, it's time to look around the landscape and strategically fill in any remaining spaces with additional structural components that will augment the available habitat for wildlife. These are the non-living or abiotic elements of the landscape. The most commonly used structural components include brush piles and rock piles, snags (dead trees), nest boxes, areas with bare soil, and water features.

Brush Piles and Rock Piles

Brush piles and rock piles provide places for wildlife to seek shelter from the elements of rain, wind and snow over the course of a year. The "nooks and crannies" afford cool, dark areas to hide from the summer sun, or a protected spot to nestle down and retain warmth against the winter's chill. Temperature extremes aside, these simple constructed piles of easily found materials also provide valuable escape cover from predators, as well as places for wildlife to raise young. Rabbits, raccoons, mice, chipmunks, box turtles, lizards, snakes, insect-eating birds are just some of the many other animals that seek out these protected areas from time to time, either to rest, find food, overwinter, or lay their eggs. Depending on how big the pile is, some species may create a burrow or nest underneath the pile to live on a more permanent basis.

The limiting factor for brush piles and rock piles, of course, will be the size of the yard, as these piles are best suited to fairly large size lots (at least an acre), with plenty of space. It's also important to locate the pile well away from buildings and vegetable gardens, in order to minimize the likelihood of attracting wildlife such as groundhogs or skunks, which might decide to seek alternative shelter under the foundation of a nearby house or shed. Very small yards, such as a courtyard or a town house lot, are not conducive to making a pile at all.

Rock piles can be placed on the edges of the property near existing vegetation, or behind a shrub bed or adjacent to a stand of trees—wherever the rocks will blend in with the surrounding landscape to look natural and not too contrived. A rock pile can also benefit frogs and other aquatic organisms when stacked loosely among the vegetation next to a creek or a pond, or partially submerged at the water's edge, at least a foot below the water's surface.

Examples of Conventional Landscaping Practices that Reduce Habitat Value	Examples of Conservation Landscaping Practices that Increase Habitat Value
Select plants primarily for their perceived decorative value, unusual physical characteristics, or rapid growth habits that will quickly and easily fill in a site, regardless of where the plant species originated.	Select plants primarily for their utility to wildlife, water quality and ecosystem processes, in order to emulate native plant habitats that would be found naturally in the local region and are most appropriate for the given site conditions. Avoid selecting non-native “alien” or “exotic” invasive plant species known to be problematic in the environment, and control these plants if they enter the landscape, in order to reduce the likelihood of their competition with native plant communities.
Maximize lawn as a predominant feature of the landscape.	Minimize lawn by using it artistically where needed, for its specific functional value, such as for a pathway, or for certain recreational activities, or to frame a view or provide an intentional edge around a planted bed.
Routinely apply fertilizer and pesticides to optimize plant growth.	Use native plant species that are well-adapted to local soils, climate, and insect predation, thereby reducing or eliminating the need for fertilizers or pesticides, which can run off the site during a rain event and have harmful effects on water quality and aquatic wildlife species.
Rake-up and bag-up leaves in autumn, and dispose of in the landfill. Remove and dispose of all downed twigs, branches and other woody debris.	Keep leaves on site by shredding and/or composting them, and use the material for mulch and/or as an organic amendment to ornamental planting beds, which will enrich the soil and provide a sustainable food source for insects and other wildlife. Keep downed twigs and branches on site by chipping them and composting the material or using it for mulch, or cut the larger branches into manageable sizes that can be used to create brush piles for wildlife cover.
Remove all dead vegetation from flowering plants in the fall.	Allow dead vegetation to remain on site throughout winter (until late February/early March), which will provide cover for dormant insects or their eggs, and places for birds to feed and seek protection from harsh weather. Design the landscape such that plant species are strategically chosen and placed to provide interesting structural elements in winter dormancy, and therefore greater visual and aesthetic interest throughout the season.
Mow all the vegetation along a creek or stream, down to the water’s edge.	Maintain at least a 35-foot buffer of plants such as shrubs and trees along waterways, which will filter runoff from the surrounding land, will shade the water, and will keep the soil from eroding the banks, thereby protecting aquatic wildlife species that cannot tolerate extremes of water temperature and that need clean water to thrive.

To build the pile, choose rocks or old bricks and blocks of various sizes and shapes, ranging from potato size to soccer ball size for the home landscape setting, or larger sizes in the more rural, spacious setting. Arrange the rocks unevenly, with open spaces between them, to fill an area at least five or six feet wide and one or two feet deep. Don’t worry about being too artistic with rock placement. Wildlife doesn’t care how pretty it looks; they just want a place to hide when the time comes. Consider planting a ground cover around the edges of the rock, or a vine that will grow over it, to provide additional protection. No need to mow there anymore!

Similarly, a brush pile is loosely constructed with lots of open spaces between the branches, which will make it easier for a wren to fly in or a rabbit to run under when threatened. Although a brush pile can be messy and built as big and wide as you like, avoid dumping a big pile of debris on the ground, which is a practice more suited to starting a compost heap. Rather, build the foundation of the brush pile in the manner of a miniature log cabin, starting with stumps or small logs, depending on what you have on hand, and criss-cross these in a couple of stacks until you have a firm base, preferably on level ground. Then stand large tree limbs up against the base, stacked against it, tipi style, with the butt ends of the branches on the ground, and the thinner, lighter tips pointing up above. This will form a somewhat pyramidal-looking structure that you can continue to add smaller branches to, until most of the interior is no longer visible, but with plenty of empty voids remaining throughout the stack. Place the greatest number of branches on the side of the pile that faces the prevailing winds, to ensure additional protection from summer thunderstorms and winter winds.

Effective brush piles are quite large. In a rural landscape or on a very large lot, they should be at least 12 to 15 feet in diameter and at least five or six feet tall. However, this may not be practical for a smaller suburban lot. A smaller pile, such as six to eight feet wide and four to five feet

tall, may be more appropriate for a residential setting and should still be adequate for many wildlife species to use.

Snags

Another structural component that some would say is "worth its weight in gold" for wildlife is a dead tree or snag. Dead trees provide a cornucopia of benefits, because the decaying material is host to innumerable insects and their larvae that chew their way through the wood or otherwise feed beneath the bark. Approximately 30 percent of native bee species use abandoned beetle tunnels in dead trees as a nesting site to lay their eggs. This abundance of burrowing insects, grubs, and eggs provide an invaluable protein source for dozens of bird and mammal species. Woodpeckers make their homes in dead trees, too, and the holes they leave behind in the trunk and the branches provide places for bluebirds, chickadees, nuthatches, tree swallows, screech owls, titmice, opossums, tree squirrels, bats, raccoons, and other cavity-seekers to raise their young. Snags provide open perches for hawks to hunt from, and when dead trees are located near a water body, kingfishers, flycatchers, and herons can hunt from these perches as well. Other birds use snags as a convenient post to sing from when proclaiming their territory. Dead trees also provide a refuge for birds and hibernating mammals in winter, when fewer resources for cover may be available in other parts of the landscape. In a pond environment, a fallen tree in the water can provide excellent habitat structure for fish and other aquatic species.

The astonishing array of wildlife species that rely on dead trees—and on decomposing logs and branches on the ground—cannot be overstated. Therefore, whenever possible, leave dead trees standing. If a dying or dead tree poses a threat to a walkway, driveway, or building, the tree can be taken down and left on the ground to decompose naturally and become an interesting if not unusual focal point, especially if it's used as a backdrop for planting flowers and ferns around it. Or, sections of the tree can be cut up and used to make a brush pile, as described earlier. Either way, retaining dead trees and woody material on site will greatly enhance the habitat value for wildlife and also recycle nutrients back into the soil.

Nest Boxes

Where no dead or dying trees are present, the next best thing is to put up nest boxes for cavity-seekers. Nest boxes provide vital homes for birds and small mammals such as flying squirrels to bear and raise their young, and each species that uses them has different requirements for the box dimensions, including the overall size of the box, the diameter of its opening, and the depth of the cavity within.

There are several considerations for constructing a bird house. Use untreated wood and select rough-cut lumber that's a minimum of ¾- inch thick (one inch is better). Cedar is a good choice, if available, because of its durability. The box should provide for adequate ventilation near the top, for heat to escape, and holes in the bottom for drainage, if water gets in. The roof of the

Examples of Common Nest Box Dimensions

Bird Species	*Diameter of Entrance Hole (inches)*	*Depth of Cavity (inches)* - *from bottom of hole to the floor of the box*	*Floor of Cavity (inches x inches)*	*Height of Box Above the Ground (feet)*	*Comments*
Eastern Bluebird	1 1/2	6 1/2	5 x 5	5-15	Place in open areas away from buildings and spaced 100 feet apart
Carolina Chickadee	1 1/8	8	4 x 4	5-15	Place in area with mature hardwoods
Northern Flicker	2 1/2	16-18	7 x 7	8-10	Fill box with sawdust
House Wren	1	6-8	4-6	5-10	This species will fill the nest box with sticks

Various sources may recommend different dimensions. More detailed specifications for constructing nest boxes are available in Woodworking for Wildlife and on the Cornell Lab of Ornithology web site, listed in the "Resources for Further Reference" section below.

box should overhang the front, to keep rain from entering, and the box should also have a provision for opening up the side or the top to clean out the contents at the end of the breeding season. Roughen the inside of the front part of the box, or attach a small piece of hardware cloth to it, to make it easier for young birds to climb out when it's time for them to fledge; do not paint the inside of the box. Also, do not attach a perch to the outside of the box, which merely provides an easier foothold for predators and encourages other non-native birds like starlings and house sparrows to attempt to enter.

To install a bird house, place it on a free-standing post or pole, well away from trees, which are the domain of the black rat snake. Secure a conical or stovepipe-type baffle to the post or pole beneath the box, in order to discourage raccoons, snakes and other predators. Do not use grease on the pole, as this is an unreliable method for deterrence and may sicken animals which ingest it. Be sure the front of the box is directed away from the prevailing winds, but face the box towards a distant tree where young birds can land when they leave the nest.

Bat houses are constructed very differently than bird houses. A bat house has no floor on the bottom, because bats fly in and out from below, and the interior of the box is made up of several narrow partitions, conducive to the bats hanging between the baffles. The species that most commonly use bat houses in the mid-Atlantic region are the little brown bat and the big brown bat; females of these species congregate in nursery colonies in the summertime and may use boxes to raise their young. However, success with bat houses is mixed and seems to depend on many variables, such as the numbers of partitions within the box and the width between them; or how much sun the box receives (it should be painted a dark color to absorb sunlight, because bats need warm temperatures); or how far above the ground the box is mounted (typically 12 to 20 feet). Boxes placed in proximity to a natural water source, such as a pond, lake, stream or river, are often said to have the greatest success of use, because bats frequent aquatic areas where insect numbers are typically high. Place bat houses on the side of a building away from nighttime lights, and orient the box towards the southeast for maximum exposure to sunlight in the early morning. [More detailed specifications for constructing bat houses are available at Bat Conservation International; see "Resources for Further Reference" section below.]

Another type of nesting house is one that can be made for orchard mason bees, which seek out holes or tunnels in plant stems to build brood cells in which to lay their eggs. Make the bee nest house from plants that have hollow stems, such as reed grass or teasel. If there happens to be a stand of invasive bamboo available, select narrow stems approximately half inch or less in diameter and cut them into five or six inch lengths. Then hollow out about three and a half inches on the end of each stem, leaving part of the tube closed. Gather about 10 to 15 of these pieces, tie them into a bundle with the closed ends together, and hang the bundle horizontally from a tree or building about three to six feet off the ground, in a sunny area with the holes facing east or southeast, and sheltered from the elements.

Or, make a "bee block" by drilling a series of holes between 3/32 and 3/8 inch in diameter, about ¾ inch apart on center, into an untreated (preservative free) block of wood, or into an old log or stump. Do not drill all the way through but rather only three to four inches deep, for holes less than ¼ inch diameter, or five to six inches deep for holes larger than ¼ inch.

Areas with Bare Soil

Bare soil is an often an overlooked element in the landscape that can be useful for some wildlife species. Songbirds will appreciate an occasional dust bath where bare soil is available, in order to control mites and other external parasites on their skin or in their feathers. Birds also ingest bits of grit and coarse sand, which help to grind up food such as hard seeds in the bird's gizzard. A simple way of providing the dust they need is to scrape away the vegetation from a two to three foot diameter patch of ground and allow it to dry out.

Areas of bare ground are also extremely important to bees, because almost 70 percent of North America's 4,000 native bee species nest in the ground [USDA/NRCS-Xerces]. These are solitary-nesting bees, which means that individual females seek out their own nest site to tunnel into the ground. Since the soil surface should be bare in order to provide bees the access they need to dig, a good rule of thumb is to clear small patches of bare ground in a sunny, open space, up to a few feet across, and pat the areas firmly to compact the surface. Different locations will attract different bee species; therefore try clearing patches on both flat ground and on slopes, particularly those that are facing south.

Bare ground can also be supplemented with sand pits for bees. Find a sunny spot, dig a hole in the ground about two-feet deep, and fill it with a mix of sand and loam that

will provide good drainage.

Water Features

Another structural element that's essential to any habitat garden is the presence of water, which can be provided in many ways. Bird baths are perhaps the easiest and can be purchased in a variety of shapes and sizes. Choose a bird bath with a shallow basin that has gradually sloping sides and is no more than two or three inches deep. Put one or two fist-sized stones into the water where birds can land, and place the bird bath several feet away from a shrub or tree, so that birds can easily seek cover if needed. To extend the season for year-round bird use, install a small heating element that will keep the water from freezing in winter.

An even simpler way of creating a bird bath is to turn the lid of an old trash can upside-down and nestle it within a plant border, or use a large, plastic plant dish the same way. Regardless of size or type, completely empty, clean, and replenish all bird baths with fresh water every few days throughout the summer to keep mosquitoes from breeding there.

Creating small mud puddles for insects is another method of providing water. Butterflies in particular use wet patches of soil (or wet manure) to obtain minerals, and this "puddling" behavior is commonly seen along the muddy edges of roads after a rain storm. To replicate a small mud puddle, fill a shallow cake pan with a mixture of sand and soil, fill it with water, and place it in a sunny area near a flower bed.

There may also be opportunities in the landscape to capture and divert a portion of the rainwater that falls and to collect it in a shallow depression to create a mini-wetland. Unlike a true rain garden, which is constructed several feet deep with permeable soil and is designed to hold water for no more than four days, the mini-wetland is only about 12 to 15 inches deep and is lined with a layer of clay at the bottom to hold the water for a longer time. The depression is filled with a soil mixture that contains mostly loamy organic matter and a bit of clay, then it's planted with species that are adapted for periodic inundation—hence the habitat. Locate this water feature in a low-lying area where water already naturally collects.

Or, construct the mini-wetland approximately 10 feet away from a building where it will receive some of the water from a downspout, with the aid of a shallow, planted swale that directs the water from the downspout to the area below. One can also connect a flexible plastic pipe to the downspout and bury it in the ground, with the end of the pipe daylighting directly into the clay-lined depression. However, be sure there's enough slope between the building and the water feature, so that the pipe doesn't back up during a heavy downpour.

The above examples are simple ways of providing water for terrestrial wildlife species to drink from or bathe in. A water garden or frog pond provides a larger habitat for aquatic species to live and breed in and is discussed in the section below, "Water Garden for Frogs, Salamanders and Other Aquatic Species."

Study Questions

1. The Department of Game and Inland Fisheries Wildlife Action Plan has identified ____ (how many) species of "Greatest Conservation Need."
2. There are many factors that cause habitat loss and declining populations of wildlife species. List 3 of these.
3. What is a plant community?
4. What's the difference between an ecosystem and a habitat?
5. T/F: Vegetative or vertical structure refers to layers of plants that provide a level of complexity and functionality in their arrangement, such that they sustain a broad array of wildlife species.
6. Which of the following best describes the layers that make up vertical structure in a forest ecosystem: a) Brushy cover; short plants; tall plants; rocky outcrops; b) Soil layer; animal layer; bird layer; air layer; c) Mulch layer; herbaceous layer; shrub layer; tree layer
7. Which of the following terms best describes the process of change in a plant community over time? Choose one: Horizontal structure; interspersion; succession; decomposition; edge effect
8. Which of the following statements best completes this sentence: "Habitat structure refers to how plants are arranged in relation to each other…. a) and whether or not they're well-adapted to the site conditions. b) and how long it takes for the plants to decompose. c) in both the horizontal and

the vertical plane. d) and their management with mowing, grazing and burning.

9. In just a few sentences, explain the statement: "There is a strong correlation between the use of native plants in the landscape and insect biodiversity."

10. T/F: It doesn't matter which native plant species you pick to improve a habitat, because all native plant species support the same number of wildlife species and are therefore equally productive.

11. Which of the following is not an example of Conservation Landscaping that increases habitat value: a) Control non-native invasive plant species known to be problematic in the environment. b) Keep leaves on site by shredding and/or composting them. c) Maximize lawn as a predominant feature of the landscape. d) Select plants primarily for their utility to wildlife, water quality and ecosystem processes. e) Maintain at least a 35 foot buffer of plants such as shrubs and trees along waterways.

12. Which of the following statements are correct: a) Snags are hosts to innumerable insects that provide an invaluable protein source for many bird and mammal species. b) Brush piles and rock piles provide valuable escape cover from predators, as well as places for wildlife to raise their young. c) A bird house should not be installed directly on a tree, because black rat snakes are an arboreal species and can easily prey on the birds. d) Areas of bare ground are extremely important to bees, because almost 70 percent of North America's 4,000 native bee species nest in the ground. e) Butterflies commonly gather in muddy patches of soil to obtain minerals, called "puddling" behavior. f) None of the above. g) All of the above.

Answers:
1 - 925; 2 - Development and fragmentation of forest; prevalence of impervious surfaces that contribute to erosion and runoff; extensive use of lawn and other non-native plants; routine use of herbicides and pesticides; "clean" farming practices that remove hedgerows and large expanses of vegetation; proliferation of invasive exotic plants; 3 - A plant community is an assemblage or collection of plant populations found in an area; 4 - An ecosystem is a complex, functional system made up of living (biotic) plant and animal communities and the non-living (abiotic) components in the environment. A habitat is the area within an ecosystem where an animal is able to secure the food, water, cover and space it needs to survive and reproduce; 5 - True; 6 - Mulch layer; herbaceous layer; shrub layer; tree layer. 7 - Succession; 8 - in both the horizontal and the vertical plane; 9 - Tallamy's study showed that native plants produced over four times more insect biomass than alien plants produced. 10 - False; 11 - Maximize lawn as a predominant feature of the landscape; 12 - All of the above.

Selected Habitat Gardens that Sustain Wildlife Diversity

Habitat Garden for Butterflies and Other Pollinators

One of the most popular, visually-rich landscaped habitats is a garden designed specifically to support pollinators. Pollinators are wildlife species that move pollen from the flowers of male plants to the flowers of female plants of the same species, when the pollinator travels from flower to flower in search of nectar, pollen or other insects to eat. Pollinators include hummingbirds, butterflies, moths, bees, wasps, beetles, flies and some species of bats. Their role is to help fertilize female plants and enable the plants to produce seeds, nuts or other fruit. These animals are therefore critical for ecological function. Without pollinator services, plants would not be able to survive reproductively, because over 85% of flowering plants require an animal—usually an insect—to move pollen [Ollerton, Winfree & Tarrant; 2011; How Many Flowering Plants are Pollinated by Animals? Oikos 120], and over 25% of the global diets of birds and mammals are comprised of pollinator-produced fruits and seeds [Xerces]. Our agricultural industry is also heavily reliant on pollinators to produce the high yielding crops we've come to expect in food production. "The economic value of pollinator-dependent crops in the United States was estimated to be between $18 and $27 billion in 2003." [Xerces] In Virginia, bees are attributed with supporting $33 million of the apple industry [2010 VA Apple Board] and $8 million of cucurbits [2006 VDACS].

Restoring a site by replacing lawn with pollinator habitat can transform the landscape, because as the new plants

become established and begin blooming, insects of all types very quickly descend on the flowers, seemingly from out of nowhere. To plan a pollinator garden, as with any other kind of habitat garden, it's helpful to remember that each group of organisms has different requirements. [Note: Hummingbirds are discussed in the "Bird Garden" Section below.] When we attempt to select plants for butterflies, we need to think of butterflies as if they're "two animals in one," because of their metamorphic life cycle. A butterfly starts out as an egg, develops into a caterpillar that must eat leaves, and then after several stages and successive molts, it forms a chrysalis and develops into an adult, which must get its energy from flower nectar. Hence, to be successful, a butterfly garden must include host plants for the larvae and nectar plants for the adults. For example, the larvae of monarchs need milkweed leaves, while the adults can forage among numerous nectar-producing plants. If the only plants we select for a garden are the ones that simply provide a colorful bed of blooms, then we will have missed half the equation, and the overall habitat value for butterflies will be lower as a result.

A tremendous number of butterfly species rely heavily on tree species as host plants. For example, black cherry trees support swallowtails, painted ladies and luna moths, and black locust trees support sulphurs and skippers. Elm is the host plant for mourning cloak butterflies, willow is the host for tiger swallowtail, and hackberry tree for question marks. Dr. Doug Tallamy's research assistant, Kimberly Shropshire, has developed a list of 20 woody plant genera, which includes trees and shrubs, ranked by their value for supporting Lepidoptera (the classification of butterflies, moths and skippers). The list is based on an exhaustive search of the scientific literature about host plant ecology. Below are the top 10 tree genera for supporting Lepidoptera:

Ten Most Valuable Woody Native Plant Genera for Supporting Lepidoptera
Quercus (oaks) support 534 species of Lepidoptera
Prunus (cherries) 456 species
Salix (willows) 456 species
Betula (birches) 413 species
Populus (poplars) 368 species
Malus (crabapples) 311 species
Vaccinium (blueberries) 288 species
Acer (maples) 285 species
Ulmus (elms) 213 species
[Tallamy, Bringing Nature Home, 2009]

Ten Most Valuable Woody Native Plant Genera for Supporting Lepidoptera
Pinus (pines) 203 species
[Tallamy, Bringing Nature Home, 2009]

In addition, Tallamy's project has also gathered rankings for 20 native perennial flowering plant genera. Below is a list of those top 11:

Most Valuable Ornamental Native Perennial Plant Genera for Supporting Lepidoptera
Solidago (goldenrods) support 115 species of Lepidoptera
Aster (asters) 112 species
Helianthus (sunflowers) 73 species
Eupatorium (pyeweeds, boneset) 42 species
Ipomoea (morning glories) 39 species
Carex (sedges) 36 species
Lonicera (honeysuckles) 36 species
Lupinus (lupines) 33 species
Viola (violets) 29 species
Geranium (geraniums) 23 species
Rudbeckia (coneflowers) 17 species
[Tallamy, Bringing Nature Home, 2009]

These data clearly indicate that butterfly species—indeed, whole populations of butterfly species—are dependent on hundreds of species of trees, shrubs and perennial flowers. We would therefore do well to select several trees, shrubs and flowering plants from the above groups when planning our pollinator garden, knowing that when we do, we'll have all our bases covered, because the myriad connections between all those groups will ensure a high likelihood of a biodiverse habitat.

In addition to Tallamy's work, other scientists are also conducting field research to further document the association between pollinators and specific plant species. In Pennsylvania, for example, Connie Schmotzer at Penn State Extension devised a series of "Pollinator Trials," in part to evaluate "the level of insect attractiveness of various perennial plant species or cultivars." The study monitored "88 pollinator-rewarding herbaceous perennial plants," to see how many and what type of insect pollinators would seek them out. Below is a synopsis of some of the study results:

Best Plants for Pollinator Visitor Diversity (ranked in order of preference, out of 88)
Clustered Mountain mint (*Pycnanthemum muticum*)
Coastal Plain Joe Pyeweed (*Eupatoriadephus dubius*)
Stiff Goldenrod (*Solidago rigida*)
Swamp Milkweed (*Asclepias incarnata*)
Gray Goldenrod (*Solidago nemoralis*)
Rattlesnake Master (*Eryngium yuccifolium*)
Flat Topped Aster (*Doellingeria umbellata*)
Spotted Joe Pyeweed (*Eupatoriadelphus maculatus* 'Bartered Bride')
[Schmotzer 2013]

Best Plants for Sheer Number of Bee and Syrphid [Fly] Visitors
Clustered Mountain mint (*Pycnanthemum muticum*): 19 bees/syrphids*
Gray Goldenrod (*Solidago nemoralis*): 14 bees/syrphids
Pink Tickseed (*Coreopsis rosea*): 14 bees/syrphids
Lance-Leaved Coreopsis (*Coreopsis lanceolata*): 13 bees/syrphids
Spotted Joe Pyeweed (*Eupatoriadelphus maculatus* 'Bartered Bride'): 12 bees/syrphids
Rattlesnake Master (*Eryngium yuccifolium*): 12 bees/syrphids
**Mean number of bees/syrphids observed per plot in 2 minutes*
[Schmotzer 2013]

Best Plants for Attracting Butterflies
Coastal Plain Joe Pyeweed (*Eupatoriadephus dubius*): 17 butterflies/skippers*
Blue Mistflower (*Conoclinium coelestinum*): 5 butterflies/skippers
Showy Aster (*Eurybia spectabilis*): 4 butterflies/skippers
Sweet Joe Pyeweed (*Eutrochium purpureum* subsp. *maculatum* 'Gateway'): 3 butterflies/skippers
Dwarf Blazing Star (*Liatris microcephala*): 3 butterflies/skippers
**Mean number of butterflies/skippers observed per plot in 2 minutes*
[Schmotzer 2013]

As one can see, certain plants are like powerhouses when it comes to supporting pollinators. Therefore, all one needs to do to have a highly productive pollinator habitat is to start with the above top genera [goldenrods (*Solidago*); milkweed (*Asclepias*); tickseed (*Coreopsis*); mountain mint (*Pycnanthemum*); pyeweed (*Eupatorium* or *Eutrochium*); asters (*Eurybia*); mistflower (*Conoclinium*); and blazing star (*Liatris*)], and then look at the Virginia regional native plant list for the garden area in question [Coastal Zone, Piedmont or Mountain—see "Resources for Further Reference" section], in order to determine the particular species of goldenrod, milkweed, tickseed, pyeweed, aster etc. that would be most suitable for the given site conditions.

Moreover, not only do these represent a broad spectrum of species and flowering types, they also bloom at different times throughout the season, which adds a temporal dimension to the association of insects that will frequent the plants. For example, peak bloom time for mountain mint is mid-June to mid-July; for swamp milkweed, mid-July to mid-August; and for pyeweed, mid-August to early September. This means if we select a variety of plants across flowering times, in addition to selecting across genera, we can magnify the habitat benefits even more. A good rule of thumb is to "provide blooming plants from early spring to fall, with at least three species of flower in bloom each season" [Xerces Pollinator Conservation Fact Sheet].

In addition to the genera listed above, other excellent pollinator plants include those in the coneflower (Rudbeckia), beardtongue (Penstemon), phlox (Phlox), bergamot (Monarda), and ironweed (Vernonia) genera. Flowering perennials such as these, combined with native warm-season grasses to form meadows in large open settings, will provide early successional habitat that benefits many bird species as well. Some native warm-season grasses suitable for dry, sunny meadows are the following: big bluestem (*Andropogon gerardii*); little bluestem (*Andropogon scoparius* or *Schizachyrium scoparium*); Indiangrass (*Sorghastrum nutans*); and switchgrass (*Panicum virgatum*). (For woody plant recommendations, see the Appendix for a table of native shrubs, which includes a column indicating their "Value to Pollinating Insects.")

Looked at another way, if landscape diversity is currently low in the built-environment around us, and if we add more forestal and meadow-like components (i.e. a diversity of shrubs, trees, grasses and flowering perennials), then we'll be supporting the butterfly species that are associated with each of those vegetation types (see table below).

An established pollinator habitat garden or meadow should be allowed to stand throughout the dormant months in fall and winter to provide winter cover. Mowing a pollinator garden is rarely necessary, and typically this practice is reserved for larger landscapes where the predominant vegetative type is native warm-season grasses, which are either burned or mowed only once every three years, to keep the thatch on the ground from becoming too thick. There's a fairly short window

of time for mowing or burning these rural fields, usually between mid-February to mid-March, which is at the end of winter, when insects have been dormant in the dead vegetation, but before birds begin nesting in the spring.

Here are some additional pollinator habitat tips from Xerces:

* "Avoid pollen-less cultivars and double-petaled varieties of ornamental flowers."
* Butterflies need warmth in order to fly; therefore plant pollinator habitats in open, sunny areas.
* Shelter pollinator habitats from the wind with some type of cover, such as groups of shrubs or hedgerows, trees, or a nearby wall or fence.
* Include some tall grasses in the habitat, allow the grass to remain overwinter, and conserve dead leaves and sticks in small piles. Caterpillars will use the grasses and brush piles to seek safety to build a chrysalis.
* Avoid cleaning out leaves and garden debris in the weeks leading up to the first severe cold spells of winter, because butterflies overwinter (hibernate) in the debris, either as eggs, larvae, pupae or even adults, depending on the species.
* Do not use insecticides in or near the garden, especially neonicotinoids, which "are systemic chemicals absorbed by plants and dispersed through plant tissues, including pollen and nectar."

Bird Garden

In earlier sections of this chapter we describe the importance of enhancing layers of vegetative structure within the landscape to support a biodiverse assemblage of plant and animal communities, and here we revisit that theme again in the context of providing good habitat for birds. The most effective way to design a garden space that will become a home for many bird species is to grow lush shrub borders and hedgerows replete with fruits and seeds; to plant trees for an overhead canopy; and to fill the landscape between those two layers with pollinator habitat that will attract the insects and spiders that birds feed on for protein. These vegetative elements—the herbaceous flowering layer, the shrub layer and the canopy layer—along with other structural elements like brush piles, nest boxes and water features already described above [in the section "Other Habitat Amenities: Structural (Abiotic) Components"], will ensure an abundance of bird species throughout the seasons.

Birds need plenty of space to establish a territory, engage in courtship, build a nest, raise and feed their young, and move about in the landscape to find food and escape cover. The choice of shrub species and how they're arranged in

Butterfly Species Associated with Forest, Field, and Forest/Field Intergrade

Forest	Field	Forest/Field Intergrade
Zebra Swallowtail	Black Swallowtail	Monarch
Easter Tiger Swallowtail	Cabbage White	Common Wood Nymph
Spicebush Swallowtail	Clouded Sulphur	Red-Banded Hairstreak
Pipevine Swallowtail	Orange Sulphur	
Common Blue	American Copper	
Question Mark	Eastern Tailed Blue	
Eastern Comma	Great Spangled Fritillary	
Mourning Cloak	Meadow Fritillary	
Red Spotted Purple	Pearl Crescent	
	Red Admiral	
	Common Buckeye	
	Hackberry Emperor	
	Tawny Emperor	
	Northern Pearly Eye	

[Source: Maria Van Dyke, Native Bee Research Lab, Dept. Entomology, Cornell University]

relation to the surrounding trees and other elements will provide varying degrees of food and cover depending on the time of year. During the growing season in spring and summer, deciduous plants are full of leaves that provide shade and protection, but in winter, birds will need the cover of evergreens such as eastern red cedar (*Juniperus virginiana*), bayberry (*Morella pennsylvanica*) , American holly (*Ilex opaca*) and Virginia pine (*Pinus virginiana*).

In spring, the new growth on trees like oaks, cherry and poplar are a magnet for insects, and migratory neotropical birds such as orioles, warblers, tanagers and vireos will utilize the canopy to glean insects from the leaves and branches. As late spring gives way to summer and birds begin breeding, they turn their attention to berry-producing shrubs and other mast (fruits and seeds), as more food becomes available.

Birds will also use hedgerows as a protective corridor to get from one area to another throughout the year. Shrubby thickets made up of species such as blackberries (*Rubus*), sumac (*Rhus*), chokeberry (*Aronia*), dogwood (*Cornus*) and viburnums (*Viburnum*) provide excellent cover and mast for catbirds, mockingbirds, thrashers, robins and many others.

The advancing progression of fruit ripening over the seasons ensures there's always plenty of food available from spring to fall, and many berries and seeds are persistent through the winter. Therefore, prune trees and shrubs in late winter, after the majority of fruits and seeds have been eaten, and before nesting season begins.

In large landscape settings, a good size shrub bed is a large circle of 15 to 30 feet in diameter, with a variety of species planted at least eight feet apart. This many plants results in a deep mass of leaves and branches, where birds can nest or easily dart in and out of when threatened. Alternatively, select one species to fill an entire plant bed, for example five inkberry (*Ilex glabra*) in one bed, or five American beautyberry (*Callicarpa americana*), or five New Jersey tea (*Ceanothus americanus*). In smaller landscapes with less room, plant clusters of just three shrubs instead. Mainly the goal is to group plants together as much as possible, rather than singly, here and there. (See the Appendix for a table of native shrubs suited for birds and other wildlife species.)

Every once in a while we hear folks complain that "all the quail and rabbits are gone," and they claim it's because "there's too many hawks." But the reality is that the decline of small mammals and birds is because too many landowners—in cities and in rural areas—are "cleaning out" fencerows, hedgerows and ditches. There's a definite need to educate the public about the value in letting hedgerows and fencerows stay a little more wild with blackberries, greenbrier, grape vine and Virginia creeper, in order to preserve habitat for the small mammals and birds that the hawks feed on, whether one lives on a tiny urban lot or on a large rural farm. "Gardening for birds" is so rewarding that it shouldn't be limited to foundation plantings but extended throughout the landscape.

One other special consideration is the ruby-throated hummingbird, which is a joy to see in any habitat setting, and a bird garden would seem incomplete without these jewels on the wing. As pollinators, they're especially keen on the nectar of tubular-shaped flowers, but they will also use a few other flower types selectively. If the landscape doesn't already include a pollinator patch with some of the following plant species in it, choose at least a few from the plant list below, based on the region of the state it's in, and the growing conditions of the site:

Plant List for Ruby-Throated Hummingbird
Wild Columbine (*Aquilegia canadensis*)
Oxeye Sunflower (*Heliopsis helianthoides*)
Coral Bells (*Heuchera americana*)
Jewelweed (*Impatiens capensis* or *I. biflora*)
Seashore Mallow (*Kosteletzkya virginica*)
Cardinal Flower (*Lobelia cardinalis*)
Great Blue Lobelia (*Lobelia siphilitica*)
Virginia Bluebells (*Mertensia virginica*)
Horsemint or Wild Bergamot (*Monarda bradburiana* or *M. fistulosa*)
Beebalm (*Monarda didyma*)
Sundrops (*Oenothera perennis*)
Narrow-Leaved Sundrops (*Oenothera fruticosa*)
Foxglove Beardtongue (*Penstemon digitalis*)
Lyre-Leaf Sage (*Salvia lyrata*)
Buttonbush (*Cephalanthus occidentalis*)—SHRUB
Yellow Poplar or Tuliptree (*Liriodendron tulipifera*)—TREE
Trumpetvine or Trumpet Creeper (*Campsis radicans*)—VINE
Crossvine (*Bignonia capreolata*)—VINE
Trumpet or Coral Honeysuckle (*Lonicera sempervirens*)—VINE
Carolina jasmine or jessamine (*Gelsemium sempervirens*)—VINE

Water Garden for Frogs, Salamanders and Other Aquatic Species

The most effective habitat for supporting frogs, salamanders and other aquatic species is an in-ground

wildlife pool that mimics a natural pond or wetland system. There are many options for providing ground-level water features, ranging from small and inexpensive to large and elaborate. Pre-fabricated liners are available at many garden centers and offer a convenient way to get a water source into the landscape quickly. These are often shaped like bathtubs and are available in different dimensions. Most are about three feet deep and made of thick, durable plastic or fiberglass, with built-in, shallow shelves for placement of potted aquatic plants. To install a pre-fabricated liner, dig a proportionate hole to accommodate its shape and size, and make sure the liner is level once it's in the ground. [Remember to call Miss Utility at 811 before digging.]

Alternatively, one can dig a water garden by hand and create a custom-made shape that's tailored to the specific site, as big or as small as practical. Locate the garden where it can be seen from a porch or window, and in a level area where there will be at least three to five hours of sunlight per day, with plants shading the water the rest of the day, because most aquatic organisms such as tadpoles need shade protection from temperature extremes.

Dig the deepest area 36 inches, then create shallower edges in concentric circles around this, to make ledges of different heights, such as 24 inches deep, 14 inches deep, and eight or 10 inches deep. The biggest challenge will be to level the sides with each other. Remove any rocks, roots, sticks or other sharp objects from the hole as it's being dug.

A hand-dug water garden will require two flexible plastic (PVC) liners and two geo-textile pads that are at least eight ounces in weight each. The size of the liners and pads should be larger than the total size of the pond (for example, a 30 foot diameter pond would need liners 40 x 40 feet). An ideal size is about 18 to 20 feet long by 12 to 15 feet wide, but do some research first to see what size pond liners are actually available on the market. Be sure to buy a liner specifically designed for aquatic gardens, and at least 30-45 mil thick, rather than an ordinary tarp or liner from a hardware store, because the typical home improvement products are usually too thin and are often pre-treated with a fungicide or algicide.

The installation is assembled like a giant sandwich: start with a two-inch layer of sand on the bottom, or use one geo-textile pad; next lay one of the PVC liners over the sand or pad; then lay another geo-textile pad down; and finish with the second PVC liner. The padded underlayment will help protect the water feature from tree roots and small burrowing animals that might tunnel underneath; some folks use old carpeting for this purpose.

Once the plastic layers are installed, use large rocks to hold the liner down in the middle, as well as along the ledges and around the upper edge. Small logs can also be used for edging around the top. If the pond is large, provide shallow, muddy areas, and also flat rocks in the open, where amphibians can bask in the sun. Fill the pond with non-chlorinated water (or wait several days for the chlorine in treated water to dissipate), and check the level during the driest part of the summer, to see if water may need to be added from time to time. To prevent a terrestrial animal like a bird or a chipmunk from falling in and not being able to escape, place a small branch or log in the pond that an animal can use to climb out.

After all the rocks are in place, the next step is to choose the plants. Just as we use layers of plants in a terrestrial habitat for wildlife diversity, use layers in the water garden to achieve the same effect. Ideally the pond will have enough plants to cover from one half to two-thirds of the surface area of the water. Select native aquatic plants suited to the different levels within the pond. Emergent plants root in the bottom, and their stems and leaves grow upright, out of the water. This is the area where salamanders and frogs spawn and lay their eggs, and the matrix of plant roots and stems will provide a good micro-habitat for breeding, as well as multiple places for tadpoles and other organisms to feed and to hide. Floating plants root in the bottom, and their leaves float on the water's surface. Submergent plants grow completely underwater.

To achieve the best plant diversity, bring a list with you to the aquatic garden center to make the selection (see chart at the end of this section, "Native Plants for Moist Sites or Aquatic Habitats"). Choose plants that are adapted for each of the pond layers (emergent, floating and submergent), as well as plants to place around the edge that will hang over the water and provide additional cover. Avoid using cattails from a local farm pond, because cattails are very aggressive and will fill a pond quickly and choke out other vegetation.

One other consideration is whether or not to consider using a recirculating pump or an aerator. The benefits of an aerator are that it provides water movement, keeps the water's oxygen content high, and minimizes algae build-up. Some amphibians prefer to live and breed in quiet

water, while others only live and breed in moving water. Therefore, if the pond is large enough and designed with different shelves for layers of varying depths, you can provide both types of micro-habitats (i.e. shallow, quiet water, and deeper water with a current) to support a broader range of species. If a pump or aerator will be used, have an electrician install a GFCI (ground-fault protected) outlet in the vicinity of the pond, during the digging stages.

However, if the pond is very small (less than 10 feet in diameter) and is filled with plants, the species that use the water garden will most likely be those that primarily associate with vernal or temporary pools. In this case, the abundance of diverse plants should support enough insect diversity to ensure there will be numerous predaceous insects as well as frogs eating any mosquito larvae, and a pump may not be necessary.

"Mosquito dunks" are not generally recommended for use in a frog pond. These pellets contain spores of bacteria known as Bt, which is widely used to control grasshoppers, caterpillars and other insects. Since the overarching goal of the aquatic habitat is to increase the diversity of organisms, which includes insects, using dunks may be counter-productive. As the water garden becomes established with a full complement of diverse plants, many predatory, carnivorous aquatic invertebrates will move into the habitat, such as copepods, water bugs, diving beetles, and dragonfly and damselfly nymphs. These insects and their larvae all feed on mosquito larvae, as do frogs and salamanders. The strain of Bt in the pellets is said to kill only mosquito larvae; however, according to some references such as the Tree Walkers International Pond Building Guide (www.treewalkers.org/pond-building-guide), "despite many retailers' claims, Bt does infect non-target insects. Studies of Bt in ponds have shown general declines in aquatic invertebrate populations after two years of use."

Perhaps the most important recommendation for providing a safe haven for frogs and salamanders is: do NOT add fish. Fish prey on tadpoles; fish body wastes increase nitrogen in the water and can cause a nutrient imbalance; and goldfish and koi are non-native. Likewise, it is not recommended to purchase tadpoles or snails, as their genetic source cannot be fully confirmed, and releasing organisms from other areas into a new site can introduce pathogens to the environment that may be detrimental to the health of local aquatic populations.

A healthy aquatic habitat will gradually reach an equilibrium as various organisms become established. Over time, though, the pond is bound to gradually fill in with sediment from fallen leaves, and the amount of total water will gradually decrease as the plants' roots fill in and take over. Therefore, every two to three years in late winter (late February), remove any excessive amounts of decaying material or sediment, being careful to scoop out any newts, salamanders or frogs among the material, and temporarily hold them in a bucket, until the job is completed and they can be returned to the water.

Study Questions

13. What is a pollinator, and what is its role in the ecosystem?

14. To be most successful, a butterfly garden should (circle all that apply): a) be installed in very shady conditions. b) be mowed every year at the end of summer, to clean up the site. c) include host plants for larvae and nectar plants for the adults. d) be designed with plant species native to the region. e) only use one species of native plant. f) bloom only during August. g) include some tall grasses. h) be periodically sprayed with an insecticide to keep aphids in check.

15. Name the butterfly species that each of the following tree host species supports: Black cherry, Elm, Willow, Hackberry.

16. There are many ways to improve habitat for a diversity of bird species. List at least 6.

17. Describe the growth habits of the following (where do their roots, stems and leaves grow): a) Emergent plants b) Submergent plants c) Floating plants

Answers:
13 - Pollinators are wildlife species [hummingbirds, butterflies, moths, bees, wasps, beetles, flies and some species of bats] that move pollen from the flowers of male plants to the flowers of female plants of the same species; their role is to help fertilize female plants and enable the plants to produce seeds, nuts or other fruit; 14 - c, d, and g; 15 - Black cherry: swallowtails, painted ladies and luna moths; Elm: mourning cloak butterflies, Willow: tiger swallowtail, Hackberry: question mark butterflies. 16 - Answer should include examples for providing a diversity of food, water, cover and space, such as the following: Provide elements in an arrangement such that birds have enough space to establish a territory, engage in courtship, build a nest, raise and feed their young, and move about in the landscape to find food and escape cover; Plant a shrub border or a large shrub bed, Plant trees for an overhead canopy, Add a layer of pollinator habitat between the shrubs and trees to attract the insects and spiders that birds need to feed on, Add structural elements such as brush piles, snags, nest boxes and water features, Allow areas to naturalize and become shrubby thickets, Plant a hedgerow or fencerow as a corridor; Provide tubular-shaped flowers for hummingbirds, Provide berry-producing shrubs, Avoid pruning shrubs and trees until late winter; Keep dead leaves on the site. 17 - Emergent plants are those with roots in the bottom substrate, and their stems and leaves growing upright, out of the water; Floating plants root in the bottom, and their leaves float on the water's surface, All parts of a submergent plant grows completely underwater:

Troubleshooting Wildlife Conflicts

The adaptability of wildlife to our urban and suburban built environments is one of the leading causes of wildlife and human conflicts. As we've cleared the land for residences and commerce, and changed the landscape by adding a wider variety of ornamental plantings, the result has been that opportunistic wildlife species like deer, raccoons and opossums have made themselves right at home among our gardens, in our attics, and under our sheds. In some cases, the developed landscapes of today support even more of certain species than in historical times, such as deer, because habitat fragmentation caused by development has resulted in greater interspersion, increased availability of desirable landscape plants, and less hunting pressure than in bygone years.

Feeding Wildlife

Another primary reason for many of the wildlife conflicts encountered is that people just can't seem to keep themselves from feeding wildlife, whether deliberately or unwittingly. Each time a person feeds an animal, whether their love is birds or deer or squirrels, it naturally brings the animals closer to us, not further away, regardless of what species the animal is. Hence a bird feeder attracts a bear; dog food attracts a skunk; salt licks and apples attract deer; and kitchen scraps thrown in the yard, or a trash can with yesterday's leftovers attracts a raccoon.

Also, feeding wildlife can be problematic for the animals themselves, because bringing animals together artificially increases their numbers and makes it more likely they'll spread diseases to each other. Their behavior may also be altered, and they can become more aggressive towards each other or even towards people, because they gradually lose their fear of humans. Oftentimes when there's an escalating problem in a neighborhood—for example where deer are eating every dogwood and azalea in sight—it's attributed to someone who's been feeding deer. The very first step to resolving this type of problem would be to simply stop feeding. It's also important to remember that state regulations govern the feeding of deer. According to the DGIF 2015-16 Virginia Hunting and Trapping Regulations, "Department regulation makes it is illegal to place or distribute food, salt, or minerals to feed or attract deer or elk from September 1 through January 3 statewide; year-round in Buchanan, Clarke, Dickenson, Frederick, Shenandoah, Warren, and Wise counties (including the cities and towns within); or in any city, town or county during any deer or elk hunting season." [p. 42]

In addition, if a bird feeder is attracting a bear, the feeder must be taken down immediately, or the homeowner will be in violation of a regulation that prohibits the feeding of bears at any time.

The DGIF Regulations also state the following: "The Department does not encourage the feeding of wildlife at any time of the year. Feeding restrictions help control the transmission of diseases, nuisance problems, littering concerns, and enforcement issues about hunting with bait." [p. 23]

Therefore, some basic pointers abut feeding: 1) Do not throw large piles of old bread and kitchen scraps in the yard—this will attract crows, starlings, grackles, vultures, skunks, raccoons and opossums. 2) Do not feed apples and corn to deer and squirrels—this will only encourage them to keep coming back, and their numbers will increase until a conflict arises. It will be much harder to get rid of them later. 3) Do not put cat food or dog food out for wildlife. Avoid using a pet door in a garage for feeding pets, which may encourage wildlife to come into the building. 4) Keep charcoal grills and gas grills clean of grease and other food residue. 5) Take birdfeeders down in the summertime, to avoid attracting bears, and

Native Plants for Moist Sites or Aquatic Habitats			
Plant Type	*Common Name*	*Scientific Name*	*Approx. Height of Plant (ft)*
Trees - to plant near a water feature or in a buffer along the edge of a creek			
	Green Ash	*Fraxinus pennsylvanica*	50
	Sweetbay Magnolia	*Magnolia virginiana*	20-60
	River Birch	*Betula nigra*	45
	Northern Red Oak	*Quercus rubra*	100
	Red Mulberry	*Morus rubra*	35
	Black Willow	*Salix nigra*	40
Small Tree/Shrub - to plant near a water feature or in a buffer along the edge of a creek			
	Red Buckeye	*Aesculus pavia*	20
	American Elderberry	*Sambucus canadensis*	10
	American Beautyberry	*Callicarpa americana*	10
	Southern Bayberry	*Myrica cerifera*	8-20
Shrub - to plant near a water feature or in a buffer along the edge of a creek			
	Highbush Blueberry	*Vaccinium corymbosum*	10
	Possumhaw	*Viburnum nudum*	10
	Red Osier Dogwood	*Cornus sericea*	10
	Sweetshrub	*Calycanthus floridus*	10
	Buttonbush	*Cephalanthus occidentalis*	10
	Silky Dogwood	*Cornus amomum*	7
	Virginia Sweetspire	*Itea virginica*	3-6
	Inkberry	*Ilex glabra*	
Fern - to plant next to a water feature			
	Chain Fern	*Woodwardia areolata*	2
	Lady Fern	*Athyrium filix-femina*	2-3
	Maidenhair Fern	*Adiantum pedatum*	1-2
	Cinnamon Fern	*Osmunda cinnamomea*	3
	Royal Fern	*Osmunda regalis*	3-5
	Sensitive Fern	*Onoclea sensibilis*	1-2
Grass - to plant next to a water feature			
	Inland/River Sea Oats	*Chasmanthium latifolium*	2-4
	Eastern Gammagrass	*Tripsacum dactyloides*	4-6
	Bushy Bluestem	*Andropogon glomeratus*	3-5
	Switchgrass	*Panicum virgatum*	4-6
Herbaceous Flowering Plant - to plant next to a water feature, up to the water's edge			
	Cardinal Flower	*Lobelia cardinalis*	3-5
	Swamp Milkweed	*Asclepias incarnata*	5-6
	New York Ironweed	*Vernonia noveboracensis*	4-6
	Blue Vervain	*Verbena hastata*	4-6
	Joe Pyeweed	*Eupatorium purpureum*	4-6
	Common Boneset	*Eupatorium perfoliatum*	3-4
	Blue Mistflower	*Eupatorium coelestinum*	3
	Blazing Star	*Liatris spicata*	4
	Turtlehead	*Chelone glabra*	2-4
	New York Aster	*Symphotricum novi-belgii*	1-3

For growing requirements and range maps of these plants, refer to the plants listings provided in the "Resources for Further Reference" Section below.

Native Plants for Moist Sites or Aquatic Habitats			
Plant Type	*Common Name*	*Scientific Name*	*Approx. Height of Plant (ft)*
	Northern Blue Flag	*Iris versicolor*	2-4
	Southern Blue Flag	*Iris virginica*	2-3
Sedge—to plant at the water's edge, or in the water up to 1 foot deep			
	Tussock Sedge	*Carex stricta*	2-4
	Fox Sedge	*Carex vulpinoidea*	3
	Shallow Sedge	*Carex lurida*	3
Emergent Flowering Plants - grow in 1-2 feet of water			
	Arrowhead	*Sagittaria lancifolia*	2-3
	Pickerelweed	*Pontedaria cordata*	2-3
	Soft Rush	*Juncus effuses*	3
Floating Plants - grow in 2-6 feet of water			
	American White Waterlily	*Nymphaea odorata*	NA
	Yellow Pond Lily	*Nuphar lutea*	NA
	Illinois Pondweed	*Potamogeton illinoensis*	NA
	Longleaf Pondweed	*Potamogeton nodosus*	NA
	Frogbit	*Limnobium spongia*	NA
Submerged Plant			
	Eel Grass	*Vallisneria americana*	
	Canadian Waterweed	*Anacharis Canadensis*	
	Coon's Tail	*Ceratophyllum demersum*	

For growing requirements and range maps of these plants, refer to the plants listings provided in the "Resources for Further Reference" Section below.

because natural food sources are plentiful during the growing season. 6) Use specially-designed trash cans to exclude raccoons and bears; use clamps to tighten trash can lids.

Evaluating a Wildlife Conflict

The process for evaluating and dealing with wildlife conflicts is fairly straightforward. First, determine exactly which species is causing the damage or problem, rather than making assumptions. Just because there's a hole in the cedar soffit under the eaves doesn't necessarily mean a woodpecker made it. Second, once you know what species is involved, find out specific details about its life history and habits, in order to understand more about what the animal likely wants, or why it's doing what it's doing. The third step is to determine the various options available and start with the one that's least toxic or least invasive. These non-chemical, non-lethal options may include changing the habitat to make it less desirable to the animal, or implementing some sort of prevention or exclusion method that will deter the animal from causing the same problem again. The last step is to use chemical and/or lethal means, only if none of the previous options have worked. In some circumstances, more than one option may be necessary to fully address or eliminate the problem.

In the recommendations below, there are several references made to trapping wildlife, but it is not meant to imply that any animal can be trapped and transported somewhere else and released. It is illegal in the state of Virginia to trap and RELOCATE any animal to another area.

In the event that a situation presents itself where trapping will be necessary to address a wildlife conflict, consider contacting a licensed trapper who lives in your area and may be willing to assist you with the endeavor. A list of licensed trappers can be found on the DGIF web site (www.dgif.virginia.gov)

Also, several laws and regulations are quoted below, but this is by no means a comprehensive list. If you have any questions about legalities or conflict issues, the most practical and easiest thing to do is to call the DGIF WILDLIFE CONFLICT HELPLINE Toll Free Number

1-855-571-9003, 8:00 a.m.-4:30 p.m. Monday through Friday.

Legal Definition of "Nuisance Species"

While there may be many wildlife species we personally consider problematic, there are laws and regulations in the Code of Virginia that provide legal guidance on what actually constitutes a nuisance species. Per regulation, "the following animals: house mouse; Norway rat; black rat; coyote; groundhog; nutria; feral hog; European starling; English sparrow; mute swan; and pigeon (rock dove) are designated as nuisance species and may be taken at any time by use of a firearm or other weapon (unless prohibited by local ordinances), and on some public lands during certain time periods."

According to the Code of Virginia 29.1-100, nuisance species means "those species designated as such by regulations of the Board [as listed above], and those species found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, wildlife, livestock or other property, or when concentrated in numbers and manners as to constitute a health hazard or other nuisance. However, the term nuisance does not include (i) animals designated as endangered or threatened…(ii) animals classified as game [bear, deer, rabbit, squirrel, bobcat, red fox, gray fox, raccoon] or fur-bearing animals [opossum, weasels (long-tailed and least weasels), striped skunk, spotted skunk, river otter, mink, beaver, muskrat] and (iii) those species protected by state or federal law [all songbirds, woodpeckers, hawks, vultures, waterfowl etc. under the federal Migratory Bird Treaty Act, and many other species under the federal Endangered Species Act]."

This means that if a woodpecker is banging on your siding, you are not authorized to harm, harass or "take" (kill) it, even though it definitely is a nuisance!

By law, the only people authorized to harm, harass or "take" (kill) nuisance species as defined above are DGIF personnel, Federal personnel with wildlife responsibilities, Animal Control Officers, Commercial Nuisance Animal Permittees, licensed hunters, licensed trappers, and landowners (under certain conditions).

When a Commercial Nuisance Animal Permittee receives a complaint from a private citizen, the Permittee is authorized to: 1) capture or remove wildlife from a building or dwelling and release the animal upon the "curtilage" of the building [the fenced-in ground and buildings immediately surrounding a house or dwelling]; 2) capture and temporarily possess injured, sick or orphaned wildlife for transport to Wildlife Rehabilitation Permittees; 3) capture and temporarily possess and transport wildlife for dispatch (killed); 4) capture wildlife for immediate dispatch; 5) immediately dispatch wildlife. Commercial Nuisance Animal Permittees are not authorized to capture, possess, transport or dispatch: 1) companion animals, including dogs and cats, whether owned or feral; 2) state or federal threatened or endangered species; 3) federally protected migratory bird species; 4) black bears; 5) white-tailed deer; 6) wild turkey. They are also NOT authorized to relocate (release) any live animals, except for squirrels trapped from areas where discharge of firearms is prohibited and when permission is obtained from the landowner where the squirrel is being released.

Control Options

For specific control recommendations for each of the animals listed below, please refer to VCE publication 456-018, Pest Management Guide (PMG), Home Grounds and Animals, section 8: "Other Animals: Vertebrates as Pests." All pesticide (bait, repellent, rodenticide, etc.) recommendations must come from this VCE publication 456-018.

Deer

Too many deer in a forested area can cause overbrowsing to the extent that available habitat is severely compromised for some wildlife species that rely on understory food and cover to survive. However, the effects vary among species. On the one hand, ground-nesting birds such as ovenbirds and shrub-nesting birds like buntings may be adversely affected from overbrowsing, whereas other species like cardinals and nuthatches are not influenced. In addition to the problems posed to other wildlife by overbrowsing, an overabundance of deer can result in the spread of more invasive plants throughout the ecosystem and substantially reduce understory regeneration of oaks and other trees.

Deer are opportunistic, and in a residential setting, if deer are hungry enough and presented with enough easily accessible ornamental plants, they'll selectively pick and choose the plants best suited to their needs at that particular point in time. There are excellent publications available online [such as Managing Deer Damage in Maryland, Bulletin 354] which contain strategic guidelines and plant lists for minimizing deer damage for different land uses. For example, a Christmas tree grower can use

repellents to protect new tree seedlings until they're tall enough to be out of reach of deer, whereas repellents are not cost-effective for an agricultural operator of a large nursery, orchard or vegetable farm. A homeowner may select a plant off the recommended list for their landscape bed ("Resistance of Ornamentals to Deer Damage"), but may subsequently find that deer will eat the plant anyway. Unfortunately, these kinds of "Resistance" lists are not consistently reliable, because deer will browse on plants for a variety of reasons: the health of the individual animal; the quality of the surrounding habitat; the amount of other available food in the area; the time of year; whether or not the animal is lactating; etc. Hence, deer may always eat hostas in one neighborhood, but in another part of the state, deer may rarely ever eat hostas at all.

The take-away point is that the plants do not "resist" or "deter" anything. Rather, it's the deer that's in control. Whether or not a deer eats certain plants will depend on how desirable that plant is, how hungry the deer is, and so on. Eating or not eating is a behavior that's up to the deer, not the plant. If a plant smells bad and has waxy, unpleasant leaves, a deer can walk away and eat something else. However, just because a deer walked away one time doesn't mean that another deer won't come along later and eat that plant in one big chomp. According to DGIF Deer Biologist Nelson Lafon, "It's a myth that you can deter deer by only using certain plants." [Lafon PowerPoint] Therefore, be wary of nurseries that make claims about a plant's deterrence properties. (Please see the Appendix for a table of native shrubs, which includes a column indicating species that are said to be "Not Preferred by Deer.")

Whether or not a planted bed is browsed by deer can also depend on where the plants are located. In general, deer are less likely to browse right up against a house or where dogs or people frequently move about—but here, too, there are always exceptions, if a deer is hungry, persistent or bold enough.

The best option in a home landscape is exclusion of plants using plastic fencing, or woven wire or chain link at least eight feet and preferably 10 feet tall around vegetable gardens and other small planted beds. Use tree protectors around young seedlings to cover the vulnerable bark, and use a cage made of woven wire to protect specimen plants.

For very large areas, electric fencing eight to 10 feet tall works best. There's another fencing design for rural properties that's been promoted by Cooperative Extension for many years, which entails setting the fence at an angle such that deer are said to be less likely to jump over it. However, anecdotal conversations with landowners by this author have indicated that this method is not always very effective, and it appears that more research may be needed to test the efficacy of this practice.

For smaller scale home gardens, try using a modified electric fence with aluminum foil "tents" or wrappers that attach to the wires and are rubbed with peanut butter. A deer is attracted to the peanut butter and receives a shock when its nose touches the foil that conducts the current. This results in aversive conditioning, which deters the deer from coming back to the same area again, at least for a while.

Some homeowners have had success with placing two, 4-foot sections three feet apart from each other. Apparently the panels are too close together for deer to feel 'comfortable' jumping over.

Commercial, chemical repellents can be applied to target plants as a deterrent, but they must be applied at the beginning of the growing season before deer begin browsing on the plants, and they should preferably be applied to so-called deer-resistant species, to maximize potential effect. However, the chemicals may gradually break down over time or get washed off in rain events, and they must therefore be re-applied regularly to maintain effectiveness. There are over a dozen commercially available chemical repellent products which contain a variety of ingredients that either emit a foul odor which deer find offensive, such as putrefied egg-based compounds, garlic, fish meal, or coyote urine; or various plant compounds like capsaicin (hot pepper) or other chemicals which are distasteful or injurious to the palate. Refer to VCE publication 456-018 for specific repellent recommendations.

When everything else fails, get a dog that will chase deer out of the yard!

Bear

Black bears occur throughout most of Virginia, and as human development increases, it becomes increasingly likely that people will encounter bear in residential areas. However, in this part of the bear's range, they do not exhibit predatory behavior, and it is extremely unlikely that a bear will attack or harm a human, unless

the animal is provoked or feels threatened. As described in the "Feeding Wildlife" section above, one of the primary reasons bear are attracted to human development is because of an available food source. At least 30% of complaints about bear are attributed to the presence of bird feeders, and 50% of complaints are associated with storage of garbage. A much smaller percentage (less than 10%) is related to agricultural food sources such as apiaries, orchards, other crops and livestock feed.

According to Virginia state law: "It shall be unlawful for any person as defined in §1-230 (Code of Virginia) to place, distribute, or allow the placement of food, minerals, carrion, trash, or similar substances to feed or attract bear. Nor, upon notification by department [DGIF] personnel, shall any person continue to place, distribute, or allow the placement of any food, mineral, carrion, trash, or similar substances for any purpose, if placement of these materials results in the presence of bear."

The simplest way to prevent bear encounters is to monitor bird feeders and other food sources outside the home to ensure that bear and other wild mammals are not being attracted. If it becomes apparent that a bear is using a feeder or frequenting a garbage can, or if bear are known to have been sighted in the area, remove all feeders and other open food sources immediately. A good rule of thumb is to take down bird feeders between April 1 and December 1 to prevent problems from occurring.

If a bear is sighted, keep your distance and allow the bear to leave the area. The goal is to keep a bear from feeling comfortable around residential areas, and if there's no food source available, the bear will likely just move through the area and continue on its way. If a bear is sighted in a tree, keep dogs and other pets away, so the bear will leave.

Vole

Voles are herbivores that eat bulbs and roots. They make tunnels near the surface of the sod as they travel from tree to tree to eat roots and strip the bark; they do NOT make mounds. A common vole deterrent is a bait-station ground trap that can be installed above or below ground. To confirm whether or not voles are indeed the ones eating bulbs, use an apple bait test: place the bait near the runway on the surface of the turf, and cover the bait with a bucket, then weight the bucket down with a brick to keep other animals out. Later inspect the bait to see if the apple has been chewed by a vole. Other methods include placing a mouse trap on the ground perpendicular to the runway, then baiting it and covering it as described above. For specific bait recommendations, please see VCE publication 456-018.

Other methods of deterring voles: 1) use only a thin layer of mulch around trees, and pull the mulch away from the trunk; 2) avoid killing snakes, which are a primary predator of voles and other small mammals. Owls and hawks are also predators of voles; 3) before planting bulbs, enclose them in a small wire basket, or place a layer of gravel or sharp shale bits ('Perma Till') in the hole when planting, to surround and protect the bulb.

Mole

Moles are insectivores that prey on worms, grubs, and other insects or larvae; they do NOT eat flower bulbs, contrary to popular opinion. Moles tunnel just below the soil surface and leave mounds as they go; they can dig up to 150 feet of new tunnels a day, and their action helps to aerate the soil. It is said they can consume their body weight in food daily, which makes them an important predator of problematic grubs such as Japanese beetle larvae. Moles, like any other wildlife species, have a specific role in the environment, and the first level of dealing with them is tolerance of their activities. Allow moles to continue feeding on the grubs in the soil and consider it a service. If tunneling becomes problematic, try collapsing the tunnels by walking over them, which may also prevent mice and voles from using them as easy runways, or use an underground barrier or baffle to edge around plant beds. When all other options are exhausted, use a mole trap to kill, or use baits. For specific bait recommendations, please see VCE publication 456-018.

Raccoon

Raccoons are wily creatures that can cause all kinds of damage, and they can carry rabies. Raccoons get into chimneys and attics; they get into barns and livestock feed stores or grain; they damage agricultural crops such as corn fields; they get into trash cans and dumpsters; etc. To manage: 1) make sure the chimney has a properly fitted and secure chimney cap; 2) close off any holes under the eaves or other openings where raccoons could get in; 3) remove or secure food sources; 4) if a raccoon is already in a building or attic, try harassment with a loud radio tuned to a talk station; or bright lights.

The legal provision for raccoon damage management, according to the Code of Virginia 29.1-517 Fur Bearing Animals: "When muskrats or raccoons are damaging crops or dams, the owner of the premises may kill them

or have them killed under a permit obtained from the Conservation Police Officer [of the Virginia Department of Game and Inland Fisheries]." Under Regulation 4-VAC 15-210-51 Open Season for Trapping-generally: "November 15 through last day in February… except there shall be a continuous open season to trap raccoon within the incorporated limits of any city or town in the Commonwealth and in the counties of Arlington, Chesterfield, Fairfax, Henrico, James City, Loudoun, Prince William, Spotsylvania, Stafford, Roanoke and York."

The above Code and Regulation indicate that if you live in a city or town or one of the counties listed, you can live trap a problem raccoon and release it outside (then seal up any entrances where it was able to get in). If you don't live in one of those areas, and the raccoon is causing conflict that doesn't involve crops or a dam, and you've tried all other options, then hire a professional (Commercial Nuisance Animal Permittee).

Another alternative is to find a licensed trapper who lives in your area and is willing to assist you with the endeavor. A list of licensed trappers can be found on the DGIF web site (www.dgif.virginia.gov)

Rabbit

Use chemical repellents similar to those used for deer, to discourage feeding on plant leaves and shoots. Plant a species like onions, which rabbits do not prefer, in between other plants that are more desirable. Fence the garden with two-foot high hardware cloth (wire mesh) or chicken wire, and extend it at least five inches below the ground, all around the bed. Individual plants or vulnerable seedlings can be covered with a basket.

See also the legal provision for trapping rabbits and squirrels under the "Squirrel" section, below. For specific repellent recommendations, please see VCE publication 455-018.

Squirrel

Squirrels can wreak havoc in a variety of ways. They can chew their way through the sill of a window, or chew a hole under the eaves to make an entrance and get into an attic. To keep them away from buildings, trim any overhanging tree branches to keep limbs well-away from the roof; staple hardware cloth over any openings under the eaves, or seal them over with a board or piece of metal flashing.

If a squirrel gets inside the house, place a loud radio tuned to a talk station near the room, and/or bright lights to scare them to leave. A "Hav-a-Heart" trap may be available from a local Animal Control Office to live trap the squirrel and release it directly outside, next to the building.

Around bird feeders, squirrels will chew the edges of the feeder if it's made of wood. Many advertised "squirrel-proof" feeders are available on the market, with various designs, such as one that slides a metal baffle over the seed hopper to close it off when a squirrel stands on the edge, or a feeder that has a battery-operated sensor which spins the feeder to throw the squirrel off. Despite their intended outcome, these feeders may not always work, because squirrels eventually seem to outwit the baffle device, and squirrels have been know to continue to attempt to climb onto the 'spin-feeder' until the feeder's batteries run out. In most cases it's usually best to take feeders down for a time, until the squirrel loses interest and moves on to something else.

The legal provision for squirrel damage management, according to the Code of Virginia 29.1-516 Game Animals: "Landowners, resident members of hunt clubs and tenants (with written permission of landowner) may kill rabbits or squirrels for their own use during the closed season.

Also—Code of Virginia 29.1-530 Open and Closed Season for Trapping, Bag Limits, etc: "a landowner or his agent may trap and dispose of, except by sale, squirrels causing a nuisance on his property at any time in any area where the use of firearms for such purpose is prohibited by law or local ordinance."

Skunk

Skunks are nocturnal, secretive, solitary and opportunistic. They prey on insects and will eat grasshoppers, crickets and also mice. They may knock over and empty the contents of trashcans; dig up lawns in search of grubs or insect nests; and like raccoons, they can carry rabies. To manage for skunks: 1) use a locking trash can to secure waste; 2) do not leave pet food outside; 3) remove brush and cover away from the foundation of dwellings or other buildings; 4) use a chemical treatment for the grubs in the lawn if their numbers exceed six per square foot; 5) if a skunk is in the crawl space under a building or has burrowed a hole under a shed, lay a board at the entrance as a ramp to try to encourage the skunk to come out; 6) when you're sure the skunk is no longer underneath

a building, tightly secure hardware cloth (wire mesh) along the edge of the building foundation to cover any burrow entrance or other opening; 7) use a covered bait trap that's designed to capture a skunk and protect others from being sprayed. Lay a towel or blanket over the trap as an added precaution.

Per Regulation 4 VAC 15-220-10 Continuous Open Season for Taking of Striped Skunks: "It shall be lawful to take striped skunks (Mephitis mephitis) at any time." And—Regulation 4 VAC 15-220-20 Taking of Spotted Skunks: "A landowner or tenant may take [kill], on his own land or land under his control, spotted skunks (*Spilogale putorius*) committing or about to commit depredation. However the pelt of the spotted skunk may not be sold."

Opossum

Opossums are also nocturnal. Since they're primarily tree-dwellers, they're inclined to enter attics without an invitation. As omnivores, they're also opportunistic when seeking food sources and will get into storage areas or outbuildings where bird seed or dog food is kept. To manage for opossum: 1) remove or secure food sources; 2) use hardware cloth or other screening or exclusion method to protect foundation openings; 3) repair eaves and areas under the roof overhang to keep animals out; and 4) trap as needed. Since Opossum is legally defined as a furbearer species, the following are applicable regulations for trapping:

29.1-517 Fur-Bearing Animals: "A landowner may shoot fur-bearing animals except muskrats or raccoons upon his own land during closed season."

29.1-530 Open and Closed Season for Trapping, Bag Limits, etc: "A landowner may trap fur-bearing animals, except beaver, muskrat and raccoons, upon his own land during closed season."

Regulation 4 VAC 15-210-51 Open Season for Trapping – generally: "November 15 through last day in February, except there shall be a continuous open season to trap opossum within the incorporated limits of any city or town in the Commonwealth and in the counties of Arlington, Chesterfield, Fairfax, Henrico, James City, Loudoun, Prince William, Spotsylvania, Stafford, Roanoke and York."

Groundhog

Groundhogs dig large burrows and can do damage beneath the foundation of a building. Their burrows can be 25 to 30 feet long and from two to five feet deep, and they usually have two entrances. Groundhogs also feed on agricultural crops and may damage fruit trees in orchards. Here it's important to remove fallen fruit as quickly as possible, to avoid attracting groundhogs to the free bounty.

The best measure for keeping groundhogs out of a structure is preventive maintenance, by ensuring that garages, porches, decks, sheds and other outbuildings do not have openings for access that will invite a groundhog's curiosity to explore and dig deeper.

In the garden, use a fence at least three feet high to keep groundhogs out, and extend the bottom of the fence under the ground at least one or two feet, as they may try to burrow underneath it.

Woodpecker

During the early spring, male woodpeckers establish their territory and attract a mate by pounding on dead trees and logs. If sufficient dead trees are not available, a woodpecker may decide that the hollow sound made by rapping on the siding of a house is just as good. In this scenario, one can try hanging reflective or noisy items from the building near where the bird has been striking, such as: old CD's; plastic grocery bags; bobbing balloons; rattling pie tins; or shiny metal flashing cut into strips.

Another possibility is that there may be some insect damage taking place underneath the siding or under the eaves that has attracted the woodpecker. Since woodpeckers are closely associated with dead trees and have a specialized tongue that's adapted for pulling grubs out of wood, these birds spend a lot of time climbing up and down trees listening for the sound of chewing insects beneath the bark, which are a clear signal that food is at hand. Therefore, if scare tactics have not worked in discouraging the woodpecker from leaving the building, it's possible that there's some decay beneath the fascia board. Check for water-damaged wood, which is often an indicator or rot, and replace any damaged material.

Also, stack firewood and lumber at least 10'-20' away from the house, to avoid insect damage from carpenter ants, termites, borers, powder post beetles, etc. which might attract woodpeckers as well.

Woodpeckers are protected by the Migratory Bird Treaty Act and may not be harmed, harassed or "taken" at any time.

Bat

Bats are very small and can squeeze between very narrow cracks and crevices underneath boards or eaves. Therefore, to reduce the likelihood of bats entering an attic space or getting into the walls, practice diligent preventative maintenance and make repairs as soon as damage is observed. It's especially important to do this before the breeding season, when nursery colonies will be looking for places to roost to raise their young. At the end of the breeding season, bats will look for shelter to hibernate over winter. Some simple practices for maintenance or repair: 1) Attach ¼ inch steel mesh (hardware cloth) to the inside of gable vents; 2) patch any holes fist size or larger with new siding, paneling, sheet metal, or plywood and paint; 3) Stuff smaller holes with steel wool or copper wool, and then cover with caulk.

If a bat does get into the house, don't panic but try to contain it in one room. Turn off all the lights and open all the windows, and continue watching the bat until you see it leave. If the bat appears to be resting quietly, try to trap it in a plastic container, and then release it outside.

If bats are living in the attic, turn on a loud radio and use bright lights as a deterrence. Another technique is to sit outside the building on a lawn chair at dusk and watch the house from the outside, to see how bats are getting in and out of the structure. Have a ladder and tools and materials ready. When darkness falls, the bats will leave the building en masse, which should provide an opportunity to make repairs and block access to their return. However, in the months of May through August, there may be young bats that stay behind when the adults come out to feed, and it's imperative there are no bats still present within the structure before sealing up the holes.

Sometimes placing a bat house on the wall near the opening where bats have been going in and out may entice them to use the bat house instead. However, if these methods are not successful and a large number of bats are still in the structure, seek professional assistance.

Bats are a nongame species and cannot be harmed or taken at any time. There are three federally endangered species of bats in Virginia. Therefore, before implementing a control technique that may cause harm, seek assistance in determining what species of bat is in question.

If a large number of bats are in the structure, seek professional assistance.

Snake

Despite people's fears, snakes are rather benign and will usually try to get away when they see anyone approaching. There are over 30 snake species in Virginia, and all but four are non-venomous. The most common venomous snake seen across the state is the copperhead, which may frequent firewood piles or other areas with protective cover.

The preventative for snakes is similar to that as mentioned early, namely keep the building maintained and seal up any small cracks, tears, or other openings around windows, doors and under the eaves. Black rat snakes are tree climbers and may get inside an attic space. Snakes may also find their way into a basement or crawl space. If a snake gets in, use a towel or small blanket to place over the snake and then secure it to release it outdoors.

Canada Goose

One goose produces a pound of manure every day. That's a lot of organic matter that can pollute ponds, lakes and other waterways. Feeding geese only makes the problem worse, because it encourages them to congregate, and the concentration of nitrogen and urea from their droppings will kill fish and other wildlife in the pond water and can also cause an algae bloom. The wisest rule of thumb is not to feed geese at all.

To manage goose conflict, use scare tactics such as reflective tape; noise makers such as horns and whistles; and predator replicas. There's also a bright yellow, inflatable plastic ball with a red eyeball on it that is sometimes used. Inflate the ball and hang it from a tree limb near the water, so it's easily visible to the geese. It's said that they apparently perceive the yellow ball and eye as a predator or something to be avoided. In large areas, such as around a lake in a big subdivision, a dog can be employed to chase geese and keep them from landing. This is most effective if initiated early in the season, when geese are flying over looking for places to land and a safe site to begin nest-building.

Geese prefer wide open lawns and fields, and another effective way to deter them is to leave a wide buffer of grasses, shrubs and other vegetation around the perimeter of the lake or pond. Geese usually approach land from the water's side, and if the bank is full of vegetation, they will not come up on land in that location. Therefore avoid

mowing down to the water's edge wherever possible. If a view of the water is desired, carefully select a few small areas between trees or shrubs ,where a few branches can be strategically removed to open a small 'window' to the water, in lieu of cutting out entire shrubs or mowing all the vegetation. Retaining a buffer will be more beneficial to aquatic organisms that live in the water or at the water's edge, too. If there's currently no vegetated buffer to work with, set up a temporary fence or other barrier such as rocks at the very edge of the water along the entire length of the bank, to discourage geese from walking up onto land from the water side.

If geese have already become well established and are nesting, another technique that field biologists use is called "egg addling." This is a mechanical method whereby the eggs in the nest are rapidly shaken in order to break up the contents within, so they won't hatch. Although the adults may still not leave, the method ensures that the goose population at that location will not grow any larger.

In some municipalities a special goose hunt may be organized to reduce their numbers. To inquire how to set this up, contact a DGIF Waterfowl Biologist or a Conservation Police Officer.

Study Questions

18. What are two primary causes of human-wildlife conflicts?

19. Feeding wildlife can be problematic, because when animals are concentrated together, it artificially _____and makes it more likely _____ _____. Their behavior may also be altered, and they can become more _____, because they gradually lose their fear of humans.

20. Which of the following statements are true? a) It is illegal in Virginia to place or distribute food, salt, or minerals to feed or attract deer or elk from September 1 through January 3 statewide, b) It is illegal in Virginia to trap and RELOCATE any animal to another area, c) It is illegal in Virginia to feed bears at any time; if a bear begins using a bird feeder, the feeder must be taken down.

21. List 5 recommendations about how to avoid attracting wildlife to food sources:

22. Put the following statements into the correct order to describe the process of evaluating and dealing with wildlife conflicts: a) Use chemical and/or lethal means, b) Find out details about the animals' life history and habits, c) Use non-chemical options, such as changing the habitat or exclusion, d) Determine which species is causing the damage or problem.

23. List 3 recommendations or ways that deer may be deterred from browsing plants.

Answers:
18 - Two primary causes of human-wildlife conflicts are: 1) The adaptability of wildlife to our urban and suburban built environments, and 2) people feeding wildlife (or leaving food out where wildlife can get to it); 19 - increases, they'll spread diseases to each other, aggressive towards each other, or even towards people; 20 - All of the statements are true; 21 - Recommendations about how to prevent feeding of wildlife—any of the following are correct: 1) Do not throw large piles of old bread and kitchen scraps in the yard—this will attract crows, starlings, grackles, vultures, skunks, raccoons and opossums. 2) Do not feed apples and corn to deer and squirrels—this will only encourage them to keep coming back, and their numbers will increase until a conflict arises. It will be much harder to get rid of them later. 3) Do not put cat food or dog food out for wildlife. Avoid using a pet door in a garage for feeding pets, which may encourage wildlife to come into the building. 4) Keep charcoal grills and gas grills clean of grease and other food residue. 5) Take birdfeeders down in the summertime, to avoid attracting bears, and because natural food sources are plentiful during the growing season. 6) Use specially-designed trash cans to exclude raccoons and bears; use clamps to tighten trash can lids; 22 - d, b, c, a; 23 - any of the following: Chemical repellents; home remedies; electrical fence at least 8-10 ft. high; modified electric fences made w. aluminum foil 'tents' coated w. peanut butter; dog chasing deer.

Resources for Further Reference

General Habitat Information

Habitat at Home©, by Heiser—8 pg. booklet provides an introductory overview and a basic plant list for general public audience. This and many other habitat fact sheets and resources are available for download from the VA Department of Game and Inland Fisheries Habitat Partners© Program. www.dgif.virginia.gov/habitat [DVD available for $7.95 from DGIF e-Store]

Backyard Wildlife Habitats, by Eaton and Wright; revised 2015; VA Cooperative Extension [Publication 426-070]; 7 pg. document for general public. https://pubs.ext.vt.edu/426/426-070/426-070_pdf.pdf

Bringing Nature Home: How You Can Sustain Wildlife with Native Plants, by Tallamy; 2009 edition; Timber Press; 360 pgs. Related articles are also available at http://bringingnaturehome.net

The Living Landscape: Designing for Beauty and Biodiversity in the Home Garden, by Darke and Tallamy; 2014; Timber Press; 392 pgs.

Wildlife Habitat Evaluation Program Manual—198 pg. document covers habitat concepts and numerous wildlife management practices. Originally published by National 4-H Council and Cooperative Extension; revised in 2011. http://utahenvirothon.org/wp-content/uploads/2011/09/WHEP_Manual_20103.pdf

The Woods in Your Backyard: Learning to Create and Enhance Natural Areas Around Your Home, by Kays, Drohan, Downing and Finley; 2006; Natural Resource, Agriculture and Engineering Service, Cooperative Extension [NRAES-184]; 138 pgs. Handbook for landowners of one to 10 acres; provides guidelines for assessing a site and planning land management; includes sections on wildlife ecology and habitat improvement methods.

Wild Ones: Landscaping with Native Plants, 4th edition, 2004; 28 pgs. Contains sections on planting woodlands, meadows, wet gardens, and landscaping for wildlife. https://www.csu.edu/cerc/documents/LANDSCAPINGWITHNATIVEPLANTS.pdf

Conservation Landscaping Guidelines: The Eight Essential Elements of Conservation Landscaping; Chesapeake Conservation Landscaping Council; 2013; 37 pgs. www.chesapeakelandscape.org

The Nature of Change: Preserving the Natural Heritage of a Dynamic Region [Northern VA], ed. by Waggener; 2005; National Audubon Society Inc. and The Audubon Society of Northern Virginia; 80 pgs. Contains photos of numerous habitat examples plus gardening tips for planning a habitat. http://www.audubonva.org/audubon_at_home/nature_change_content.pdf

Wildlife Habitat Guide for Restoration and Landscaping in the Elizabeth River Watershed [Tidewater VA], by Pease; 1999; Elizabeth River Project; 141 pgs. Available for $5 at http://www.elizabethriver.org/#!native-plants/c1dqv

Bat House Builder's Handbook, by Tuttle and Kiser; updated and revised 2013; Bat Conservation International; 36 pgs. http://www.batcon.org/pdfs/BHBuildersHdbk13_Online.pdf

Native Plant Resources

Native Plants for Wildlife Habitat and Conservation Landscaping, by Slattery, Reshetiloff and Zwicker; 2003; 84 pgs. Booklet covers plants found throughout the mid-Atlantic states and is available for download at www.nps.gov/plants/pubs/chesapeake or as a searchable database at www.nativeplantcenter.net

Native Plants for Conservation, Restoration and Landscaping (VA Department of Conservation and Recreation, Natural Heritage Division): Plant lists for physiographic regions of the state (Coastal, Piedmont and Mountain), with a key indicating relative value of plants to wildlife. Also includes a link to a list of Virginia invasive plant species. http://www.dcr.virginia.gov/natural_heritage/nativeplants.shtml

Regional Native Plant Guides are available (such as Eastern Shore, Northern Neck, Northern Virginia) at VA Coastal Zone Management Program, www.deq.virginia.gov/Programs/CoastalZoneManagement/CZMIssuesInitiatives/NativePlants.aspx

Digital Atlas of Virginia Flora www.vaplantatlas.org Use the Atlas to see which plants are actually native in your own County.

Three complete listings of native "Herbaceous Plants," "Shrubs" and "Trees" are available online at http://blogs.lt.vt.edu/mastergardener/app-nativeplants-wildlife/, which are used with permission from the USDA-NRCS (2014) Field Office Technical Guide, Section 2, Plant Establishment Guide.

Gardening for Butterflies and Other Pollinators

U.S. Fish and Wildlife Service Pollinators web site http://www.fws.gov/pollinators/pollinatorpages/yourhelp.html

Numerous excellent publications are available from the Xerces Society for Invertebrate Conservation at www.xerces.org , as follows:

–Attracting Native Pollinators: Protecting North America's Bees and Butterflies, by Mader, Shepherd,

Vaughan and Black; 2011; Xerces Society; 380 pgs.

–XERCES "Invertebrate Conservation" FACT SHEETS (http://www.xerces.org/fact-sheets/):

* Pollinator Conservation: Three Simple Steps to Help Bees and Butterflies
* Butterfly Gardening
* Nests for Native Bees
* Protecting Bees from Neonicotinoid Insecticides in Your Garden http://www.xerces.org/wp-content/uploads/2013/06/NeonicsInYourGarden.pdf
* Pollinator Plants [for] Mid-Atlantic Region http://www.xerces.org/pollinator-conservation/plant-lists/

Conserving Bumble Bees: Guidelines for Creating and Managing Habitat for America's Declining Pollinators, by Hatfield, Jepsen, Mader, Black and Shepherd, 2012. http://ncagr.gov/spcap/bee/documents/ConservingBumbleBees.pdf

Pollinator Trial Results, by Schmotzer; 2013; Penn State Extension; 2 pg. Fact Sheet. http://extension.psu.edu/plants/master-gardener/counties/lancaster/pollinator-friendly-garden-certification/2013-pollinator-trial-results

Attracting Pollinators to Your Garden Using Native Plants, by Reel; U.S. Forest Service; 16 pg. color booklet, excellent for the general public http://www.fs.fed.us/wildflowers/pollinators/documents/AttractingPollinatorsEasternUS_V1.pdf

Urban and Suburban Meadows, by Zimmerman; 2010; Matrix Media Press; 272 pgs. Step-by-step guidelines for evaluating, designing, preparing and planting a site.

Gardening for Birds

Bird Gardening Book: The Complete Guide to Creating a Bird-Friendly Habitat in Your Backyard, by Stokes; 1998; Little, Brown & Co. 95 pgs.

Hummingbird Gardens: Turning Your Yard into Hummingbird Heaven, edited by Marinelli and Hanson; 2000; Handbook # 163, Brooklyn Botanic Garden Inc.; 111 pgs.

Attracting Birds, Butterflies and Other Backyard Wildlife, by Mizejewski; 2010 edition; National Wildlife Federation; 128 pgs.

Web Page – How to Attract Birds to Your Garden, National Wildlife Federation http://www.nwf.org/How-to-Help/Garden-for-Wildlife/Gardening-Tips/How-to-Attract-Birds-to-Your-Garden.aspx

Cornell Lab of Ornithology http://www.birds.cornell.edu/Page.aspx?pid=1478 [see also Nest Watch: All About Bird Houses http://nestwatch.org/learn/all-about-birdhouses/]

Woodworking for Wildlife: Homes for Birds and Animals, 3rd edition, by Henderson; 2010; Minnesota Department of Natural Resources; 164 pgs.

Gardening for Aquatic Wildlife

Backyard Ponds: Guidelines for Creating and Managing Habitat for Dragonflies and Damselflies, by Mazzacano, Paulson and Abbott; 2014; Migratory Dragonfly Partnership; 22 pgs. www.migratorydragonflypartnership.org

How to Create a Frog Pond (Emerging Wildlife Conservation Leaders); Amphibian Ark; 17 pgs. http://www.amphibianark.org/pdf/Husbandry/How%20to%20Create%20a%20Frog%20Pond.pdf

Pond-Building Guide (contains sections on "Characteristics of Amphibian Friendly Ponds" and "Mosquito Control"); 2015; 5 pgs. http://www.treewalkers.org/pond-building-guide/

A Guide to Creating Vernal Ponds: All the Information You Need to Build and Maintain an Ephemeral Wetland, by Biebighauser; 2002; USDA Forest Service and Izaak Walton League; 36 pgs. http://herpcenter.ipfw.edu/outreach/vernalponds/vernalpondguide.pdf or http://www.watershedconnect.com/documents/science_management_interventions_wetlands

Habitat Management Guidelines for Amphibians and Reptiles of the Southeastern United States [Technical Publication HMG-2], by Bailey, Holmes, Buhlmann and Mitchell; 2006; PARC (Partners in Amphibian and Reptile Conservation); 88 pgs. http://www.privatelandownernetwork.org/pdfs/seHabitatManagementGuide.pdf or https://separc.files.wordpress.com/2013/04/se-hmg.pdf

Wildlife Conflicts

WILDLIFE CONFLICT HELPLINE Toll Free Number 1-855-571-9003, 8:00 a.m.-4:30 p.m. Monday through Friday (VA Department of Game and Inland Fisheries).

VA Department of Game and Inland Fisheries—FACT SHEETS on 20 wildlife species available on web site, How to Prevent or Resolve Conflict with Wildlife. http://www.dgif.virginia.gov/wildlife/problems/

ARTICLES for the general public: When Wildlife Overstays its Welcome, and Feeding Wildlife: Food for Thought— www.dgif.virginia.gov/habitat

Wildlife Damage Control FACT SHEETS available on Beavers, Black Bears, Canada Goose, Moles, and Snakes, from VA Cooperative Extension https://pubs.ext.vt.edu/category/wildlife.html

Snakes of Virginia, VA Department of Game and Inland Fisheries [Booklet available for $4.95 through e-Store at www.dgif.virginia.gov]

A Guide to the Bats of Virginia, Special Publication No. 5, by Reynolds and Fernald; 2015; VA Department of Game and Inland Fisheries; 40 pgs. Includes information about how to handle bats in homes or buildings. [Booklet available for purchase through e-Store at www.dgif.virginia.gov]

DEER RESISTANT PLANTS: "Deer Resistant Plants," North Carolina Cooperative Extension, Urban Horticulture Fact Sheet 15; 8 pgs; http://pender.ces.ncsu.edu/files/library/71/Deer%20Resistant%20Plants.pdf

Resistance of Ornamentals to Deer Damage, Fact Sheet # 655; 2003; Maryland Cooperative Extension; 8 pgs. http://s130859622.onlinehome.us/ocg/wp-content/uploads/2011/06/DeerResistantOrnamentals.pdf

Deer: A Garden Pest [Hort 62NP], by Hussey; 2013; VA Cooperative Extension; 4 pg. Fact Sheet. http://www.pubs.ext.vt.edu/HORT/HORT-62/HORT-62-PDF.pdf

REPELLENTS: "White-Tailed Deer," [Wildlife Damage Management Fact Sheet Series], by Curtis and Sullivan; 2001; Cornell Cooperative Extension; 6 pgs. http://wildlifecontrol.info/pubs/Documents/Deer/Deer_factsheet.pdf

Managing Deer Damage in Maryland [Bulletin 354], by Kays; 2003; Maryland Cooperative Extension; 40 pgs. Excellent guidelines that can be applied to Virginia, not just Maryland! http://extension.umd.edu/sites/default/files/_docs/programs/woodland-steward/EB354_ManagingDeerDamage.pdf

Deer Proofing Your Yard and Garden, 2nd Edition, by Hart; 2005; Storey Publishing; 208 pgs.

Squirrel Wars: Backyard Wildlife Battles and How to Win Them, by Harrison; 2000; Willow Creek Press; 176 pgs.

Appendix: Selected Native Shrubs for Wildlife Habitat

Source: USDA-NRCS (2014). Field Office Technical Guide, Section 2, Plant Establishment Guide. [NOTE: This shrub list is excerpted and adapted from a much larger database.

Three complete listings of native "Herbaceous Plants," "Shrubs" and "Trees" are available online at http://blogs.lt.vt.edu/mastergardener/app-nativeplants-wildlife/]

Appendix: Selected Native Shrubs for Wildlife Habitat

Common Name	*Scientific Name*	*Height (feet) at 20 years*	*Not Preferred by Deer*	*Fruit / Seed Abundance*	*Value to Pollinating Insects*	*Bloom Period*	*Shade Tolerance*	*Anaerobic (Wet) Soil Tolerance*	*Drought Tolerance*
Highbush Blueberry	*Vaccinium corymbosus*	6		High	High	Spring	Tolerant	Medium	Medium
Buttonbush	*Cephalanthus occidentalis*	15		Medium	High	Summer	Tolerant	High	Medium
Eastern Red Cedar - EVERGREEN	*Juniperus virginiana*	20	x	Medium	High	Late Spring	Intermediate	Low	High
Black Chokeberry	*Photinia melanocarpa*	15	x	Medium	Moderate	Spring	Tolerant	Medium	Medium
Red Chokeberry	*Photinia pyrifolia*	5	x	Medium	Moderate	Mid Spring	Intolerant	Medium	Low
Coralberry	*Symphoricarpos orbiculatus*	2	x	High	Low	Mid Spring	Intermediate	None	Medium
Southern Crabapple	*Malus angustifolia*	30		High	High	Mid Spring	Intolerant	Low	Medium
Flowering Dogwood	*Cornus florida*	20		Medium	Low	Early Spring	Tolerant	None	Low
American Black Elderberry	*Sambucus nigra,* ssp. *canadensis*	7	x	High	Moderate	Spring	Intolerant	Low	Medium
White Fringetree	*Chionanthus virginicus*	20		High	Low	Mid Spring	Tolerant	Low	Medium
Cockspur Hawthorn	*Crataegus crus-galli*	30		High	High	Late Spring	Intolerant	None	High
American Holly- EVERGREEN	*Ilex opaca*	20	x	Low	High	Mid Spring	Tolerant	Low	Medium
Winterberry Holly	*Ilex verticillata*	6	x	High	High	Late Spring	Intermediate	High	Low
Indigobush	*Amorpha fruticosa*	6	x	High	High	Late Spring	Intolerant	None	Medium
Common Ninebark	*Physocarpus opulifolius*	10		High	Moderate	Late Spring	Intolerant	None	High
Pawpaw	*Asimina triloba*	25	x	Medium	Low	Mid Spring	Tolerant	Low	Low
American Plum	*Prunus americana*	24	x	Medium	Moderate	Mid Spring	Intolerant	Medium	High
Chickasaw Plum	*Prunus angustifolia*	12	x	Medium	Moderate	Early Spring	Intolerant	None	None
Eastern Redbud	*Cercis canadensis*	25		Medium	High	Spring	Tolerant	None	High
Swamp Rose	*Rosa palustris*	8		Medium	Moderate	Spring	Intolerant	High	Low
Canada Serviceberry	*Amelanchier canadensis*	20	x	High	Moderate	Mid Spring	Intermediate	Medium	Low
Northern Spicebush	*Lindera benzoin*	12	x	Low	High	Mid Spring	Intermediate	Medium	Low
Strawberrybush	*Euonymus americanus*	8		Medium	Low	Late Spring	Intolerant	Low	None
Smooth Sumac	*Rhus glabra*	12		High	Moderate	Mid Spring	Intolerant	Low	Medium
Winged Sumac	*Rhus copallinum*	8		High	Moderate	Mid Spring	Intolerant	Medium	Medium
Eastern Sweetshrub	*Calycanthus floridus*	7	x	Medium	Low	Summer	Intolerant	Low	Low
Blackhaw Viburnum	*Viburnum prunifolium*	16	x	Medium	Moderate	Spring	Tolerant	None	Medium
Southern Arrowwood Viburnum	*Viburnum dentatum* var. *dentatum*	15	x	Medium	Moderate	Early Spring	Intermediate	None	Low
Silky Willow	*Salix sericea*	12		Medium	High	Mid Spring	Intermediate	High	Low

Source: USDA-NRCS (2014). Field Office Technical Guide, Section 2, Plant Establishment Guide. [NOTE: This shrub list is excerpted and adapted from a much larger database. Three complete listings of native “Herbaceous Plants,” “Shrubs” and “Trees” are available online at http://blogs.lt.vt.edu/mastergardener/app-nativeplants-wildlife/]