



## Bull Creek Permit Study Guide

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## Background

*“Fifty years from now, our children and grandchildren are going to look back and say, ‘How is it that they had the foresight to do this sort of thing?’ It’s as powerful in this time as the creation of Central Park was in another century.” – Former Secretary of the Interior Bruce Babbitt at the permit-signing ceremony establishing the BCCP on May 2, 1996*

A preserve differs from a park in that it is created specifically for the protection of wildlife or natural resources. The Balcones Canyonlands Preserve (BCP) is actually a system of preserves consisting of several tracts of land in western Travis County, totaling more than 33,000 acres as of 2024. This land is held in the public trust for the specific purpose of preserving the unique biodiversity of the region for both current and future generations. The BCP differs from the [Balcones Canyonlands National Wildlife Refuge](#), which is owned and operated by the federal government.

**The overriding goal of the BCP is to protect the welfare of the species targeted by the conservation plan.**

Given this priority, access into the preserve areas is allowable only if endangered species protection is not compromised. After species conservation, recreational opportunities are considered a secondary use of the Preserve lands. Decisions on what recreational activities are allowed within preserve areas are made based on whether the activity will be detrimental to either the species or the habitat.

The Balcones Canyonlands Conservation Plan (BCCP) represents a compromise between land development for economic growth and land preservation for endangered species. It established a method whereby landowners in Travis County may proceed with otherwise lawful activities on their land that impact identified habitat by purchasing or setting aside habitat of equal quality—a process known as mitigation. In order for Austin to continue to benefit from this compromise, the long-term viability of the Preserve to provide habitat for the species of concern, such as the Golden-cheeked Warbler, must be sustained.

The Bull Creek Nature Preserve is one preserve within the larger Balcones Canyonlands Preserve system. The 1,140 contiguous acres making up the Bull Creek Nature Preserve were acquired by the City of Austin to protect the Golden-cheeked Warbler using funds expressly designated for the purchase of endangered species habitat. Because the Bull Creek Nature Preserve is considered prime habitat for the warbler, access during the breeding season (March 1 through July 31) is by permit only. Many recreational activities can have a negative impact on the behavior and productivity of birds. The Bull Creek Nature Preserve is open to hiking without a permit during the non-nesting season (August 1 – February 28th or 29th if a leap year), as long as recreational activities do not result in significant modifications to either land or vegetation. Even though warblers are in Mexico and Central America during the non-nesting season, it is vital to protect against the degradation of soil, vegetation, and water resources year-round in order to preserve the habitat and overall ecosystem upon which the warbler depends.

**Given the potential for degrading or disturbing habitat, horseback riding, dog walking, and mountain biking are not allowed within the Bull Creek Nature Preserve at any time.**

### Why Preserve Biodiversity?

The Kretschmarr Cave mold beetle, a cave invertebrate protected by the Balcones Canyonlands Conservation Plan, is not exactly the most charismatic animal on the Endangered Species List. This small, eyeless insect lacks

the majestic beauty of the whooping crane or the ‘cute and cuddly’ appeal of the black-footed ferret. It lives far from the public eye in underground caves, surrounded by total darkness and buried in silt. However, the mold beetle is the perfect example of the many reasons why all endangered species should be protected.

**Existence.** This is the simplest reason for preserving biodiversity—all species have a right to exist. The mold beetle evolved and adapted over millions of years to the unique habitat of cave systems, and it is not our place to step in and destroy it. In addition, the existence of biodiversity serves as a unique and natural heritage for future generations.

**Knowledge.** The amazing range and abundance of species provide a foundation for scientific education and the continued pursuit of knowledge. There is also the more practical argument of applied research for economic, agricultural, and medicinal purposes. For example, the Pacific yew tree was considered a non-commercial weed species until an anti-cancer drug known as taxol was developed using the bark of the tree.

**Balance.** Every species is an integral part of a larger interdependent web known as an ecosystem. For instance, the Kretschmarr Cave mold beetle helps to decompose organic matter and control populations of tiny insects called microarthropods. When a strand of the ecosystem web is altered or removed, such as the loss of a species like the mold beetle, it affects the natural balance of the whole ecosystem. Over time, as more strands are lost, the web begins to weaken and unravel, which can cause the entire ecosystem to come apart.

**Warning.** This is often called the “canary in the coal mine” argument. In years past, miners would take a canary down into coal mines because canaries were more sensitive to toxic and explosive gases. If the canary stopped singing, the miners knew that the gases had reached a dangerous level and they had to leave immediately. Likewise, species that are sensitive to pollution levels can function as an early warning system for declining air or water quality in an area. This can help to identify deteriorating ecosystems as well as human health risks.

**Open Space.** One of the primary purposes of the Endangered Species Act is “to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved.” This means that the preservation of endangered species like the Kretschmarr Cave mold beetle also protects the surrounding ecosystem—providing beautiful and interesting areas of open space like the Bull Creek Nature Preserve to enrich and inspire us.

## Preserve Management

The primary goal of species conservation is accomplished through protection, management, enhancement, and monitoring of Preserve habitats.

A major component of **habitat protection** is targeted acquisitions of land that are considered to be prime habitat for endangered species and species of concern. Other activities include establishing secure boundaries using fencing, posting signs in and around the Preserve, and patrolling Preserve properties to prevent inappropriate uses that may jeopardize endangered species protection.

**Habitat management** activities include development and implementation of land management plans, promotion of good neighbor relations, maintenance operations such as trail creation (where appropriate), and access control. Part of the management strategy for the Bull Creek Nature Preserve is limiting access during the breeding season of the Golden-cheeked Warbler to avoid disturbing the behavior and productivity of the birds. Also, an essential part of management is public education and outreach. While earning an entry permit

for the Bull Creek Nature Preserve through this course, community members learn about the purpose, ecology, and proper stewardship of the Preserve—thus creating an informed user group on the trails during the Preserve’s most sensitive time.

**Preserve and species monitoring** activities include observing and counting endangered species within the Preserve in order to determine their current status or well-being in comparison to previous years. This monitoring data is published in an annual report submitted to the U.S. Fish and Wildlife Service. Preserve management practices are also monitored and evaluated for their success in meeting the primary goal of species conservation in order to determine which are effective and which should be adjusted or eliminated.

**Habitat enhancement** activities are designed to improve the habitat for protected species. For example, Balcones Canyonlands Preserve staff collects seeds of native plants and grows these native species for habitat restoration and revegetation in degraded areas. Other enhancement activities may include erosion control, oak wilt suppression, use of prescribed fires, and the removal of exotic and invasive species, such as imported red fire ants, ligustrum, and honeysuckle.

### Preserve Rules

The following rules apply to the 1,140 acres of the Bull Creek Nature Preserve. This fenced area is accessed through the dodgeway entrances at Loop 360, Jester Blvd., Aralia Dr., and the southern corner of St. Edwards Park. For information on the rules for St. Edwards Park, please visit the [Parks and Recreation Department website](#).

### Proper Trail Use

- Stay on marked trails. Do not create new trails or widen existing trails. Use of unauthorized trails can disturb sensitive habitat and impede the growth of restored vegetation. Trails may be rerouted due to safety concerns or habitat sensitivity. Again, to safely enjoy a trail, stay on the marked path.
- The Preserve is open for foot-traffic only. Hikers and joggers should be in groups of three or less. Mountain biking, dog walking, horseback riding, and use of motorized vehicles are not allowed at any time.
- Children should be supervised at all times.
- During Golden-cheeked Warbler breeding season—March 1 through July 31—community members must obtain a permit to access the Preserve.
- Hours are from dawn to dusk. No nighttime activity is allowed.
- Trails are closed when wet.

### Take Only Photographs and Leave Only Footprints

- Do not collect plants, animals, rocks, or fossils. Fallen leaves and branches are habitat for insects and contribute to soil formation. The weathering of rocks and fossils contributes important minerals to soil.
- Camping, hunting, fishing, picnicking, and the building of fires are strictly prohibited. All trash must be carried out and placed in containers outside the Preserve. Glass containers, alcohol, and weapons are strictly prohibited in the Preserve.
- Do not harm or harass wildlife. Due to endangered species protections, playing recordings of Golden-cheeked Warbler sounds during nesting season (March 1 through July 31) is prohibited.

- Do not release unwanted cats, dogs, fish, raccoons, opossums, or other animals into the Preserve. They disturb the balance of the ecosystem by competing with native animals and preying on endangered species and their young.

## Safety Tips

- Stay on the marked trails at all times. Bull Creek Nature Preserve contains hundreds of acres. You can get lost and there are steep ravines and drop-offs.
- Hike with a friend and take a cell phone. You may need to call for assistance. Remember that cell phones may not have service within a ravine or valley.
- Do not approach potentially dangerous animals such as feral (wild) pigs, feral dogs, feral cats, white-tailed deer during breeding season, and venomous snakes. Remember that killing snakes of any variety is prohibited. Simply walk away in the opposite direction and warn approaching hikers. If charged by a sow that is protecting piglets, you can climb a tree on the trail until they pass.
- Take extra water - especially during hot weather - and wear sunscreen and a hat.
- Wear appropriate shoes suited for hiking. Limestone surfaces can be slippery so use caution.
- Supervise children. The Preserve is inappropriate for children without adults.
- Know how to identify poison ivy and avoid it. If you are sensitive, wear long pants, long sleeves, and a poison ivy barrier product. If you believe you have the oils on your skin, you may want to wash with a product that helps dissipate the oils within a certain number of hours. A native plant to our area, poison ivy is abundant on the banks of Bull Creek.
- In case of emergency, call 911.

## Ecosystem

### A Complex Network — An Ecosystem

The organisms of the Bull Creek Nature Preserve, as well as the physical environment, interact continuously, forming a complex network or web known as an ecosystem. Components of an ecosystem, or strands in this web, can be either living or non-living.

*"Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself."* – Chief Seattle

Examples of the living (biotic) components of an ecosystem include plants, animals, and bacteria. Examples of the non-living (abiotic) components include soil, temperature, and rainfall.

All components of an ecosystem, living and non-living, are interdependent- connected through food chains and the cycling of important nutrients, such as nitrogen and phosphorus.

### A Delicate Balance

When a strand of the web is altered or removed, such as the loss of a species or a decline in rainfall levels, it affects the whole ecosystem. For instance, the placement of backyard bird feeders in an area can cause an increase in the number of Blue Jays. As a predator, this additional presence of Blue Jays could cause the population of Golden-cheeked Warblers to drop significantly. This in turn could influence the local insect populations and so on. Over time, as more strands are lost, the web begins to weaken and unravel, which can cause the entire ecosystem to come apart.

## The Habitat

While learning about the Bull Creek Nature Preserve, it is important to remember that while the Preserve was created to protect endangered species, these species are intricately linked to the rest of the ecosystem. Even though the Golden-cheeked Warblers are not here year round, it is critical that a healthy and functioning habitat is maintained within the Preserve for their annual return. The unique geology, habitats, and species of the Bull Creek Nature Preserve all contribute to the welfare and conservation of endangered species such as the Golden-cheeked Warbler—and thus must be protected as well.

## Benefits

Besides supporting a diverse number of species and habitats, the ecosystem of the Bull Creek Nature Preserve also provides several services that benefit the human residents of Austin.

One major benefit is the improvement of water quality. Surface water runoff from urban and paved areas may contain pollutants such as metals, oils, sediment, and excess nutrients. The vegetation and soil of the Preserve act as a natural filter, intercepting and absorbing water flows as well as storing and transforming pollutants. This process reduces stormwater runoff during rain events and helps to purify the water entering creeks and rivers, as well as that which percolates into underground aquifers.

Another benefit provided is the improvement of air quality. Trees and other vegetation in the Bull Creek Nature Preserve remove several pollutants from the atmosphere, including carbon monoxide, sulfur dioxide, nitrogen oxides, ozone, and particulate matter. Through photosynthesis, vegetation can also remove and store carbon dioxide—a greenhouse gas believed to contribute to global climate change. These air quality benefits from the preserve areas help to offset air pollution from additional traffic and other impacts of growth in Austin.

A third benefit has to do with local climate. Due to the large amounts of heat-absorbing surfaces (buildings and asphalt) as well as high-energy use, temperatures in urban areas are often significantly higher than in rural areas. This phenomenon is known as the urban heat island effect. Trees and vegetation in the preserve areas transpire—meaning water is taken up through the roots and released into the atmosphere through the leaves as water vapor. This process can create a cooling effect resulting in a lowering of local temperatures that helps to combat the urban heat island.

A final benefit of the Preserve ecosystem includes the intangible values we can derive from Nature. The Preserve can provide natural and scenic beauty, spiritual and artistic inspiration, opportunities for learning and knowledge, and a unique heritage for future generations.

## Geology

Spanish explorer Bernardo de Miranda y Flores struck out across the Texas Hill Country in 1756, writing of the “hills and rocks...and thickets of cedar and oak” as he crossed what he called “los Balcones.” The name (pronounced bäl-COH-nees) was a reference to the dramatic stair-step terrain of the region that resembled a series of rising balconies.

Today, the Balcones Canyonlands remain a unique classroom for the study of the history and structure of the earth known as geology. Geology is essential to learning about the ecosystem of the Bull Creek Nature Preserve. Geological features, both above and below ground, significantly affect the habitat of species. For instance, prime Golden-cheeked Warbler habitat can often be found in steep-sided canyons dotted with

natural springs or seeps. In addition, six of the eight endangered species protected by the conservation plan are small and highly specialized karst invertebrates adapted to living underground in caves.

The term “karst” is of German origin and describes a type of landscape characterized by the dissolution of limestone forming caves, sinkholes, springs, and underground streams. The limestone in our area, including the rock upon which one hikes in the Bull Creek Nature Preserve, was formed during the Cretaceous Period over millions of years when the area was covered by advancing and retreating shallow seas. The natural steps that can be seen along the trails at Bull Creek are formed by layers of solid limestone and marl. Marl is a softer, clay-containing limestone that crumbles and erodes easily, collapsing underneath the solid layers that lose support and fall, creating a stair. On a larger scale, this process is responsible for the stair-step terrain of the Hill Country.

Another geological feature to look for on the Bull Creek Nature Preserve is groundwater seeping from the layers of limestone. These seeps can be seen and heard coming from cliff faces as well as along the trail. The ridge on the Preserve is capped with Edwards Limestone—the same type of limestone found within the Edwards Aquifer—which absorbs water during rainstorms. Limestone is naturally full of small pores and conduits and has an amazing storage capacity for water. Once absorbed at the top of the ridge, water moves down through the hillside and is slowly released out of small cracks and fissures. The slow release of water allows the plants and animals of the Preserve to take full advantage of this vital resource. In addition, the gradual infiltration and discharge helps prevent rapid stormwater runoff and potential flooding of surrounding streams and creeks.

For more information on the geology of the region, check out the [Guidebook to the Geology of Travis County](#).

## Habitat

A habitat is the type of natural environment in which a species can live and grow. This includes adequate food, a water supply, shelter, and associated species. Some species, called generalists, can live in a wide variety of habitats. Examples of generalists include raccoons, sparrows, and squirrels. Other species, called specialists, have evolved with very specific habitat needs. Examples of these needs are the constant temperatures required by some cave species or the presence of a certain plant for nectar by insect pollinators. In the example of one of our local endangered species, the Golden-cheeked Warbler requires the bark of mature Ashe juniper trees in order to build nests.

The Bull Creek Nature Preserve contains five major types of habitat. Shrub habitat is dominated by low shrubs and small trees, such as evergreen sumac and shin oak. These small woody plants usually grow after a major disturbance such as a fire or clearing. This habitat can often be relatively short-lived, as it may eventually develop into mature woodlands.

Savannah, a common habitat in the Safari region of Africa, is a dry grassland that is interspersed with small groups of trees called mottes. Mottes in Central Texas are often composed of live oaks, but can also include other tree species such as hackberry and persimmon.

Prairies, described by early settlers as ‘oceans of grass’, are grasslands composed mostly of native grasses and wildflowers. Prairies are often created and maintained by natural fires, which keep woody vegetation to a minimum. However, due to development and fire suppression practices, prairies in the preserve area have become smaller and more fragmented than in pre-settlement times.

Woodland habitats are dominated by tree species, which vary with topography and available water. Riparian woodlands grow close to water sources, such as creeks and rivers. Major species are largely deciduous and include pecan, willow, and sycamore. Mixed-evergreen woodlands are found in the uplands and often contain more drought-tolerant species such as Ashe juniper and live oak. This specific combination of juniper and oak species (known as oak-juniper woodlands) creates a habitat that is characteristic of the Balcones Canyonlands and vital for the Golden-cheeked Warbler.

The final type of habitat exists below ground in the caves within the limestone bedrock. Known as karst, these habitats are home to invertebrates that are specially adapted to living underground. Six of these invertebrates found within karst habitats of the Balcones Canyonlands Preserve are listed as Endangered species.

## Golden-cheeked Warbler

The Golden-cheeked Warbler is a small bird with a big reputation. Birdwatchers from around the world travel to the Texas Hill Country for a mere glimpse of this rare songbird. Listed as Endangered in 1990, the warbler has gained fame in Austin as one of the eight endangered species protected by one of the first major urban habitat plans in the country—the Balcones Canyonlands Conservation Plan. In fact, the 1,140 acres of the Bull Creek Nature Preserve were acquired with the primary goal of protecting the warbler.

Whether admired for its own splendor or the unique landscape its listing has helped to preserve, the Golden-cheeked Warbler is a vital asset to both local ecology and heritage.

### Appearance

The Golden-cheeked Warbler is best known for the brilliant yellow markings on its face with a black stripe through the eye. The male, approximately four to five inches in length, has a black back, throat, and cap with a white belly. The female resembles the male warbler, but with less striking colors. In the wild, the warbler is usually recognized first by the distinct buzzy notes of its song. The warbler also makes a single sharp chipping note while foraging in the trees.

### Diet and Habitat

Golden-cheeked Warblers are insectivores, meaning they forage, or feed, almost entirely on caterpillars, spiders, beetles, and other insects found in the tree foliage. These insects are abundant in the relatively moist conditions of the wooded slopes and canyons the warbler occupies. Ashe juniper and oak species such as Spanish oak, which both support large insect populations known as insect blooms during the warbler nesting season, are essential to successful foraging.

### Habitat and Range

The prime habitat of the Golden-cheeked Warbler during breeding season is tall, dense, mature stands of Ashe juniper mixed with species of oak such as Spanish oak, live oak, and shin oak. The juniper trees preferred by the warbler are generally over twenty years old and fifteen feet tall, since these trees have shredding bark that can be used for nests. This type of mixed woodland, known as oak-juniper habitat, typically grows in mesic, or relatively moist, areas such as steep-sided canyons and slopes. One of the biggest threats to Golden-cheeked Warblers in Central Texas is habitat loss and fragmentation due to urban encroachment.

Of the nearly 360 bird species that breed in Texas, the Golden-cheeked Warbler is the only one that nests exclusively in Texas. The warbler's entire nesting range is located in about 33 counties along the Edwards



Plateau. Travis County, home to the Balcones Canyonlands Preserve, contains the greatest amount of warbler habitat in large, undisturbed tracts. The warblers arrive in the Texas Hill Country in mid-March. From late June to mid-August, the warblers migrate to their wintering grounds in Central America.

The Golden-cheeked Warbler was actually first discovered when it was collected in Guatemala in 1859 by a British ornithologist. The pine-oak forests of Guatemala, along with Honduras, Nicaragua, and the Chiapas region of southern Mexico, make up the winter home of the warbler.

In Central America the warbler faces similar threats of habitat destruction as forests are cleared for agriculture and human settlement.

### Territory and Nesting

When the Golden-cheeked Warblers migrate to Central Texas in mid-March, mature males arrive first and establish and defend territories by singing. The boundary delineated by each male's song marks an area approximately three to six acres in size from which the male will exclude other males and attempt to attract a female. Studies using banding have shown that upon arriving from Central America each breeding season, male warblers will often occupy the same territory as before.

Once attracted, female warblers will weave a cup-shaped nest using strips of juniper bark and spider webs. The nests are placed an average of fifteen feet in the air in the fork of vertical tree limbs, where they are camouflaged to blend in with the bark of the tree. From late March to mid-April, the female warbler will lay and incubate a clutch of three to four eggs. The eggs hatch in twelve days, after which both parents will care for the young. The nestlings will begin to fly after eight or nine days, but will remain in the territory for at least four weeks. It is advantageous for the young birds to leave the nest as soon as possible to minimize their predation by animals that target the nests.

Golden-cheeked Warblers will usually nest only once per season. If the nest is lost to accident or predation, the female will sometimes lay a second clutch. Common nest predators that prey upon eggs and nestlings include blue and scrub jays, opossums, squirrels, raccoons, rat snakes, and coachwhip snakes. Two other species that can create problems for nesting warblers are imported red fire ants and brown-headed cowbirds. Fire ants prey upon warbler nestlings and can also cause the female warbler to abandon the nest by stinging her brood patch. The cowbird is a nest parasite that lays its own eggs in the nests of other birds, causing the warbler to either abandon the nest or raise the cowbird young which can often outcompete its own young. Recreational activities can also disturb warbler nesting, causing a decrease in abundance and nest survival.

### Native Animals

The habitats of the Bull Creek Nature Preserve support an interesting variety of mammals. Although none of the mammals are specific only to the Central Texas region, they are an integral part of the Preserve ecosystem and food web. For instance, the guano (excrement) produced by bats such as the Mexican free-tailed bat serves as a nutrient source for cave fauna. Several mammals—including carnivores that keep prey in check and large herbivores such as the white-tailed deer that shape habitat—function as keystone species in the Preserve ecosystem. A keystone species is a species that influences and interacts with numerous other species in the community. Elimination (or overabundance) of a keystone species can have profound effects on other species and the overall structure of the ecosystem. The problem of overabundance is further discussed in the *White-tailed Deer* section.

The mammals of the Preserve are active during different times of the day, depending on the habits and survival techniques each species has developed. For instance, skunks and raccoons are nocturnal, meaning they engage in feeding and other activities at night. Adapted to living in the dark, these species have light-sensitive eyes and darkly-colored fur to camouflage themselves from predators. Contrarily, other species such as squirrels are diurnal, meaning they are active during the day. Diurnal mammals have eyes that are adapted to bright light and are often colored to blend in with their surrounding habitat. The white-tailed deer and the eastern cottontail are crepuscular species, meaning they are active in the early morning at dawn and in the late evening at dusk. This is an ideal time for these species to feed because the light is too bright for nocturnal predators and too dim for daytime predators. The nine-banded armadillo has adapted to its lack of fur by changing from nocturnal to diurnal depending on the season. During the summer, the armadillo is active during the late evening and night. However, during winter, the armadillo will venture out in the warm hours of the afternoon.

Since many of the mammals on the Preserve are nocturnal, it is difficult to find species while hiking along the trail. Depending on the time of day, keep an eye out for fox squirrels in the trees as well as other diurnal and crepuscular species. Given the difficulty of actually seeing mammals on the Preserve, one of the best ways to identify and learn about the behavior and habitat of mammals is by looking for signs such as tracks and scats (droppings). The signs left by mammals can often tell an interesting story. Was the animal fleeing from a predator? Does the scat contain seeds and berries, or perhaps fur and feathers? Also, look for burrows and possible nesting areas along the trail. For instance, opossums and raccoons will often use hollow trees or logs as dens. Armadillos den in burrows along creek banks as well as in the natural crevices and openings of the limestone.

### Amphibians and Reptiles

Despite differences in appearance and reproduction, amphibians and reptiles are generally grouped together into one category known as herpetofauna, or simply 'herps'. Herps play a crucial role in the Preserve ecosystem through the control of rodent and insect populations as well as by serving as prey for numerous species, such as the greater roadrunner and the striped skunk. Herps can be found in a wide variety of habitats across the Bull Creek Nature Preserve. For instance, the Texas spiny lizard is an arboreal (or tree-dwelling) species known for its skillful climbing. The cliff chirping frog is a terrestrial (or ground-dwelling) species that lives in the crevices and caves of the limestone hills. The red-eared slider is an aquatic (or water-dwelling) turtle that feeds on aquatic plants and can be seen in Bull Creek basking in the sun on logs.

Amphibian species such as salamanders and frogs have smooth skin that is permeable to water, making them more vulnerable to toxins than most species. For this reason, amphibians can serve as an indicator species, or a "canary in the coal mine". Historically, miners would take a canary down into coal mines because canaries were more sensitive to toxic and explosive gases. If the canary stopped singing, the miners knew that the gases had reached a dangerous level and they had to leave immediately. Similarly, if amphibian populations start to decline in the Preserve, it can indicate that watershed conditions and the overall health of the ecosystem may be declining due to pollution.

One important indicator species in the Preserve is the Jollyville Plateau salamander. The salamander lives under rocks and rubble in waters around springs and seeps. Studies have found significantly lower populations of the salamander in areas of increased development and degraded water quality. This means that the

salamander could function as an early warning for water quality problems of potential concern to human health. The Jollyville Plateau salamander was listed as Threatened in 2013.

Reptiles found on the Preserve include lizards, turtles, and snakes. Only a small percentage of the snakes on the Preserve are venomous—including the broad-banded copperhead, the western diamondback rattlesnake, and the Texas coral snake. However, it is important to always use caution around snakes while hiking. If you see a snake on the Preserve, it is safest to slowly backup or walk away and allow the snake to pass. For more information on identifying poisonous snakes, visit the Texas Parks and Wildlife [Venomous Snake Safety](#) website.

## Birds

Birds play an important role in the Preserve ecosystem by controlling insect populations as well as dispersing the seeds and pollen of native plants. The Balcones Canyonlands Preserve is home to many species of birds, including the endangered Golden-cheeked Warbler and the rare Black-capped Vireo. The Black-capped Vireo, like the Golden-cheeked Warbler, is a neotropical migrant, meaning that it migrates south to Central America during the winter. The Black-capped Vireo was listed as Endangered when the BCP was established, and was removed from the Endangered Species List in 2018. The BCP continues its commitment to protect and manage vireo habitat in the preserve. Nesting habitat for the vireo includes irregular, low scrubby growth that develops after a disturbance such as a fire or the clearing of trees.

With over 80 observed species, the Bull Creek Nature Preserve is an excellent place to learn about the complex and fascinating behavior of birds. For instance, the Indigo Bunting, a neotropical migrant recognized for its brilliant turquoise blue coloring, navigates using the same method as ancient sailors—by tracking the North Star. The Northern Mockingbird, the state bird of Texas, can be heard mimicking not only the calls of other birds, but also squeaking gates and backfiring cars. Turkey Vultures, often seen roosting in tall trees or soaring overhead, are known for their extraordinary sense of smell. With the largest olfactory (smelling) system of all birds, they are able to smell carrion from over a mile away.

Although many birds on the Preserve can be found feeding and roosting in trees, birds occupy a wide variety of habitats. The Greater Roadrunner prefers cactus thickets to trees, running along the ground and catching snakes, lizards, and spiders. Other birds, like the Hermit Thrush and the Chipping Sparrow, can be seen foraging for insects or seeds on the ground in woodland areas. Areas along Bull Creek support wading birds like the Great Blue Heron and Green Heron. The Belted Kingfisher, seen in trees along the creek as well as hovering over the water, is a crested bird with a large, thick bill that will plunge into the water headfirst to catch fish.

Apart from owls, most birds are diurnal, or active during the day. However, they can be difficult to see since many birds hide or seek shelter to avoid predation. Birds often will conceal themselves behind foliage and watch the observer through a small opening. When hiking in the Preserve, try moving slowly and being as quiet as possible to avoid scaring birds away. The best indicators of the various species in the area are songs and calls. For instance, the Carolina Chickadee has a buzzy ‘chickadee-dee-dee-dee’ song. To see a bird that is singing or calling, try making a ‘spsh, spsh, spsh’ sound. Birds will often move closer to find out what is making the noise. It is important to note that, due to endangered species protections, playing recordings of Golden-cheeked Warbler sounds during nesting season (March 1 through July 31) is prohibited (unless a biologist has a permit to do so). For more birding tips, check out the Texas Parks and Wildlife [Introduction to Birdwatching](#).

## Invertebrates

*"If all mankind were to disappear, the world would regenerate back to the rich state of equilibrium that existed ten thousand years ago. If insects were to vanish, the environment would collapse into chaos."* – Edward O. Wilson

Invertebrates are animals without a backbone, ranging anywhere from sea urchins to snails to scorpions. Numerous types of invertebrates can be seen on the Bull Creek Nature Preserve, including insects, spiders, and worms. Although invertebrates often do not receive as much favorable attention as larger vertebrate species, they are incredibly diverse and interesting creatures, making up 95 percent of the species on earth and six of the endangered species protected by the Balcones Canyonlands Conservation Plan.

Invertebrates play several critical roles in the Preserve ecosystem. Many invertebrates, such as beetles and pill bugs, act as scavengers that break down dead animal and plant matter, recycling the nutrients back into the ecosystem. Invertebrates are also a food source for numerous species, including the Golden-cheeked Warbler. The warbler is an insectivore, meaning that it feeds exclusively on insects. Another crucial function performed by invertebrates is the pollination of flowering plants. Butterflies will visit flowers to collect nectar and inadvertently carry pollen from one flower to another. This is an example of mutualism, where both species benefit from interaction. Other major pollinators include bees, moths, wasps, flies, and beetles.

Although the mammals and birds of the Bull Creek Nature Preserve can often prove elusive, insects are the one animal guaranteed to be seen while hiking. The Preserve literally hums with the sounds of these small six-legged invertebrates. What may sound like a constant buzzing is actually one of the many forms of complex communication used by insects in locating mates, finding food sources, defending against predators, and caring for their young. For instance, mosquitoes are attracted to each other by the unique sound of their buzzing wings. Some insects such as beetles and lacewings will communicate potential dangers by sending vibrations through plants. In a particularly fascinating example, honey bees perform elaborate 'waggle dances' in the shape of a figure eight to tell other bees where to find a new field of flowers.

Insects develop and grow in distinct stages - a process known as metamorphosis that can happen in a variety of ways. For instance, in gradual metamorphosis, insects like grasshoppers hatch from eggs as small, wingless nymphs and grow larger through several molts, or shedding of their exoskeleton, before eventually developing wings and becoming adults. Young dragonflies called naiads develop underwater and emerge into the air as flying adults. This is called incomplete metamorphosis. In an example of complete metamorphosis, caterpillars hatch from eggs and grow as larvae before spinning a cocoon and entering into an inactive pupal stage. After undergoing extensive internal changes, a moth will break out from the cocoon as a fully-formed adult.

Spiders are another common invertebrate that can be found on the Bull Creek Nature Preserve - often by walking through the webs that stretch across the trail. Orbweaving spiders like the black-and-yellow argiope build these circular, spiraling webs between tree branches, using a sticky silk to trap flying insects. Look for the actual spider around the edge, waiting for prey by monitoring a signal or trip line attached to the web. Although orb webs may be the most recognized spider web, many species trap insects using different forms of webs or capture insects without using a web at all. For instance, grass spiders build flat sheet webs along the ground with a tube or funnel leading off from the center of one edge. The spider will hide in the bottom of the funnel and dart out to capture approaching prey. Jumping spiders and wolf spiders have excellent vision and will often actively hunt insects on the ground, while tarantulas will hide in burrows and feed on passing prey.

Spiders greatly benefit the Preserve ecosystem by capturing and controlling the local insect population. In addition, webs can be used by birds such as the Golden-cheeked Warbler for nesting material.

## Karst Invertebrates

The six endangered karst invertebrates protected by the Balcones Canyonlands Conservation Plan are all troglobites. A troglobite is an animal that is specially adapted to living underground, spending their entire lives in caves. Adaptations to this environment can include small eyes or complete lack of eyes, long appendages, and reduced pigmentation. Most species are believed to feed on tiny insects called microarthropods as well as decomposed organic matter. However, relatively little is known about the biology of these endangered karst species.

The **Tooth Cave ground beetle** is a reddish-brown beetle approximately 7 to 8 mm in length. It is the most active of the endangered invertebrates, searching the cave floor for prey and digging holes into silt to feed on cave cricket eggs.

The **Tooth Cave pseudoscorpion** is a large, eyeless pseudoscorpion that is golden brown in color. The pseudoscorpion, about 4 mm in length, does not have a tail. It is usually found under rocks and uses its pinchers to prey upon microarthropods.

The **Tooth Cave spider** is a small, whitish spider with long, thin legs. With a length of 1.6 mm, it is the smallest of the listed invertebrates. It feeds on microarthropods, hanging from a small web.

The **Kretschmarr Cave mold beetle** is a small shiny, reddish-brown beetle with short wings and long legs. It is found in total darkness under rocks and buried in silt.

The **Bone Cave harvestman** is a blind, pale orange harvestman. Harvestmen, sometimes referred to as daddy longlegs, are spider-like arachnids with small bodies and long thin legs. It is especially sensitive to low humidities and in the hottest parts of summer can only be found in the coolest, dampest parts of the cave.

The **Bee Creek Cave harvestman** is an orange color, with long legs and well-developed eyes. It preys on tiny, hopping insects called collembolans. It is usually found under rocks in darkness or dim light.

## Native Plants

### Multi-Functional Trees

Trees are an integral part of the Preserve ecosystem, performing multiple functions. For example, the root systems of trees enhance soil development and increase soil permeability, making it easier for water to move through the soil. The extensive root systems also help to hold soil in place, preventing soil and streambank erosion.

*“To plant trees is to give body and life to one's dreams of a better world.”* – Russell Page

Another function is the formation of organic matter on the soil surface from leaf litter, which creates a microhabitat for small animals and cycles important nutrients. As explained in the *Benefits* section, trees can act as a natural filter, helping to improve air and water quality.

Finally, a key role of trees is providing habitat for numerous animals, including the Golden-cheeked Warbler.

### Tree Species

The composition of tree species in an area depends on the local topography and availability of water. Riparian areas, which are lowlands found along creeks and rivers, are hosts to many tree species, especially those requiring a relatively large amount of water and deeper soils. Often, these species are mostly deciduous, meaning they lose their leaves in the winter. Common riparian species include pecan, black willow, hackberry, sycamore, bald cypress, and cottonwood.

In upland areas, tree species are a more drought-tolerant mix of deciduous and evergreen trees, which retain their leaves year-round. Common upland species include Ashe juniper, live oak, Spanish oak, shin oak, escarpment black cherry, bigtooth maple, and cedar elm. The oak-juniper woodlands found in upland areas serve as prime habitat for the Golden-cheeked Warbler, as well as the insects it feeds upon.

## Ground Cover

Ground cover species are a diverse group of small, low-growing plants. A high diversity of plant species is important because it means that more wildlife is supported and that the ecosystem is better able to resist disturbances such as invasive species and disease. Ground cover benefits the Preserve ecosystem by holding soil in place and providing habitat and food for birds, small mammals, insects, and other species. Insects also use ground cover plants to hide from predators, to wait for passing prey, and as a surface for eggs.

Common ground cover plants found in the Bull Creek Nature Preserve include grasses, sedges, vines, ferns, succulents, and wildflowers. Grasses and sedges are small, non-woody plants with narrow leaves. Vines are plants with a climbing or creeping stem that use other plants for support. Ferns are flowerless, seedless plants, often with featherlike fronds. Succulents are water-storing plants such as cacti and yucca that are adapted for dry climates.

Wildflowers are a forb, which is a small, non-woody plant other than grass. Common plants considered weeds, such as clovers and dandelions, are forbs as well. Besides contributing to the heritage and natural beauty of the region, wildflowers provide food for insects and birds. For example, wildflowers produce an abundant supply of seeds for granivorous (seed-eating) birds, including the Painted Bunting and the Carolina Chickadee. They also attract insects that are preyed upon by insectivorous (insect-eating) birds, such as the Golden-cheeked Warbler.

## Exotic Species

Every species of plant has a native range. This is a region or habitat where the plant occurs naturally, meaning it has adapted to the local climate, soils, and surrounding species of plants and animals over thousands of years without any direct or indirect human action. When a species occurs outside of this native range, it is called a non-native, introduced, or exotic species. Exotic species can be brought in from other habitats, ecosystems, regions, or even continents. For instance, Johnsongrass was introduced into the United States from its native range around the Mediterranean Sea.

The population of a plant species in its native range is controlled by a number of complex factors, including disease, parasites, and herbivorous (plant-eating) species. However, in a new environment, free from these natural constraints, some exotic species can undergo rapid and unrestricted growth, spreading over large areas. When an exotic species exhibits this rapid growth and spread, it is called an invasive species. One of the most notorious invasive plants in the southern United States is a climbing vine known as kudzu, or “the plant that ate the South.” Originally introduced to reduce soil erosion, kudzu can grow up to a foot a day, smothering native trees and shrubs under a solid blanket of leaves.

As demonstrated by the kudzu example, invasive species can severely threaten the ecology of the natural ecosystem, often outcompeting native plants for space and resources and disrupting the food chain. For example, chinaberry—an invasive tree found on the Preserve—grows extremely fast and forms dense thickets that shade out and exclude the native vegetation many birds, mammals, and insects rely upon for food and habitat. The vines of Japanese honeysuckle can kill native shrubs and trees by twisting tightly around the stem or trunk and cutting off the flow of water through the plant. Particularly devastating, the tree-of-heaven prevents the establishment of other plant species by releasing a toxin through its roots that functions as an herbicide.

Removal and control of invasive species is a critical part of Preserve management. The major source of invasive species on the Preserve is from the gardens and landscaping of nearby homes. One of the best ways to prevent this threat is through native landscaping, which is discussed further in the *In the Neighborhood* section. Native landscaping benefits native wildlife and reduces the staff time and budget consumed by the removal and control of invasive plants.

## Shrubs

A shrub is a low-growing woody plant that branches out from the base. On the Bull Creek Nature Preserve, shrubs are found growing within the understory of woodland areas as well as scattered across savannah habitats. Shrubs provide forage for browsing animals, such as white-tailed deer, seeds and fruit for birds, and habitat or cover for many species, including nesting sites for the Black-capped Vireo.

Along the trail, shrubs (and plants in general) are an excellent place to look for insects and spiders. Insects rely upon plants to provide habitat as well as food (i.e. leaves, sap, bark). While most insects feed on a wide range of plant species, some are adapted to feed only on a specific species. For instance, the monarch caterpillar feeds exclusively on milkweed. Plants also provide a surface for insects to lay eggs upon and shelter from insectivorous predators like songbirds. Some insects, such as the walking stick and the cloudless sulphur, are specially adapted to mimic the twigs and leaves of plants as a defense mechanism.

Two rare native shrubs found in the BCP are among the 27 species of concern (species that are in jeopardy but have not been listed as endangered or threatened) protected by the Balcones Canyonlands Conservation Plan. Canyon mock orange and Texabama croton are endemics, meaning that they only occur in a certain limited area. Canyon mock orange is a small, deciduous shrub with white flowers that grows on limestone rock outcrops. Texabama croton is a semi-evergreen shrub, which will keep its leaves during mild winters. Texabama croton has leaves with a silvery underside and pale yellow-green flowers. It grows on forested limestone slopes, forming large colonies and often dominating the shrub layer.

## Stewardship

We make decisions that benefit the environment every day, such as buying an efficient air-conditioner, taking the bus to work, or recycling glass bottles. These actions reflect a personal choice—going above and beyond what is simply mandatory. To take personal responsibility for the care of resources, in this instance the natural environment, is known as stewardship. Stewardship of the environment is essential to maintaining the health and integrity of ecosystems.

This idea of environmental stewardship is discussed in the writings of **Aldo Leopold**, the father of wildlife ecology. Leopold developed the concept of the land ethic, which views the environment as part of our community rather than as a commodity. “A land ethic simply extends the boundaries of the community to

include soils, waters, plants, and animals, or collectively: the land,” Leopold wrote in *A Sand County Almanac*. “A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land.”

As a steward of the Bull Creek Nature Preserve, this responsibility includes actions taken on the Preserve as well as at home. At home, stewardship involves minimizing negative impacts on the surrounding environment. Our impact and demand on the environment are called an ecological footprint. This footprint includes all the land and water needed to produce the resources we consume (such as food and energy) and to absorb our waste.

The following sections provide information and tips on how to reduce this footprint and help improve the ecosystems of the Preserve and the greater Austin area. Stewardship is basically about choices. Do I drive to work or take the bus? Should I pick up litter I see along the trail? As an environmental steward, consider the ways your decisions impact the surrounding environment and take action accordingly. Follow your ecological conscience.

## In Austin

*“Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it's the only thing that ever has.”* – Margaret Mead

Even if you don’t live near a Preserve, there are numerous ways to reduce your impact on the unique ecosystems of the Austin area. Each resident is an important and interconnected strand in the ecological web of the region. Whether our impacts on this web are positive or negative depends on our actions as stewards. For instance, riding your bike on errands rather than driving reduces the amount of ground-level ozone, which contributes to smog, respiratory problems, and the degraded health of trees and other plants. The following are descriptions of some of the programs, incentives, and helpful tips that the City of Austin offers to promote environmental stewardship.

### Landscaping

The City of Austin [Grow Green](#) program provides extensive information on landscaping with native plants.

### Water Quality

The City of Austin [Watershed Protection Department](#) program offers a number of community outreach programs, including monitoring programs and a 24-hour environmental hotline for community members to report pollution complaints and spills in local creeks.

### Water and Energy Efficiency

[Austin Water's Water Conservation program](#) offers a number of rebate programs for efficient water use. [Austin Energy's PowerSaver program](#) also has several residential and commercial rebates, loans and workshops.

## In the Neighborhood

As an educated steward of the Preserve, it is important to remember that what you do outside the Preserve can be just as important as your behavior on the actual trails. This is especially true if you live on the edge of or near the Bull Creek Nature Preserve or any of the other preserve areas that make up the BCP system. Your actions at home can have a direct and immediate impact on the Preserve. For example, exotic garden plants



can spread to the Preserve and outcompete native plants that are necessary for habitat. The following are a number of steps you can take that will benefit the Preserve ecosystem and the species, endangered and otherwise, it supports.

## **Landscaping**

The essence of native landscaping is to select the plants for the place rather than changing the place for the plants using irrigation, fertilizers, and pesticides. The use of native plants in landscaping reduces environmental impacts and benefits the surrounding ecosystem. Native plants create valuable habitat, attracting native wildlife such as songbirds and beneficial insects. In addition, because native plants are well adapted to local conditions, the amount of chemicals needed (i.e. pesticides, fertilizers) is significantly reduced or eliminated altogether which improves water quality. With extensive root systems, native plants can also stabilize the soil and prevent erosion more over the long term than exotic turf grasses like Bermuda and St. Augustine.

Native landscaping provides a number of economic benefits as well. Native plants greatly lower maintenance costs, reducing or even eliminating the need for mowing and watering thus lowering water bills, as well as reducing any costs for fertilizers and pesticides. On a larger scale, native landscaping in neighborhoods near the Bull Creek Nature Preserve can help reduce the Preserve management time and budget consumed by the removal and control of exotic plants.

## **Pets**

Responsible pet ownership is a critical part of reducing our impacts on the surrounding environment. One step is to always feed your pets indoors. Leaving or storing pet food outside attracts common nest predators, such as Blue Jays, raccoons, and squirrels - increasing the already large number of these species found in and around the Preserve ecosystem.

Domestic cats can pose a specific threat for animals in the Preserve. They continue to hunt whether or not they are well fed. To protect native and endangered animals from cats - as well as to protect cats from traffic, disease, and other outdoor dangers - cats should be kept indoors. For more information on domestic cats in the wild, visit the American Bird Conservancy [Cats Indoors!](#) website.

Another important part of responsible pet ownership is never to abandon your pet in the wild. Released animals (especially cats and dogs) can harm native wildlife by displacing predators, transmitting diseases, and preying on small vertebrates including lizards, field mice, and birds. If you are no longer able to care for your pet, you should either find it a new owner or take it to an adoption facility.

## **Wild Animals**

A final way to reduce your impact on the surrounding environment is to discourage nest predators and overpopulated animals in your area. Nest predators such as Blue Jays and squirrels prey on the eggs and nestlings of songbirds, including the Golden-cheeked Warbler. Overpopulated animals like the white-tailed deer and the feral hog can often destroy valuable habitat and vegetation while foraging for food.

One way to discourage these problem species is to never feed wild mammals, including squirrels, raccoons, deer, and opossums. Also, never attempt to capture wild mammals and release them into preserve areas. This can have a devastating effect on warbler and vireo populations and habitat.

Birdfeeders are a fun and easy way to create wildlife habitat in your yard. By following the tips below, you can help discourage abundant nest predators and continue to enjoy attracting and watching wildlife:

- Only use feeds containing seeds avoided by Blue Jays, such as flax and thistle.
- Use weight-sensitive feeders adjusted to exclude large birds or caged “squirrel proof” feeders. Do not use an open tray feeder or a suet feeder.
- Shorten the perch length on your feeders to one inch and remove trays.
- Do not scatter seeds or scraps on the ground.
- Use other methods of attracting songbirds, such as planting native fruit and nut trees as well as native understory plants like shrubs and wildflowers.

## In the Preserve

Posted along the dodgeway entrances to the Bull Creek Nature Preserve you will see signs listing the rules of the Preserve. However, as an environmental steward, you should strive to go above and beyond these posted rules in caring for the Preserve ecosystem. This can involve simple actions such as picking up litter or clearing debris from water bars designed to prevent trail erosion.

Stewardship also involves serving as the “eyes and ears” of the Preserve. This means reporting the creation of unauthorized trails, vandalism of fences, dodgeways, or signs, and indications of unauthorized use (such as bike tracks or campfire sites) to the Wildland Conservation Division - either by emailing [wildlands@austintexas.gov](mailto:wildlands@austintexas.gov) or calling 512-972-1660.

Another way to care for the Preserve ecosystem is through volunteering. The Balcones Canyonlands Preserve (BCP) volunteers help with long-term habitat restoration, performing activities such as gathering native seeds and planting native trees and shrubs or helping remove invasive exotic plants. Education is also an important part of stewardship. Learning about the Golden-cheeked Warbler and the Preserve ecosystem - and sharing that knowledge with others - helps to increase awareness about the BCP and the environment in general. For more information on volunteering and education, visit the [Balcones Canyonlands Preserve website](#).

## Threats

The primary threat to species worldwide is habitat degradation and loss - with perhaps the most dramatic example being the clearing of millions of acres of tropical rainforest. However, the loss of even a relatively small area can still significantly disturb species such as the Golden-cheeked Warbler by fragmenting remaining habitat. Large, continuous tracts of habitat, especially in urban areas like Austin, are broken up into smaller, isolated patches by new development and construction. For instance, the building of a road across a grassland divides that habitat into separate sections.

The surrounding edge of a habitat fragment that borders development or construction is abrupt and unnatural, creating a highly altered environment. This edge habitat is preferred by generalist species such as raccoons, opossums, and Blue Jays that are adapted to living and feeding in both developed and undeveloped areas. These edge species can often be seen in neighborhoods as well as in the Preserve. Conversely, many native plants and animals are adapted to specialized conditions and thus prefer areas of undisturbed habitat that are found in the interior of fragments. For instance, wildflowers that grow in shaded areas will not be found near the edge due to the exposure to direct sunlight. As habitat is divided into smaller fragments, the amount of edge habitat increases, making these interior species more vulnerable to invasive species and predators found along the edge—an impact known as the “edge effect.”

Another negative effect of habitat fragmentation is that it can limit the movement of species by creating open areas and roads that many birds, mammals, and insects will not cross. Animals that do venture into the open are exposed to dangers such as hawks, domestic cats, and traffic. This limitation can often confine animals to one isolated fragment. However, many of these smaller fragments may not be able to support certain species that require relatively large tracts of habitat for survival. For example, animals at the top of the food chain like bobcats and foxes require large tracts of habitat to hunt for prey and establish territories. These top predators, critical to controlling the white-tailed deer population, are rarely seen in the Austin area anymore.

## Oak Wilt

Oak wilt is an incurable disease caused by a fungus that affects mainly live oaks and red oaks. The fungus clogs water-conducting tissues called xylem, which prevents water from reaching the leaves and causes the tree to wilt and die. Upon showing symptoms of yellowing or browning leaves, red oaks can die in as little as three to four weeks. Live oaks typically survive three to six months. Oak wilt has killed over 10,000 trees in the Austin area. This major loss jeopardizes the habitat of the Golden-cheeked Warbler, which relies on oak trees for foraging during the nesting season.

The disease can be spread either by insects or underground through interconnected tree roots. When sap-feeding beetles feed on the sweet-smelling fungal mats produced by infected red oaks, the spores stick to their bodies. The beetles can then transmit the spores from these infected trees to healthy live and red oaks by feeding on the sap oozing from fresh wounds. Live oaks generally grow in large, dense groups called mottes that have common, interconnected roots. This means that if one tree is infected, the disease can spread to the rest of the trees in the motte and create an infection center.

Although oak wilt cannot be cured, there are several suppression measures that can be taken to prevent the disease from spreading. To stop the underground spread of oak wilt, mechanical trenching is used to disrupt root connections between live oaks. Infected red oaks are cut down and either removed or allowed to dry out in order to avoid the formation of fungal mats. The fungal spores cannot survive when there is low moisture content in the wood. Oaks that are threatened with infection but are not yet showing symptoms can also be treated with a fungicide. For information about treatment of oak wilt, contact the [Texas Forest Service](#) or a local arborist. On a more general note, it is important to consider impacts on water quality when deciding to use chemicals such as pesticides or herbicides. Always use caution when applying chemical treatments and follow the provided directions carefully.

To prevent oak wilt at home, oaks should only be pruned during the summer and winter months when the beetles are least active. All wounds should be treated immediately with pruning paint. In addition, oak firewood should be handled cautiously as it can contain fungal mats and beetles. Avoid oak firewood from infected trees, and if possible, collect or obtain only wood that is dead or dry. To determine if wood is dry, look for cracks developing on the cut ends and loose bark. As an added precaution, cover any freshly-cut oak firewood with clear plastic and bury the ends. This dries out the wood faster to prevent a fungal mat from forming, and also prevents beetles from either entering or leaving the woodpile. Black plastic should not be used because trapped beetles can find light holes to escape. For more information on the identification and management of oak wilt, visit the [Oak Wilt Information Partnership](#).

## Problem Species

As described in the *Habitat Fragmentation* section, edge species thrive on the boundaries between habitat and development, which causes problems for species like the Golden-cheeked Warbler that occupy the

interiors of habitat tracts. One major problem that arises is elevated rates of nest predation near habitat edges as well as along trails. Common nest predators include Blue Jays, scrub jays, opossums, raccoons, skunks, squirrels, and domestic cats. These predators feed on the eggs and the nestlings of birds.

Cited as a reason for listing both the Golden-cheeked Warbler and the Black-capped Vireo as Endangered, another problem edge species is the Brown-headed Cowbird. Cowbirds evolved to follow herds of buffalo and eventually earned their name by shifting to herds of cattle. Since the females had to lay eggs and move on with the herd, the cowbird adapted by parasitizing the nests of other species. The cowbird will lay its eggs in a host nest, which results in the host species raising the cowbird hatchlings. Sometimes the female cowbird will even eliminate possible competition by pushing other eggs out of the nest or poking holes in the eggs.

The cowbird hatches one to two days earlier than the other nestlings, giving the cowbird an early advantage both in size and noisiness. Considerably larger, the cowbird hatchling will often then dominate in the nest in getting fed. This parasitism is especially devastating in the case of the Black-capped Vireo because it cannot raise its own young once the nest has been parasitized. As many as 3 out of 4 vireo nests are parasitized by cowbirds, posing a serious threat to the viability of the already endangered species. To protect the welfare of the Golden-cheeked Warbler and the Black-capped Vireo, cowbirds are currently trapped and removed as part of Preserve management.

Red imported fire ants outcompete native species of ants and reduce the native insect supply for animals. They can also directly prey upon the hatchlings of birds. In some cases, fire ants can even cause the Golden-cheeked Warbler to abandon its nest by stinging the brood patch of the female while she is sitting on the eggs. To avoid pesticides that can be potentially toxic to wildlife, red imported fire ants are currently managed by pouring boiling water directly onto the mounds.

The invasive feral (or wild) hog can tear up large sections of valuable riparian habitat by foraging, wallowing, rooting, and rubbing against tree trunks and posts. Hogs consume acorns that would contribute new trees to the ecosystem and disturb the roots and seeds of other plant species, thus altering the native plant community. While rooting in the soil, hogs use their tusks and strong snouts to turn up and loosen soil in search of grubs, acorns, and roots. The soil is then washed into creeks during rainstorms, removing valuable soil from hillsides and increasing the level of silt in creeks which can negatively impact aquatic species and habitat. As part of habitat management on the Preserve, feral hogs are currently trapped and removed. While hiking in the Bull Creek Nature Preserve, do not approach feral hogs. Although feral hogs generally avoid people, sows will aggressively defend their young.

A final problem species is the white-tailed deer. However, given the acute impacts of deer overpopulation on the Preserve, this threat will be more extensively covered in the *White-Tailed Deer* section.

### White-tailed Deer

The population of white-tailed deer in Central Texas has rapidly grown over the last century due to a number of factors—including a decline in natural predators such as mountain lions and wolves, suppression of the blow fly screw-worm parasite by cattle ranchers, and a ban for several decades on the hunting of does. Another important reason for the population increase is urbanization. Residential developments provide a variety of edible and accessible plants, with some homeowners even supplementing this food supply with salt blocks, corn, and pellets.

The deer population on the Balcones Canyonlands Preserve exceeds the carrying capacity of the ecosystem, which is the maximum number of deer the ecosystem can support without degradation of habitat. Passing this upper limit leads to increased competition for limited food resources, causing starvation and disease in the deer population. These large populations of starving deer will begin to browse on plants they normally would avoid—a problem known as overbrowsing.

The most common sign of deer overpopulation is the browse line, where all vegetation from about five feet high down to the ground is stripped of leaves. Although the mature oak and juniper trees are often tall enough to escape extensive browsing, overbrowsing still has a devastating effect on Golden-cheeked Warbler habitat because it removes all seedlings and saplings that could eventually develop into mature trees. Overbrowsing also removes other understory vegetation (shrubs, grasses, and wildflowers) that is essential for preventing soil erosion, protecting water quality, and providing habitat for a large range of animals, including the rare Black-capped Vireo.

The most cost-effective solution available for deer overpopulation is lethal, humane culling by professionals, which replaces the ecological role of the now-absent top carnivores. Wild mammal contraceptives are being researched for possible future use, but currently are not practical or effective on a large scale and have not been approved for use in Texas. The meat produced by culling is required by state law to be used beneficially and is usually donated to food banks and similar charities. The City of Austin donates venison to local food banks and zoos.