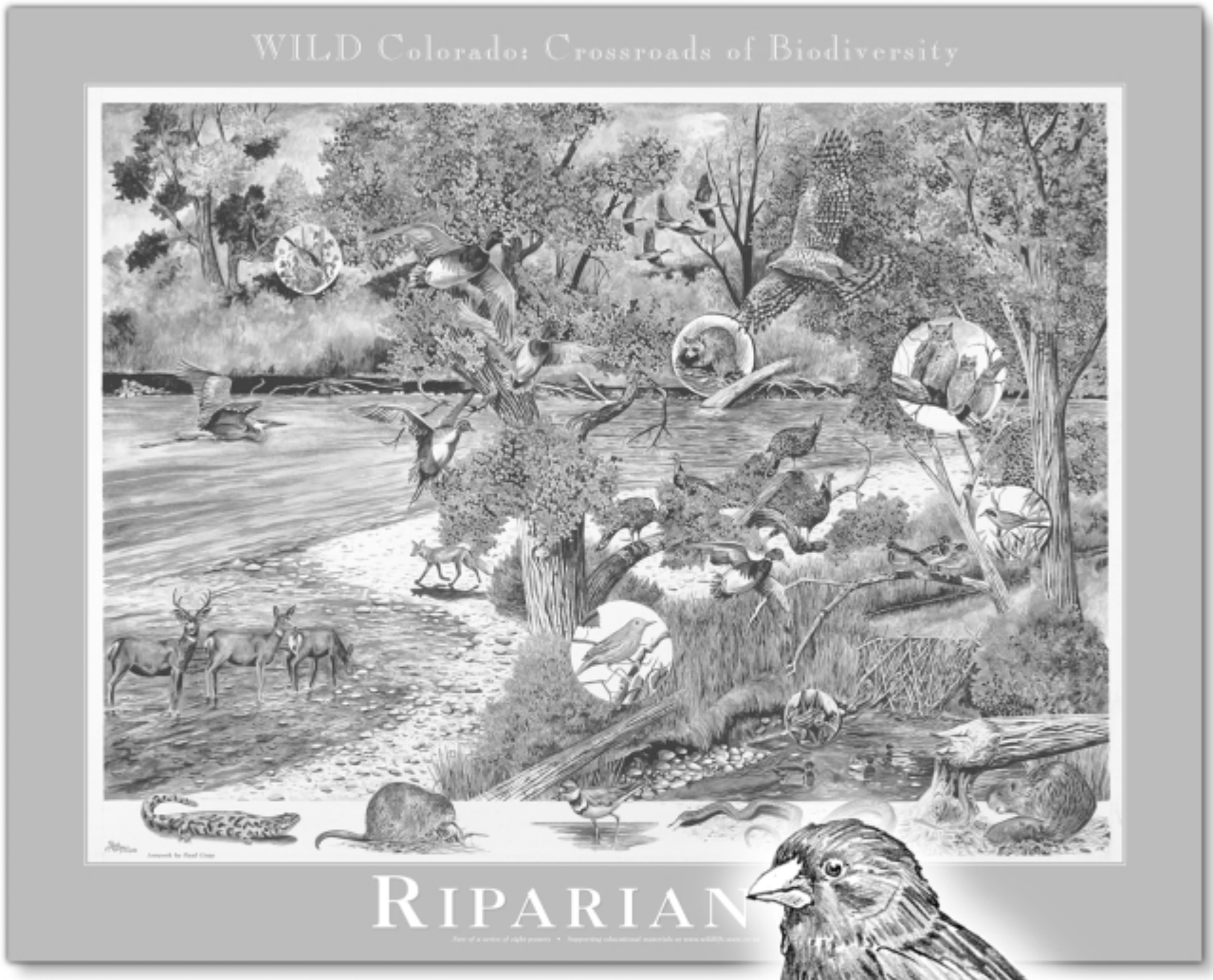
WILD Colorado: Crossroads of Biodiversity



COLORADO · DIVISION OF WILDLIFE ·

A Message from the Director

For Wildlife – For People

July 1, 2003

Dear Educator,

Colorado is a unique and special place. With its vast prairies, high mountains, deep canyons and numerous river headwaters, Colorado is truly a crossroad of biodiversity that provides a rich environment for abundant and diverse species of wildlife. Our rich wildlife heritage is a source of pride for our citizens and can be an incredibly powerful teaching tool in the classroom. To help teachers and students learn about Colorado's ecosystems and its wildlife, the Division of Wildlife has prepared a set of ecosystem posters and this education guide. Together they will provide an overview of the biodiversity of our state as it applies to the eight major ecosystems of Colorado. This project was funded in part by a Wildlife Conservation and Restoration Program grant.

Sincerely,

Russell George

Russell George, Director
Colorado Division of Wildlife

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This book was written by Wendy Hanophy and Harv Teitelbaum
with illustrations by Marjorie Leggitt and paintings by Paul Gray. Book design and printing by the State of Colorado Integrated Document Factory.
Colorado Division of Wildlife, Education Section, 6060 Broadway, Denver, Colorado 80216

Introduction

What is Biodiversity?

Biodiversity is short for biological diversity. It includes the variety of species, the variety of *genetic* differences within species, and the variety of ecosystems within a recognizable area. It is the richness of life.

Colorado—Crossroads of Biodiversity

Colorado's location and natural features make it home for a wide variety of species. From the prairie at elevations below 4,000 feet to the alpine tundra above 14,000 feet, a diversity of landscapes provides opportunities for a rich mixture of wildlife. From dry semi-desert shrublands to cool and moist riparian areas, from treeless canyonlands to expansive montane forests, Colorado has an enormous diversity of **habitats**—the places where organisms live and get the food, water, shelter and living space they need to survive.

The Continental Divide provides a natural barrier between species from the eastern and western United States. Northern and southern species meet and mix among the sagebrush and piñon-juniper in the lower portion of the state. Colorado also lies within the migratory routes of many North American bird species. Some of these birds make their home in the state part of the year and others are just passing through. Colorado truly is a crossroads of biodiversity.

Habitats and Ecosystems

All of the species that live and interact in an area form a **community**. Each species within that community has its own distinct habitat needs, which may be found within one or more ecosystems. The word **ecosystem** is used to describe the sum of the interactions between a community of species and the non-living components of the environment, such as temperature, soils, water, and elevation. Together, the non-living, or **abiotic** factors, and living, or **biotic** factors, in an ecosystem help determine which species of plants and animals can thrive there.

Living things effect other living things, directly or through habitat alteration. The influence of two species on each other over time helps shape the appearance and behavior of both species. This shared shaping of adaptations is known as **coevolution**, and often benefits both species. In each of Colorado's major ecosystems, we find examples of species that influence, and have been influenced by, other species over time. Some have even evolved to depend on each other for their very survival.

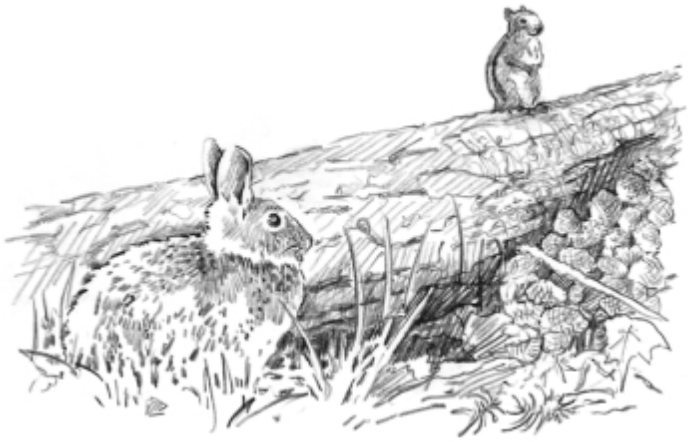
The great diversity of habitats and abiotic factors in Colorado's ecosystems create numerous opportunities for species. These opportunities, the "jobs" or functions available to living things in an ecosystem, are known as **niches**. More niches in an ecosystem in turn provide more options and choices for a great number and variety of species, and make the ecosystem better able to adapt to change.

Biodiversity and Ecosystems

Many ecologists determine the vitality of an ecosystem by considering its current biodiversity along with the ecosystem's ability to maintain its biodiversity in the future. Colorado's major ecosystems have evolved over thousands, even millions of years. These ecosystems are dynamic, and disturbances are normal. Change is natural, and organisms have evolved over time to cope with all sorts of upsets such as storms, fire, floods and other disturbances.

Small-scale disturbances can promote biodiversity by increasing the variety of habitat and niches. For example, a fallen tree can allow more sunlight to reach plants on the forest floor, or provide food and shelter for animals and microorganisms. If there is enough biodiversity, even large-scale natural disasters such as fires and floods can eventually lead to increased biodiversity as new species rush in to fill empty niches.

Problems occur when there is not enough biodiversity available in an ecosystem to survive changes in environmental conditions. When too much habitat and genetic diversity has been lost, and the complex interactions that make ecosystem recovery possible are severely disrupted, human intervention can



sometimes aid in restarting natural processes, and reclamation can make a landscape inhabitable for a minimal range of species. However, in areas that contain **endemic species**, those found nowhere else in the world, natural or man-made disturbances can precipitate the extinction of a species and the loss of its function in an ecosystem, an irrevocable disaster.

Colorado is notable for the presence of a large number (93) of endemic species. In addition, some 10 percent of the total number of plant and animal species found in Colorado are considered rare or at risk of extinction—11.2 percent of vascular plants, 4.1 percent of reptiles, and 18.8 percent of freshwater fish. When people know the relative status of biodiversity in their area, they are better able to make decisions that may impact sensitive species.

Biodiversity: You Can't Judge a Book by its Cover

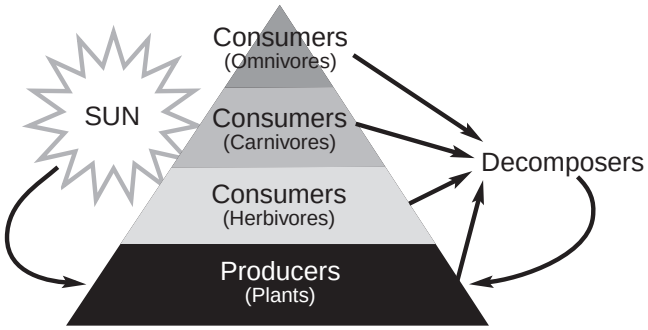
Sometimes appearances can be deceiving when it comes to biodiversity. We tend to view green landscapes as desirable, lush, and rich with life. While Colorado's native grasslands may seem brown and lifeless in comparison to our rich green lawn, they support a far greater diversity of life in the same sized space. That's because our lawn contains just a single species of grass; it is a **monoculture** landscape that provides habitat for only a limited number of species

Similarly, a healthy ponderosa pine forest may look somewhat dry and sparse. Nonetheless, it contains a variety of individual trees of differing ages and sizes, along with changing patterns of shade, light, open spaces, moisture, and soil types, providing many niches.

A Place in the Food Web

Ecologists often group species in an ecosystem according to their role in the food chain, or their **trophic** (feeding) **level**. **Producers** produce their own food and serve mostly as food for others. **Consumers** mostly eat or consume others, and **decomposers** help break down, or decompose, all the others. Plants are producers. Consumers include large animals like deer and mountain lions, or smaller species such as lizards and mice. Decomposers are mostly small microorganisms. It is important to realize that, while one species might be a consumer some of the time, it may itself be food at another time. The biggest predator may someday be food for the smallest decomposer. The relationships are not simple and direct, but form a web of relationships.

Decomposers are the most numerous organisms in an ecosystem, followed by producers, and then consumers. Since energy is partly used and dissipated as it passes from one living thing to the next, this proportional relationship helps ensure that there is sufficient food for species in the different trophic levels to survive. We can visually represent this general relationship in the form of a pyramid like this:



An organism's place in the food web is an essential component of its niche, and each species occupies one or more of these trophic levels. Species at one level provide life energy (food) for the species in the next level. If biodiversity is severely reduced and there is not enough food available at one trophic level to support the next level, the pyramid can "collapse," and the ecosystem cannot function.

Interestingly, while there exist more species of microorganisms than plants, and more plants than animals, we've actually identified more animals than plants, and more plants than microorganisms! A pyramid of known species would be labeled like the one above, but would have the point facing down! Perhaps this is because we're drawn to study those species to which we feel closest, or those that appear to affect us directly. As we discover more about food webs and the interrelationships between species, however, we are paying more attention to all the living organisms in an ecosystem.

Measuring Biodiversity

Diversity of life is difficult to measure precisely. However, some methods have been developed that give a good indication of species biodiversity. These methods usually involve two steps. First, the number

of species in the area being studied, or **species richness**, is counted. Then the number of individuals in each species, or **species abundance**, is counted. Considering these two counts together gives an indication of biodiversity.

In general, areas that contain many different species, with an appropriate number of individuals in each species, are more biodiverse. Areas with few of the possible species, or with most individuals belonging to only one or two of the many species present, are less biodiverse. However, a high number of species in an ecosystem does not necessarily mean that the ecosystem is healthier or more important than another ecosystem with few species. In Colorado, alpine tundra ecosystems cannot support the same numbers or variety of species as the state's grasslands or forests.

Measuring biodiversity can be very helpful in seeing differences and changes between areas, or in one area over time. Remember that living things include more than just big, familiar animals. Plants and insects are as important to biodiversity as the animals that depend on them, as are the microorganisms that make up the majority of life forms on earth.

Each species is itself an ecosystem containing additional species. For example, just as different kinds of birds make use of ponderosa trees, insects and microorganisms find homes on and in the birds. Opportunities for birds create opportunities for other life forms. Diversity breeds diversity. A wide variety of species finds homes in Colorado's ecosystems.

Why is Biodiversity Important to Wildlife?

Loss of biodiversity directly affects wildlife by reducing opportunities for food, shelter, nesting, cover, and other necessities. This affects species' ability to survive. A loss of biodiversity can make an ecosystem less able to withstand stress and change and may lead to poor quality habitats and declining wildlife populations.

Biodiversity is Important to People Too!

Biodiversity generates goods and services for the most basic human needs such as food, shelter, medicine, and fresh air and water. In addition, humans have used a wide variety of plant and animal species to produce forms of transportation, musical instruments, tools, weapons, food holders and many other products.

All the food we grow comes from plants and animals that originated from varieties found in nature. We often must return to nature to find wild species with different genetic traits to improve domestic varieties of crops so that they can grow faster, or are more resistant to disease or insect attacks.

Our homes, the furnishings inside them, and often the fuel to heat them come from materials in our environment. The woods, oils, resins, waxes, and gums of many tree species provide us with many options for building and heating. Likewise, our clothing is often made from natural plant fibers (such as cotton or linen) or from animals (wool, silk, skins).

About 80 percent of the world's population still use plants as their primary source of medicine. Close to 30 percent of all pharmaceuticals sold in Colorado were developed from plants and animals.

In addition to providing products, diverse ecosystems provide us with life-sustaining services. We can thank a pollinator for every third bite of food we take. Many plants grown in our state depend on bees, butterflies, moths, wasps, beetles, birds, and bats for pollination. Feed crops such as alfalfa and hay, and the wonderful peaches produced on Colorado's western slope, all depend on pollinators!

Diverse ecosystems sustain processes that purify both air and water. Through photosynthesis, trees and other plants regulate water vapor, release oxygen, and cycle nutrients. Vegetation plays a crucial role in maintaining the planet's water cycle. Not only do plants give off moisture through their leaves and provide shade to slow evaporation, but they often filter water before it reaches lakes and rivers, providing clean water for all. Plants hold moisture in the soil and help reduce the effects of drought. Plant communities also play an important role in flood control, holding soil in place and preventing erosion.

In a state with abundant natural resources and a variety of landscapes like Colorado, biodiversity is also good for the economy. Many people come to our state to visit its grasslands, mountains, and canyons, spending millions of dollars each year on activities such as hunting, fishing, camping, skiing, hiking, and wildlife watching. A sustainable supply of natural materials for business also depends on biodiversity.

There are benefits from species diversity that are less tangible, but nevertheless priceless. For many of us, nature is vital to our emotional, psychological, and spiritual well being, providing a source of relaxation, rejuvenation, beauty, and peace. In some cultures, certain species are integral to spiritual beliefs, traditional rituals, and the people's heritage. What's more, learning from examples in nature improves the quality of our lives. For example, watching different birds and how they use their wings helped humans achieve flight and continues to help us improve airplane design.

While all of the benefits mentioned are incentive for all of us to protect and preserve biodiversity, many people feel that each species should be respected and protected simply because it exists. *We don't always know how a species or an ecosystem can or will benefit us. Perhaps we're encouraged by the beauty we see in diverse landscapes, or by how we feel after we've been in a diverse landscape, to treasure biodiversity for its own sake.*

Biodiversity is Important to the Planet!

In prairies, ponds, deserts or forests, important processes and interactions are taking place. Predators are consuming prey, decomposers are breaking down dead plants and animals and returning nutrients to the soil, and myriad other exchanges are taking place. Each of these processes and ecosystems are intricately linked, supporting each other. Loss of biodiversity anywhere on the planet greatly impacts human society as well as ecosystems and their valuable services.

Definitions and Classification: Something to Think About

Colorado scientists, teachers and public officials have in recent years increasingly accepted the use of the term **"ecosystem"** to describe major areas of our state. But a different word could have been used. **Landscape** is a general term for an area that shares enough features to set it apart from another area. A **biome** is a large geographic area with uniform climatic conditions and distinct vegetation such as the North American desert, prairie, or coniferous forest. A **life zone** is a band or belt of plant and animal life, usually on the side of a hill or mountain, which changes with elevation or latitude. A **bioregion** is an area whose physical, ecological, or cultural characteristics set it apart from surrounding areas. The meaning of words changes and evolves over time and place. Even you can have an effect on their meanings in the future by how you understand and use these words today.

Some of you may wonder…why eight Colorado ecosystems, and not more or fewer? It is true that different scientists have looked at Colorado and seen different numbers of major ecosystems. Professional differences, as well as differences in outlook and standards have resulted in different numbers. In addition, where one ecosystem ends and another begins is not always clear. Changes within and between these ecosystems can be gradual. Features of one can often be found in others. Even so, each of these eight major ecosystems generally has a particular set of plants, animals and other characteristics. Dividing the state into these eight has become widely accepted and has led to a greater appreciation of our Colorado environment.

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Activity: Which Niche?

Objectives

Students will:

1.) define ecological niche; and

2.) give at least one example of an animal and its ecological niche.

Method

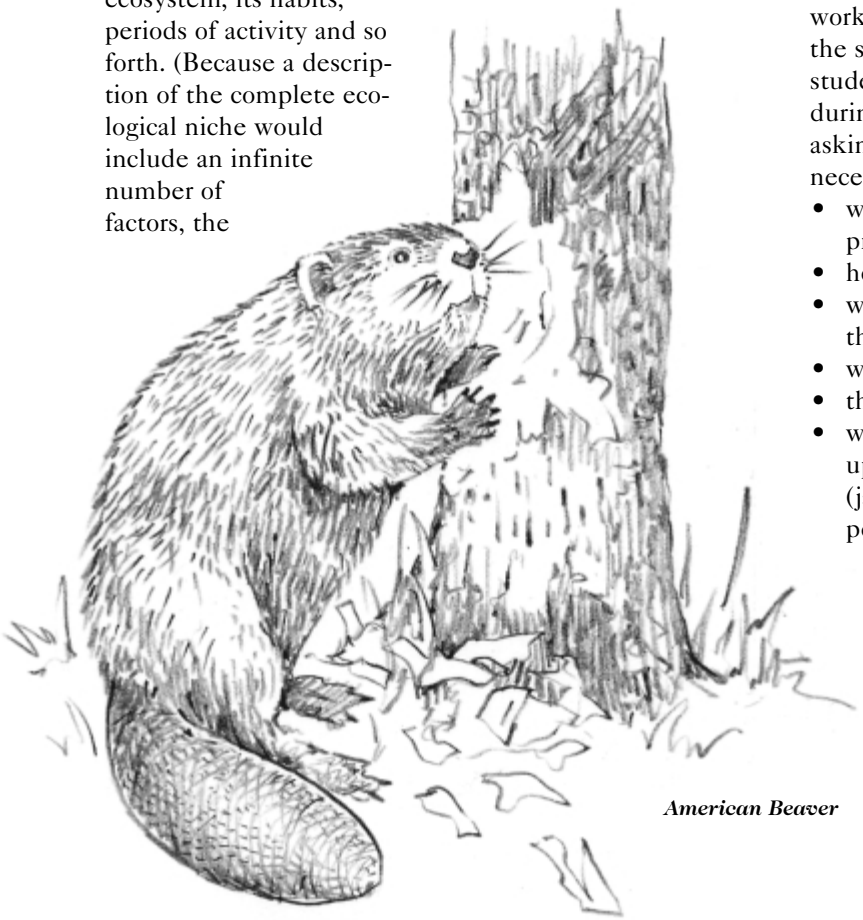
Students compare ecological niches with careers in their community.

Materials

A guest speaker; chalkboard; reference materials.

Background

Each animal has a role in the ecosystem. This role is called its ecological niche. The niche includes such things as where and how it gathers food, its role in the food chain, what it gives to and does for the ecosystem, its habits, periods of activity and so forth. (Because a description of the complete ecological niche would include an infinite number of factors, the concept is most useful in terms of *differences* among species. For instance, one could compare the niches of four American warblers that all breed in the same habitat, a spruce forest, but forage and nest in different parts of the spruce tree.)



American Beaver

An animal's niche can be described as *what it does for a living.* In a sense, this role can be compared to what people do for a living—that is, what their jobs or professions are in the communities in which they live.

The major purpose of this activity is for students to understand the concept of ecological niche, simultaneously learning more about potential careers in their own community.

Procedure

1.) Explain to the students that in this activity they will be comparing human professions to the roles of animals in environments (animal professions).

2.) Select a few interesting jobs for discussion. Invite a doctor, dentist, social worker, truck driver, cook, etc., to your class to talk about their work. Ask questions of the speaker. Work with the students to develop the questions. Have the students take notes and record the answers during or immediately after the presentation, asking additional questions for clarification as necessary. Points to include:
   - what they do for the community (the service provided);
   - how they provide the service;
   - what resources are used by them in providing the service;
   - where they live and work;
   - the times during which they work;
   - what other professions they are dependent upon for the functioning of their profession (janitor, delivery person, secretary, repair person);

- what special habits they exhibit;
- what other professions they compete with, if any; and
- what other professions they cooperate with, if any.

Ask the students to produce a written summary of the information they acquire concerning each of the jobs they investigate.

3.) Have the students brainstorm a variety of animals living in a particular ecosystem (forest, stream, desert, tundra). A photograph could serve as a stimulus. List representative members of this ecosystem on the blackboard. Make sure a variety of animals—including predator, prey, scavengers, etc.—are included.

4.) Choose one of the animals listed and, as a group, begin discussing the same questions for it asked of the visiting professional. In this way the students can see how the *profession* concept applies as a metaphor. Identify the animal's profession as its *ecological niche*.

OPTIONAL: As individual projects or in teams, students should select one animal, research the *niche* it fills and answer the same questions used for human jobs. As a culmination, each team can make a visual and/or verbal presentation about its animal and its niche.

Extension

Have the students identify niches that are overlapping and that compete or cooperate for resources. Connections may also be made between niches to illustrate interdependency webs in the ecosystem.

Evaluation

1.) Define ecological niche.

2.) Select any animal and describe its ecological niche. Include: what it does for the ecosystem, how it provides this service, the resources it uses, where it lives, when it does its work, what other organisms depend upon it, what other organisms it is dependent upon, what special adaptations it uses or needs, what special habits it exhibits, what other organisms it competes with for the same niche, and anything else you think is especially interesting about this niche and how it is filled.

3.) Create a poster that shows all the facets of an animal's niche.

Duration: one to four 45-minute sessions
Group Size: any
Setting: indoors
Vocabulary: ecological niche, career, community

This activity was adapted with permission from, "Project WILD K-12 Curriculum and Activity Guide."

"Which Niche?" is an example of the many Project WILD educational activities that can be used in both classroom and non-formal settings to teach concepts found in *WILD Colorado: Crossroads of Biodiversity*." For more information about Project WILD activities and workshops, please see the inside back cover of this book.

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WILD Colorado: Crossroads of Biodiversity

Artwork by Paul Gray

GRASSLANDS

Part of a series of eight posters • Supporting educational materials at www.wildlife.state.co.us

Setting—Picket Wire Canyonlands near La Junta

Birds

1. **Burrowing Owl** *(Athene cunicularia)*—a long-legged, ground-dwelling owl usually found near prairie dog towns. They are able to imitate the sound of a rattlesnake when threatened.
2. **Scaled Quail** *(Callipepla squamata)*—common in southeastern Colorado grasslands, but also found in shrublands and piñon-juniper woodlands. They are easily identified by their pronounced white-tipped crests.
3. **Western Meadowlark** *(Sturnella neglecta)*—found at all but the highest elevations of Colorado in summer, and in eastern and western lowlands year round. The meadowlark sings a melodic, flute-like song.
4. **Swainson's Hawk** *(Buteo swainsoni)*—found throughout the eastern prairie spring to fall, less common in western Colorado. In addition to hunting for rodents, reptiles and other birds from the air, Swainson's hawks also hop around the ground in search of insects.
5. **Golden Eagle** *(Aquila chrysaetos)*—a somewhat common resident of all but the higher Colorado elevations in winter, less common at other times. White patches under the wings and on the tail are indicative of an immature Golden.
6. **Lark Bunting** *(Calamospiza melanocorys)*—historically abundant in short-grass prairie, also found in the shrublands of northwestern Colorado. The male of our state bird is easily identified in summer by its black body and white wing patches.

Mammals

7. **Pronghorn** *(Antilocapra americana)*—often mistakenly called an antelope, named for the short prongs that extend forward from near the midpoint of the horns. Among the fastest animals on Earth, pronghorn can sustain speeds of 30 mph and have been timed achieving 70 mph.
8. **American Badger** *(Taxidea taxus)*—ranges throughout Colorado, wherever prairie dogs, gophers, ground squirrels and other rodents can be hunted. The badger can be identified by a white stripe running up from the nose to the back of the head.
9. **Black-tailed Prairie Dog** *(Cynomys ludovicianus)*—named for the black hairs at the tip of the tail, a crucial species of eastern Colorado grasslands whose numbers and environmental effects influence the numbers and habitat opportunities of many other species. Prairie dogs form colonies, called towns, and engage in complex social interactions.

Reptiles

10. **Western Rattlesnake** *(Crotalus viridis)*—found throughout much of Colorado from grassland to montane forest, an important predator of smaller mammals. These snakes hibernate in rodent burrows or rock crevices, emerging usually mid-April to mid-May.
11. **Ornate Box Turtle** *(Terrapene ornata)*—identified by streaks or dots of yellow on an otherwise dark shell. These turtles can often be found on roads after heavy rains, resulting in large numbers being killed by automobiles.

Spider

12. **Tarantula** *(Aphonopelma hentzi)*—sometimes called the Texas Brown, one of three tarantula species found in Colorado. After about ten years of living apart from females, the males migrate, usually in September or October, in search of mates.

Insect

13. **Painted Grasshopper** *(Dactylotum bicolor)*—brightly colored with patterns of red-orange, blue-black, yellow and white, found in dry grasslands and foothills. They show a dietary preference for grasses, especially alfalfa.

Plants

14. **Yucca** *(Yucca glauca)*—prefers dry slopes and hillsides. The pod-like fruit of the yucca grows along a tall stalk, while the leaves, long, thin and sharp, radiate from the base.
15. **Common Sunflower** *(Helianthus annuus)*—a common plant with bright yellow petals surrounding a maroon-colored center on a stalk that can grow 10 feet high or more. Besides the bright color of its petals, the sunflower was so-named because the heads follow the sun from dawn to dusk.
16. **Prickly-pear** *(Opuntia polyacantha)*—cactus characterized by flat, green, oval-shaped pads with spikes arranged in regularly spaced bundles. The flowers that appear in late spring are yellow or reddish in color and up to 3 inches across.
17. **Cholla** *(Cylindropuntia imbricata)*—sometimes called the tree cholla or candelabra cholla, a leafless bush or small tree with jointed branches occurring in Colorado primarily in the southeast. In late spring and early summer, the cholla can be covered with many reddish or lavender-colored flowers.

Tree

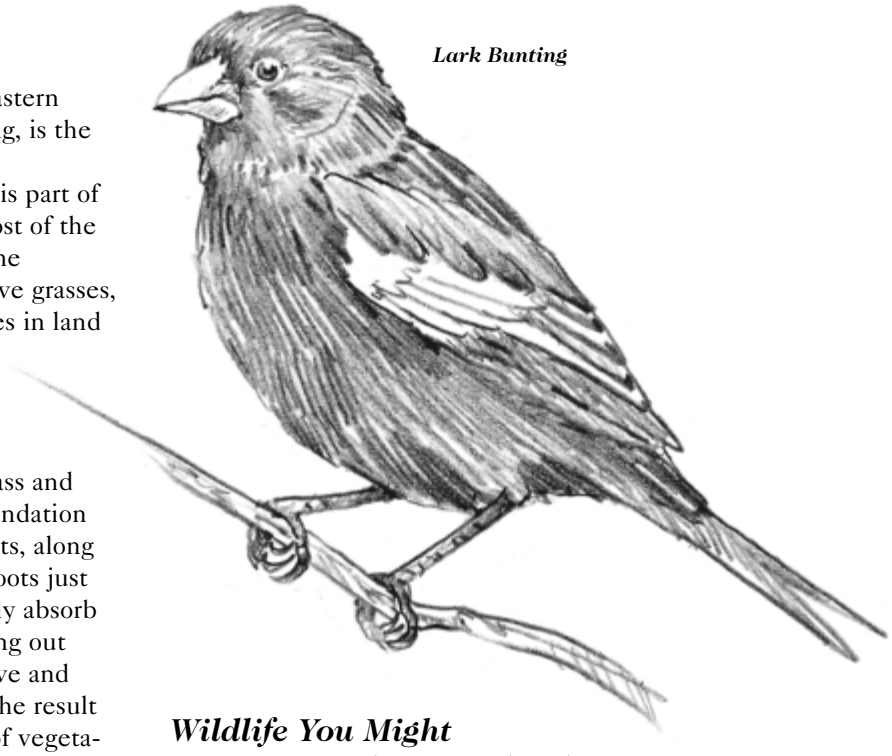
18. **Oneseed Juniper** *(Sabina monosperma)*—more typically associated with piñon-juniper woodlands, but found in higher grasslands and transitional zones. Cones of any one tree are of only one sex, with the female cones larger and berry-like.

Grasslands

Near the town of Briggsdale in northeastern Colorado, between Fort Collins and Sterling, is the Pawnee National Grassland, one of the last remaining native grasslands in our state. It is part of a larger grassland ecosystem that covers most of the eastern third of the state. Grasslands like the Pawnee, containing historical mixes of native grasses, are now rare in Colorado because of changes in land use, fire cycles, and grazing patterns. High altitude grasslands, found in a few areas such as South Park, support their own mix of animal and plant life.

Sod-forming grasses such as buffalo grass and our state grass, blue grama, provide the foundation for grassland ecosystems. Deep vertical roots, along with a widespread network of fine lateral roots just below the surface help these grasses quickly absorb scarce rainwater. They reproduce by sending out shoots and runners above and below the ground. The result is a turf-like mat of vegetation ideal for grazing.

Blue Grama



Lark Bunting

Wildlife You Might Discover in the Grasslands

Look closely and you may spot the distinctive black and white markings of our state bird, the lark bunting. You may hear the beautiful song of the meadowlark. Since there are few trees in this ecosystem, birds have adapted by building their nests on the ground, and calling their songs from the grass or in flight.

You may see and hear prairie dogs, and the collection of dirt mounds that make up their colonies or "towns." In the distance you may see a herd of our state's fastest mammal, the pronghorn, often referred to as an antelope. Above you might be lucky enough to spot a red-tailed hawk or golden eagle on the lookout for small mammals, reptiles, and other birds to eat. But there's also much activity in the grass beneath your feet. Here you may find a crab spider, named for its crab-like appearance when holding up its two front legs, hunting for a meal. Unlike many spiders found in forested ecosystems, the crab spider does not build a web to catch its prey, relying instead on its eyes to detect the slightest movements in the grass.

What Shaped the Grasslands?

Geography and climate helped shape the grassland ecosystem. About 65 million years ago, the Rocky Mountains began reforming. Even as they were building up, wind and water were working to

wear them down by carrying away rocks, dirt and sediment to the east. Over many centuries this eroded material became the soil that supports the plant and animal life of Colorado's grasslands.

Colorado's eastern climate is too dry to support trees, and the soil is not moist enough to support the tall grasses of the Midwest prairies to the east of Colorado. Our short-grass prairie lies in the "rain shadow" of the Rocky Mountains. Just as the sun casts a shadow when blocked by the mountains, the mountains block much of the moisture until clouds and storms can regroup about 200 miles to the east. As moisture in the atmosphere is forced upwards by the Rockies, rain and snow fall over the mountains and foothills, leaving little for the grasslands until near the Kansas border. Mostly, Colorado's grasslands get moisture from intermittent streams, and from occasional summer storms.

Colorado's eastern grasslands are cold in the winter and hot in the summer. It is often windy. In the winter, these winds can lead to blizzard conditions, blowing the snow into high drifts. In the summer the winds dry the grasses, providing ample fuel for natural fires.

Historically, fire was a regular occurrence before people settled the grasslands. Fire renewed and restored the grassland. Many grassland species are not only adapted to fire, but have evolved ways to benefit from it. Most of the grass's **biomass** (its living material) is underground. When fires swept the grasslands during the dry season, the native grasses were dormant. Though they appeared brown and lifeless on the surface, their deep roots were alive and escaped permanent damage from the fires. Many non-native grasses and other plants that could take over the native grasses' territory were not adapted to fire. They were pushed back by fire, allowing native grasses to thrive. Fire also helped clean out dead plant material while adding nutrients to the soil. Fire suppression efforts since the early 1900's have changed the makeup of many grassland communities, and it is now recognized that using controlled fires as a management tool can improve the quality of grasslands.

Prairie Dogs

A Closer Look at One Grassland Species

American bison, often called buffalo, benefited from fire. They preferred to graze on the fresh native grasses in newly burned areas and, by doing so, initiated the return of other grass species. Moving from one grazing location to another, bison thinned and opened the ground cover, allowing moisture and light to penetrate. The nitrogen from bison urine acted as a fertilizer, encouraging plant growth. Their hooves helped break up the hard crust on the grassland soil. The hair on their foreheads and front legs picked up seeds as they fed. The seeds were then carried to recently burned areas that lacked mature seed-producing grasses, helping revegetate the region. Bison droppings **(scat)** also contain a large variety of seeds.

Other animals, such as kangaroo rats, found abundant food by following the bison along their migratory wanderings. The bison's feeding and trampling actions exposed the insects and seeds that made up the rat's diet. Bison scat, known unceremoniously as buffalo chips, was itself food, shelter, and nursery for a variety of invertebrate life. Some flying insects stuck close to herds, awaiting the appearance of fresh dung, while others traced the scent from the ground. The tumblebug beetle shaped a bit of dung into a ball, deposited its egg into this protective environment, then rolled the ball back to its nest. Since bison were grazers, meaning that they primarily eat grass, they did not compete with pronghorn which, as browsers, fed on a variety of plant materials.

While, overall, bison grazing clipped the height of grasses and contributed to the vitality of the grassland, localized affects varied greatly. Areas favored by the bison might have been grazed down to stubble, while other areas were left virtually untouched. Buffalo wallows, rounded depressions that result from bison rolling on their backs to clean themselves and relieve itching, remain as bare dirt a hundred years after their creation. The range of bison grazing behavior resulted in a greater diversity of habitats available to many plains' species. For example, the

American Bison

mountain plover depends on a sufficient supply of open and bare areas to successfully hunt for insects and to more easily spot predators. On the other hand, land predators, such as coyote and fox, benefit from the increased cover provided by ungrazed grasses.

Until slain to near extinction, bison wandered the plains in great numbers. Bison still exist on preserves in Colorado but, since they are no longer found in the wild, are called an **extirpated** species. With the absence of bison from this ecosystem, there have been attempts to replicate some of the ecologically important effects of bison on the grasslands. Ranchers, who need to ensure sustainable pasturage for their cattle, seek to mimic the migratory grazing patterns of bison by utilizing rotational grazing techniques. Pasture condition is carefully monitored and cattle are moved from one site to another so that plant root sufficiency is maintained.

However, it's important to avoid a single approach to grassland management, which, if applied universally throughout the grassland ecosystem, might favor some species at the expense of others. Large expanses of ungrazed grasses can allow populations of pest species such as grasshoppers to increase to destructive levels, while vast areas of barren ground lead to erosion. Planners, farmers and conservation biologists now recognize that a diversity of grass height and cover is desirable because it increases biodiversity. With proper rangeland management, grazers such as cattle can replace many of the ecosystem functions of the bison, providing both cleared landscapes for species such as the mountain plovers, and sufficient grazing and browsing opportunities for other species. Enhanced biodiversity tends to neither maximize nor minimize populations, but rather optimizes population balance.

Crossroads of Biodiversity—Colorado's Grasslands

The outermost ranges of the thirteen-lined ground squirrel and the white-tailed jackrabbit overlap in the short-grass prairie of eastern Colorado. Primarily a species of the upper mid-western U.S., the thirteen-lined ground squirrel is near the western end of its range in Colorado, while the white-tailed jackrabbit is at the southern end of its range.

Both animals eat grasses and other vegetation. The ground squirrel will also eat insects and other

Thirteen-lined Ground Squirrel

small animals. Both the ground squirrel and jackrabbit are themselves food for coyotes, foxes, hawks and eagles.

Although they have similar diets and require similar homes on the range, they occupy different niches and don't usually compete with each other. That's because, while the white-tailed jackrabbit is **nocturnal** (most active at night), the thirteen-lined ground squirrel is **diurnal** (most active in the daytime). The ground squirrel lives in shallow burrows and hibernates in winter, while the jackrabbit does not hibernate, often burrowing out hiding places in the snow.

Were they ever to meet, however, and challenge one another to a race, it would be no contest. Cruising along at a leisurely eight miles per hour, the thirteen-lined ground squirrel is no match for the white-tailed jackrabbit, which has been clocked at speeds of 45 miles per hour!

A Grassland by any Other Name…

Other names for *grassland* ecosystems include *prairie*, *plain*, *steppe*, *pampa*, *savannah*, and *veld*. These names describe grasslands that may differ in moisture, elevation and vegetation from those found in Colorado. Some describe grasslands found only in particular regions of the world.

White-tailed Jackrabbit

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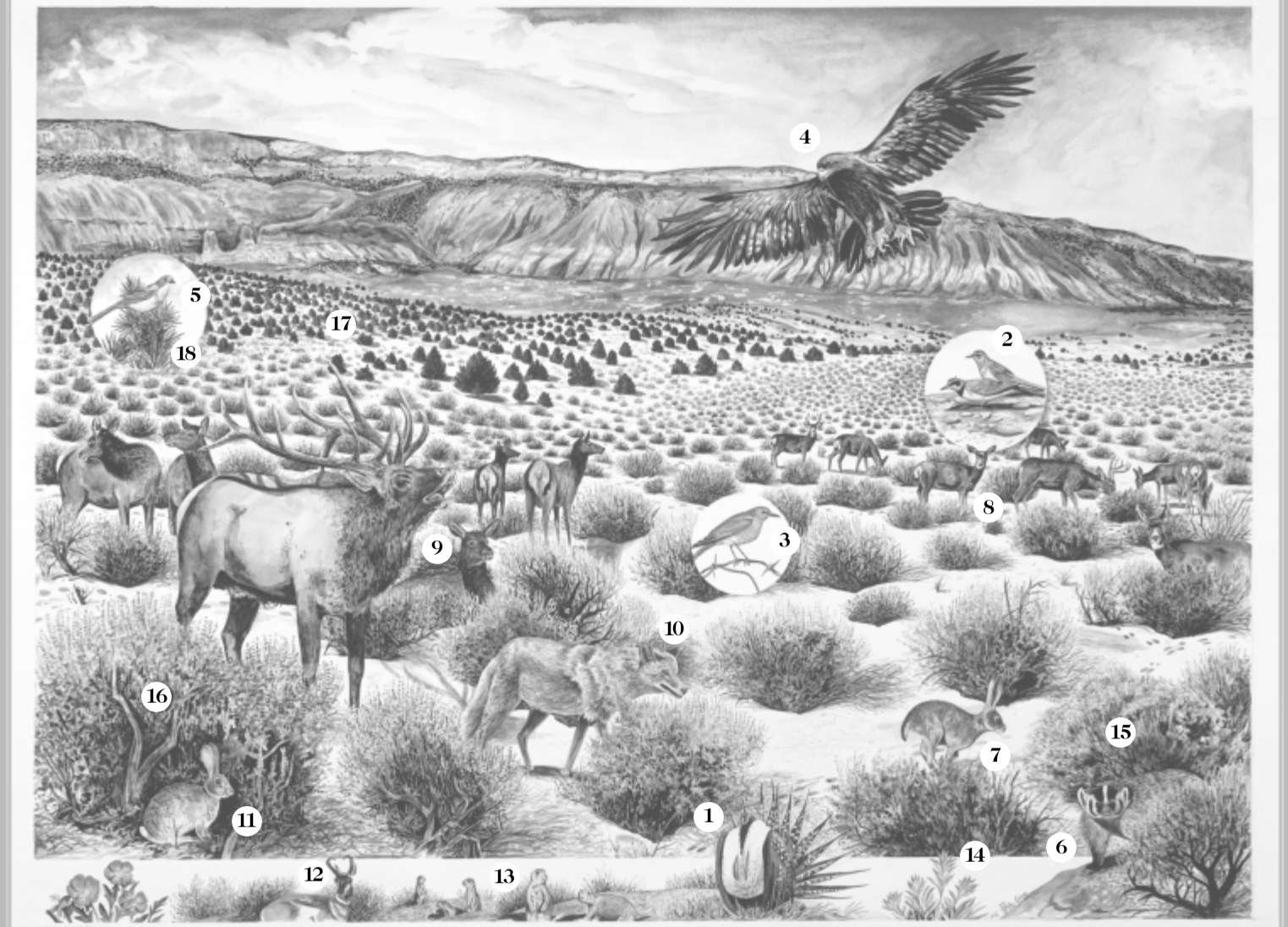
WILD Colorado: Crossroads of Biodiversity



Artwork by Paul Gray

SAGE SHRUBLANDS

Part of a series of eight posters. • Supporting educational materials at www.wildlife.state.co.us

Setting—Moosehead Mountain, north of Rangely

Birds

1. **Sage Grouse** *(Centrocercus urophasianus)*—found in sage shrubland habitats in northwestern Colorado and the Gunnison River basin. As part of the mating ritual, males inflate air sacs on their chests, fan their sharp-pointed tails, and engage in complex struts, steps and other movements.
2. **Horned Lark** *(Eremophila alpestris)*—named for their black, "horned" feathers, more pronounced on the male; prefers open, low-vegetation habitats. Aerial courtship displays by the male begin with a steep ascent, with circling and singing at the high point, followed by a steep dive.
3. **Mountain Bluebird** *(Sialia currucoides)*—brilliantly sky blue-colored, found primarily in central and western Colorado. These bluebirds are secondary cavity-nesters, often using old woodpecker holes and cliff swallow nests, in addition to buildings and nesting boxes.
4. **Golden Eagle** *(Aquila chrysaetos)*—the golden color is most noticeable on the crown and nape of adults. In addition to rabbits and squirrels, road-kill deer help sustain these eagles through the winter.
5. **Western Scrub Jay** *(Aphelocoma californica)*—inhabits open shrublands and woodlands between 5,000–7,000 feet. These sky blue-colored jays are usually found in pairs occupying fixed territories.

Mammals

6. **American Badger** *(Taxidea taxus)*—ranges throughout Colorado, wherever prairie dogs, gophers, ground squirrels and other rodents can be hunted. The badger can be identified by a white stripe running up from the nose to the back of the head.
7. **Black-tailed Jackrabbit** *(Lepus californicus)*—so-named for the black stripe that extends from the tail to the rump; also nicknamed "jackass rabbit" for its huge ears. Feeding mostly on grasses, shrubs and forbs, they are themselves a primary food for coyotes and golden eagles.
8. **Mule Deer** *(Odocoileus hemionus)*—inhabit all of Colorado's ecosystems from grasslands to tundra. Named for the large ears, these deer have white tails tipped with black and scent glands above the back hooves.
9. **American Elk/Wapiti** *(Cervus elaphus)*—common throughout central and western Colorado above 5,000 feet. In spring, migrating elk follow the melting snow pack to higher elevations; in winter, snow depth triggers downward migration.
10. **Coyote** *(Canis latrans)*—common in all Colorado habitats at all elevations, generally identified by a long pointed muzzle, pointed ears, and a bushy tail held downward, even when running. The coyote's scientific name means "barking dog" while its common name comes from the Aztec Nahuatl word "coyotl", meaning "singing dog".
11. **Desert Cottontail** *(Sylvilagus audubonii)*—pale gray-brown with rust-colored patches on the throat and chest. This cottontail requires an adequate density of shrubs and small trees as cover from predators.
12. **Pronghorn** *(Antilocapra americana)*—often mistakenly called an antelope, named for the short prongs that extend forward from near the midpoint of the horns. Among the fastest animals on Earth, pronghorn can sustain speeds of 30 mph over long distances and have been timed achieving 70 mph.
13. **White-tailed Prairie Dog** *(Cynomys leucurus)*—distinguished from the black-tailed prairie dog of eastern grasslands, and the Gunnison's prairie dog of south central and southwestern Colorado, by a white or whitish tip on the tail and dark facial markings. While black-tailed prairie dogs can undergo a slowed metabolism called torpor during extreme cold and snowstorms, white-taileds hibernate for three to six months.

Plants

14. **Paintbrush** *(Castilleja* spp.*)*—several species, commonly called Indian paintbrush, often found in conjunction with sagebrush. Representative is desert paintbrush *(C. chromosa)*, whose colorful two-tone flowers are pale in the middle and reddish-orange at the edges.
15. **Rabbitbrush** *(Chrysothamnus* spp.*)*—several species found in sage shrublands and piñon-juniper woodlands, a favored food of jackrabbits. Native Americans used the golden yellow flowers to make dyes.
16. **Sagebrush** *(Seriphidium* spp.*)*—three common species found in Colorado's sage shrubland habitats. Big sagebrush *(S. tridentatum)*, the tallest, is found at lower elevations in deeper soils, black sagebrush *(S. novum)*, dense and dark in appearance, at middle elevations, and mountain sagebrush *(S. vaseyanum)* at the higher limits of this ecosystem.

Trees

17. **Utah Juniper** *(Sabina utahensis)*—predominant juniper of the lower-elevations of western Colorado. Unlike Colorado's other juniper trees, the Utah Juniper usually has both male flowers and female berries on the same tree.
18. **Piñon Pine** *(Pinus edulis)*—defining tree of the piñon-juniper woodland, cones contain large pine nuts which are eaten by a variety of animals, including humans. In addition to food, this tree provided Native Americans and settlers with firewood and building material needed for furniture, shelter, and household items.

Sagebrush Shrublands

About 27 miles southwest of Craig in northwestern Colorado, nestled between the Yampa River and Highway 13, lie the rolling sagebrush-covered ridges of the Axial Basin. The Axial Basin and much of the Yampa River region comprise an ecosystem defined by dry, shrub-covered soils and few trees - the sagebrush shrublands of Colorado.

Sagebrush shrublands are prevalent in central and western Colorado, on the Colorado Plateau, and in the Gunnison River and Colorado River basins. Examples of this ecosystem can also be seen in Middle and North Park, and in the San Luis Valley between Villa Grove and Saguache.

High and Dry

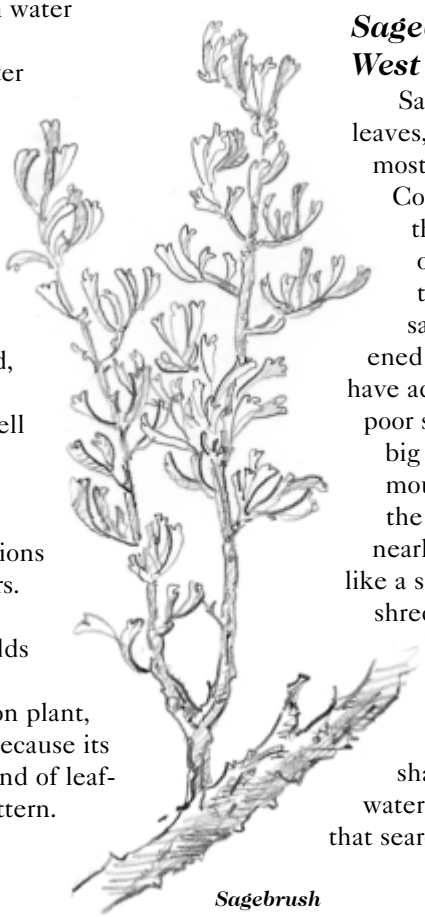
The sagebrush shrubland ecosystem is sometimes referred to as Colorado's cool, high desert. Occurring above grassland at approximately 5,000 to 10,000 feet, sagebrush shrublands usually receive less than ten inches of precipitation annually, making them the driest of all Colorado's major ecosystems. Most precipitation falls as winter snow, and the small amount of summer rain that does fall evaporates quickly. Temperatures are very high in the summer and sub-zero in the winter. The soils are poor, either very alkaline or very acidic, and drain water rapidly.

Trees, with more demanding water requirements, are not suited for this ecosystem. Woody vegetation is largely in the form of shrubs and brush, which can handle the wide temperature swings, alkaline soils, and the lack of moisture. Some common species include sagebrush, yellow-flowered rabbitbrush, antelope brush or bitterbrush, greasewood, shadscale, and four-winged saltbush.

Several beautiful flowers grow well in the dry soils of sagebrush country. Scarlet or skyrocket gilia, with its trumpet shaped scarlet flowers, is a biennial that adapts to the dry conditions by spreading its growth over two years. During the first summer, the plant develops its rosette of leaves, then adds a flower stalk the following growing season. Sulfur flower, another common plant, is also known as the umbrella plant because its small yellow flowers develop at the end of leafless stalks in a circular, spoke-like pattern.

Indian Paintbrush

Indian paintbrush, whose red-orange flowers brighten the landscape, is a partial **parasite**. It survives by extending its roots into the roots of other plants and drawing off moisture and nutrition.



Sagebrush

Sagebrush, Designed for the West

Sagebrush, with its silvery gray-green leaves, dominates this ecosystem. The most pervasive plant in western Colorado, sagebrush is not related to the culinary species, but is a member of the sunflower family. Still, the three-lobed leaves emit a distinct sage-like odor when crushed or dampened by rain. Several species of sagebrush have adapted to the harsh conditions and poor soils found in this region, including big sagebrush, black sagebrush, and mountain sagebrush. Big sagebrush is the most common. Standing two to nearly ten feet tall, this shrub looks a bit like a small, twisted tree with dark, shredded bark.

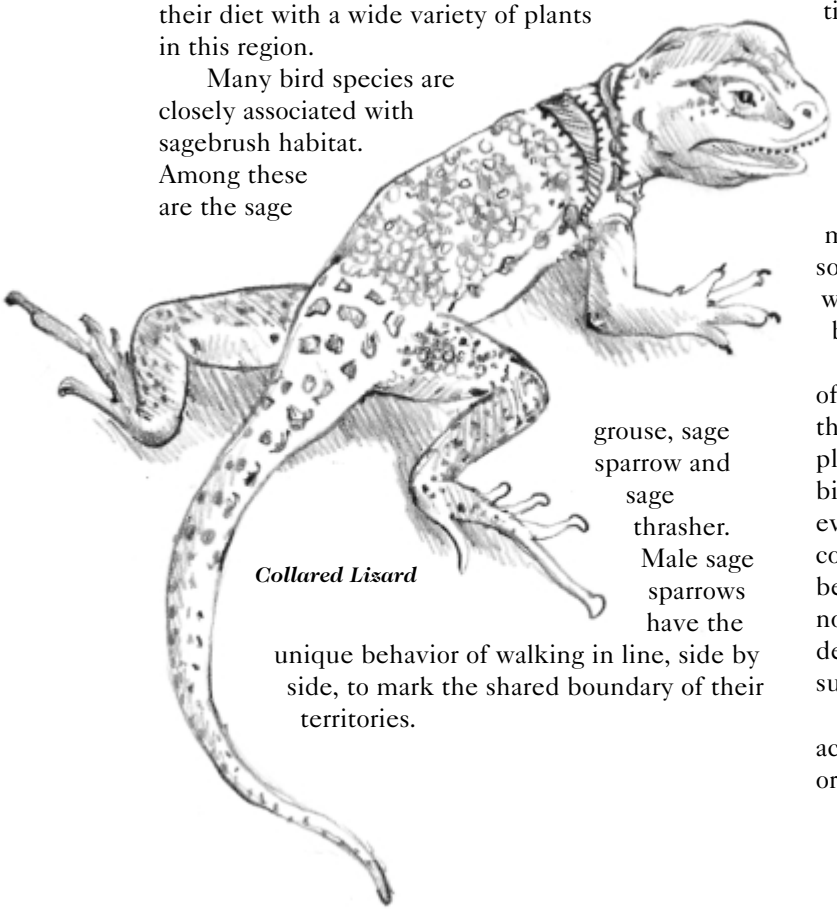
Tailor made for survival in a windy, arid environment, all species of sagebrush have unique root systems, with widespread, shallow roots that quickly trap rainwater from a brief storm, and longer roots that search deeper down for water. Sagebrush

retains water because its narrow leaves expose only a minimum evaporating surface to the sun. The fine, silky hairs that cover the leaves counter the drying force of the wind. As sagebrush leaves drop and decay, they emit a toxic compound in the soil that acts as a herbicide, preventing other vegetation from taking root, thereby reducing competition for water and soil nutrients.

Wildlife You Might Discover in the Sagebrush Shrublands

For a seemingly harsh climate, sagebrush shrublands support a surprising variety of wildlife. The sagebrush provides shade, shelter, nest sites, and dens for a variety of small animals. Collared lizards, side-blotched lizards, sagebrush lizards, western rattlesnakes and bullsnakes are some of the reptiles associated with sagebrush. On summer evenings, the California myotis, a small, pale-colored bat, leaves its roost in the sagebrush to feed on flies, moths, and spiders. Mexican woodrats, deer mice, and sagebrush voles also forage at night. So does Ord's kangaroo rat, a small rat with a long tail that hops around on its two hind legs. Black-tailed jackrabbits are more active during the daylight hours, browsing on flowering plants and shrubs. Ferruginous and red-tailed hawks feed on white-tailed and Gunnison prairie dogs and other rodents. Other predators such as owls, coyotes, and gray fox actively roam the sagebrush for prey. Large mammals such as mule deer, elk and pronghorn supplement their diet with a wide variety of plants in this region.

Many bird species are closely associated with sagebrush habitat. Among these are the sage grouse, sage sparrow and sage thrasher. Male sage sparrows have the unique behavior of walking in line, side by side, to mark the shared boundary of their territories.



Collared Lizard

Ord's Kangaroo Rat

Other common birds are the scrub jay and the horned lark, named for the small black tufts of feathers on the back of its head. The male horned lark courts the female with impressive aerial displays, soaring high, then circling and diving.

A Closer Look at One Species: Gunnison Sage Grouse

In 1977, Dr. Clait Braun, formerly with the Colorado Division of Wildlife, noticed that sage grouse wings collected in the Gunnison Basin of southwestern Colorado were smaller than sage grouse wings collected in northern Colorado. He also noted that these grouse were one-third smaller than the northern sage grouse, and the males had more distinct, whiter tail feathers and more elaborate filoplume feathers on their necks. For over two decades, Dr. Braun and other researchers, most notably Dr. Jessica Young of Western State College, studied the **morphological** (physical form and structure), behavioral, and genetic differences between Colorado's sage grouse and made an exciting discovery. The sage grouse from southwestern Colorado was a distinct species! This was the first time in decades that a new species of bird was described in the continental United States.

Unlike new species discoveries in remote parts of the globe, the Gunnison sage grouse, named for the area of Colorado where it is found, has been in plain view all along. Traditionally hunted as a game bird, viewed by bird-watchers, and heard at sunrise every spring as part of one of the avian world's oddest courtship rituals, the Gunnison sage grouse had long been assumed to be the same species as the related northern sage grouse. What was the conclusive evidence that the Gunnison sage grouse was not just a subspecies, but a species in its own right?

Taxonomists (scientists who classify organisms) acknowledge that the process of deciding when an organism constitutes a separate species can some-

times be a judgment call. In the past, physically distinct but closely related animals have either been "lumped" into one species, with each form classified as a subspecies, or "split" into two species. But the scientists that have reviewed this case agree this bird is clearly a different **species**. The Gunnison sage grouse *does not interbreed* with the northern sage grouse; the two are strikingly *different in both appearance and behavior*; and detailed studies of the two groups' DNA showed that they were *far too distantly related* to be considered the same species.

All species of male sage grouse are equipped with air sacs on their breasts, which they use to attract females each spring. Males position themselves in the center of their strutting grounds, called **leks**, and commence with their mating rituals. The mating call that male sage grouse make with their air sacs is audible a mile or more away, and has been compared to the sound of bubbles, or gulps, underwater. The superiority (as determined by other grouse) of the male's call and the vigor and quality of the rapid head shaking, strutting dance that accompanies it, determine its position in the lek. Dominant males occupy the center of the lek and win the opportunity to breed with the majority of females.

Gunnison Sage Grouse

When Dr. Young listened to and analyzed hundreds of tapes of northern sage grouse as part of a biology project, she noticed different vocal patterns on tapes of sage grouse from the Gunnison Basin. While northern sage grouse consistently pop their air sacs twice in each of the many brief strut displays they perform, the Gunnison birds pop their air sacs nine times, and the sounds they produced are notably deeper. She went to the leks to study the entire mating ritual. Male sage grouse in both the Gunnison and northern areas had a highly elaborate strut display that began with males taking a few steps, then raising their wings, brushing them twice against the stiff feathers of the pouch to make swishing noises to accompany the mating calls. She noted that sage grouse in Gunnison had fewer displays per minute and would also throw their filoplumes over their head and wag their tail at the end of their display.

Dr. Young's research on the behavioral differences of the sage grouse, along with Dr. Braun's documentation of morphological differences, led to analysis of the birds' genetics in 1999. The DNA studies, by Dr. Tom Quinn and Dr. Sara Oyler-McCance of Denver University, provided definitive evidence that the two groups were separate species.

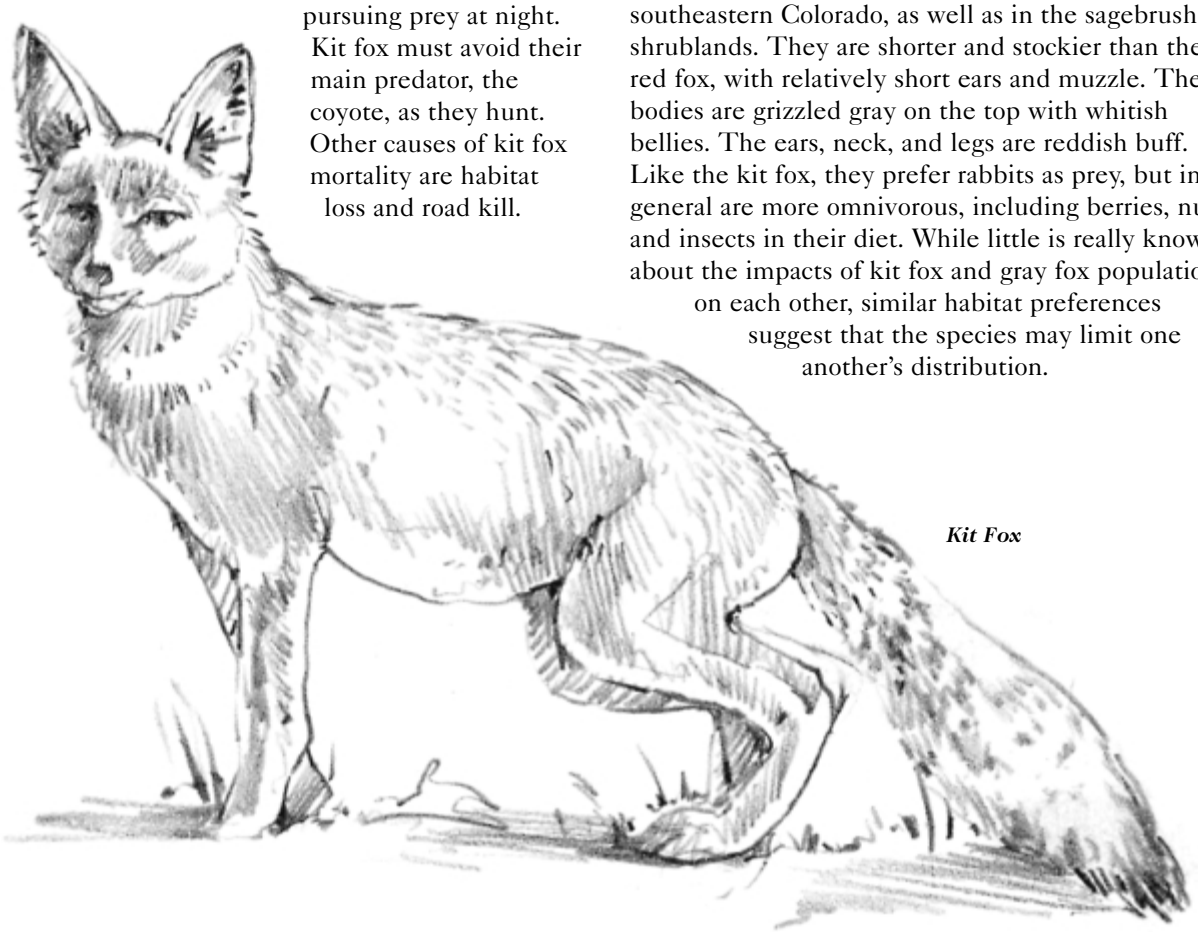
Crossroads of Biodiversity—Sagebrush Shrublands

The kit fox is one of many mammal species found in Colorado that originated in the semi-arid highlands of the Chihuahua region of northern Mexico. The sagebrush shrublands of western Colorado represent the northeastern limit of its range. This small fox, weighing only three to six pounds, competes for prey with larger predators and two other species of fox, the red fox and the gray fox. The kit fox is classified as **state endangered**, which means it is in jeopardy of becoming extinct in Colorado.

Kit fox closely resemble a species found on the eastern plains of Colorado, the swift fox, but they do not interbreed and have distinctly different habitat requirements. Kit fox have long,

black-tipped, bushy tails and yellowish to gray, grizzled coats. Researchers have only found 47 kit foxes in Colorado, in one small area near Delta, and believe their statewide population is less than 100. Once classified as a **furbearer** (animal with marketable fur) that could be legally harvested, the kit fox has been protected in Colorado since 1994.

Kit fox prey mainly on cottontail rabbits, jackrabbits, and kangaroo rats, but will also eat birds, reptiles, and insects. They spend most of the day in their dens, and move from one den to the other while pursuing prey at night. Kit fox must avoid their main predator, the coyote, as they hunt. Other causes of kit fox mortality are habitat loss and road kill.



Kit Fox

In contrast to the kit fox, the red fox has the widest distribution of any carnivore in North America. This fox has three color phases—red, cross, and silver—and is found in every ecosystem in Colorado. Its ears are pointed and erect, and its feet, nose and backs of the ears are typically black. All red fox, no matter the color phase, have a white tip on their tail. In general, red foxes are opportunistic and will eat whatever is available, but are particularly adept at taking ground-nesting birds and their eggs.

Gray foxes are found along the foothills and in southeastern Colorado, as well as in the sagebrush shrublands. They are shorter and stockier than the red fox, with relatively short ears and muzzle. Their bodies are grizzled gray on the top with whitish bellies. The ears, neck, and legs are reddish buff. Like the kit fox, they prefer rabbits as prey, but in general are more omnivorous, including berries, nuts, and insects in their diet. While little is really known about the impacts of kit fox and gray fox populations on each other, similar habitat preferences suggest that the species may limit one another's distribution.

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WILD Colorado: Crossroads of Biodiversity

MONTANE SHRUBLANDS

Part of a series of eight posters. • Supporting educational materials at www.wildlife.state.co.us

Setting—Between Roxborough State Park and Deer Creek Canyon Open Space, west of Littleton

Birds

1. **Great Blue Heron** *(Ardea herodias)*—adults identified by size and distinctive shape in the air and in water, have black streak over the eye and, in breeding adults, head, neck, and back plumes. The largest heron in the U.S., and the most widespread, this four-foot tall bird can often be seen wading or slowly walking through shallow water in search of food.
2. **Black-billed Magpie** *(Pica pica)*—identified by its black and white coloring and long tail, prefers lightly treed, cool, dry habitats. The magpie is the ultimate generalist, with a diet that includes fruit, berries, seeds, insects, worms, garbage, carrion, birds' eggs and hatchlings.
3. **Green-winged Teal** *(Anas crecca)*—small duck preferring wetlands and riparian habitats along the Front Range and higher mountain parks. Flocks of these iridescent-green-winged birds can often be seen in low, seemingly erratic flight, twisting and turning as a single unit.
4. **Canada Goose** *(Branta canadensis)*—identified by a white chinstrap on an otherwise black head and neck. This once uncommon species is now numerous in many of the state's riparian areas and valleys, especially along the northern Front Range.
5. **Common Raven** *(Corvus corax)*—similar in appearance to the American Crow *(C. brachyrhynchos)*, but is larger and has a more massive bill. Ravens engage in elaborate aerial courtship displays.
6. **Great Horned Owl** *(Bubo virginianus)*—distinguished by its large ear tufts and found at all but the highest elevations, has the widest distribution of any North American owl. The distinctive hooting calls of this nocturnal owl are heard throughout the year, especially in late winter when they begin to nest.
7. **Steller's Jay** *(Cyanocitta stelleri)*—identified by its prominent head crest and deep blue wings and tail. This jay is opportunistic when searching for food, often taking advantage of unguarded offerings at campgrounds and picnic areas.
8. **Wild Turkey** *(Meleagris gallopavo)*—of the two Colorado subspecies, the native Merriam's turkey is found in the lower montane. Sociable birds often seen in large flocks, the familiar fanning of the tail is a courtship display done by the male while strutting and "gobbling".

Mammals

9. **Colorado Chipmunk** *(Tamias quadrivittatus)*—common chipmunk of southern Colorado up to 10,500 feet and the Front Range below 7,000 feet. This chipmunk feeds on seeds, berries, and flowers of a wide variety of plants, often ascending to the tops of trees in search of food.
10. **Red Fox** *(Vulpes vulpes)*—the most widespread carnivore in the world, in Colorado may range in color from red to black, but always with a white-tipped tail. This fox's hearing is sensitive to low-frequency sounds, enabling it to hear the underground activities of its burrowing prey.
11. **Abert's Squirrel** *(Sciurus aberti)*—closely associated with ponderosa pine forests of southern Colorado and the Front Range where they are typically dark gray or black; identified by conspicuous tassels, or tufts of hair, on the ears. These squirrels build their nests in favorite ponderosas and utilize the inner bark, seeds, twigs, buds and cones of the trees as their principal food sources.
12. **Mule Deer** *(Odocoileus hemionus)*—inhabit all of Colorado's ecosystems from grasslands to tundra. Named for the large ears, these deer have white tails tipped with black and scent glands above the back hooves.
13. **Mountain Lion** *(Felis concolor)*—feeds principally on deer, but also elk and smaller game over a home range of up to 500 square miles. These lions are distributed from Canada to Argentina, and in Colorado are found primarily in foothills, canyons, shrublands, and piñon-juniper woodlands.

Reptile

14. **Bullsnake/Gopher Snake** *(Pituophis catenifer)*—a crucial predator of rodents, found throughout Colorado in almost all habitats below 8,000 feet. While the name "gopher" snake reflects its excellent burrowing ability in search of gophers and other small mammals, it is also adept at climbing trees in search of birds and bird eggs.

Shrub

15. **Mountain Mahogany** *(Cercocarpus montanus)*—widespread, tall shrub, whose seeds have the ability to bore themselves into the ground. Native Americans used mountain mahogany to make arrow shafts, dyes, and a medicinal laxative.

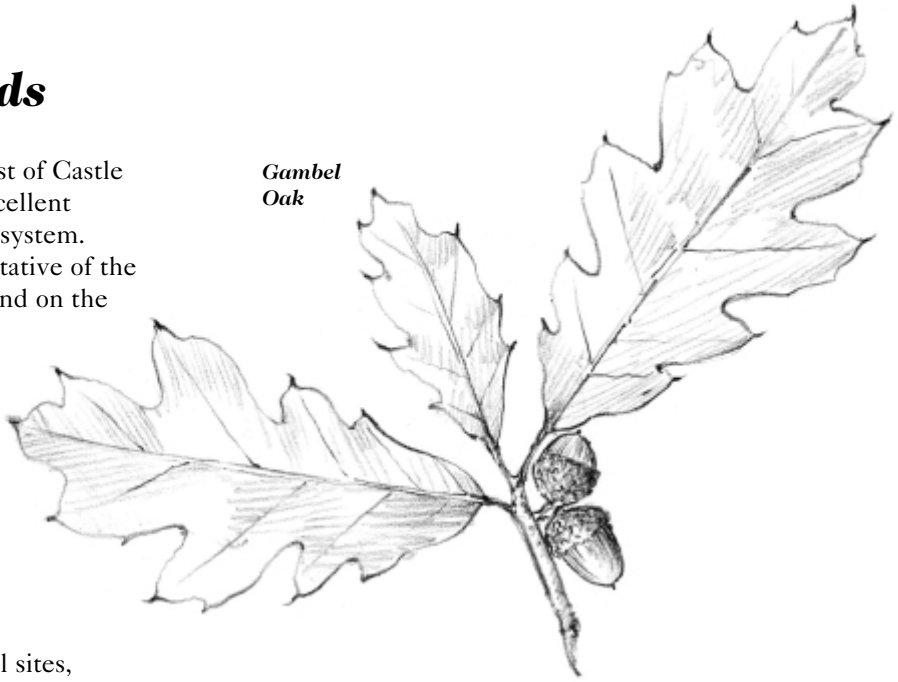
Trees

16. **Ponderosa Pine** *(Pinus ponderosa)*—the defining tree of the lower montane, especially the eastern foothills. This pine has the longest needles of any Colorado conifer and prefers south-facing slopes and warm unshaded soil for re-growth.
17. **Rocky Mountain Juniper** *(Sabina scopulorum)*—abundant at higher, cooler, wetter elevations in Colorado. Sometimes called red cedar for the reddish-brown color of its bark, this juniper produces small bluish berries that are a favorite food of rock squirrels, Colorado chipmunks, and other montane residents.
18. **Gambel Oak** *(Quercus gambelii)*—also called Scrub Oak. In addition to black bear, elk and deer, birds such as black-capped chickadees, spotted towhees, and scrub jays find food in the oak's foliage and acorns, or in the insects that are attracted to the oak.

Montane Shrublands

Southwest of Denver and northwest of Castle Rock, is Roxborough State Park, an excellent example of the montane shrubland ecosystem.

Roxborough State Park is representative of the narrow band of montane shrubland found on the eastern slope of the Rocky Mountains. Larger expanses of montane shrubland are found at similar elevations, from 5,500 to 10,000 feet, on the western slope. Montane shrublands represent a transitional zone between grasslands and montane forest.



Gambel Oak

A Veritable Smorgasbord of Nuts, Berries and Browse

Usually found on dry, rocky foothill sites, montane shrublands have a mix of vegetation, from grasses to scattered piñon or ponderosa pine trees. These areas get about the same yearly precipitation as the grasslands, but their coarse soils do not retain the water for long. Typically, the plants that do best in this ecosystem are shrubs that hold onto moisture during long dry spells.

Mountain mahogany, a shrub that grows up to eight feet tall, is the dominant plant on the east slope foothills. Mountain mahogany is highly tolerant of heat and drought. It is very long-lived, averaging 85 years, with some as old as 1,350 years! A ragged looking plant with greenish-gray leaves covered with soft fuzzy hairs on top and bottom to prevent water loss, mountain mahogany has self-planting seeds. Each seed is equipped with a long, curved, hairy "tail" that allows the sharp pointed seed tip to float to the ground first. As the humidity changes, the "tail" curls and uncurls, driving the seed into the ground like a drill. Mountain mahogany is one of the few browse species that meets or exceeds protein requirements for wintering deer and elk.

Mountain Mahogany

Self-planting seeds

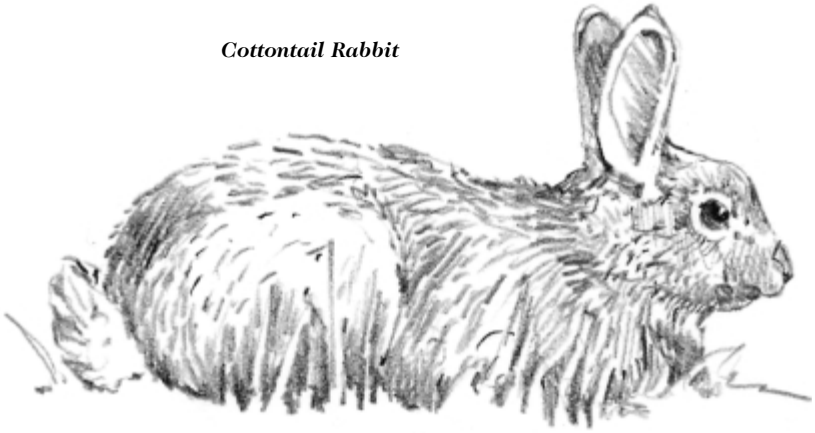
Gambel oak is another important plant in the montane shrubland. It is scattered among mountain mahogany on the southern Front Range foothills, but is dominant and widespread on western slope shrublands. Along with sumac and serviceberry, other deciduous shrubs whose leaves turn red and orange before being dropped, it adds to Colorado's beautiful fall color display. Sometimes called scrub oak, Gambel oak is able to survive in this dry, rocky environment because many of these tall tree-like shrubs sprout from a common root system. This extended horizontal root system efficiently captures the limited rainfall of the lower mountainsides. Gambel oak acorns are rich in nutrients and soft enough to be eaten by almost any animal.

In addition to nutritious mountain mahogany and Gambel oak, a variety of plants in this ecosystem produce a bountiful supply of berries and fruits. Kinnikinnik, a low plant with dark green leaves, produces bright red berries that are an important wildlife food. Skunkbush, or three-leaved sumac, produces tart orange and red berries that were once used to make a lemon-tasting drink. The fruits, or rose hips, of the wild or Wood's rose are an important winter crop for many animals. Wild gooseberries, raspberries, currants, and other fruit-bearing shrubs add to this ecosystem's reputation as a cornucopia for wildlife.

Wildlife You Might Discover in the Montane Shrublands

In an ecosystem filled with seeds, acorns, and berries, its not surprising that mice, chipmunks, ground squirrels, and other rodents are abundant—on the ground, in trees, and among rocks. Cottontail rabbits, which find shelter and cover from predators underneath the shrubs, feed on green leafy vegetation when it is available, and browse on buds, twigs, and bark in the wintertime. Deer, elk, raccoons, and black bear spend a lot of time foraging in this region.

Cottontail Rabbit



Eastern fence lizards and northern side-blotched lizards might sun themselves on rocks or search for insects under shrubs. An unusual lizard, the plateau striped whiptail, can be found in the montane shrublands in western Colorado. This species is unisexual—all are egg-laying females!

An abundance of prey species attracts an abundance of predators. Golden eagles, and Swainson's, red-tailed and sharp-shinned hawks cruise on thermals common along the foothills looking for their next meal. Western rattlesnakes and bullsnakes invade rodent burrows and eat their fill. Gray and red fox, bobcats, skunks, weasels, and coyotes hunt rodents and reptiles, while mountain lion pursue their preferred diet of deer.

The wealth of seeds, insects, and nest sites attracts many birds to this ecosystem. Scrub jays, distinguished from other jays by their lack of a crest, their blue collar and the brownish patch on their back, are common in montane shrublands. One of the survival adaptations of this species is **cooperative breeding**, in which the previous years' offspring help the parents raise the new brood. These "helpers" assist in essential activities such as defending the nesting site, repelling predators, and feeding the young. Indigo and lazuli buntings, western tanagers, black-headed grosbeaks, spotted towhees, dusky flycatchers and Virginia's warblers are also common in the montane shrublands.

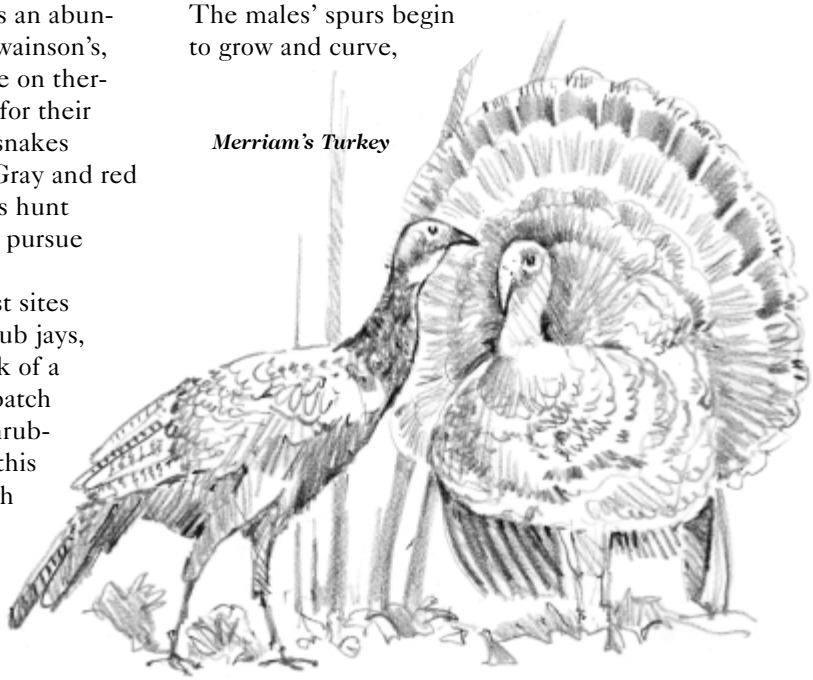
A Closer Look at One Species—Merriam's Turkey

The belt of shrubs and oak below the ponderosa pines provides both food and cover for Merriam's turkey, one of five subspecies of North American wild turkey. Merriam's turkey is a Colorado native, and is distinguished from an introduced subspecies, the Rio Grande turkey, by both its habitat preference and by the nearly white feathers on the lower back and tail feather margins. Merriam's turkeys forage in the montane shrubland for leaves, seeds, nuts, and lots of insects. Wild turkeys are wary birds, with keen eyesight and hearing, and they move toward cover at the slightest indication of danger. They rarely stray far from the ponderosa pines that provide safety from predators and nighttime roost sites.

Merriam's turkeys stand about 37 to 46 inches in height, with males larger than females. Males are more colorful, with iridescent feathers, glittering in varying colors of red, green, copper, bronze and gold. Females' feathers are a more drab brown, to blend in with the surroundings. Both sexes have naked heads, but the males (toms) have deep blue and red colored skin with loose red throat skin known as "wattles."

Two other major characteristics that distinguish the sexes are spurs and beards. When both male and female wild turkeys hatch, they have a small button spur on the back of their legs. The males' spurs begin to grow and curve,

Merriam's Turkey



often reaching a length of two inches, while the females' spurs seldom develop. Males also have beards—tufts of modified feathers—that grow out from their chests. These beards average about nine inches in length, but can grow much longer. A small percentage of females (hens) also develop beards.

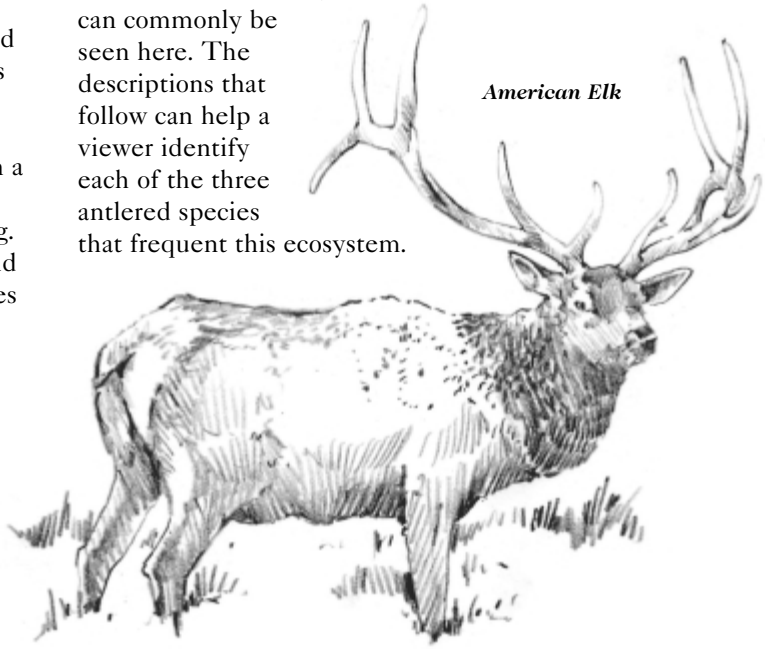
During the winter, turkeys flock together in mixed-sex groups. Sometime between February and April, as the breeding season approaches, the flocks break up into smaller all-male or all-female groups. Later, the male flocks disperse, and males begin to gobble and strut to attract hens. Hens respond with a yelping call. Males may breed with many females. Females are solely responsible for raising the young. Hens lay nine to twelve eggs in a shallow scrape and frequently dump eggs in each other's nests. Females incubate the eggs for about four weeks. **Precocial** young hatch with fully formed feathers, eyes open, and the ability to move about. They leave the nest within a day of hatching to feed, but roost close to the hen for the first few days.

Merriam's turkey is the state's largest **game** bird, a wildlife species that can be hunted according to legal seasons and limits. Current populations of these birds exceed historic levels, but that was not always the case. During the 1800's, both in Colorado and nationwide, commercial slaughter for meat and feathers, habitat destruction, and disease decimated wild turkey populations. In the 1920's, only 250–500 Merriam's turkeys remained in the state, and fewer than 30,000 wild turkeys remained in the entire country. Public concern for the turkey, along with remarkable commitment from the nation's hunters, wildlife agencies and wildlife conservation organizations, brought this grand bird back from the brink of extinction.

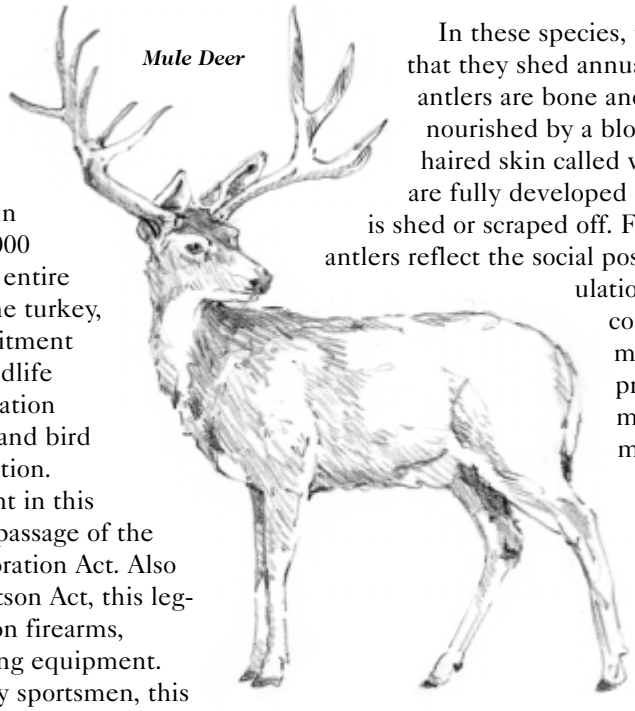
The most important event in this recovery effort was the 1937 passage of the Federal Aid in Wildlife Restoration Act. Also known as the Pittman-Robertson Act, this legislation placed an excise tax on firearms, ammunition, and other hunting equipment. Lobbied for and supported by sportsmen, this tax has raised billions of dollars for wildlife restoration. With extensive transplant efforts, habitat improvement projects, and protection through game laws, Colorado's wild turkey population has grown to an estimated 20,000 to 24,000 birds.

Crossroads of Biodiversity—Montane Shrublands

The montane shrublands are a mid-elevation melting pot where many species mingle. Three of Colorado's four antlered mammals, elk, mule deer, and white-tailed deer, can commonly be seen here. The descriptions that follow can help a viewer identify each of the three antlered species that frequent this ecosystem.



American Elk



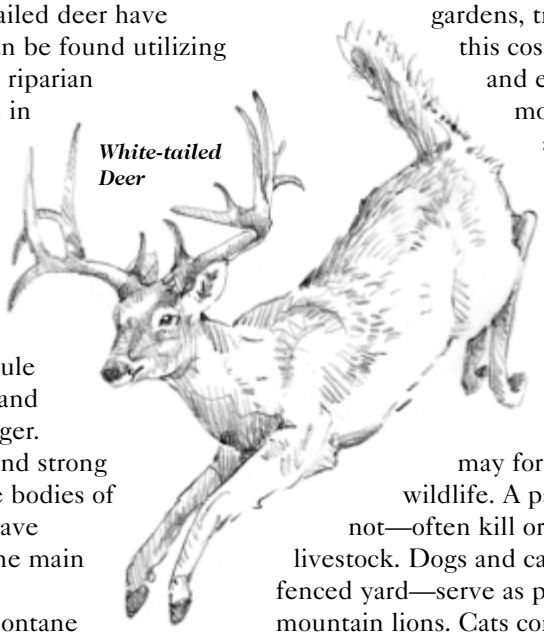
Mule Deer

In these species, the males have antlers that they shed annually in late winter. The antlers are bone and are re-grown each year, nourished by a blood-engorged, finely haired skin called velvet. When the antlers are fully developed and hardened, the velvet is shed or scraped off. For deer, elk, and moose, antlers reflect the social position of males in the population and are important for courtship displays. Antlers, more often than not, provide a deterrent from male to male combat for mating privileges.

Mule deer are found statewide in all ecosystems, but especially favor shrublands, montane forests, and piñon-juniper woodlands in the winter. Named for their large ears that seem constantly in motion, mule deer are primarily browsers. Mule deer have a white tail that is tipped in black. They run with a stiff-legged gait, with back legs, then front legs moving together. The **buck**s' (male deer) antlers branch equally, forking

into two tines, four tines, or more. Young males have either single spikes or a single fork near the tip of the antlers.

White-tailed deer historically have occupied riparian lands, woods, and farmlands of the eastern U.S. where they can get the highly nutritious foods that they prefer. With agricultural development on Colorado's eastern plains, white-tailed deer have expanded their range, and now can be found utilizing both the montane shrublands and riparian areas all along the front range and in select areas west of the Continental Divide. The white-tailed deer has a brown tail, edged with white, but completely white on the underside. When alarmed, this deer raises, or "flags," its tail to communicate danger to other deer. Like mule deer, white-tailed deer also snort and stamp their hooves to convey danger. These deer are graceful runners and strong swimmers, and can go across large bodies of water. Male white-tailed antlers have several tines that come up from the main shaft.



White-tailed Deer

Often seen in herds on the montane shrublands in winter, elk are much larger than deer. They generally have a pale tan or brown body color, with a darker mane of longer hairs on the neck and a paler yellowish tan rump patch. The **bulls** (male elk) have large antlers, with a main beam extending backward over the neck and shoulders. Several tines or points arise from the main beam.

Living With Wildlife in Colorado's Foothills

For people as well as wildlife, montane shrublands are a desirable place to live. Often, people move to the foothills to experience a closer connection to the wild places and wildlife found there. As communities along the foothills grow, habitat is changed and some wildlife is displaced. Some species continue to live in open space areas, parks, river bottoms, and undeveloped parcels of land. Others adapt to urban living. As humans and wildlife adjust to the changes, their relationship is fraught with both promise and pitfalls. Finches and buntings at the bird feeder are a delightful sight—bears at the same feeder are not. By and large, people and wildlife can coexist, if people are alert to the needs and habits of their wild neighbors.

For many species, particularly large grazers and browsers such as deer and elk, subdivisions and roads may block traditional migration routes between summer and winter range. The number of places where deer and elk can move from mountains to lowlands has been squeezed, like going through a funnel. Deer-crossing signs mark many of these areas, and it is essential that drivers slow down and proceed cautiously, especially at night.

It is also common for deer and elk to browse gardens, trees and shrubs. Not only is this costly and annoying, but deer and elk attract predators, such as mountain lions and coyotes, who also eat pets and domestic livestock. Property owners can plant species that are distasteful to deer, use commercial repellents and use fencing to avoid these problems.

Pets can be exceptionally challenging for wildlife. Dogs, when left to roam, may form packs and harass or kill wildlife. A pack of dogs—well fed or not—often kill or mutilate deer and domestic livestock. Dogs and cats left unattended—even in a fenced yard—serve as potential food for coyotes and mountain lions. Cats commonly prey on small, ground-dwelling wildlife and birds. They can be especially damaging during the spring bird-nesting season. It is vital that individuals are responsible pet owners, obey leash laws, and keep dogs and cats under control.

Litter and trash are also problematic. Litter can injure or kill wildlife, particularly birds. Careless handling of trash and pet food can attract bears, raccoons, squirrels, skunks and other species that most people would prefer to keep at a distance! Pet food should be stored inside. Unless bear-proof trash cans are used, trash should not be put outside until right before pick up.

Finally, people must respect the wildness of wildlife. Many dangerous and potentially harmful encounters occur because people fail to leave wild animals alone. Wildlife should not be harassed, captured, domesticated, or—in most cases—fed. Intentional or inadvertent feeding is a cause of a number of wildlife problems. Wildlife habituated to feeding may injure someone in their eagerness to get food. Animals congregating unnaturally to feed may pass diseases to one another. People should not approach sick, injured or even young animals that appear to be abandoned. Such cases should be reported to the Colorado Division of Wildlife.

Acting responsibly, people can enjoy the wildlife they see in the montane shrublands!

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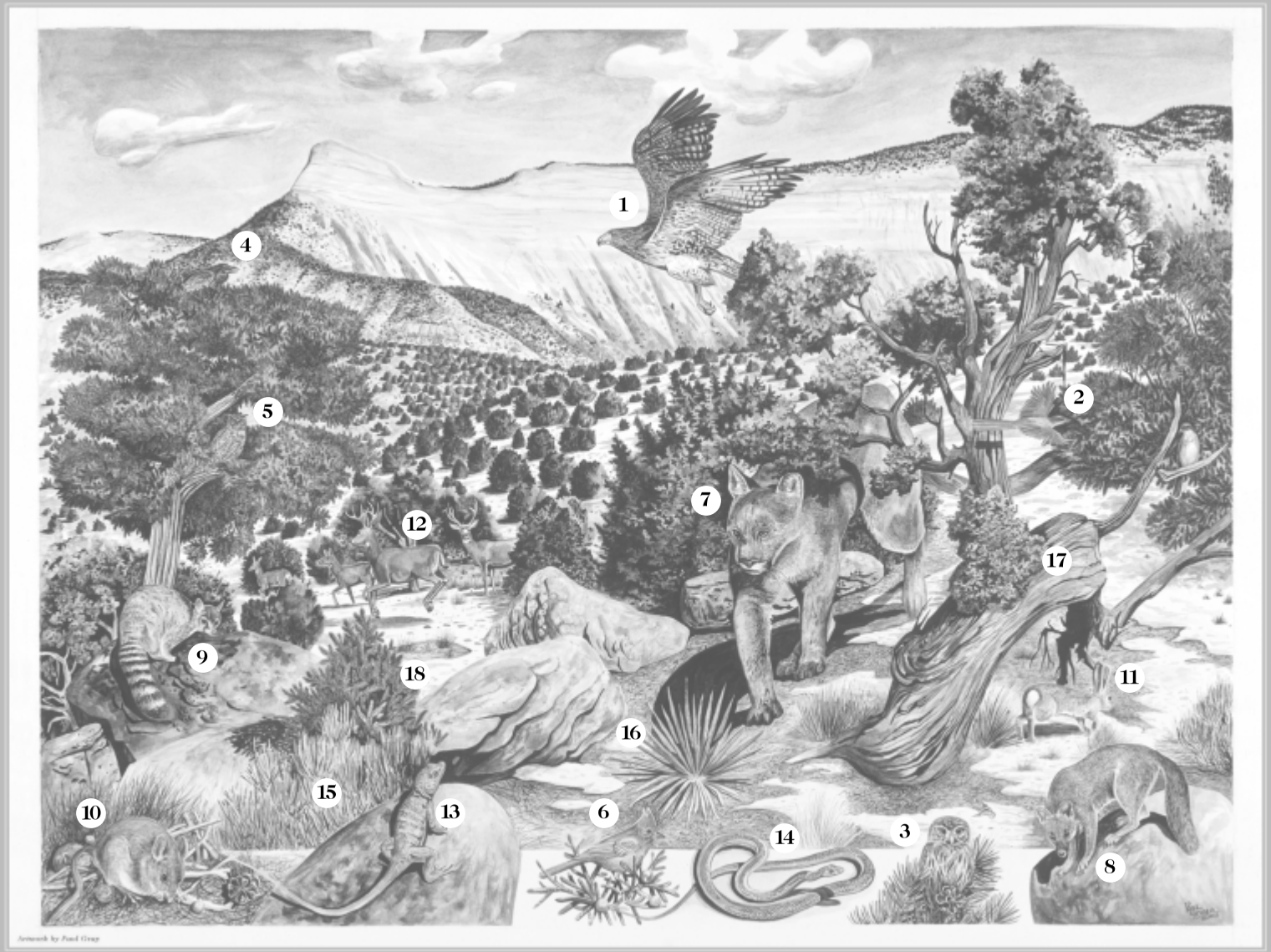


Artwork by Paul Gray

Piñon-Juniper Woodland

Part of a series of eight posters. • Supporting educational materials at www.wildlife.state.co.us

Setting—Near Mesa Verde National Park, near Mancos

Birds

1. **Red-tailed Hawk** *(Buteo jamaicensis)*—most widespread hawk in Colorado, especially numerous in piñon-juniper woodlands and winter grasslands, but occurring year-round from grassland to tundra. In addition to rodents such as prairie dogs, these hawks prey upon reptiles and rabbits.
2. **Western Scrub Jay** *(Aphelocoma californica)*—inhabits open shrublands and woodlands between 5,000–7,000 feet. These sky blue-colored jays are usually found in pairs occupying fixed territories.
3. **Northern Pigmy-Owl** *(Glaucidium gnoma)*—an aggressive diurnal hunter, noisier in flight than most nocturnal owls, preys on rodents and birds, some larger than itself. On the back of the head, this owl displays two dark eye-like patches rimmed in white.
4. **Common Raven** *(Corvus corax)*—distinguished from the all-black American Crow *(C. brachyrhynchos)* by its larger size and more massive bill. Male ravens engage in elaborate aeronautical courtship displays.
5. **Great Horned Owl** *(Bubo virginianus)*—distinguished by its large ear tufts and found at all but the highest elevations, has the widest distribution of any North American owl. The distinctive hooting calls of this nocturnal owl are heard throughout the year, especially in late winter when they begin to nest.
6. **Juniper Titmouse** *(Baeolophus ridgewayi)*—formerly known as the plain titmouse, grayish bird with a small head crest. As part of the courtship ritual, males offer food to females who in turn vibrate their wings and produce high-pitched vocalizations in acceptance.

Mammals

7. **Mountain Lion** *(Felis concolor)*—feeds principally on deer, but also elk and smaller game over a home range of up to 500 square miles. These lions are distributed from Canada to Argentina, and in Colorado are found primarily in foothills, canyons, shrublands, and piñon-juniper woodlands.
8. **Gray Fox** *(Urocyon cinereoargenteus)*—identified by a black "mane" running along its tail, ending in a black tip. Omnivorous and primarily nocturnal, this fox is also an excellent tree climber.
9. **Ringtail** *(Bassariscus astutus)*—a nocturnal member of the raccoon family with a body like a cat, a face like a fox, and a long tail with black circles. Ringtails are excellent mousers, and were kept by early settlers for that very purpose, hence their nickname, "miner's cat."
10. **Mexican Woodrat** *(Neotoma mexicana)*—has a noticeably bi-colored tail, dark on top and light below, and feeds largely on piñon nuts and juniper berries in this ecosystem. In addition to using vegetation in constructing the nest, this woodrat adds debris such as bones and feathers.
11. **Desert Cottontail** *(Sylvilagus audubonii)*—pale gray-brown with rust-colored patches on the throat and chest. Capable of light climbing and swimming, this cottontail requires an adequate density of shrubs and small trees as cover from predators.
12. **Mule Deer** *(Odocoileus hemionus)*—inhabit all of Colorado's ecosystems from grasslands to tundra. Named for the large ears, these deer have white tails tipped with black and scent glands above the back hooves.

Reptiles

13. **Collared Lizard** *(Crotaphytus collaris)*—can be identified by a yellowish head and black bands around the neck. To escape danger, the collared lizard has the interesting habit of getting up on its hind legs and running away.
14. **Striped Whipsnake** *(Masticophis taeniatus)*—identified by a whitish stripe running along each side. Found only in the western Colorado, this snake is a speedy predator that preys upon other snakes including smaller whipsnakes, in addition to insects, lizards, and rodents.

Plants

15. **Mormon Tea** *(Ephedra viridis)*—identified by greenish, leafless, jointed stems, found in rocky areas and canyons. Also known as Cowboy Tea, this plant was used by Native Americans and settlers to make a palatable drink.
16. **Yucca** *(Yucca glauca)*—prefers dry slopes and hillsides. The pod-like fruit of the yucca grows along a tall stalk, while the leaves, long, thin and sharp, radiate from the base.

Trees

17. **Piñon Pine** *(Pinus edulis)*—defining tree of the piñon-juniper woodland, cones contain large pine nuts which are eaten by a variety of animals, including humans. In addition to food, this tree provided Native Americans and settlers with firewood and building material needed for furniture, shelter, and household items.
18. **Utah Juniper** *(Sabina utahensis)*—distinguished from the One-seed juniper *(S. monosperma)* of south central Colorado by having drier and grittier berries/cones and by having a less tapered, more irregular crown. Unlike Oneseed juniper, whose individuals are of either sex, the Utah Juniper usually has both male flowers and female berries on the same tree.

Piñon-Juniper Woodland

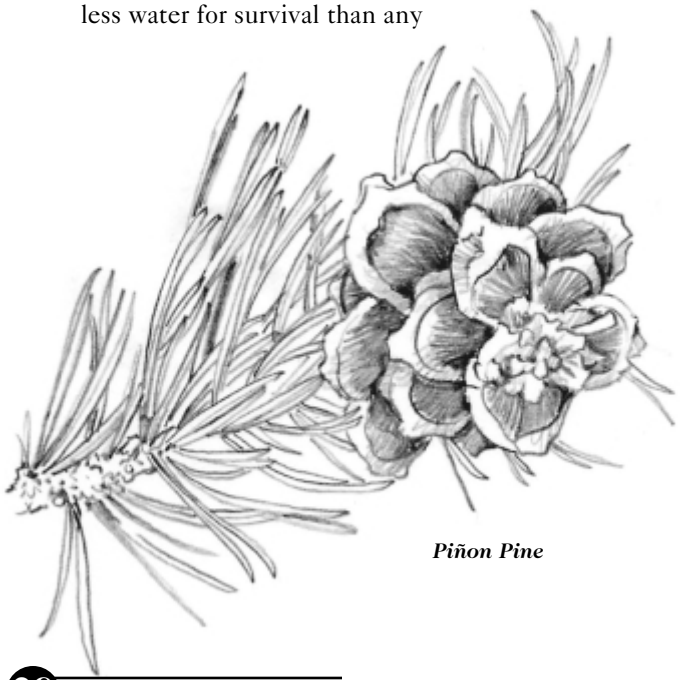
The Colorado National Monument is located west of Grand Junction and south of Fruita. This scenic viewing area, overlooking the Grand Valley, is an excellent example of a piñon-juniper woodland ecosystem.

Piñon-juniper woodlands lie in the transition zone between grasslands or shrublands and lower montane forest, at elevations from 5,000–7,000 feet. They are primarily found in the western part of our state, and in central Colorado south of Colorado Springs. Another piñon-juniper woodland is found in the "Four Corners" area, where the borders of Utah, Colorado, Arizona, and New Mexico come together. Interestingly, there is one isolated stand of piñon-juniper woodland in Owl Canyon, north of Fort Collins, over 100 miles from any other stands! This may be a relict stand from an earlier climate condition—no one knows for sure.

The Pygmy Forest

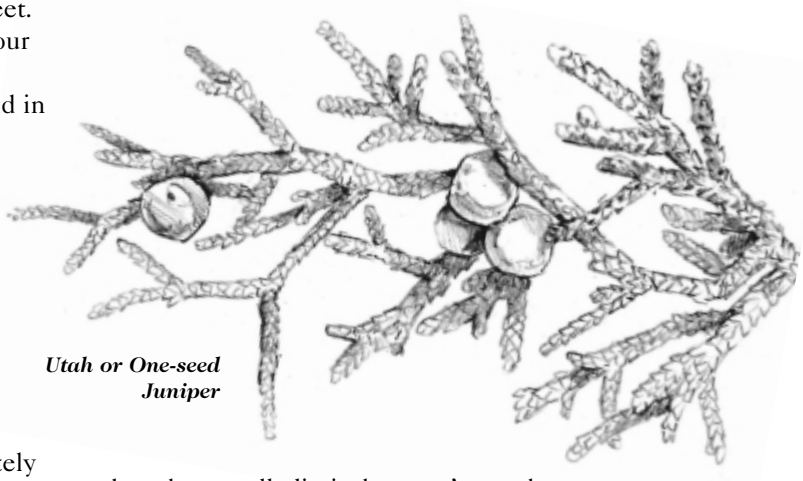
Piñon-juniper woodlands receive approximately 10–20 inches of precipitation each year. The water sinks quickly down through the gravelly soils, discouraging the growth of grasses, and favoring the deeper roots of trees. The result is a landscape of short, evenly spaced trees separated by open areas relatively free of vegetation; a landscape sometimes referred to as the pygmy forest.

This ecosystem flaunts a variety of small trees including Gambel (scrub) oak, Douglas fir and mountain mahogany, but the predominant trees are the piñon pine and either the Utah or one-seed juniper. Piñon pine and juniper require less water for survival than any other Colorado trees. Piñon is more cold tolerant, and prevails at the higher, wetter elevations. The more drought-tolerant juniper is favored at lower, drier sites.



Piñon Pine

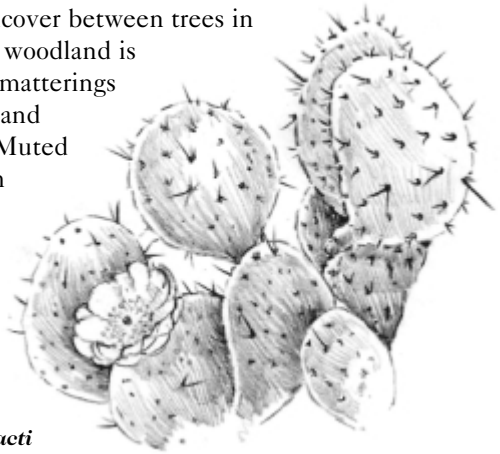
The piñon pine has short one to two-inch-long needles grouped in bundles of two (and rarely three), with small two-inch cones bearing large, edible seeds. While piñons can reach heights of fifty feet, periodic droughts usually limit the trees' growth to heights of thirty feet or less, giving them their stunted, gnarly look.



Utah or One-seed Juniper

The Utah juniper occurs in western slope piñon-juniper woodlands, while the one-seed prevails in the woodlands of south central Colorado. Juniper leaves on both varieties appear as tiny, overlapping scales along the branches, giving the tree a unique and easily identifiable appearance. The bluish-gray or purplish berries are actually modified cones in which a few fleshy scales enclose a seed. Foliage color and berries distinguish the two. The berries of the yellow-green Utah juniper are dryer than the juicier berries of the gray-green one-seed. Utah junipers usually have both male and female cones, while one-seed juniper trees are single gender, with the females possessing the larger, berry-like cones.

While groundcover between trees in the piñon-juniper woodland is sparse, there are smatterings of grasses, shrubs and flowering plants. Muted green grasses such as blue grama, Junegrass and Indian ricegrass are interspersed with succulent prickly-pear

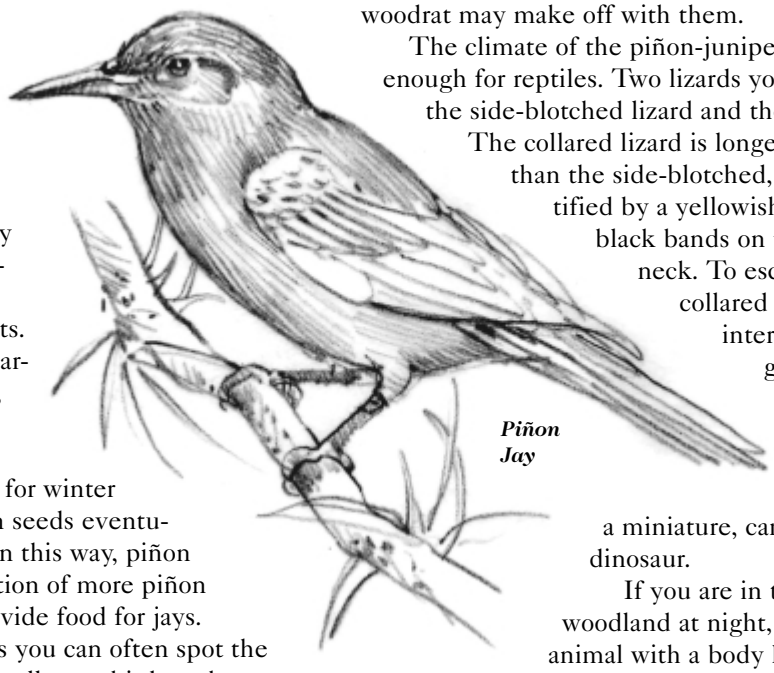


Prickly-pear Cacti

cacti and bright yellow sunflowers. Raggedy shrubs such as the cliff rose, apache plume, and antelope brush or bitterbrush, provide browse for game animals that visit the woodlands.

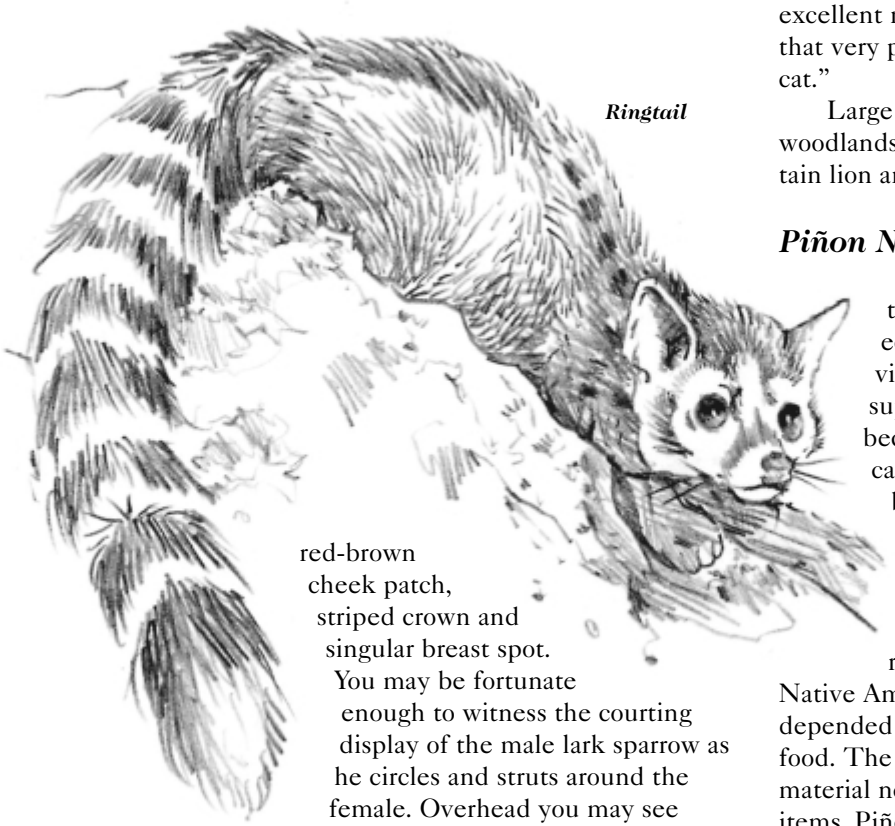
Wildlife You Might Discover in the Piñon-Juniper Woodland

If you visit the piñon-juniper woodland, you may see large numbers of blue-colored birds pecking at pinecones to get at the nuts. These are piñon jays, a year-round resident. In the fall, jays carry away pine nuts, which are actually piñon seeds, and stockpile them for winter food. Some of the uneaten seeds eventually grow into new trees. In this way, piñon jays assist in the reproduction of more piñon trees, which will again provide food for jays.



Piñon Jay

Elsewhere in the trees you can often spot the nests of bushtits. These small, gray birds make use of spiders' silk to attach their nests to branches. There may also be ground-nesting birds such as the canyon towhee and the lark sparrow, identified by its red-brown cheek patch, striped crown and singular breast spot. You may be fortunate enough to witness the courting display of the male lark sparrow as he circles and struts around the female. Overhead you may see red-tailed hawks, golden eagles, American kestrels, and prairie falcons on the lookout for rodents such as the ever-present Piñon mouse and the bushy-tailed woodrat. The woodrat's nickname of "packrat" is well deserved. If you leave items lying around your campsite, the woodrat may make off with them.



Ringtail

The climate of the piñon-juniper is still warm enough for reptiles. Two lizards you might spot are the side-blotched lizard and the collared lizard. The collared lizard is longer and bulkier than the side-blotched, and can be identified by a yellowish head and the black bands on the back of the neck. To escape danger, the collared lizard has the interesting habit of getting up on its hind legs and running, giving the appearance of a miniature, carnivorous dinosaur.

If you are in the piñon-juniper woodland at night, you may see an animal with a body like a cat, a face like a fox, and a long tail with black circles—a ringtail. This nocturnal member of the raccoon family walks on its toes, and dens in hollow tree stumps, logs, and rock crevices. Ringtails are excellent mousers, and were kept by early settlers for that very purpose; hence their nickname, "miner's cat."

Large mammals found in the piñon-juniper woodlands include pronghorn, mule deer, elk, mountain lion and black bear.

Piñon Nuts—The Heart of the Ecosystem

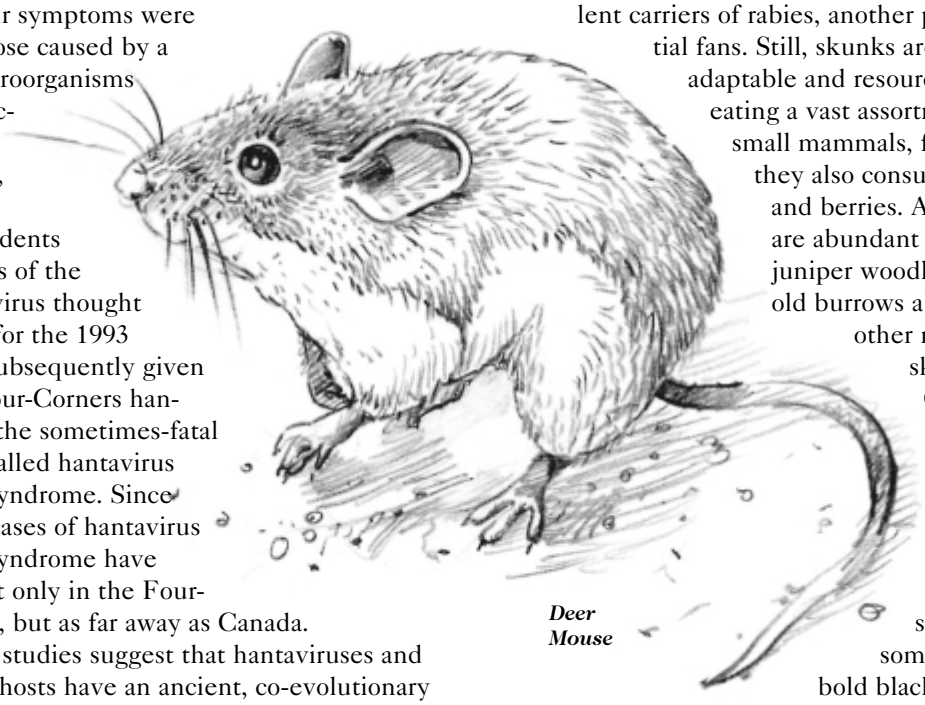
Piñon in Spanish means "nut" or "nut tree." Many of the species in this ecosystem depend on these nuts for survival. The nuts provide an ample food supply for birds and rodents, which in turn become prey for other species. The high calorie nuts are also a critical fall food for black bears, and the presence of a good crop helps bears gain the necessary weight they need to survive the winter and successfully reproduce.

The piñon pine nut was an important resource for the people who settled here. Native Americans and early European settlers depended on the sweet, highly nutritious nuts for food. The tree also provided firewood and building material needed for furniture, shelter and household items. Piñon pitch was used as glue and for waterproofing various domestic items, as well as for

dressing wounds. Today, piñon pine nuts are still a highly coveted food item and are even harvested commercially for sale in grocery and specialty shops.

A Closer Look at One Species: Four-Corners Hantavirus

In 1993, a severe illness appeared in a cluster of people in the region where Colorado, New Mexico, Arizona and Utah meet. Studies revealed that these people had been exposed to deer mouse droppings and that their symptoms were similar to those caused by a group of microorganisms known collectively as hantaviruses, which are carried by rodents in other parts of the world. The virus thought responsible for the 1993 illness was subsequently given the name Four-Corners hantavirus, and the sometimes-fatal illness was called hantavirus pulmonary syndrome. Since then, other cases of hantavirus pulmonary syndrome have appeared not only in the Four-Corners area, but as far away as Canada.



Deer Mouse

Genetic studies suggest that hantaviruses and their rodent hosts have an ancient, co-evolutionary relationship, and that Four-Corners hantavirus did not emerge from a sudden evolutionary mutation. Why, then, did hantavirus pulmonary syndrome seemingly appear out of nowhere?

Scientists noted that during the period 1992–1993, the weather was unusually warm and wet, with an earlier spring thaw, resulting in an abundance of the vegetation that makes up the bulk of the deer mouse's diet. The result was a tenfold jump in the deer mouse population. The increased populations of both mice and humans in this area, along with the mouse's attraction for human dwellings, brought more deer mice and their droppings into close proximity to people.

While research continues, scientists have suggested that the recent occurrences and spread of this illness may coincide with changing climate and population patterns. Some are using El Niño cycles, which often bring warmer and wetter weather to the area, to predict possible outbreaks of hantavirus pulmonary syndrome. The complex relationship between weather, microorganisms and their hosts, and human wellness illustrate the intricate dynamics of biodiversity.

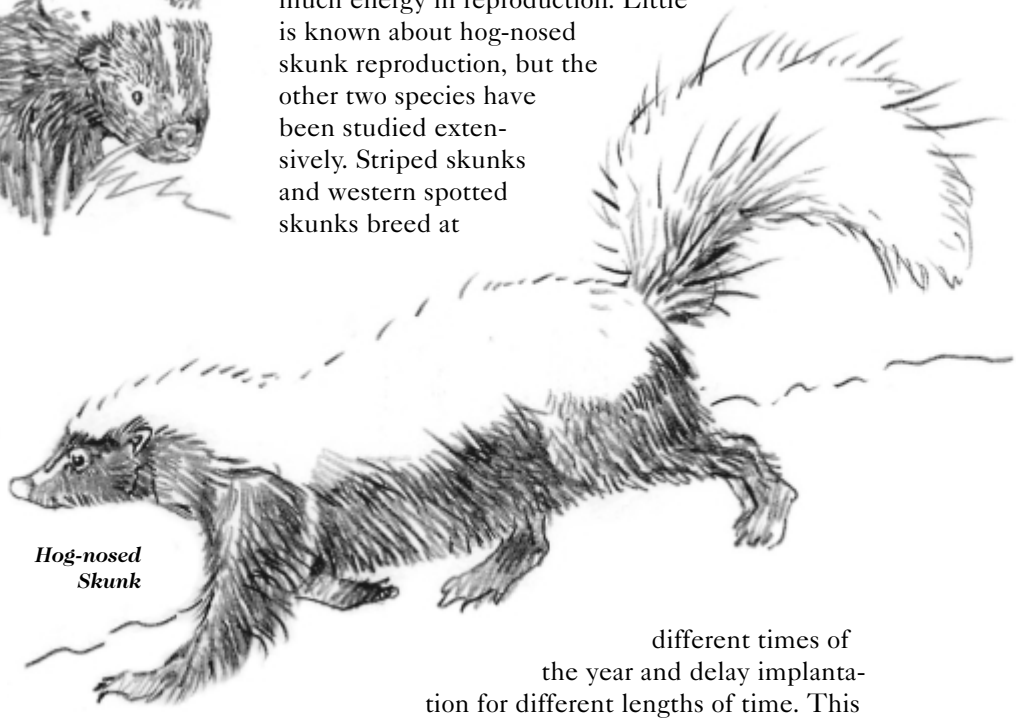
Crossroads of Biodiversity— Piñon-Juniper Woodlands

Skunks may not be the most popular of animals. They have perhaps the most widely known and despised defense system of any mammal, and even a picture of the foul smelling scent-spraying omnivore can trigger a powerful reaction in some people. The noxious vapor often causes nausea and burns the eyes and nasal cavities of the unfortunate target. Skunks are also known to be among the most prevalent carriers of rabies, another put-off to potential fans. Still, skunks are highly adaptable and resourceful. Besides eating a vast assortment of insects, small mammals, fish and reptiles, they also consume fruits, nuts, and berries. All of these foods are abundant in the piñon-juniper woodlands, as are the old burrows abandoned by other mammals that skunks use to den. Consequently, three of North America's skunk species reside in this ecosystem.

All three species exhibit some variation of the bold black and white markings that serve as a warning to potential predators. The most common of the three is the striped skunk. It has black fur with a white stripe that begins as a triangular shape on the top of its head, forks into two wide stripes that travel down the sides of the back, and usually merges again near the base of the tail. Another white stripe runs from the base of the snout between the eyes and ends on the forehead. Because the striped skunk is found throughout the continental U.S., in nearly every habitat and elevation, this is the pattern that first comes to mind when the word "skunk" is mentioned.

The western spotted skunk prefers the middle elevations where piñon-juniper woodlands exist. As its name implies, the western spotted skunk is found in the western and southwestern U.S., with Colorado's eastern foothills marking the eastern edge of its range. It is less common and much smaller than the striped skunk. Its pelt has many broken black and white stripes of equal width on its upper back that begin between the ears or just behind them. A large white patch covers more than half the area between the western spotted skunk's eyes. Its tail is white on the underside for nearly half its length with an exclusively white tip.

Striped Skunk



Hog-nosed Skunk

Spotted Skunk

Colorado represents the extreme northern range of the common hog-nosed skunk, which is not really common in Colorado. This is a rather large skunk with a single, broad white stripe from the top of its head to the base of its long, bushy tail. Its tail is white all over except for a few scattered black hairs beneath. It does not have a white stripe on its head, but does have a distinguished long, flexible snout.

All skunks utilize **delayed implantation**, in which the attachment of the fertilized egg to the uterine wall is delayed as a survival strategy for lean times. If food resources are insufficient to raise a family, the female skunk aborts before investing much energy in reproduction. Little is known about hog-nosed skunk reproduction, but the other two species have been studied extensively. Striped skunks and western spotted skunks breed at different times of the year and delay implantation for different lengths of time. This may be one way that the two species avoid competition at a critical time and ensure that each can successfully reproduce. This type of survival strategy, where species restrict their activities to a specific time period or part of the environment, is called **specialization** or **niche differentiation**.

Here's how it works: male skunks use their pungent defense odor to communicate with the opposite sex during mating season and to mark their territories. It might be troublesome to have two different species spraying at the same time. So, striped skunks breed in the spring, but implantation of the eggs is delayed about 19 days, with new litters arriving usually in late May or early June. The western spotted skunks mate in early fall, but delay implantation for nearly six months, giving birth around the same time as the striped skunk, when food is plentiful for the young.

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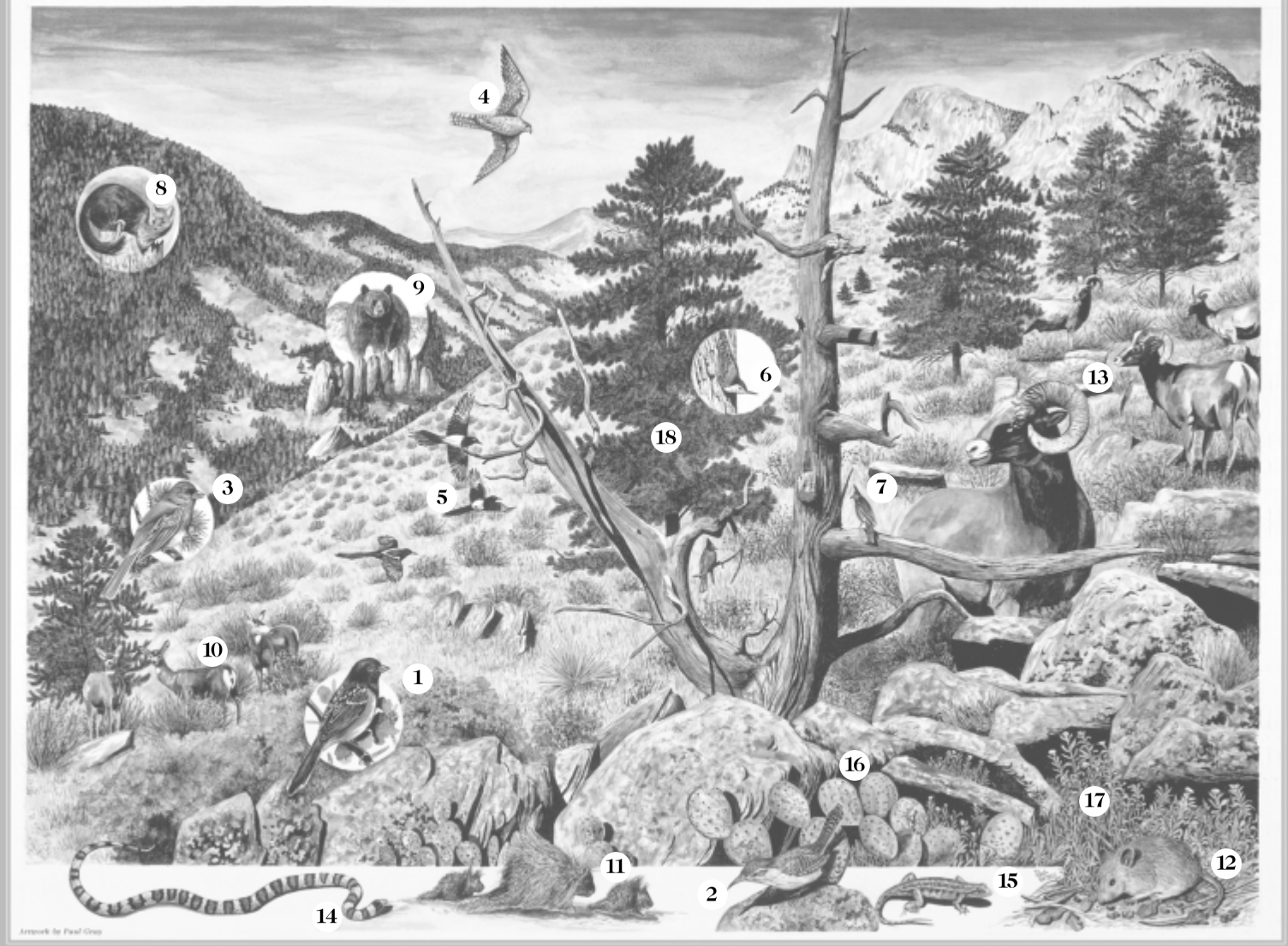
WILD Colorado: Crossroads of Biodiversity



MONTANE FORESTS

Part of a series of eight posters • Supporting educational materials at www.wildlife.state.co.us

Setting—Above the Big Thompson River, east of Estes Park

Birds

1. **Spotted Towhee** *(Pipilo maculatus)*—formerly called the rufous-sided towhee, recognized by a dark head, brownish sides, and spotted wings. In addition to eating insects, spiders and lizards, this towhee rakes up vegetable matter by hopping backwards on the ground.
2. **Rock Wren** *(Salpinctes obsoletus)*—favors rocky or broken terrain from grassland to tundra. The rock wren paves its nest entrance with pebbles and rock pieces, adding more material if the nest is reused in subsequent years.
3. **Dark-eyed Junco** *(Junco hyemalis)*—gray-headed bird found in the montane forest. Flocks of these ground-nesting birds tend to return to the same area each year.
4. **Prairie Falcon** *(Falco mexicanus)*—identified by dark wing lining seen from below, and thin, dark cheek bars. Tagged Canada hatchlings have been found in Colorado in winter.
5. **Black-billed Magpie** *(Pica pica)*—easily identified by its black and white coloring and long tail, prefers lightly treed habitats. The magpie is the ultimate generalist, with a diet that includes fruit, berries, seeds, insects, worms, garbage, carrion, birds' eggs and hatchlings.
6. **White-breasted Nuthatch** *(Sitta carolinensis)*—common in Colorado's ponderosa forests, identified by white underside tinged with reddish brown and dark band along the crown of the head. This nuthatch is known for caching food in tree bark and for proceeding headfirst down trees while hunting for insects.
7. **Steller's Jay** *(Cyanocitta stelleri)*—distinguished by its prominent head crest and deep blue wings and tail. This jay is opportunistic when searching for food, often taking advantage of unguarded offerings at campgrounds and picnic areas.

Mammals

8. **American Marten** *(Martes americana)*—often called the pine marten, an excellent climber with semi-retractile claws and the ability to rotate the back legs for a better grip during descent. This weasel-like carnivore preys primarily on voles, mice, and small squirrels.
9. **Black Bear** *(Ursus americanus)*—can range in color from light brown, even blond, to black. Black bears are omnivores, whose diet of grasses, forbs, berries, fruits, acorns, insects, mammals, and carrion varies with the seasons.
10. **Mule Deer** *(Odocoileus hemionus)*—inhabit all of Colorado's ecosystems from grasslands to tundra. Named for the large ears, these deer have white tails tipped with black and scent glands above the back hooves.
11. **Common Porcupine** *(Erethizon dorsatum)*—known for quills on the tail and lower back that are thrust, not thrown, into an adversary. Like the skunk, when threatened the porcupine may engage in displays such as tooth chattering, waving the tail with quills erect, and even on occasion issuing a strong scent.
12. **Mexican Woodrat** *(Neotoma mexicana)*—has a noticeably bi-colored tail, dark on top and light below, and feeds largely on pine cones, acorns, and juniper berries in this ecosystem. In addition to using vegetation in constructing the nest, this woodrat adds debris such as bones and feathers.
13. **Bighorn Sheep** *(Ovis canadensis)*—Colorado's state animal, used on the logo of the Colorado Division of Wildlife. The sheep's horns, massive and curled on the male, shorter on the female, have growth rings that can be used to estimate age.

Reptiles

14. **Milk Snake** *(Lampropeltis triangulum)*—banded in red or orange, white and black, occurs from Colorado's grasslands to lower montane forests. This constrictor was so-named because it was once thought to be able to milk cows.
15. **Sagebrush Lizard** *(Sceloporus graciosus)*—a common species in western Colorado, identified by two light-colored stripes running down either side of the back. Males engage in territorial head-bobbing displays.

Plants

16. **Prickly-pear** *(Opuntia polyacantha)*—cactus characterized by flat, green, oval-shaped pads with spikes arranged in regularly spaced bundles. The flowers that appear in late spring are yellow or reddish in color and up to three inches across.
17. **Skunkbrush** *(Rhus trilobata)*—found along rocky slopes of the montane shrublands. This plant is known by a variety of common names, including lemonade-bush, three-leaf sumac, and polecat bush.

Tree

18. **Ponderosa Pine** *(Pinus ponderosa)*—the defining tree of the lower montane, especially the eastern foothills. This pine has the longest needles of any Colorado conifer and prefers south-facing slopes and warm unshaded soil for re-growth.

Montane Forests

Golden Gate Canyon State Park, easily accessible from Highway 93 between Golden and Boulder, is an excellent example of the montane forest ecosystem.

The word "montane" means mountain. Montane forests are found on the slopes of the Rocky Mountains at elevations between 5,500 and 9,000 feet. Some popular sites include the Black Forest, east of Interstate 25 between Denver and Colorado Springs, the forests at the very northwestern corner of our state, and a forested area southwest of Grand Junction.

Not surprisingly, the major feature you'll see in the montane forest is trees! Ponderosa pines dominate south-facing slopes, while Douglas firs are more common on moister north-facing slopes and on the western slope of the Rockies. At lower montane forest elevations, Rocky Mountain juniper may be interspersed with ponderosa pine. At higher elevations, lodgepole pine and spruce become more common. Other trees and shrubs in the montane forest include aspen, kinnikinnik, and mountain mahogany.

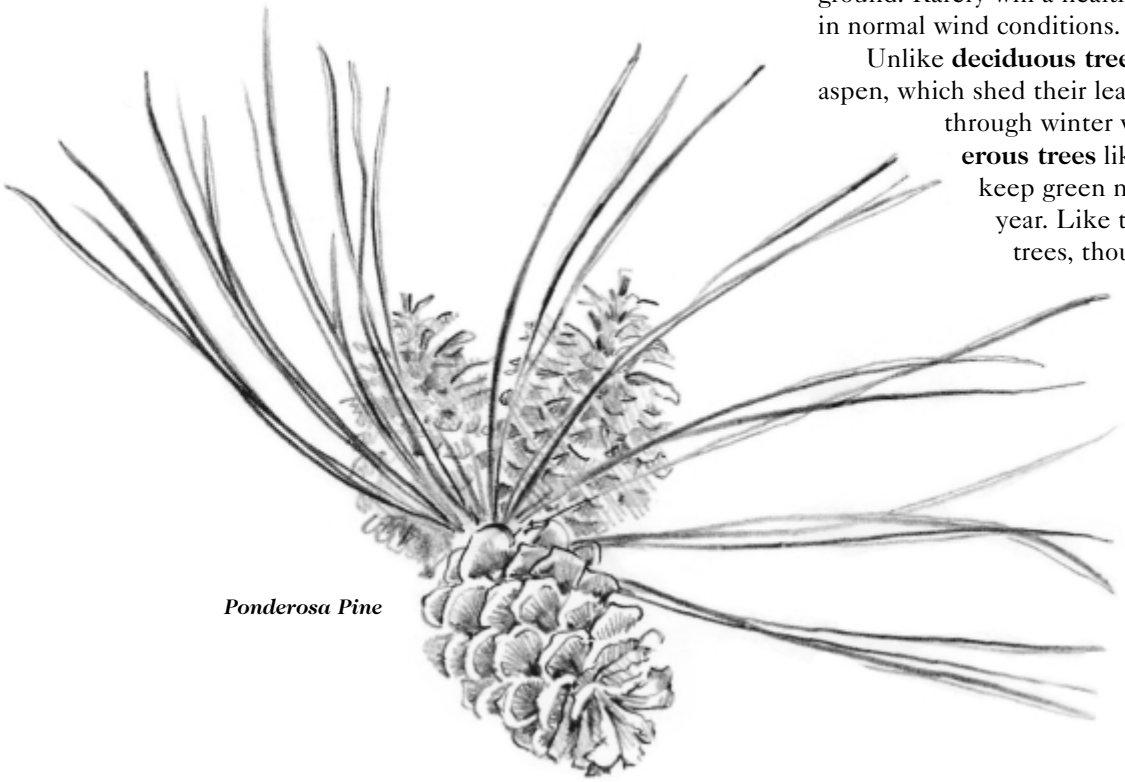
Ponderosa pines have very long, thin needles that tend to grow in bundles of two or three toward the ends of their branches. Douglas fir needles grow singly along the branches, are shorter than the ponderosa's, and are flat. An easy way to remember the shape of the Douglas fir's needles is to think, "flat fir."

Douglas Fir

The Ponderosa Forest—A Landscape Forged by Wind and Fire

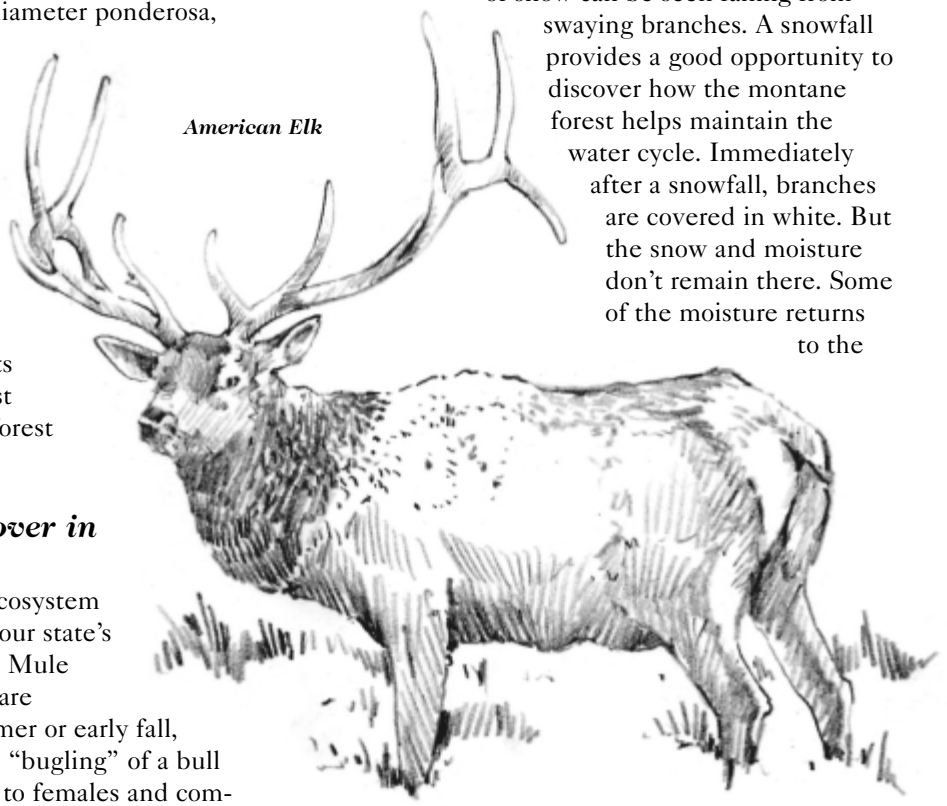
Warm, downslope winds blow across the Continental Divide from the west and descend through the foothills montane forests at speeds sometimes approaching 100 miles per hour. These "Chinook" winds can warm local temperatures as much as 60 or 70 degrees Fahrenheit within an hour. Colorado's ponderosa pines evolved with these winds, and have adapted to benefit from them. While strong winds can break off branches and even blow down stiffer species of trees, the flexible upper trunks of the ponderosa sway back and forth in the wind. These trees have also developed an extensive lateral root structure that firmly anchors them in the ground. Rarely will a healthy ponderosa blow down in normal wind conditions.

Unlike **deciduous trees** such as maple and aspen, which shed their leaves every autumn and go through winter with bare branches, **coniferous trees** like the ponderosa pine keep green needles throughout the year. Like the leaves of deciduous trees, though, needles on ponderosa do turn brown and fall off. They don't fall off, however, until new green needles have already grown. As ponderosa branches grow longer every year, new needles appear along the new growth. Further back on the branch, the oldest needles turn brown and are shed in high winds.



Ponderosa Pine

Ponderosa pines have evolved to take advantage of the periodic fires that were a regular feature of the montane forest prior to modern human settlement. Ponderosa do not grow well in the shade, preferring direct sunlight and warmer soils. Ponderosa in dense stands do not receive the nutrients, light, or water needed for vigorous growth. Periodically, lightning-caused fires would clear out forest brush and litter, as well as smaller ponderosa and other species of trees. The thicker bark of the larger ponderosa withstood the effects of low and moderate intensity fires and the surviving trees thrived in the fire-opened areas. Due to our recent history of fire suppression, the forests of the lower montane have accumulated high densities of small and medium diameter ponderosa, along with shade-tolerant species that have taken advantage of the ponderosa canopy. As a result of this accumulated fuel, most recent wildfires have been of sufficient intensity to kill even the largest ponderosa, significantly altering the landscape and threatening people and property. Elected officials, resource managers, and ecologists are currently considering the best methods to tackle the issues of forest management.



American Elk

Wildlife You Might Discover in the Montane Forest

The montane forest is the ecosystem we often associate with some of our state's most recognizable big mammals. Mule deer, named for their large ears, are common, as are elk. In late summer or early fall, you might hear the high-pitched "bugling" of a bull elk as he proclaims his presence to females and competing males. Raccoon, porcupine, deer mice, red fox, black bear and coyote also make their home in the montane forest.

Bird species abound. Looking up in the sky, you may see turkey vultures soaring in lazy circles, searching for food by smell as well as sight. Below, ground-dwelling birds such as dark-eyed juncos, gray with a bit of rust color on their backs, might be spotted searching for food or protecting their nests. Closer to eye level, you might glimpse the silent flight of a great horned owl as it glides below the tree branches. Black-chinned hummingbirds and mountain chickadees are frequent visitors to area bird feeders.

The wolf spider is common in the montane forest, and, like a wolf, hunts for food rather than waiting for some unsuspecting victim to fall into its web. Female wolf spiders spin large whitish egg sacs at the end of their bodies and carry the eggs around with them until they hatch. Hatchlings then climb on their mother's back and ride around until they can fend for themselves.

The Montane Forest through the Seasons

Colorado's seasons are on full display in the montane forest. The spectacular fall color of changing aspen leaves is just one golden example.

Look out over the forest on a breezy, sunny day right after a snowfall. One after another, great clouds of snow can be seen falling from swaying branches. A snowfall provides a good opportunity to discover how the montane forest helps maintain the water cycle. Immediately after a snowfall, branches are covered in white. But the snow and moisture don't remain there. Some of the moisture returns to the atmosphere directly as water vapor, in a process called **sublimation**. Some is taken into the branches and used by the trees. But, especially if the days following a snowfall are sunny, warmer, and breezy, much of the snow in the lower montane falls to the ground, where it is shaded and much of its moisture allowed to return to the soil. This soil moisture helps irrigate the forest vegetation and recharge ground water sources. Some of the snowmelt runs off into creeks and rivers, helping sustain Colorado's surface waters.

In late spring and summer, visitors to the montane landscape are treated to an abundance of glorious wildflowers. You may spot the blue and white colors of our state flower, the Colorado columbine, in moist low-lying areas. On open slopes

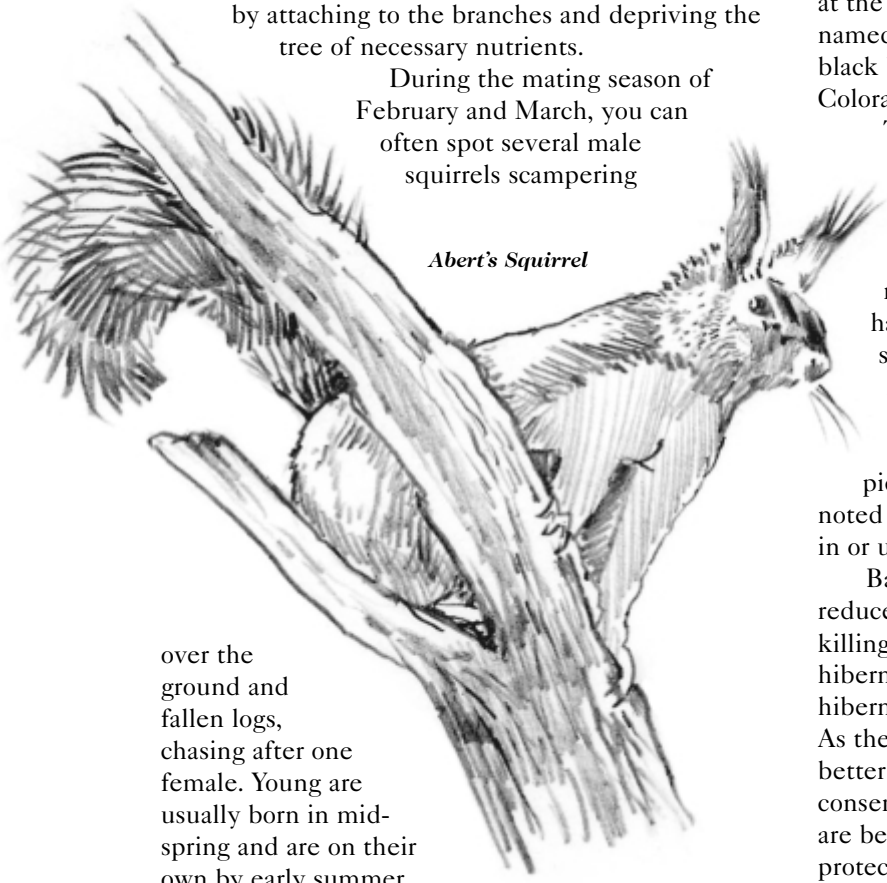
and meadows, tall, red orange-colored tips signal a clump of Indian paintbrush. The purple colors of penstemons and lupines contrast with the yellows of the many asters that grow from foothills to subalpine elevations.

A Closer Look at One Montane Forest Species

The Abert's squirrel is associated almost solely with the montane forest ecosystem. In Colorado, this squirrel has a gray or black coat, bushy tail, and long tasseled ears. They make their home among the ponderosa, often singling out an individual tree. They appear to use taste to select trees with the most nutritional value.

Abert's squirrels rely on the ponderosa pine for food, nesting, and cover. They build their nests high up in the ponderosa, and eat the cones, buds, and inner bark of the tree. Although they can consume a sizeable portion of the entire cone crop in an area, they do help to distribute ponderosa seeds. Abert's squirrels have also been known to eat mistletoe, a small parasitic plant that can debilitate ponderosa by attaching to the branches and depriving the tree of necessary nutrients.

During the mating season of February and March, you can often spot several male squirrels scampering over the ground and fallen logs, chasing after one female. Young are usually born in mid-spring and are on their own by early summer.



Abert's Squirrel

Crossroads of Biodiversity—Colorado's Montane Forests

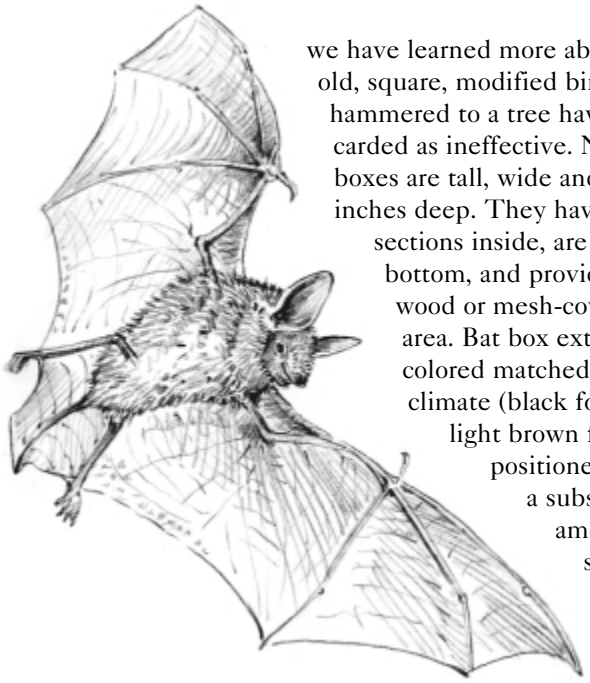
All of Colorado's eighteen known bat species are insectivores that consume enormous quantities of harmful forest and agricultural pests. A single bat often consumes half its own weight in flying insects every night! Over and above their contributions to pest control, bats are a boon to science and medicine. Their longevity, disease resistance, ease in ability to become **torpid** (lower their metabolic rate), and sonar capabilities make bats useful in scientific research. Bats have been used in studies ranging from the effects of smoking and alcohol consumption, blood cell mechanics, tissue regeneration, aging, contraception, low-temperature surgical techniques, to speech pathology and vaccine development. Montane forests are home to several species of these important animals. Among the bats that share this ecosystem are the little brown bat, long-legged myotis, and the silver-haired bat.

One of the most common species of bat found in the United States, the little brown bat is quite small, measuring only a few inches in length and weighing perhaps no more than half an ounce! The long-legged myotis ("myotis" identifies the "mouse-eared" bats) is considerably larger and found only in the western half of the United States, with Colorado at the eastern end of its range. The silver-haired bat, named for the frosted back hairs on its otherwise black body, is near the southern end of its range in Colorado.

These montane bat species prefer different sites in the forest. Little brown bats favor moist woodlands near streams and ponds for their habitat, while long-leggeds and silver-haireds choose drier forests. Long-legged bats roost in caves. Mining has actually increased habitat for this and other cave-dwelling species, since Colorado lacks a sufficient amount of natural caves. The silver-haired is one of the few bats that prefer to roost in trees rather than caves. Little brown bats are not too picky about where they roost, and have been noted roosting in tree hollows, underneath tree bark, in or under buildings, bridges or rocks, and in caves.

Bat numbers nationwide have been severely reduced, due to a variety of factors such as deliberate killing, vandalism of **hibernacula** (places where bats hibernate), disturbance by cave explorers during hibernation, habitat loss, and agricultural pesticides. As their value to ecosystems and to humans becomes better understood, concerted steps are being taken to conserve bat populations and their habitats. Efforts are being made to enhance remaining habitat and protect usable human-made environments. Mines and natural caves are being closed with entrance grates that allow access for bats while discouraging human intrusion and disturbance.

In other areas, residents are being urged to put up bat boxes to increase roosting opportunities. The design and placement of bat boxes has changed as



we have learned more about bats. The old, square, modified bird boxes hammered to a tree have been discarded as ineffective. Newer bat boxes are tall, wide and only a few inches deep. They have baffled sections inside, are open at the bottom, and provide a grooved wood or mesh-covered landing area. Bat box exteriors are colored matched to the local climate (black for coolest to light brown for hottest), positioned to receive a substantial amount of direct sunlight, and placed high up on poles or on buildings. A great resource for bat information is Bat Conservation International.

Bats: Myth and Reality

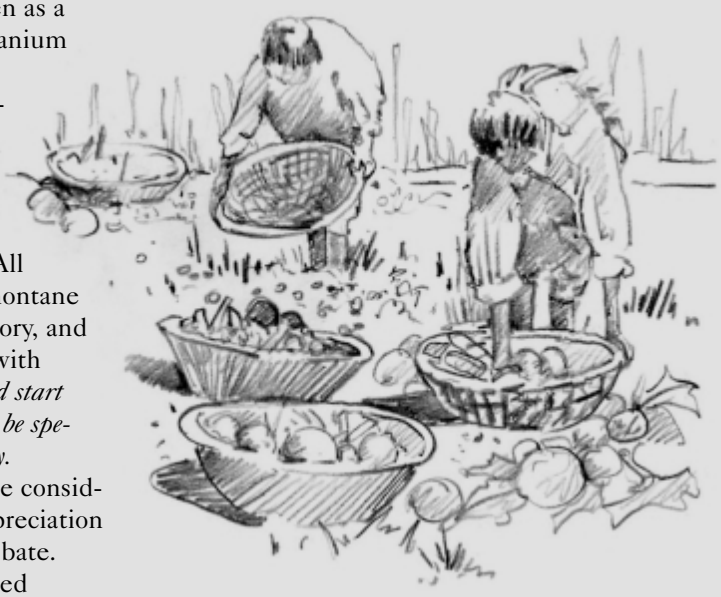
Not so long ago, bats were seen only as something to be feared and eliminated. Being nocturnal predators, they were associated with darkness. They were thought to drink human blood, because one species does feed on blood from mammals. There was also the justified fear that bats spread rabies, as can many other mammals. (As with all animals, individuals found lying on the ground or acting strangely should not be handled.) Among the myths about bats is that they are blind and can get caught up in people's hair. In reality, bats have good eyesight and are only attracted to the bugs that are attracted to people. Fortunately, the negative myths about these wondrous creatures are being dispelled as their special qualities and beneficial behaviors are more fully appreciated.

Cultural diversity

Cultural diversity describes the richness of knowledge, beliefs, and traditions within our own species. Cultures use and value natural resources in a variety of ways. The Cheyenne who frequented the foothills and mountain parks of Colorado prior to Euro-American settlement made good use of many plants and flowers. They used curly dock, a rust-colored spiral-flowered plant, as a dye and to treat internal hemorrhaging and external wounds. Green gentian, also known as the monument plant or "deers ears," was used to treat diarrhea. The tansy yarrow was taken as a cough and cold remedy. Richardson's geranium was a good treatment for nosebleed.

In addition to using plants for medicinal purposes, the Cheyenne obtained food from such plants as wild strawberry, gooseberry currant, wild onion, prickly-pear cactus, wild licorice, choke cherry, raspberry, and Indian turnip (scurf pea). All these plants are still to be found in the montane forest ecosystem, connecting us with history, and reminding us of our interconnectedness with nature and other cultures. *Don't go out and start eating these or any other plants. Many had to be specially prepared before they could be used safely.*

Some human activities that were once considered harmless or even valuable for an appreciation of nature are now the subject of much debate. Collecting samples of small animals or shed snakeskin and antlers can further wildlife education and perhaps inspire students to pursue careers in environmental fields. On the other hand, animals, plants, and organic material are important components of an ecosystem. In recent years, large numbers of visitors to montane meadows have been observed completely denuding an area of its wildflowers. This can be harmful because sufficient populations of plants are necessary to ensure their future viability. The complex and important debate over the practice of collecting continues.



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WILD Colorado: Crossroads of Biodiversity

SUBALPINE FORESTS

Part of a series of eight posters • Supporting educational materials at www.wildlife.state.co.us

Setting—Dallas Divide, south of Telluride

Birds

1. **American Dipper** *(Cinclus mexicanus)*—related to the robin; found wherever fast-moving streams are present. In order to dive, swim, and wade underwater in pursuit of aquatic insects, the dipper is able to waterproof its dense plumage and seal its nostrils.
2. **Western Tanager** *(Piranga ludoviciana)*—summer resident of Colorado's open conifer forests. While their breeding range extends from Texas to Alaska, these tanagers winter in Mexico, Costa Rica, and along the southern California coast.
3. **Sandhill Crane** *(Grus canadensis)*—courts in March in the San Luis Valley before migrating to northwestern Colorado and points beyond. This tall gray bird, marked with a dark red patch on the forehead, has benefited from increased protection of the beaver, whose dams make excellent sites for crane nests.
4. **Clarke's Nutcracker** *(Nucifraga columbiana)*—resident of coniferous forests, identified by white patches along the inner trailing edges of the wings and outer edges of the tail. These birds collect and cache thousands of pine nuts each year, cracking them open with their bills or by wedging them into rock crevices.
5. **Blue Grouse** *(Dendragapus obscurus)*—reverse migrates from lower to higher elevations in winter to feed on conifer needles and buds, spending the worst weather up in spruce and fir trees. Males, identified by yellow-orange eye combs, inflate reddish neck air sacs to court females and to amplify their mating "hoots".
6. **Green-winged Teal** *(Anas crecca)*—small duck preferring wetlands and riparian habitats along the Front Range and higher mountain parks. Flocks of these iridescent-green-winged birds can often be seen in low, seemingly erratic flight, twisting and turning as a single unit.
7. **Broad-tailed Hummingbird** *(Selasphorus platycercus)*—most numerous in montane shrublands and forests, but found up to timberline. Females, with greenish backs but lacking the males' dark red or blackish throat patch, raise the young alone, remaining in the colder valleys while males roost at warmer elevations.

Mammals

8. **Yellow-bellied Marmot** *(Marmota flaviventris)*—usually brown in color with yellowish undersides and white facial and neck markings. These marmots often crawl on their bellies when making their way through dense vegetation, leaving a distinctive path in their wake.
9. **American Elk/Wapiti** *(Cervus elaphus)*—common above 5,000 feet. In spring migrating elk follow the melting snow pack to higher elevations; in winter, snow depth triggers downward migration.
10. **Bighorn Sheep** *(Ovis canadensis)*—Colorado's state animal, used on the logo of the Colorado Division of Wildlife. The sheep's horns, massive and curled on the male, shorter on the female, have growth rings that can be used to estimate age.
11. **Least Chipmunk** *(Tamias minimus)*—least in size, but greatest in range of any Colorado chipmunk, found from sage shrublands to alpine tundra. This chipmunk, distinguished from others by its small size and dart-like movements, hibernates over the winter, but wakes periodically to feed on stored food.
12. **Moose** *(Alces alces)*—largest of the deer family, introduced into Colorado by the DOW in 1978, favors the subalpine forest. Identified by its large size, massive muzzle, and hanging dewlap, the moose's antlers spread out and back from the head like opened palms with extended tines or points.
13. **Black Bear** *(Ursus americanus)*—can range in color from light brown, even blond, to black. Black bears are omnivores, whose diet of grasses, forbs, berries, fruits, acorns, insects, mammals, and carrion varies with the seasons.
14. **Golden-mantled Ground Squirrel** *(Spermophilus lateralis)*—named for the copper-colored head and shoulders, with two white stripes bordered by black running down the back. This ground squirrel, found in the western two-thirds of Colorado, hibernates for about five to seven months, waking periodically.

Amphibian and Reptile

15. **Tiger Salamander** *(Ambystoma tigrinum)*—found throughout Colorado where aquatic breeding areas are accessible. Coloration, influenced by the environment, can range from light bars on a dark background to dark spots on a light background.
16. **Western Terrestrial Garter Snake** *(Thamnophis elegans)*—identified by light-colored stripes on the sides and one down the center of the back. Found in or near aquatic areas throughout all of Colorado except the northeast grasslands, this snake feeds on a variety of invertebrates and vertebrates including frogs, toads, lizards and small birds.

Fish

17. **Cutthroat Trout** *(Oncorhynchus clarki)*—named for the blood-red markings running down the jaw and under the throat, historically ranged from Montana to New Mexico. Reduced to about 5% if its historic range, the greenback cutthroat trout *(O. c. stomias)*, Colorado's state fish, is currently being restored to many higher-elevation streams and lakes through a cooperative effort of public and private agencies.

Plants

18. **Columbine** *(Aquilegia coerulea)*—easily identifiable flower with large, blue sepals and white petals. Colorado's state flower can be found from foothills to alpine.
19. **Paintbrush** *(Castilleja rhexifolia)*—commonly known as the subalpine paintbrush or rosy paintbrush for its rose-colored flowers. Clusters of these tall plants can often be found in open meadows of the subalpine forest.
20. **Scarlet Gilia** *(Ipomopsis aggregata)*—also known as the skyrocket or fairy trumpet for its trumpet-shaped red flowers, biennial found in open woods and fields. Poisonous to humans, and pollinated in Colorado by hummingbirds and bumblebees, some populations of this gilia have developed the ability to change colors to attract successive species of pollinators.

Trees

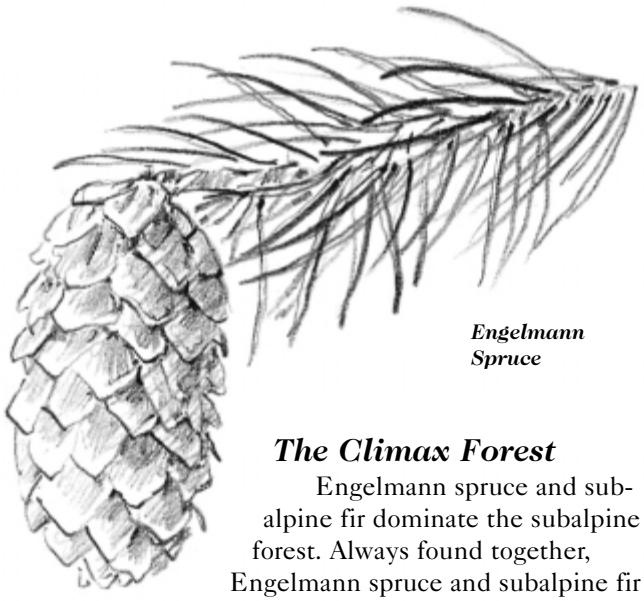
21. **Quaking Aspen** *(Populus tremuloides)*—named for the trembling of the leaves in the wind, the most widely distributed tree in North America. In the subalpine aspen inhabit south-facing, sheltered slopes, but throughout their range they also colonize disturbed sites such as burn and avalanche areas, sending out sprouts, or suckers, from an extensive underground root system.
22. **Engelmann Spruce** *(Picea engelmannii)*—predominant tree of the subalpine forest, capable of heights of 100 feet. Engelmann spruce needles are short, thick, curved, and sharp-pointed.

Subalpine Forests

Between Walden and Fort Collins, along State Highway 14, is a high-altitude forest that has been officially preserved for the people of Colorado. The Colorado State Forest State Park, ranging between 8,500 to 12,500 feet, encompasses several ecosystems, from upper montane and high-elevation riparian to alpine tundra. But for most of its elevation range, the Colorado State Forest is a landscape of subalpine fir and Engelmann spruce, the subalpine forest ecosystem.

Cold, Dark and Damp

Subalpine forests begin at about 9,000 feet and spread upward to about 11,400 feet, where fierce, icy winds and shallow soils make tree survival impossible. These are the highest, snowiest, and windiest of Colorado's forests. The average annual temperature is barely above freezing, 36 degrees Fahrenheit, with a short growing season of less than two months. Most precipitation falls as heavy winter snow. Additional snow is blown down by high winds from the peaks, and trapped by the narrow, densely packed trees. Shaded under the tree canopy, the snow melts slowly, often lasting into summer.



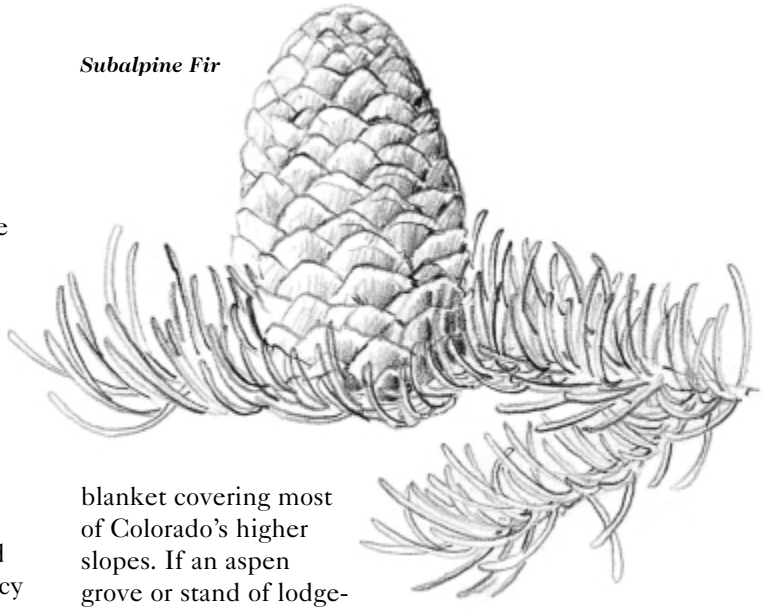
Engelmann Spruce

The Climax Forest

Engelmann spruce and subalpine fir dominate the subalpine forest. Always found together, Engelmann spruce and subalpine fir are "late successional" trees. **Succession** is the natural process by which distinct plant communities replace previous ones over time.

The **climax community** is the plant community at the end point of the successional sequence and it maintains itself if the environmental conditions stay the same. In the absence of some major change, the climax forest of Engelmann spruce and subapline fir will continually regenerate as a dense, uniform green blanket covering most of Colorado's higher slopes. If an aspen grove or stand of lodgepole pines breaks the uniform pattern of green, this means there has been some disturbance in the area. Fire, forest thinning, avalanche, and other events open the forest and allow sunlight to sprout "early successional" **pioneer** plants such as aspen, grasses, and wildflowers. After the aspen and lodgepole have established a canopy, shade-loving spruce and fir re-emerge and eventually crowd them out.

Subalpine Fir



The floor of the subalpine forest is littered with fallen trees in various stages of decay. The winter snow lingers into the summer, shaded by the dense canopy. The flowering plants (**forbs**) found here are species that thrive in a rich, moist environment. One of these is the beautiful fairy slipper, an orchid that takes its name from a hanging pink petal shaped like a ballet slipper. Another is Jacob's Ladder, identified by the vertically ascending leaves on its feather-like stalk and aromatic, pale pink or bluish flowers. The tiny woodnymph, whose fragrant, waxy white flower droops atop a four-inch stem, can also be found in the climax forest.

In forest openings and disturbed areas, enough sunlight penetrates to sustain a variety of plants that are seen in many other ecosystems. One is our state flower, the columbine. Some of the plants that grow in these openings provide good forage for wildlife. Heartleaf arnica, with its showy, bright yellow flowers and heart-shaped leaves, and wild parsley are eaten in spring and early summer. The fruits of wild rose, golden currant and mountain blueberry are favorites of birds, rodents, and black bears in the fall.

Square Sharp Spruce and Flat Friendly Fir

The Englemann spruce is a long-lived, slow growing evergreen. In the limited growing season at high altitude, it takes hundreds of years for this tree

Columbine

to reach a mature height of more than one hundred feet. The Englemann spruce has a rich, reddish brown trunk and a ragged, narrow crown. Spruce cones hang down from the branches and are light brown with papery, toothed scales. Short, sharp spruce needles are square in cross-section and singly joined to the branch.

Subalpine firs are not as long-lived as spruce, but they reproduce more readily. A mature fir has grooved, grayish-white bark and may reach a height of 75 feet. The crowns of subalpine fir tend to be very narrow and pointed, resembling church spires. Subalpine fir cones grow upright on the upper branches. The needles of the subalpine fir are one to two inches long, with whitish lines on both sides. They are flat and soft and grow individually from the branch. When fir needles fall or are pulled off, they leave a depressed round scar on the twig.

Wildlife You Might Discover in the Subalpine Forest

Subalpine forests are a tangle of robust trees, old snags and downed logs. This particular mix of habitat in these old forests provides food and shelter for a wide variety of animals—animals with behavioral or physical adaptations that shelter them from the cold and wind.

Except during the coldest months, a variety of puffy little birds nest, raise young, and roost in the subalpine forest. The small roundish body type, surrounded by a fluff of dense feathers, insulates the birds from the cold. Ruby-crowned kinglets, with white-ringed eyes, and their cousins the golden-crowned kinglets, glean insects from the bark and leaves and drink tree sap. Mountain chickadees and dark-eyed juncos, pine grosbeaks and Cassin's finches pry seeds from pine, fir and spruce cones.

Red-breasted nuthatches creep headfirst down tree trunks searching for insects. The omnivorous gray jay, or "Camp Robber," snatches sandwiches and peanuts from hikers and campers to supplement its diet of seeds and insects. A closely related species, Clark's nutcracker, shares both the jay's nickname and its habits. Unlike the gray jay, Clark's nutcracker does not move to lower elevations during the cold winter months. Instead, these birds gather seeds that they keep in a communal storage area to get them through the winter and feed their young in spring. This allows Clark's nutcracker the opportunity to get a head start on the breeding season, a definite advantage over other competing species in the forest.

Insect infested snags are great habitat for cavity nesting and wood boring birds. Three-toed woodpeckers, and hairy and downy woodpeckers nest and feed in the subalpine. The northern saw-whet owl and the boreal owl also nest in tree cavities, as well as old woodpecker holes. They feed on mice, voles, and other small mammals found in the forest. Both of these tiny owls are strictly nocturnal and are rarely seen.

Blue grouse, sometimes called "fool hens," stay in the subalpine during the long winter, and roost in the treetops. In summer, they head downhill for mating rituals and breeding. This "reverse" migration is not what makes blue grouse "foolish," but rather their strategy of freezing and relying on protective coloration, **camouflage**, to protect them from danger. The dusky blue coloration of the male and the mottled brown feathers of the female help them blend with their surroundings, keeping most predators from spotting them. However, these birds rarely move even when it is apparent that the predator is coming right at them. Rather than insuring survival, standing firm in the face of insurmountable odds makes the blue grouse a "sitting duck."

Northern goshawks speed through the trees, feeding on other birds, snatching them in mid-air. Ravens are fairly common during the summer months, feeding on nestlings and eggs, as well as rodents, seeds, and fruit.

Mule deer and elk feed in the meadows and use the trees for cover during the spring, fall, and summer months. Moose move along the streams,

feasting on willows. Rodents—chipmunks, golden-mantled ground squirrels, mice, and especially the southern red-backed vole and the pine squirrels—feed on pine nuts and spruce seeds, and fresh succulent grasses.

Snowshoe Hare

A mammal closely associated with the subalpine forest is the snowshoe or "varying" hare. Both of its names stem from its ability to navigate and survive in this forest in winter. In summer, the snowshoe hare has dark brown fur that conceals its presence as it nibbles on flowering plants and grasses. In the winter, the fur changes to white, again blending with the scenery as the hare feeds on bark, twigs, and buds. The oversized hind feet also come in handy during this season, keeping the snowshoe hare from sinking into the snow and allowing it to move unencumbered.

Some of the predators in the subalpine forest are also seasonal change artists. The ermine, or short tailed weasel, also turns white in the winter, except for the tip of the tail. The weasel can stalk prey unseen, then subdue the animal by wrapping its long body around the victim, killing it with a well placed bite at the base of the skull.

Another member of the weasel family, the American marten, or pine marten, is another important predator in the spruce-fir forest. They are as adept hunting in the trees as they are on the ground. Pine martens are about five times larger than the ermine, but have the same long, flexible body design. Their preferred diet is pine squirrels, but they also eat nesting birds, voles, and various other rodents. Feline predators such as mountain lion, bobcat, and lynx hunt here, although only the lynx is suitably equipped to pursue prey on deep snow. Like the snowshoe hare, its preferred food, the lynx has very large feet, which allow it to move freely over the snow.

A Closer Look at One Species—Moose

Historically, Native Americans, trappers, miners, and ranchers spotted the occasional moose that wandered into northern Colorado. Yet even though Colorado had prime moose habitat, moose were not present in numbers sufficient to breed and reproduce. In 1978, the Colorado Division of Wildlife began a moose introduction program, using private donations. Over several years, moose from Utah and Wyoming were transplanted into suitable locations in northern Colorado. They have thrived in their new home, and today more than 1,100 moose are in the state.

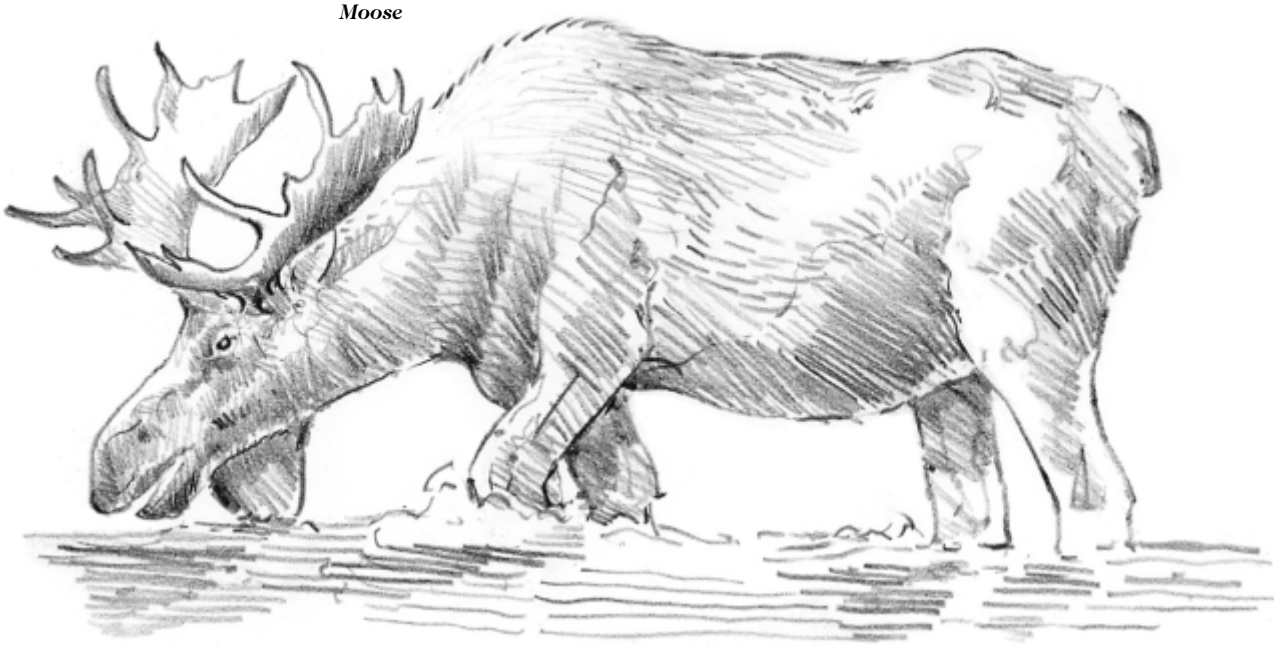
The moose is the largest member of the deer family. Bulls (male moose) can stand a formidable six feet tall at the shoulder and weigh up to 1,200 pounds! Cows (females) are smaller, about 700 pounds.

Moose produce the largest antlers known—some sets in excess of six feet have been recorded! Shaped like the palm of the hand with outstretched fingers, the size and pattern of the antlers reflect the social position and reproductive status of the male. The only time that antlers have any purpose is during the annual **rut**, or mating season, that begins in late September. Antlers are used to intimidate a rival bull in order to gain mating rights to a cow. Usually, the antler display of a prime bull is enough to frighten away a younger or weaker male. However, when males of equal status come together, there is often head-on fighting and antler wrestling.

Moose inhabit the subalpine forest edge and openings in the forest adjacent to water.

American Marten

Moose



Their preferred habitat is found in early successional subalpine forest areas that have been recently burned, logged, or manipulated by beavers. Typically, moose prefer a mixture of willow, spruce, fir, and aspen, that provides both food and shelter.

Moose are **browsers**. They mainly eat twigs and leaves of woody or brushy plants. In the summer, aquatic plants, willow, and grasses are their main foods. Unlike deer and elk that cannot tolerate deep snow, the moose stays put during winter rather than moving to lower elevations. Moose are able to move easily in as much as five feet of snow and can scrape through it to get to forage. They survive the colder months eating willow and the lower branches of other trees, sometimes creating a "browse line."

Crossroads of Biodiversity—Subalpine Forests

A diversity of habitats provides a diversity of opportunities for wildlife. In the subalpine forest, some species profit from climax or "old-growth" stands, while others benefit from the early or intermediate successional stages of the forest. For example, snowshoe hares, a vital prey species in this ecosystem, needs a mix of low-growing broad-leafed shrubs for food and mature conifers for cover. They prefer patches of trees with plenty of edge. Woodpeckers and insect-eating birds like dead snags and dying trees. The American marten, the great arboreal hunter, also succeeds best in a climax forest. The moose prefers the succulent browse of the young forest. To maintain a diversity of wildlife species in the subalpine forest, it is essential to manage for sufficient acreage of all habitat types at various stages of succession.

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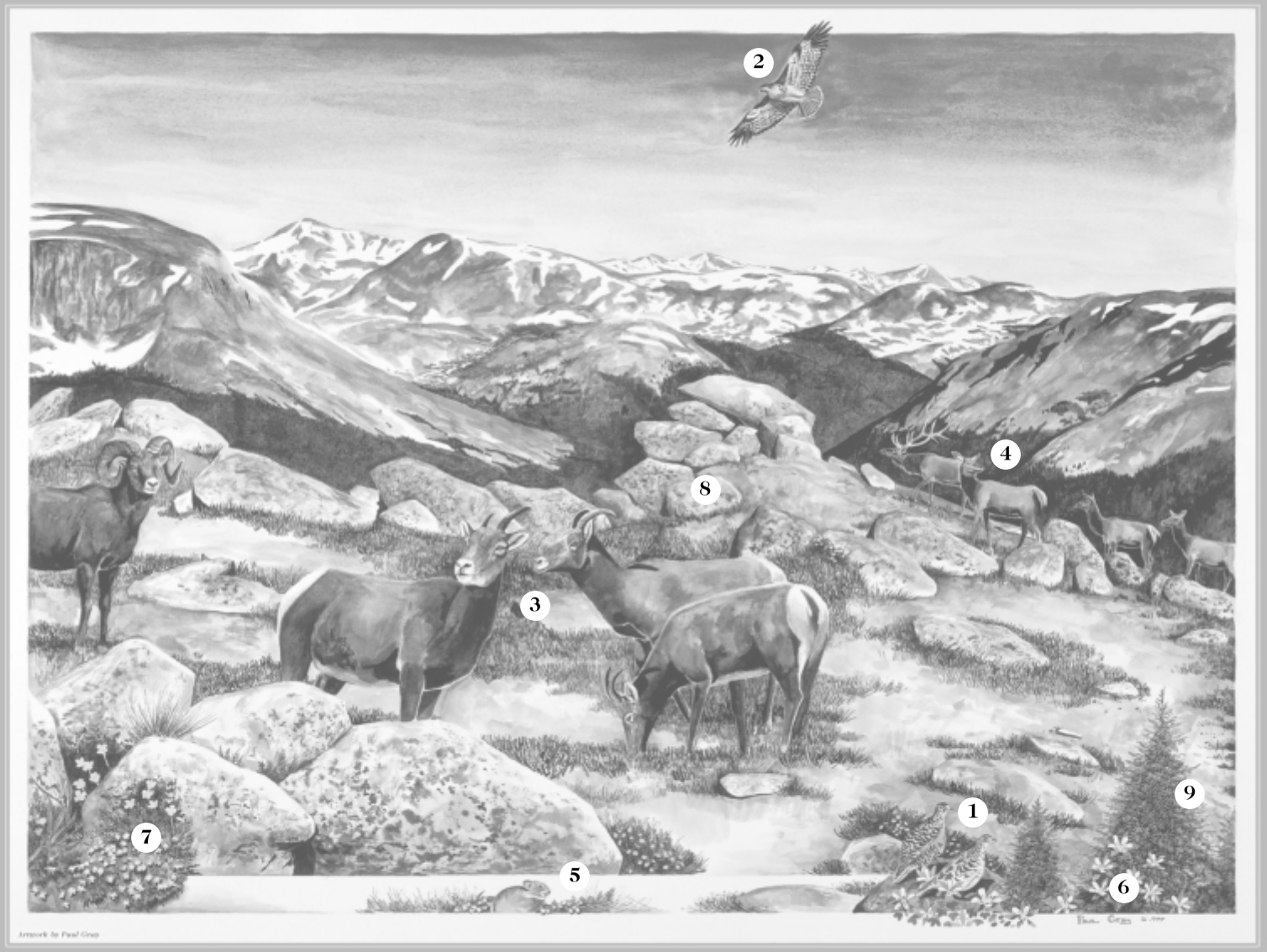


Artwork by Paul Gray

Alpine Tundra

Part of a series of eight posters • Supporting educational materials at www.wildlife.state.co.us

Setting—Rocky Mountain National Park

Birds

1. **White-tailed Ptarmigan** *(Lagopus leucurus)*—year-round tundra resident, feeds primarily on willows, sometimes foraging below timberline in winter. This ptarmigan turns from mottled and barred brown and black in summer to almost all white in winter.
2. **Red-tailed Hawk** *(Buteo jamaicensis)*—most widespread hawk in Colorado, especially numerous in piñon-juniper woodlands and winter grasslands, but occurring year-round from grassland to tundra. In addition to rodents such as prairie dogs, these hawks prey upon reptiles and rabbits.

Mammals

3. **Bighorn Sheep** *(Ovis canadensis)*—Colorado's state animal, used on the logo of the Colorado Division of Wildlife. The horns, massive and curled on the males, shorter on the females, have growth rings that can be used to estimate age.
4. **American Elk/Wapiti** *(Cervus elaphus)*—common throughout central and western Colorado above 5,000 feet. In spring, migrating elk follow the melting snow pack to higher elevations; in winter, snow depth triggers downward migration.
5. **American Pika** *(Ochotona princeps)*—sometimes called a cony, rock rabbit, or whistling hare for its many vocalizations, found in subalpine forests and tundra. The pika collects, dries, and stores a variety of vegetation in "haypiles" as a food reserve for the winter.

Plants

6. **Columbine** *(Aquilegia coerulea)*—easily identifiable flower with large, blue sepals and white petals. Colorado's state flower can be found from foothills to alpine.
7. **Alpine Avens** *(Acomastylis rossii)*—common plant found growing in dense mats in dry tundra areas. Yellow in summer, this member of the rose family turns deep red in the fall.

Fungi

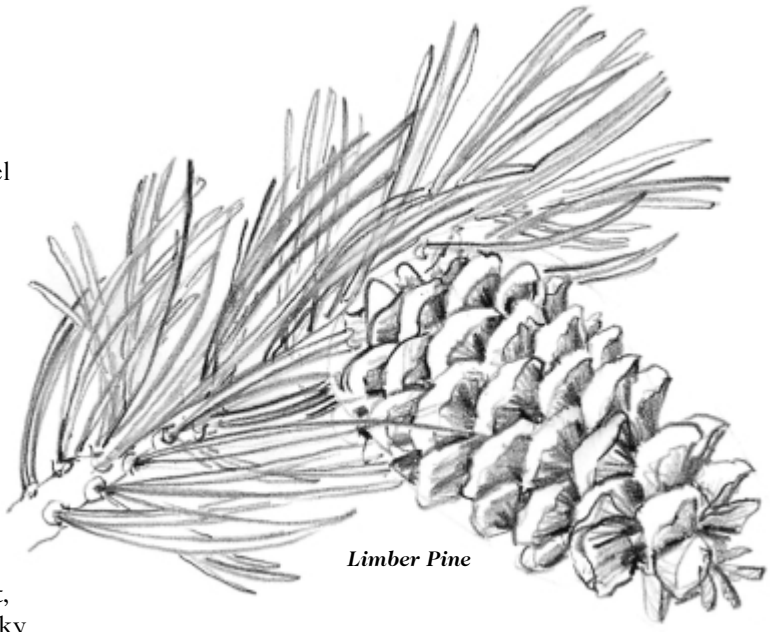
8. **Lichens**—represented by *Pleopsidium flavum* (yellow), *Caloplaca epithallina* (red-orange), and *Xanthoparmelia wyomingica* (blue-green). Lichens are composite organisms, composed primarily of fungi in partnership with either or both algae and cyanobacteria.

Tree

9. **Engelmann Spruce** *(Picea engelmannii)*—predominant tree of the subalpine forest, capable of heights of 100 feet, but usually found stunted at treeline. Engelmann spruce needles are short, thick, curved, and sharp-pointed.

Treeline and Alpine Tundra

Every summer, thousands of motorists travel from Twin Lakes to Aspen over Independence Pass. Many marvel at the beautiful vistas of conifer forests, aspen groves, waterfalls and rushing waters encountered on the east and west sides of the pass. But for those who stop at the summit parking lot near the headwaters of the Roaring Fork River, and stroll the paths at an elevation of over 12,000 feet, a stark and beautiful world awaits; the alpine tundra ecosystem of Colorado.

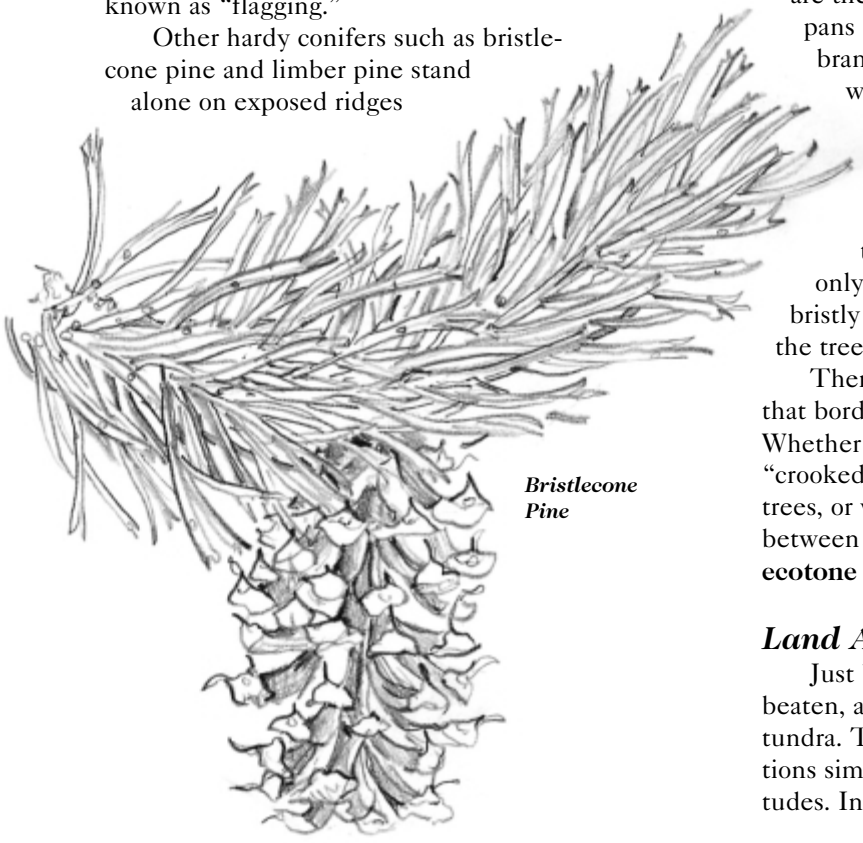


Limber Pine

The Upper Limit for Trees

At the upper reaches of the subalpine forest, fierce winds, extreme temperatures, shallow rocky soils, lack of moisture, and a short growing season make living conditions too severe for trees. Here, stunted versions of subalpine fir and Engelmann spruce, growing to only a fraction of their normal height, start to grow together in dense clusters or islands, using each other for support and protection from the wind. Those that grow above shrub height tend to have branches and limbs only on the side that is sheltered from the wind, a phenomenon known as "flagging."

Other hardy conifers such as bristlecone pine and limber pine stand alone on exposed ridges and peaks, their roots forced into narrow cracks between rocks. Limber pines, named for their flexible branches that bend in the high winds, have thick, stubby pine needles arranged in bunches of five that grow only at the end of the branches. Both the needles and cones are tightly attached and hold fast as the extra long limber pine branches twist and tangle in the wind.



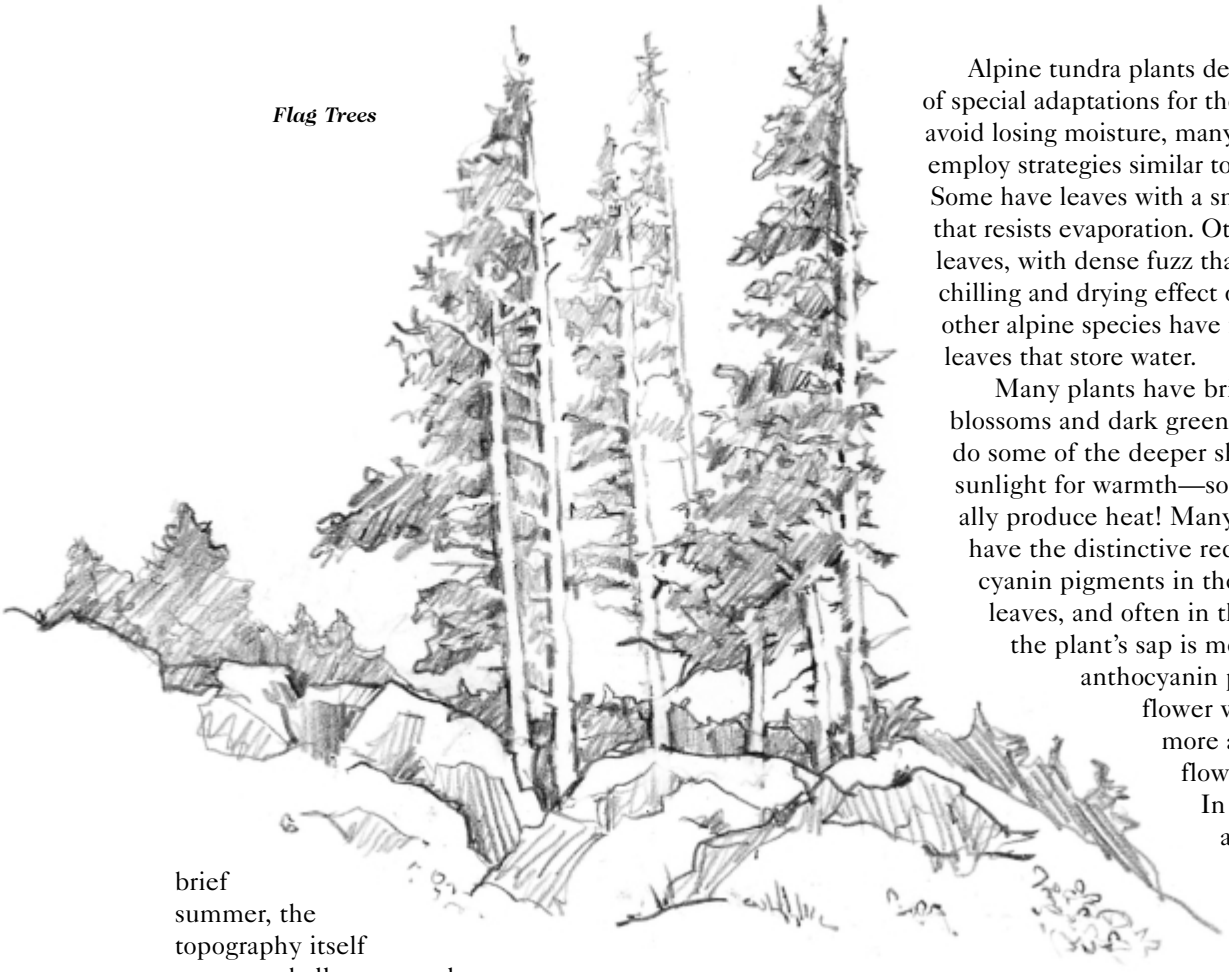
Bristlecone Pine

Contorted by wind and snow, bristlecone pines are the oldest living trees in Colorado, with lifespans measured in thousands of years. Bristlecone branches are brush like and densely covered with needles, and these trees are alternatively called "foxtail pines." Bristlecone needles are also arranged in fives, but are short and marked with small resin spots. Bristlecone pines hold their needles ten times longer than any other pine, shedding only every 25 to 30 years. The cones have sharp, bristly spikes at their edges—hence the name of the tree.

There are many terms for these twisted trees that border the highest edge of the subalpine forest. Whether collectively called **krummholz** (German for "crooked wood"), elfin forests, banner trees, flag trees, or wind-timber, this area is an ecotone, an edge between two distinct ecosystems. This specific **ecotone** is known as **treeline**, or **timberline**.

Land Above the Trees

Just beyond this ecotone of twisted, wind-beaten, and ground-hugging trees is the alpine tundra. This mountaintop zone has climatic conditions similar to the Arctic tundra at far northern latitudes. In addition to the snow, the wind, and the



Flag Trees

brief summer, the topography itself presents challenges to plant growth. Since slopes are steep and soils are porous, moisture from melting snows or summer storms quickly drains, leaving little water for plant growth. Rockslides and avalanches can destroy plants that have been tenaciously surviving for decades. Plenty of snow falls on these peaks, but high winds drive the snow from exposed areas down into forests below or into protected depressions. In the exposed areas, the wind scrapes off new plant growth. Conversely, the snowdrifts are so high in other areas that the buried vegetation is not exposed to sunlight during the growing season. Everywhere, the air is thin and the solar radiation is intense, and even plants in relatively sheltered nooks and crannies contend with dehydration.

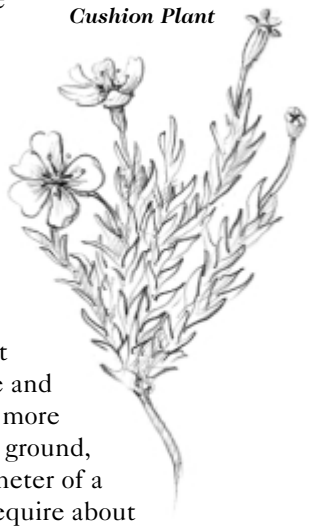
In this harsh climate, few plants can go through a complete life cycle of germination, growth, flowering, and seed production in one short growing season. Annual plants are a rarity. Most tundra plants are perennial, going through different stages of growth over many years, and may only put out one or two leaves in a growing season. It may take a decade or more for a plant to mature, and a plant only six inches in diameter may be more than a hundred years old!

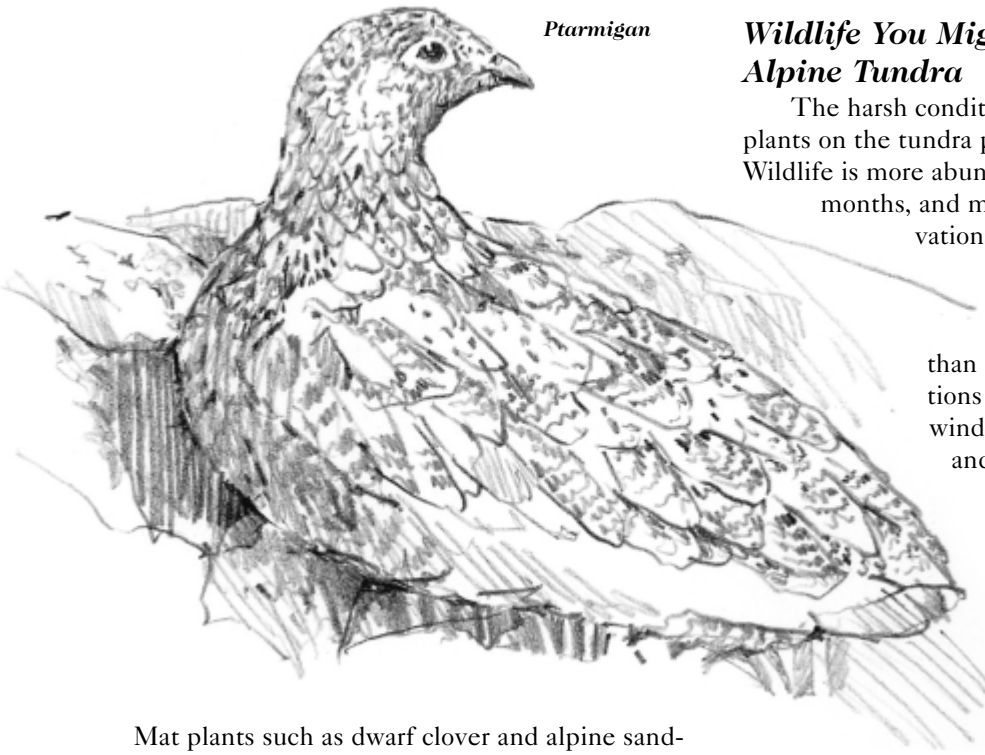
Alpine tundra plants depend on an arsenal of special adaptations for their survival. To avoid losing moisture, many alpine plants employ strategies similar to desert species. Some have leaves with a smooth, waxy finish that resists evaporation. Others have woolly leaves, with dense fuzz that lessens the chilling and drying effect of the wind. Still other alpine species have fleshy succulent leaves that store water.

Many plants have brilliantly colored blossoms and dark green leaves. Not only do some of the deeper shades absorb more sunlight for warmth—some pigments actually produce heat! Many alpine plants have the distinctive red tinge of anthocyanin pigments in their stems and leaves, and often in their blossoms. If the plant's sap is more acidic, the anthocyanin pigments in the flower will appear red, if more alkaline, the flowers will be blue. In either case, the anthocyanin pigment will convert any light waves into heat to warm the plant, a marked advantage on a cloudy, cold day.

Cushion plants, such a moss campion, alpine forget-me-nots, and alpine phlox have a rounded, low-growing form which allows wind to flow over them. Their shape exposes the maximum leaf surface for photosynthesis while protecting the plant from the elements. The stubby branches catch and hold blown-in dirt along with old decaying leaves that absorb moisture. Cushion plants put most of their energy into producing a large taproot that anchors them to the slope and absorbs water two feet or more below the surface. Above ground, plants may reach the diameter of a penny in five years and require about twenty-five years to reach seven inches. They may take ten years to flower.

Cushion Plant





Ptarmigan

Mat plants such as dwarf clover and alpine sandwort survive by spreading—they are able to root in any spot where a branch touches the ground. They cling to the rocks by a tight network of small roots that catch water trickling by.

Many of the plant species found on the alpine tundra are **circumpolar**, occurring in the same habitats across the Northern Hemisphere, in both arctic and alpine tundra regions. These plants slowly migrated into what is now Colorado during the last Ice Age. As the ice sheets retreated, some of the plants remained behind, but ascended the slopes of the mountains, where conditions are still comparable to those in the arctic.

Wildlife You Might Discover on the Alpine Tundra

The harsh conditions that make life difficult for plants on the tundra place limits on animals as well. Wildlife is more abundant during the warm summer months, and most species leave to lower elevations or southern destinations in the winter. Even in summer, there are fewer wildlife species in this ecosystem than in others, and each has adaptations to contend with the intense wind and cold, the precarious terrain, and the scarcity of food and water. Mosquitos, caddisflies, beetles, grasshoppers, ladybugs, and other insects are all present during the warmer months, but in lesser numbers than other regions. Flies are by far the most prevalent invertebrate on the alpine tundra and have an important role as pollinators. They are able to withstand lower temperatures than bees and have lower energy requirements. Arctic blue butterflies, named for the rich gray-blue wings of the males, and Mead's sulfur butterflies, also assist in pollination as they sip on tundra flower nectar.

Birds are scarce. During the summer months, prairie falcons and red-tailed hawks hunt for small rodents. White-crowned sparrows and horned larks are common and some may nest here. Just three species—ptarmigans, water pipits, and rosy finches—nest exclusively on the alpine tundra. Ptarmigans and

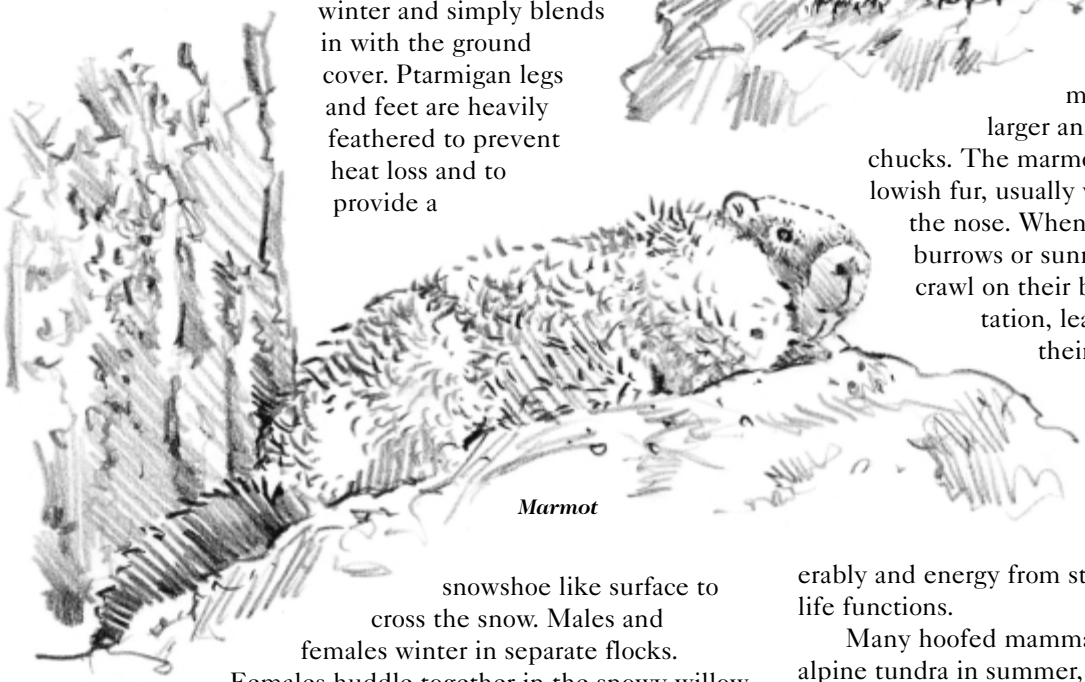
"Fourteeners"

The centerpieces of the Colorado Rockies are the 54 peaks over 14,000 feet, or "Fourteeners," as they are affectionately known by climbers. According to the Colorado Fourteeners Initiative, a non-profit coalition with the mission of protecting and preserving the natural integrity of these peaks and the quality of the recreational opportunities they provide, Colorado's Fourteeners are now visited by over 300,000 people each year—and visitor numbers continue to rise 10% each year. The lower alpine peaks have even more visitors. This increased recreational use has had serious impacts on these ecosystems. Polluted waters, displaced wildlife, eroded soils, braided trails, and trampled vegetation are some of the problems threatening the tundra. The slow growing alpine plants are very vulnerable, and recovery from even small disturbances such as trampling by hikers may take many decades. Larger disturbances can disrupt the alpine ecosystem for hundreds of years. When visiting these high peaks, it is important to stay on trails, dispose of waste properly, respect wildlife, and not collect plants, rocks, or any animal or cultural artifacts.

pipits lay eggs in depressions on the open ground, while the finches build nests among the crags. The rosy finches and water pipits search the snowfields for insects and seeds. When the weather gets colder in the fall, both species migrate to warmer climates.

Only the ptarmigan lives on the tundra year round. This bird, the size of a small chicken, feeds on willow buds during winter. In an open land with little cover, the ptarmigan protects itself by turning from mottled brown and black in summer to white in winter and simply blends in with the ground cover. Ptarmigan legs and feet are heavily feathered to prevent heat loss and to provide a snowshoe like surface to cross the snow. Males and females winter in separate flocks. Females huddle together in the snowy willow thickets near treeline, while males remain at higher locations.

Pika



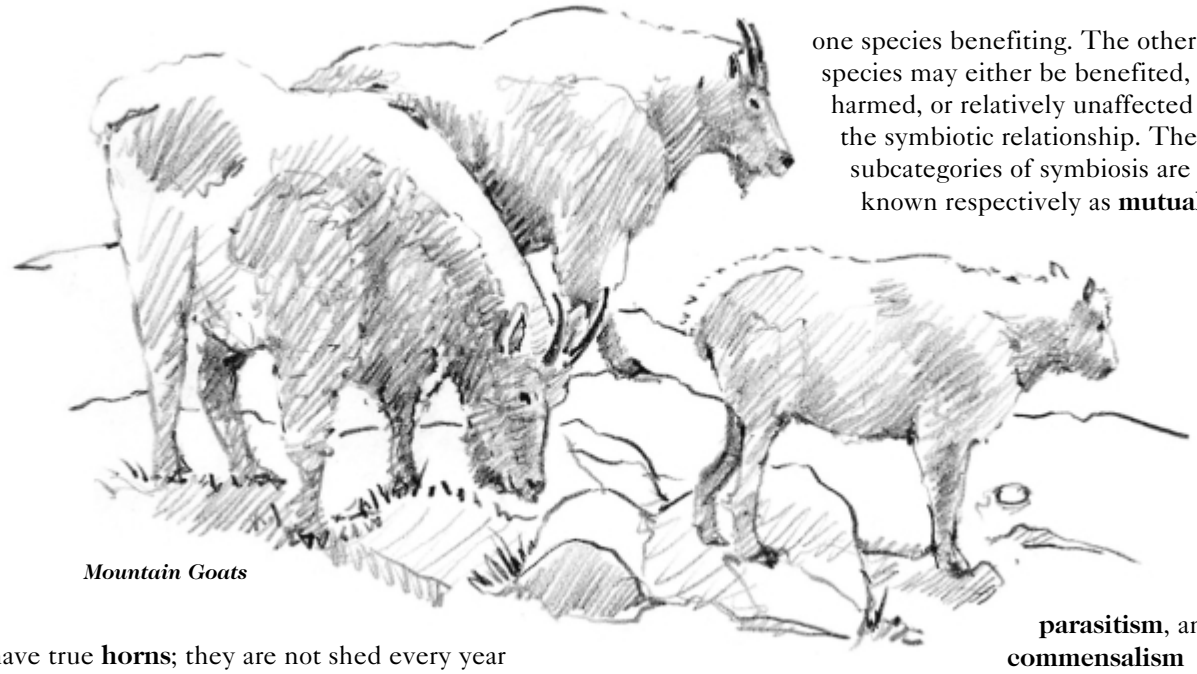
Marmot

Some burrowing mammals such as voles, mice, northern pocket gophers, and weasels also stay on the tundra year round. Two distinctive alpine mammals are the pika and the marmot. Pikas are small members of the rabbit family. Instead of sporting long ears like their relatives, they have small round ears that are not as likely to freeze. Their other extremities are also reduced in size to prevent heat loss. They have fur on the soles of their feet, for warmth and as a type of nonskid surface for running on the slick rocks. Pikas do not hibernate and are active all year. They collect and prepare stacks of "hay," that they store by their dens to make it through the winter. Like their rabbit relatives, pikas also re-ingest their own fecal matter, which is high in protein content and energy value. Pikas preserve body moisture by excreting dry, crystalline uric acid, leaving noticeable white deposits on the rocks.

Yellow-bellied marmots are comparatively larger animals, related to woodchucks. The marmot has light brownish to yellowish fur, usually with a whitish band around the nose. When marmots are not in their burrows or sunning on rocks, they often crawl on their bellies through dense vegetation, leaving a distinctive path in their wake. Marmots eat themselves fat in summer and hibernate all winter. Curled up in a tight ball during **hibernation**, the marmot's temperature and heartbeat lower considerably and energy from stored fat reserves sustains its life functions.

Many hoofed mammals can be seen on the alpine tundra in summer, but they move to lower elevations when snow covers their forage. Mule deer and elk feed in the alpine meadows. Bighorn sheep forage on the steeper slopes. Both genders

Bighorn Sheep



Mountain Goats

have true **horns**; they are not shed every year like the antlers on deer and elk. The majestic curling horns of the male are striking, and likely influenced the selection of the bighorn sheep as Colorado's state animal.

In some areas of the state, reintroduced mountain goats pick their way up the slope in search of fresh grasses and wildflowers. Both sexes have a white shaggy coat, beards, and short, smooth black horns that tilt backward. The male is larger. Mountain goats are among the most sure-footed of all animals. Their hooves have concave rubbery pads that spread to create a non-skid grip on rocks.

A Closer Look—Lichens

On some alpine rocks and ridges, the only growing things are crusts of bright-colored lichens. Lichens are **pioneer species** that are often first to colonize habitats not yet suitable for other living things. Lichens require no soil, and have enormous resistance to cold and dryness. As lichens grow and die on bare rock, they form small amounts of soil, which mosses, ferns, and flowering plants colonize. Many kinds of lichens can also fix nitrogen, an element essential for plant growth. They are able to extract nitrogen from the atmosphere and store it in soil for use by other plants. Likewise, lichens act as decomposers, breaking down wood and bones into materials needed by other species.

Lichen is not a single organism. It is a **composite organism**, composed of two or three species functioning as one. This type of living arrangement is known as **symbiosis** (literally "living together"). In symbiotic relationships, two organisms live closely associated for extended periods of time, with at least one species benefiting. The other species may either be benefited, harmed, or relatively unaffected by the symbiotic relationship. These subcategories of symbiosis are known respectively as **mutualism**, **parasitism**, and **commensalism** (literally "at table together"). Lichens are examples of mutualism, a mutually beneficial relationship.

Lichen, composed of green algae cells (and sometimes cyanobacteria) surrounded by threadlike fungal tissues, is self-sufficient, requiring only minerals and water absorbed from rocks and the atmosphere. The algae cells absorb water to photosynthesize food for both algae and fungus. The fungi protect the algae and/or cyanobacteria cells from dryness and cold.

Lichens have several adaptations to safeguard their stronghold in their rocky habitat. They are able to manufacture over 500 biochemical compounds that regulate light penetration, ward off predators, kill harmful microbes, and deter competing plant species.

There are over 3,600 lichen species in North America. Birds and mammals use many kinds of lichens for food and nesting material. Some lichen species benefit humans as well, providing dyes, antibiotics, and medicines. Most lichens are extremely vulnerable to air pollution and their sudden disappearance can be an indicator of changing air quality.

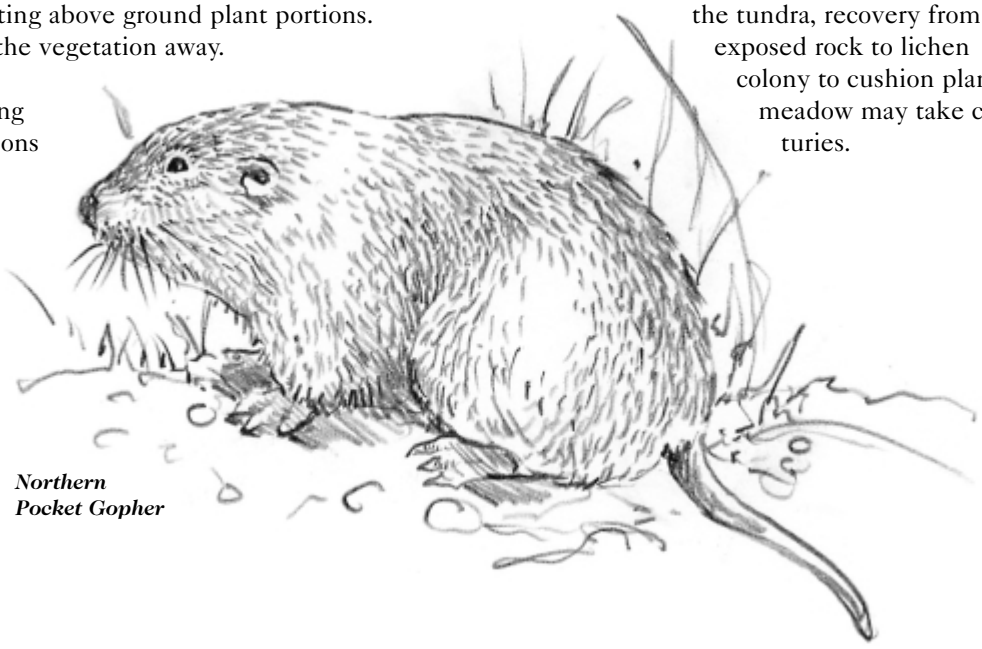
Crossroads of Biodiversity—Alpine Tundra

The Continental Divide, which runs through the alpine tundra, acts as an obstacle to east-west species migration in Colorado. Few songbirds, reptiles, amphibians, or small mammals can surmount the harsh conditions and cross the divide. It seems that only the larger birds and mammals, which can quickly move across the tundra during fair weather, and small burrowing mammals break this natural barrier.

Some of the small burrowing species, especially the northern pocket gopher, have an enormous impact on the plant diversity of the alpine tundra. Next to wind and snow cover, a gopher's presence in alpine meadows is most influential in determining the plants that can survive. Although pocket gophers can only disturb a small portion of the total tundra area, a few acres at a time, they can change those small spaces for decades.

You are more likely to see the piles of subsurface soil that the northern pocket gopher has excavated to the surface than you are the gopher itself. In spring and summer, the gophers feed on the roots of the cushion plants and weaken their fragile hold. In winter, pocket gophers dig through the protective blanket of snow. This allows them, along with mice and voles that use gopher tunnels, to feed throughout the cold season, eating above ground plant portions. Basically, they eat the vegetation away.

The following summer, meandering pocket gopher ribbons appear from beneath melting snowbanks, ranging from humps a few inches high to shallow depressions marking caved-in tunnels. Sometimes these ribbons dissect the meadows and make them look a bit like a moth-eaten quilt. At other times, these patches have the appearance of a cultivated garden. Seeds of tall plants with bright flowers, such as sky pilot, alpine avens, and bistort take root in these mounds of dirt. These plants have less defense from the high winds, and as they are clipped off by blowing rock and ice, most of the soil blows away as well. The meadow is further eroded when the gopher tunnels channel runoff from melting snow. Usually, a pocket gopher will re-work an area over and over, maintaining its gopher garden for several years. At some point, the soil from tundra meadow is gone and only bare rock remains. Since succession is such a slow process on the tundra, recovery from exposed rock to lichen colony to cushion plant meadow may take centuries.



Northern Pocket Gopher

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Activity: The Edge of Home

Objectives

Students will:

Identify the characteristics of ecotones, or transitional zones, between two wildlife habitats.

Method

Students explore the concept of ecotones by visiting places where habitats overlap.

Materials

Pencils; paper; long rope or string for marking intervals in one-foot segments; clipboards.

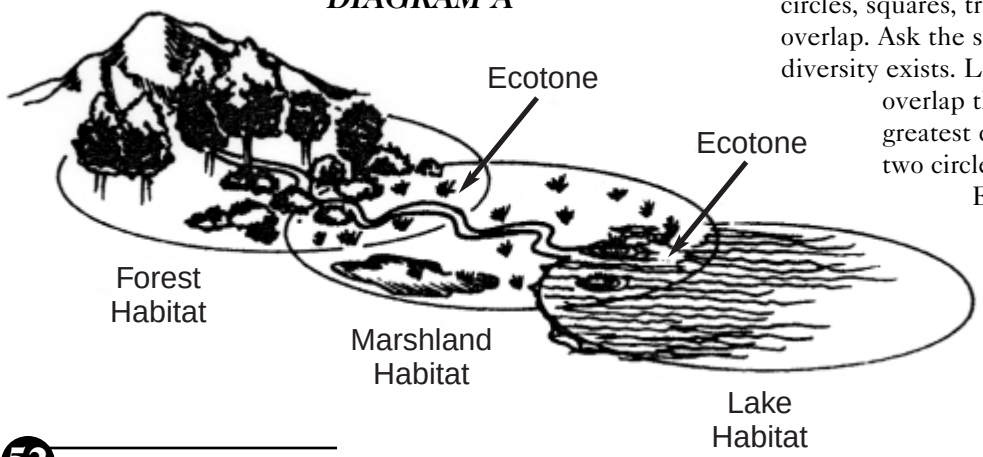
Background

Ecology is the study of the interactions between living things and their environments. Ecology comes from the Greek word *oikos*, which means *home*. The word ecosystem refers to the system of interactions between living and nonliving things.

An ecotone is a unique environment created by the overlap of two or more surrounding habitats. The area of overlap between two ecosystems creates a habitat *edge* where parts of each surrounding habitat are present. Those places where the edges of ecosystems come together and overlap are the places where the action occurs and change takes place. (See Diagram A.)

In local communities there are abundant edges and overlaps of edges that may be accessible to the students. Playgrounds, school grounds, parking lots, stream banks, lake shores and marsh edges can be found within walking distance for many students.

DIAGRAM A



In ecotones, overlapping ecosystems are more complex than any ecosystem by itself. For example, in an overlap of forest and marsh it is common to find forest plants growing within the marsh. Often the growth of the forest plants is stunted due to the water in the marsh.

The overlapping ecosystems also offer a wider diversity of wildlife because animals common to both ecosystems are brought together. Even though they may not be seen, there is indirect evidence of the animal populations—for example: footprints, droppings and feathers are all common.

Although ecotones play an important role in the overall landscape, it is also important to keep these areas from becoming too fragmented. This fragmentation can adversely affect wildlife that depends entirely on one ecosystem. The concept of maintaining ecotones and all of their components in a dynamic natural balance is defined as preserving the biodiversity of that area. The absence of diversity in ecotones is often a clue that problems may exist in the ecosystems that overlap.

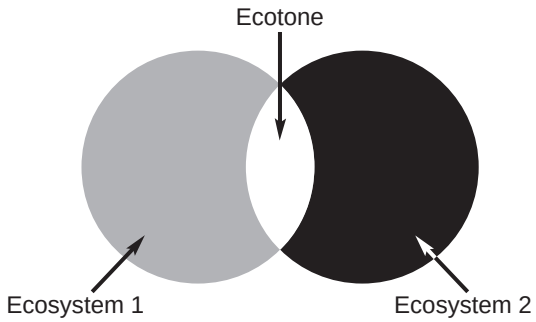
Procedure

Before the Activity:

Locate an outside study site for this activity. Choose a place where plants are invading a parking lot or playing field, or the edge of a forest where it meets a meadow.

1.) On the chalkboard, draw two large overlapping circles. Put a large number of small squares and triangles in one circle. Avoid the area of overlap. In the second circle draw many tiny circles and stars. Again, avoid the overlap area. Ask the students to predict what kinds of things they would expect to find in the overlapping circles. Draw circles, squares, triangles and stars in the area of overlap. Ask the students where the greatest diversity exists. Label the whole area of the overlap the ecotone (this is the area of greatest diversity). Label the original two circles as Ecosystem 1 and Ecosystem 2. Ask the students to point out the edges of the *overlap*. These are the places

where the two ecosystems come together and interact. The process and results of this interaction are called the edge effect.



2.) Inform the students that they are going to investigate a natural setting where there are habitats that overlap similar to the illustration. Ask them to take paper, pencils and clipboards on which to record their observations.

3.) Take the students to the selected site. Ask them to work in teams of two or three to list the things found on either side of the edge. Each team should examine two different ecosystems, not examining the interactions and area where the two ecosystems meet and overlap. Have the students list the different species of plants and animals they observe, and tally what they find. Include direct and indirect evidence of life. Ask them to discuss the similarities and differences, and to keep notes.

4.) Next, ask the students to carefully examine the edge. Determine how wide the ecotone or zone of shared characteristics is. Point out that this is a miniature ecotone. The students might try to estimate the size of the ecotone as well as the diversity of species within the ecotone. Compare the diversity of plants and animals found within the ecotone with the diversity of the plants and animals found in the two separate ecosystems they originally examined.

NOTE: *It may help the students organize more systematic observations if they stretch a length of rope or string from one ecosystem to another. Have the students make and record observations every foot (or other unit of measure) along the line. It helps to mark the string or rope at these intervals.*

5.) After the trip, compare and interpret the students' findings. Ask them for evidence they found to support the idea that populations of plants and animals tend to be more diverse within ecotones than in separate ecosystems.

OPTIONAL: Take the class to a site in the community that has aquatic edges. Educators may be able to find a beach, highway edges, the edge of town, a place where a stream enters or exits a lake or others that might be available in the community. Once there, ask the students to use the same investigating techniques, working again in teams of two or three. They should identify at least two ecosystems; list and describe the characteristic organisms in each; identify the ecotone; and list, observe and describe the organisms in the ecotone.

Extensions

1.) Create an ecosystem map or model of your community. Indicate the location of the principal ecotones.

2.) Take a simple piece of paper and measure the edges. Cut the paper into four equal pieces—and measure the edges again. Repeat this twice again, measuring the edges each time. Support the idea that each new rectangle is a suitable habitat for some aquatic organism and discuss how diversity is related to *edges*.

3.) Assess the overall health of any ecotones that seem particularly important to the quality of life for aquatic species in your community. What could be done to protect the area from being damaged, degraded or lost?

Evaluation

1.) Write a paragraph about the characteristics of ecotones. Write two additional paragraphs to describe two ecosystems and an associated ecotone.

2.) Choose a species of wildlife and write a story about its life as it roams through several different ecosystems and ecotones. Explain how the animal's experiences are different at each of the various locations.

Duration: one or two 45-minute sessions
Group Size: any
Setting: outdoors and indoors
Vocabulary: ecosystem, ecotone, edge effect

This activity was reprinted with permission from, "Project WILD Aquatic K-12 Curriculum and Activity Guide"

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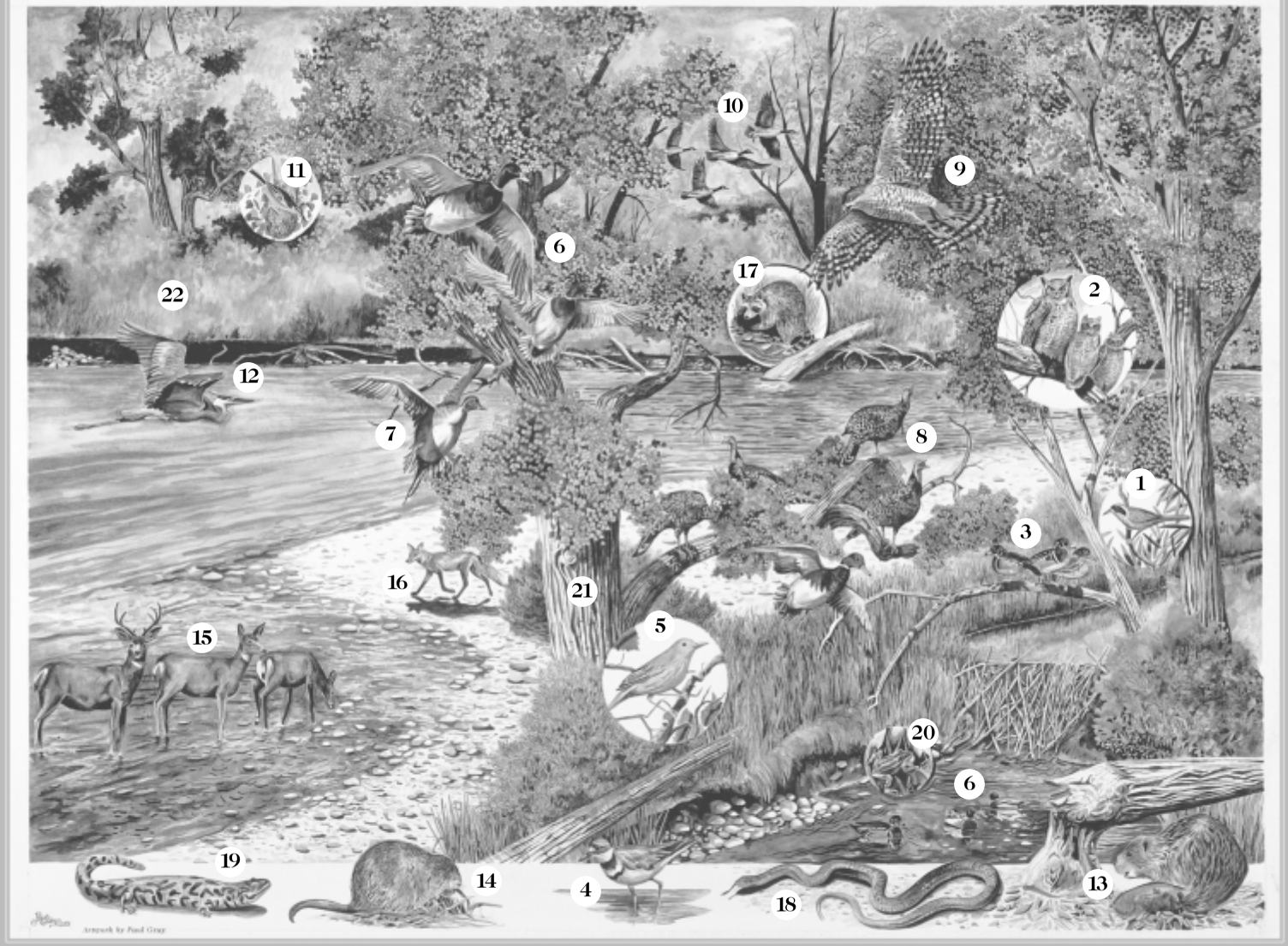
WILD Colorado: Crossroads of Biodiversity



Artwork by Paul Gray

RIPARIAN

Part of a series of eight posters • Supporting educational materials at www.wildlife.state.co.us

Setting—The Rio Grande between Monte Vista and Alamosa

Birds

1. **Common Yellowthroat** *(Geothlypis trichas)*—favors riparian habitats, primarily cattail marshes and swamps, below 8,000 feet. Known as the "witchety" bird from the sound of its song, the yellowthroat gleans insects from the ground or from low shrubs.
2. **Great Horned Owl** *(Bubo virginianus)*—distinguished by its large ear tufts and found at all but the highest elevations, has the widest distribution of any North American owl. The distinctive hooting calls of this nocturnal owl are heard throughout the year, especially in late winter when they begin to nest.
3. **Wood Duck** *(Aix sponsa)*—usually found in lower-elevation, wooded riparian areas, and identified by a distinctive head crest, larger on the male. Females call a loud "oo-eek" during flight.
4. **Killdeer** *(Charadrius vociferus)*—named for the sound of its call and identified by two dark neck rings, widespread up to about 10,000 feet. This ground-nesting plover has the interesting habit of dragging a wing along the ground as if injured to draw predators away from its nest.
5. **Yellow Warbler** *(Dendroica petechia)*—prefers cottonwood-willow riparian habitats up to about 10,000 feet. Males, identified by reddish streaks on their yellow breasts, arrive in Colorado in May and increase their singing upon the arrival of the females.
6. **Mallard** *(Anas platyrhynchos)*—the male, or drake, distinguished by iridescent green head and yellow bill. Perhaps the most numerous and widespread of any wild duck, only the female of the species "quacks".
7. **Northern Pintail** *(Anas acuta)*—duck named for its long pointed tail. At birth, pintail ducklings are well developed and immediately walk to water, sometimes covering distances up to a mile on their first day of life.
8. **Wild Turkey** *(Meleagris gallopavo)*—introduced Rio Grande subspecies found in riparian cottonwood habitats. Sociable birds often seen in large flocks, the familiar fanning of the tail is a courtship display done by the male while strutting and "gobbling".
9. **Sharp-shinned Hawk** *(Accipiter striatus)*—found in riparian areas at all elevations. The relatively short wings and long tails that typify accipiters like these "Sharpies" are useful in catching smaller birds in mid-air.
10. **Canada Goose** *(Branta canadensis)*—identified by a white chinstrap on an otherwise black head and neck. This once uncommon species is now numerous in many of the state's riparian areas and valleys, especially along the northern Front Range.
11. **Bullock's Oriole** *(Icterus bullockii)*—formerly the Northern Oriole, has black eye-line and markings on otherwise orange face compared to all-black hood of the Baltimore oriole *(I. galbula)*. Great Plains settlers planted deciduous trees like cottonwoods, providing a bridge between the two species and allowing for interbreeding.
12. **Great Blue Heron** *(Ardea herodias)*—adults identified by black streak over the eye and, in breeding adults, head, neck, and back plumes. The largest heron in the U.S., and the most widespread, this four-foot tall bird can often be seen wading or slowly walking through shallow water in search of food.

Mammals

13. **American Beaver** *(Castor canadensis)*—largest rodent in North America, found in riparian areas from grassland to alpine tundra. The beaver's eyes, ears, nose and mouth can be covered for swimming, its hind feet are webbed, and its paddle-like tail can be used as a rudder, or a water-flapping alarm call.
14. **Common Muskrat** *(Ondatra zibethicus)*—smaller than the beaver with a thinner, side-flattened tail. More closely related to voles than to true rats, muskrats can stay underwater for periods of fifteen minutes or more, needing only seconds above water between submersions.
15. **Mule Deer** *(Odocoileus hemionus)*—inhabit all of Colorado's ecosystems from grasslands to tundra. Named for the large ears that can move independently, these deer also have scent glands above the back hooves.
16. **Red Fox** *(Vulpes vulpes)*—the most widespread carnivore in the world, in Colorado may range in color from red to black, but always with a white-tipped tail. This fox's hearing is sensitive to low-frequency sounds, enabling it to hear the underground activities of its burrowing prey.
17. **Raccoon** *(Procyon lotor)*—identified by a black mask and a bushy tail with alternating black and lighter-colored rings. These ringtail relatives are omnivorous and primarily nocturnal.

Reptile and Amphibians

18. **Smooth Green Snake** *(Liochlorophis vernalis)*—grass green with white undersides, found in mid-elevation riparian areas of Colorado. Active from about May to September, large numbers of these sociable snakes often hibernate together.
19. **Tiger Salamander** *(Ambystoma tigrinum)*—found throughout Colorado where aquatic breeding areas are accessible. Coloration, influenced by the environment, can range from light bars on a dark background to dark bars or spots on a light background.
20. **Western Chorus Frog** *(Pseudacris triseriata)*—occurs at all elevations, usually in or near standing water. The male's mating call is an ascending "pre-ee-eep".

Trees

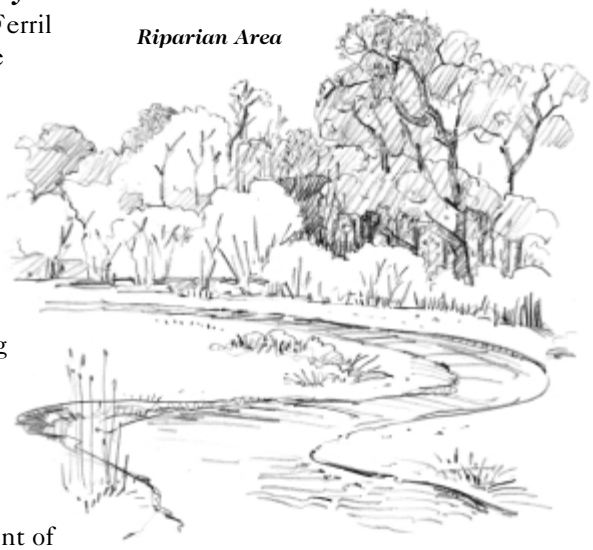
21. **Cottonwood** *(Populus deltoides)*—the water tree of riparian Colorado, occurs on the eastern prairie as the Plains Cottonwood, and in lowland areas of the west slope as the Rio Grand or Valley Cottonwood. The more abundant Narrowleaf Cottonwood *(P. augustifolia)* is found at higher elevations with the Lanceleaf hybrid in between.
22. **Sandbar Willow** *(Salix exigua)*—sometimes called Coyote Willow, common along lower-elevation stream banks in tandem with cottonwood. A characteristic riparian species, this willow colonizes and helps stabilize newly created sandbars.

Aquatic Ecosystems, Riparian Areas, and Wetlands

Water: Essential for Life

Poet Thomas Hornsby Ferril described Colorado as a state where "life is written in water." With an average annual precipitation of just less than 16 inches, Colorado is considered a semi-arid state. Yet, the water that collects in the rivers, creeks, lakes, ponds, spring seeps and surrounding wetlands is vital to sustain the biodiversity of the state. Together, freshwater ecosystems, riparian lands, and wetlands constitute an estimated one to three percent of the state's land, but support most of Colorado's plant and animal species!

Riparian Area



Water Worlds

Colorado's streams, rivers, ponds, lakes, irrigation ditches and reservoirs are all aquatic ecosystems. The kind of habitat that each provides and the variety of life that each can support is determined by many factors—water temperature, water clarity, current, amount and kind of dissolved minerals, and the materials that line the bottom. Dissolved minerals in the water influence the variety and abundance of aquatic plants. For insects, fish, and other animals, oxygen levels are the decisive factor governing what species can thrive in a particular body of water. The mix of plants and animals that live in the cold, fast moving waters of high mountain streams and rivers is very different than the mix of species inhabiting relatively warm, tranquil low elevation lakes and ponds.

Riparian Lands

A riparian land scene was chosen to represent water-associated ecosystems for this poster series. The word "**riparian**" is an adjective used to describe lands bordering bodies of fresh water, usually the banks of rivers, streams, and ponds. Riparian areas are found at all elevations and within all ecosystems of the state from grassland to alpine tundra. Riparian lands represent an **ecotone**, an area of transition between distinct ecosystems. They are strongly influenced by the nearby presence of water, and generally, have microclimates that are cooler and wetter than the bordering land ecosystem. Species diversity in riparian areas is two to three times higher than in the surrounding ecosystems.

Wet Meadows, Marshes, and Peatlands

Wetlands, as varied as the topography of the state, support more life acre for acre than any other habitat. But what are they? How can you know a wetland when you see one?

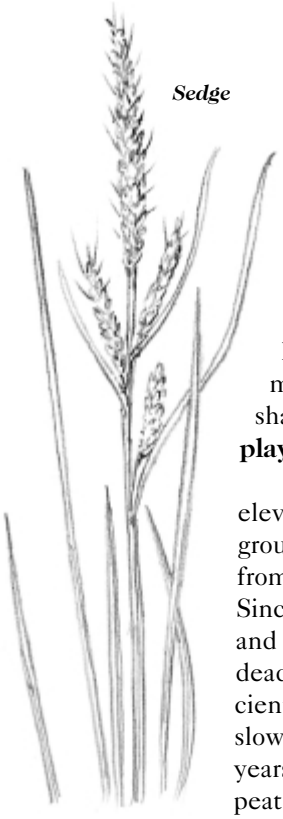
Wetlands are places where *the soils are flooded or saturated long enough each year that most plants would drown*. The presence of unique **hydric** soils, which are oxygen poor, and the special "water-loving" plants, **hydrophytes**, that have adaptations to thrive in them, indicate a wetland. Common hydrophytes such as cattails, bulrushes, sedges, saltgrass, willows and cottonwoods draw oxygen out of the air down their stems to their roots.

Rush

Two types of common wetland plants are rushes and sedges. Grass-like in appearance, rushes have round stems and sedges have triangular stems with three edges. Just remember: Rushes are Round, Sedges have Edges!

Colorado has three main types of wetlands: wet meadows, marshes, and peatlands. **Wet meadows** are often located near riparian areas. Wet meadows have saturated soils during a portion of the year, usually spring and early summer, just after snowmelt. These lush meadows often look greener or darker than the surrounding land. Wet meadows are the most prevalent wetland type in Colorado.

Marshes are similar to wet meadows, but they flood in the spring. Usually, there is an impervious layer of rock somewhere



Sedge

below the surface of the soils, which holds the water like a bucket. In the spring, some marshes may have standing water as deep as three to four feet. The water slowly evaporates throughout the summer. On Colorado's eastern grasslands, clay soils beneath the marshes hold the water, forming shallow temporary lakes called **playas**.

Peatlands or "**fens**" are high elevation wetlands that form when groundwater seeps to the surface from enormous underground springs. Since the soils are low in oxygen, and the bacteria that decompose the dead plants do not work very efficiently, the dead leaves and roots slowly accumulate over thousands of years, packing down into layers of peat.

Cottonwoods—the Water Markers

Cottonwood trees are common in riparian areas across our state. Cottonwoods serve as evidence that surface water or groundwater is nearby, or was in the past.

Cottonwoods depend on a cycle of flooding and erosion to reproduce. Cottonwood seeds can only germinate on bare, wet soil. Once sprouted, they grow very quickly, sending roots down three feet or more during their first year. These deep roots help sustain the tree during periods of low water and anchor the tree during flood events.

Each year, as spring snowmelt overflows the banks of stream channels, Colorado's creeks and rivers wander and reshape themselves. The water washes away existing vegetation, leaving bare ground for more cottonwood seeds to germinate. At the same time, old cottonwoods are uprooted and washed into the stream. The fallen trees decompose while acting as a dam to prevent sand in the flowing waters from passing through. The sandbars that form are first colonized by willows and eventually by new cottonwoods.

At other times, streams meander far away from remaining cottonwoods, leaving them as silent markers of bygone streambeds. Over time, this persistent flooding and meandering creates a mosaic of older, middle-aged and young trees, benefiting biodiversity by creating a variety of different niches.

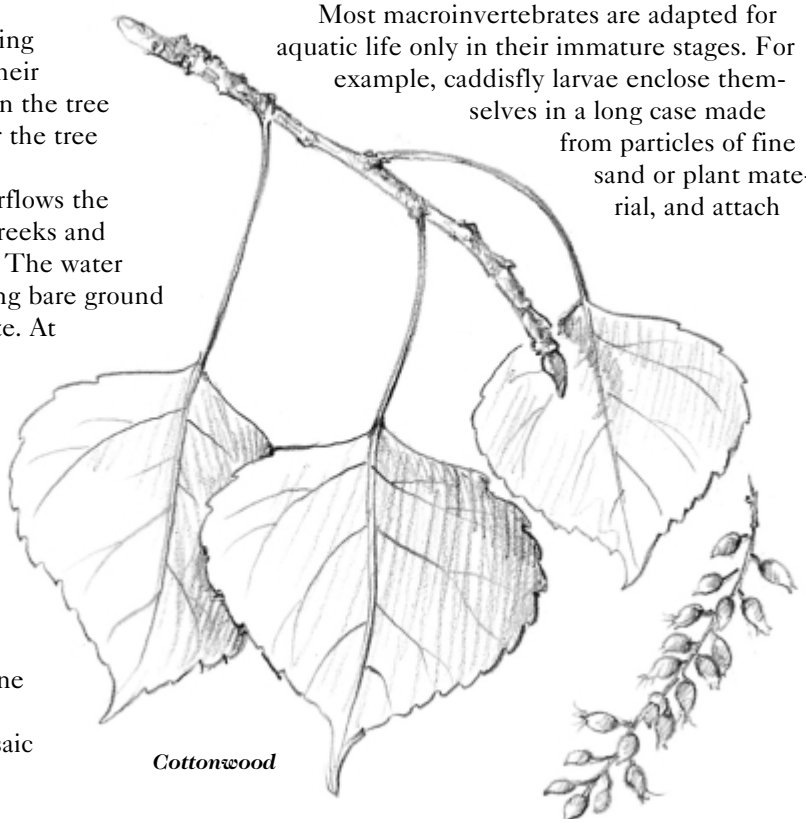
Colorado boasts several varieties of cottonwood—the Plains cottonwood is found east of the divide, while the Rio Grand, or Valley cottonwood, is found in the west. The Narrowleaf cottonwood is found at higher elevations, but hybridizes when it intermingles with the other varieties at intermediate elevations to produce the Lanceleaf cottonwood.

Wildlife You May Discover in Aquatic Ecosystems and Wetlands

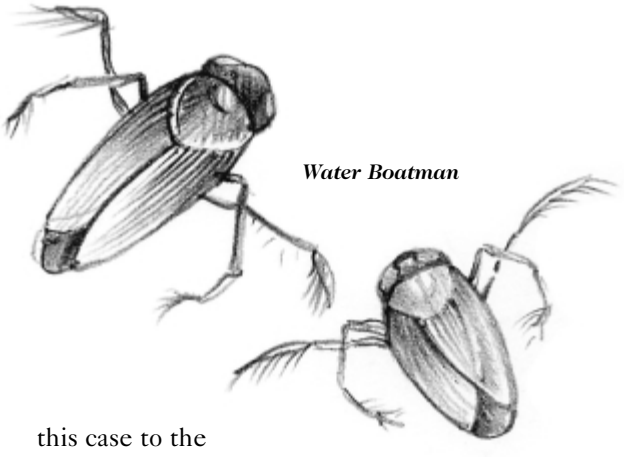
The most numerous organisms in aquatic ecosystems are impossible to see with the naked eye. These microscopic plants (**phytoplankton**) and animals (**zooplankton**) form the base of the aquatic food chain and are vital to the healthy functioning of aquatic ecosystems and wetlands. They provide food for **macroinvertebrates**, animals lacking backbones but visible to the naked eye. Macroinvertebrates, in turn, play a significant role in the food chain of freshwater ecosystems by providing food for fish, birds, reptiles and amphibians.

Some macroinvertebrates are solely **aquatic**, living their entire lives in the water. A common aquatic species one might see is the water boatman, which uses its paddle-like hind legs as tiny oars to move through the water. Like a scuba diver, the water boatman carries its own air bubble to supply oxygen. Water striders, backswimmers, diving wasps and beetles also provide entertaining watery antics.

Most macroinvertebrates are adapted for aquatic life only in their immature stages. For example, caddisfly larvae enclose themselves in a long case made from particles of fine sand or plant material, and attach



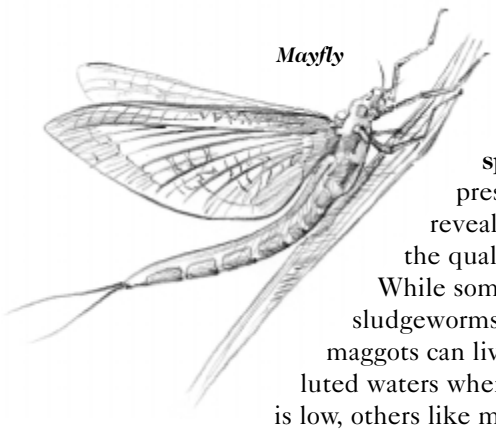
Cottonwood



Water Boatman

this case to the stream bottom. Inside, the caddisfly larvae grow and mature through their pupal stage. Mature individuals then cut themselves free, crawl or swim to the surface of the water, and take wing. Mayflies, damselflies, dragonflies and stoneflies are other familiar flying insects, as are mosquitoes, gnats, and flies.

The diversity of macroinvertebrate species in aquatic ecosystems is a measure of the health of the ecosystem. Certain macroinvertebrates are **indicator species**, whose presence or absence reveals much about the quality of the water. While some species like sludgeworms and rat-tailed maggots can live in highly polluted waters where oxygen supply is low, others like mayflies, caddisflies, and riffle beetles are very sensitive to pollution and can only survive in cleaner environments.



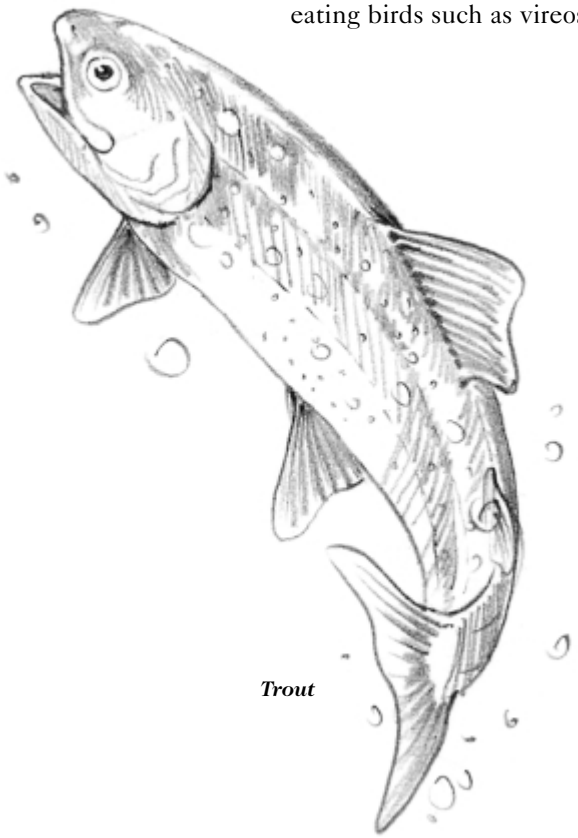
Mayfly

In high mountain streams, brown, rainbow, brook, and native cutthroat trout feed on emerging insects and smaller fish such as fathead minnows, johnny darters, and sculpins. Some of the larger mountain lakes and reservoirs are stocked with kokanee salmon and North American's largest trout, the mackinaw, or lake trout. At lower elevations, channel catfish and various sucker species are plentiful in streams and lakes. In the 1980's, Tiger Muskie, a hybrid of northern pike and muskie, were often introduced to control catfish and sucker populations. These large, sterile fish have become a favorite with many Colorado anglers, providing trophy-fishing opportunities. Largemouth and smallmouth bass, yellow perch, bullhead, green sunfish, crappie, wiper, and bluegill also provide great fishing recreation in Colorado's warmer waters.

Colorado's wetlands and aquatic ecosystems provide ideal habitat for reptiles as well as amphibians. Most amphibians and reptiles live at elevations below 6,000 feet, with few species above 8,000 feet. Lowland riparian areas, floodplains, ponds, and marshes, host an abundance of these animals, including Woodhouse's toad, plains and northern leopard frogs, northern cricket frogs, northern water snakes and the common garter snake. The Great Plains toad is found only in lowland riparian areas in eastern Colorado. When danger threatens, this toad inflates itself, closes its eyes, and gets close to the ground. On the western side of the state, red-spotted toads and canyon treefrogs occupy riparian zones in rocky canyon bottoms.

At the higher elevations, wet meadows, marshes, bogs, beaver ponds and other wetlands, especially those near areas riddled with rodent burrows that amphibians can use for hibernation and shelter, are home to tiger salamanders, western chorus frogs, wood frogs, and boreal toads. Colorado's boreal toad once thrived in wetlands above 7,000 feet. Since 1985, these toads have disappeared from more than 80 percent of their historic range. A likely cause of the decline is a chytrid fungus. Scientists don't know how this fungus is transmitted from one area to another, or if this is the sole factor in the decline of this toad, and research continues.

Wetlands and riparian lands contain the greatest diversity of bird species of any Colorado ecosystem. Within the cottonwood riparian forests, you can spot insect and seed-eating birds such as vireos,



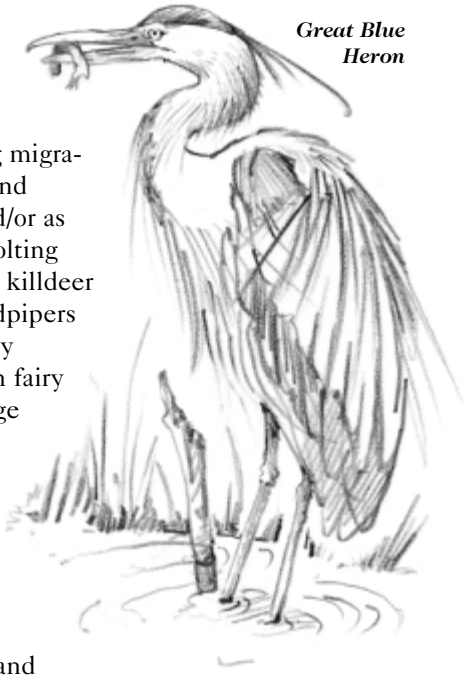
Trout

Boreal Toad

warblers, orioles, blackbirds, grosbeaks, finches and flycatchers, as well as cavity-nesting birds such as woodpeckers and merganser ducks. Look to the stream banks and you may see an entrance hole for a kingfisher's nesting tunnel. On the shore or in the water, you may see an American dipper. In its search for food, the dipper can dive underwater and can actually walk along river bottoms! It has special scales that seal its nostrils and oil glands that waterproof its plumage. Great blue herons can often be seen wading or slowly walking through shallow water in search of food.

Raptors, like golden eagles and prairie falcons, Cooper's hawks, American kestrels, and great horned owls commonly roost and hunt among the cottonwoods. Bald eagles, whose main prey is fish, perch on mature cottonwoods alongside open water. On the high, rocky cliffs overlooking these riparian areas in Western Colorado, a visitor may be lucky enough to spot a peregrine falcon, which preys upon smaller wetland birds such as red-winged blackbirds and swallows.

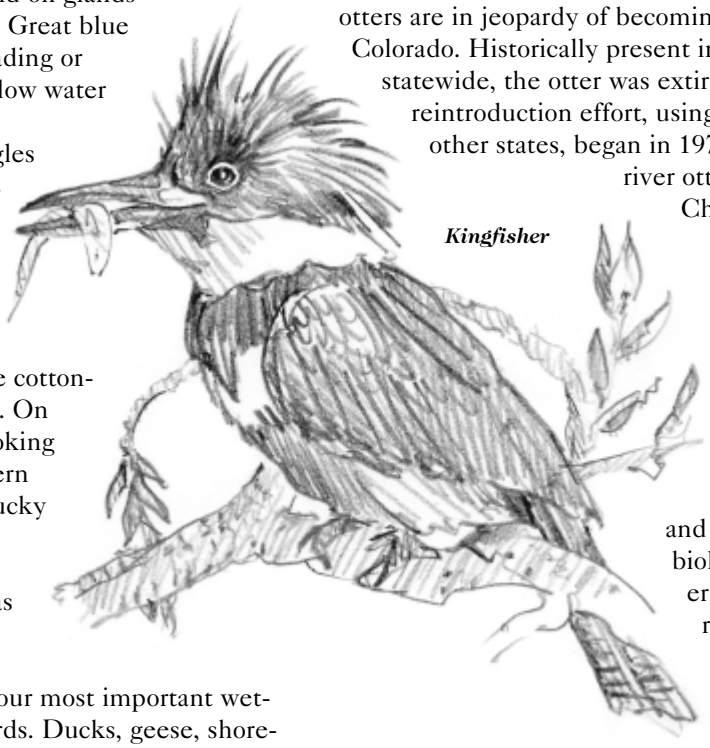
Colorado's marshes are our most important wetlands for migratory water birds. Ducks, geese, shorebirds, and wading birds all use marshes as stopovers during migration, as resting and feeding sites and/or as breeding and molting grounds. Ducks, killdeer and spotted sandpipers arrive in the early spring to feed on fairy shrimp and midge larvae, a rich protein source that they require for egg laying and migration. Wet meadows also provide browse and shelter for shorebirds and waterfowl. Mallards and pintail ducks commonly nest in these areas in the early spring.



Great Blue Heron

Wetlands are important to mammals also. Cottontail rabbits, mice, voles, and raccoons are common. Elk and deer graze in wet meadows alongside domestic livestock. Nearly all mammal species in the state visit riparian areas at one time or another, but beaver, mink, muskrat and river otter call them home.

River otters are carnivores that feed on fish, frogs, and crayfish. River otters are classified as an **endangered species** by the state. This means that otters are in jeopardy of becoming extinct in Colorado. Historically present in riparian habitats statewide, the otter was extirpated by 1907. A reintroduction effort, using otters trapped in other states, began in 1976. More than 100 river otters were released at Cheesman Reservoir and on the Piedra, Gunnison, Upper Colorado and Dolores Rivers. Currently, there are three healthy populations of river otters on the Gunnison, Piedra and Green rivers and biologists are considering reclassifying the river otters' status to state threatened.



Kingfisher

River Otter

A Closer Look at One Species: American Beaver

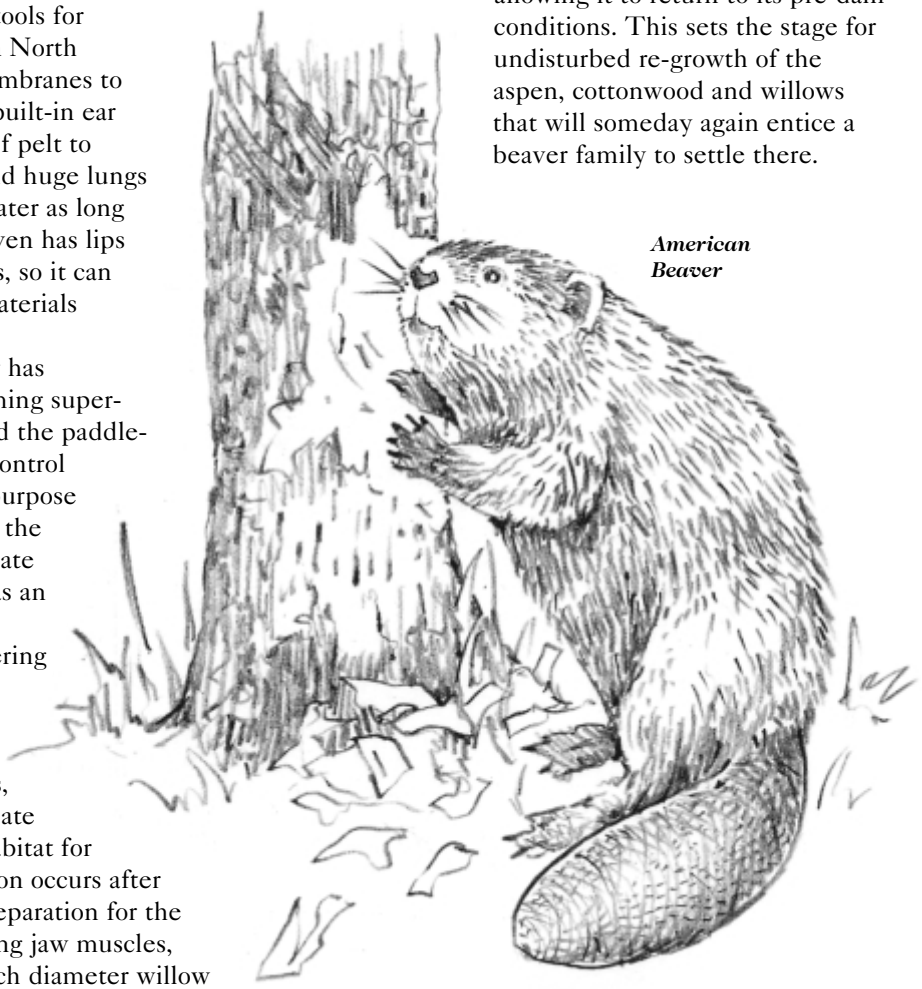
The American beaver is an extraordinary creature, possessing all the right tools for aquatic life. The largest rodent in North America, the beaver has clear membranes to cover its eyes when submerged, built-in ear and nose plugs, a thick waterproof pelt to keep it warm in wintry waters, and huge lungs which allow it to remain under water as long as fifteen minutes. The beaver even has lips that close behind its front incisors, so it can swim carrying food or building materials without taking in water!

Awkward on land, the beaver has appendages that make it a swimming superstar. Its hind feet are webbed, and the paddle-shaped tail provides a rudder to control swimming direction. The multi-purpose tail can be slapped loudly against the surface of the water to communicate potential danger and also serves as an important fat-storage area.

This animal is capable of altering the environment to perhaps a greater extent than any other except humans. Natural engineers, beavers build dams, lodges, bank burrows, and canals to regulate water levels to create a perfect habitat for themselves. Most dam construction occurs after spring runoff and in the fall in preparation for the winter. With sharp teeth and strong jaw muscles, beavers can cut through a four inch diameter willow in about three minutes. Beavers then use their surprisingly dexterous forepaws to embed building materials in the streambed and anchor them by piling and interlacing other materials. Behind the dams, waters slow and pool, often producing good fish habitat and increasing forage.

Beavers mate for life and usually live in family groups of up to eight related individuals called colonies. The entire colony shares a lodge made of sticks, mud and rocks, which may have multiple underwater entrances. Although they are well designed, with air vents and moisture absorbing floors, lodges, as well as dams, need constant maintenance and repair.

In Colorado, beavers use willow, aspen and cottonwood for food as well as for building material. They eat the leaves, buds, and **cambium** (a thin layer of living, dividing cells just under the bark of trees). Since they do not hibernate, beavers store food in underwater caches where it is available for use throughout the winter. The average beaver colony needs about eight to ten acres of suitable trees to survive. Once their supply of preferred wood is depleted, beavers will abandon the area, allowing it to return to its pre-dam conditions. This sets the stage for undisturbed re-growth of the aspen, cottonwood and willows that will someday again entice a beaver family to settle there.

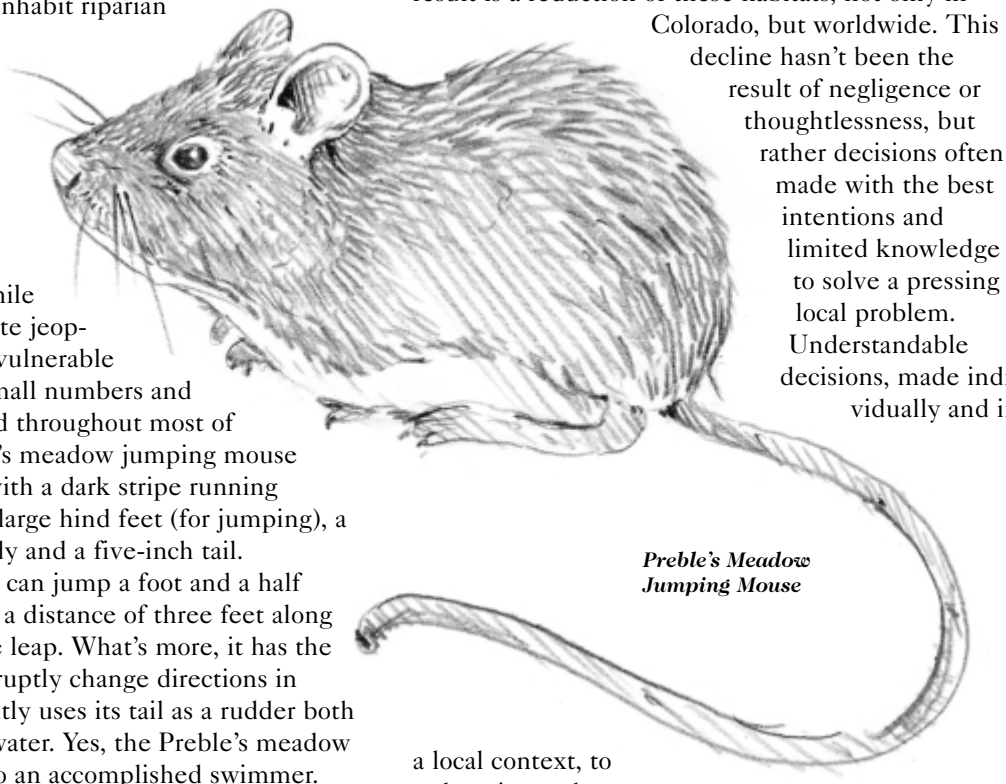


American Beaver

Wetlands and Aquatic Ecosystems—Biodiversity at a Crossroads

Wetlands, riparian lands, and aquatic ecosystems, as home to our greatest diversity of species, also host the most species listed as threatened and endangered. Sixty-nine percent of the mammal, bird, amphibian, and fish species listed in "Wildlife in Danger", published by the Colorado Division of Wildlife, inhabit riparian and aquatic areas.

Among the mammals listed as **threatened**, both by the state and federal government, is the Preble's meadow jumping mouse. This means this mouse, while not being in immediate jeopardy of extinction, is vulnerable because it exists in small numbers and is extremely restricted throughout most of its range. The Preble's meadow jumping mouse is brownish in color with a dark stripe running down its back. It has large hind feet (for jumping), a three to four-inch body and a five-inch tail.



Preble's Meadow Jumping Mouse

This little mouse can jump a foot and a half into the air and cover a distance of three feet along the ground in a single leap. What's more, it has the uncanny ability to abruptly change directions in mid-jump! It apparently uses its tail as a rudder both in the air and in the water. Yes, the Preble's meadow jumping mouse is also an accomplished swimmer.

Like the Preble's meadow jumping mouse, each threatened and endangered species in Colorado is unique and is worth our respect, admiration, and wonder. Through concerted recovery efforts undertaken by dedicated public and private partnerships, there have been many success stories of restoring threatened and endangered populations. People in Colorado continue to make a difference.

Management Issues and Challenges

Acre for acre, Colorado's aquatic ecosystems and wetlands are the state's most valuable lands for wildlife habitat, agricultural production, water quality, tourism, outdoor recreation and ecosystem services (refer to the activity "Wetland Metaphors" for details). These regions face natural and human pressures that must be addressed by government, landowners, and private citizens to conserve their capacity to meet future wildlife and human needs.

Aquatic ecosystems, riparian lands, and wetlands are constantly changing. Lakes and ponds fill in with vegetation and gradually become dry land. Rivers meander across valleys, leaving oxbow lakes, marshes or wet meadows behind. Climate shifts enlarge or shrink existing wetlands. Droughts, like the one that Colorado currently faces, dry streams and wither marshes and riparian areas.

Human activity has dramatically increased the rate and magnitude of change in these areas. The net result is a reduction of these habitats, not only in Colorado, but worldwide. This decline hasn't been the result of negligence or thoughtlessness, but rather decisions often made with the best intentions and limited knowledge to solve a pressing local problem. Understandable decisions, made individually and in a local context, to reduce insect-borne disease, create jobs, feed people, and build roads and cities, have had cumulative unintended consequences.

There are a host of human activities that have impacted aquatic ecosystems and wetlands:

Draining of Wetlands—Historically, it was common practice to drain or fill in wetlands to provide agricultural land, build cities and transportation systems, and to reduce the possibility of insect-borne diseases such as malaria and yellow fever.

Introduction of Invasive Plant Species—Quick growing, ornamental exotics such as tamarisk and Russian olive trees were intentionally cultivated by people in riparian areas to stabilize stream banks. Unfortunately, these exotics sucked up tremendous quantities of moisture and displaced native plant species. While they provided habitat for a few bird species, overall they reduced wildlife habitat. Many exotics are very resistant to control efforts.

Channelization—Before humans understood the ecologically beneficial functions of stream meandering, it was common practice to straighten and deepen watercourses. This was done to make stream dynamics more predictable and to aid in transporting water from one location to another. With flow rates, shores, stream banks and streambeds altered, and with islands and sandbars reduced or eliminated, channelization of Colorado's waterways has also contributed to reduced cottonwood tree regeneration and the precarious status of several of our state's species.

Heavy Metal Pollution from Acid Mine Drainage—Mining practices of the 1800's left a negative legacy of tailing piles and acid seepage. It is estimated that one-third to one-half of the state's total stream mileage has heavy metal loads which exceed current water quality standards.

Other activities that have degraded Colorado's wetland and aquatic areas include: contamination from poorly sited or constructed landfills, overgrazing by livestock, gravel mining, runoff of oils, pesticides, chemicals, and other pollutants, overuse by recreationists and changes related to water storage and diversion (which can positively affect some areas while harming others).

When the full value of wetland, riparian lands and aquatic ecosystems was recognized, both public and private groups began to manage these areas in a manner to ensure that their beneficial functions—from fishing opportunities to water purification—would continue. Some management tools are mitigation, restoration, enhancement, and acquisition. **Mitigation** is the strategy by which a wetland destroyed by one activity is replaced with a comparable human-made wetland in the same region. **Restoration** is the process of reestablishing the original condition of a degraded environment. It may involve "undoing" what was previously done, such as de-channelizing a waterway and allowing it to meander in its historic course. **Enhancement** makes an existing environment even better, by plantings, by providing nesting boxes for birds, or improving the water quality. **Acquisition** is buying critical habitats or water rights outright, or negotiating conservation easements. Colorado has a rich history of protecting critical habitats, both by private groups such as the Nature Conservancy and Ducks Unlimited, and publicly through lottery proceeds from the Great Outdoors Colorado Trust Fund.

Good stewardship of these lands is an ongoing challenge, often complicated by a fragmented array of laws and separate sets of rules managed by different local, state, and federal agencies. Much of this land is privately owned, and wetland and riparian land conservation is often not economically beneficial to the landowner that might otherwise develop the property. The challenge of the government role is not to try to control or usurp private rights, but to encourage landowners to manage these lands in such a way as to maintain and enhance their value to society as a whole.

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Activity: Wetland Metaphors

Objectives

Students will:

1.) describe the characteristics of wetlands; and

2.) evaluate the importance of wetlands to wildlife and humans.

Method

Students are presented with a selection of objects for investigation as metaphors for the natural functions of wetlands.

Materials

A large pillowcase, bag or box; sponge; small pillow; soap; eggbeater or mixer; small doll cradle; sieve or strainer; paper coffee filter; antacid tablets; small box of cereal; 3-inch x 5-inch cards with pictures that could be used to show other wetland metaphors. (A zoo could represent the idea of wildlife diversity in a wetland, a lush vegetable garden could represent the idea of a productive wetland in which food is abundant, a vacation resort could represent the idea of a resting or wintering place for migrating waterfowl.)

NOTE: A metaphoric approach such as this allows a variety of objects to suggest some appropriate linkage to the basic characteristics of wetlands.

Background

Wetlands are many different things to many different people. Some people have never heard or thought about wetlands. Others are working actively to protect wetlands because of their importance.

Wetlands include such areas as freshwater and saltwater marshes, wet meadows, swamps, lagoons, bogs and prairie potholes. All wetlands, whether coastal or inland, provide special habitats that serve areas far beyond their boundaries. Wetlands are uniquely important to plants, animals, humans and the total environment.

Because of the abundance of food, vegetative cover (shelter) and water found there, most wetlands are rich with diverse wildlife species.

Coastal and inland marshes, for example, provide breeding, resting and wintering habitats for thousands of migratory birds—including ducks, geese, swans, cranes and shore birds. Many species of fish that are important for commercial and personal use by humans reproduce and spend part, or all, of their life cycles in fertile wetlands adjacent to larger, more open bodies of water. These fish species include bass, salmon, walleye, perch and pickerel. A wide variety of reptiles, amphibians, insects and crustaceans also breed and live in wetlands. Frogs and toads, turtles of all kinds, salamanders, snakes, dragonflies, water striders, clams and crayfish flourish in wetland habitats. Many mammals—from muskrat and beaver to white-tail deer and moose—also depend on wetland areas.

Wetlands are often referred to as *nurseries* because they provide critical breeding and rearing habitats for countless numbers and kinds of wildlife.

Wetlands also have the unique ability to purify the environment. They act as natural filtering systems and have been shown to be extremely effective. For example; they can trap and neutralize sewage waste, allow silt to settle and promote the decomposition of many toxic substances.

The importance of vegetation associated with wetlands cannot be overlooked. Plants absorb nutrients and help cycle them through food webs. Plants also help keep nutrient concentrations from reaching toxic levels. Plants slow down water flow, causing silt to settle out. Through photosynthesis, plants add oxygen to the system and provide food to other life forms. Of great importance to humans are the flood-control characteristics of wetlands. When runoff from rains and spring thaws are high, wetland areas absorb excess water until it gradually drains away down streams and rivers and through the soil. Acting as buffers, healthy wetlands prevent flooding and erosion. In dryer periods, wetlands hold precious moisture after open bodies of water have disappeared.

The many activities that take place in wetlands make them among the most productive ecosystems in the world.

As remarkable and resilient as wetlands are, these unique areas have limits. Their destruction and/or abuse can have devastating effects on wildlife, humans and overall environmental quality.

Many of the major attributes of wetlands can be explored through the use of metaphors. To use a metaphor is to apply a word or phrase to an object or concept that does not literally denote in order to suggest a comparison between the two. A metaphor represents a concept or idea through another concept or idea. "*A tree is a home*" and "*Books are windows of thought*" are two examples. In this activity, a variety of

everyday objects are used to represent the nature functions of wetlands. For example:

Object	***Metaphoric Function***
sponge	absorbs excess water caused by runoff; retains moisture for a time even if standing water dries up (e.g., sponge placed in a small puddle of water absorbs water until saturated, then stays wet after standing water has evaporated)
pillow or bed	is a resting place for migratory birds
mixer or eggbeater	mixes nutrients and oxygen into the water
cradle	provides a nursery that shelters, protects and feeds young wildlife
sieve or strainer	strains silt, debris, etc., from water
filter	filters smaller impurities from water
antacid	neutralizes toxic substances
cereal	provides nutrient-rich foods
soap	helps cleanse the environment, as wetlands do

Wetland habitats are being converted to other uses (agriculture, roadways, housing developments) or otherwise being altered (drained for pest control or polluted) at the rate of about a half-million acres per year. And although many wetlands are protected by federal and state laws, there still appears to be a significant need to create a greater understanding of the importance of wetlands as ecosystems and as wildlife habitat.

The major purpose of this activity is for students to develop an appreciation and understanding of wetlands through the power of metaphor, linking the characteristics and natural functions of wetlands to the familiar realm of everyday life.

Procedure

1.) Prepare a "*Mystery Metaphor Container*" (pillowcase, bag or box). It should be possible for students to put their hands into the container and pull out an object without being able to see inside the container. Educators may want to collect as many as one metaphor object per student, but at least have enough for one per group of four students. Put the container aside to use later.

2.) Discuss the variety of wetlands found in your local area, state, country, etc. Then invite the students to sit quietly and close their eyes. Ask them to picture a wetland. Have them examine what it looks like. Have them look carefully at the plants and animals, including insects and small creatures. What does the air feel like? How does it smell?

3.) Invite the students to tell what they imagined. Compile a list of their offerings. Encourage discussion and mutual sharing.

4.) With their lists as a point of reference, help the students identify which plants and animals are most likely to be found in a wetland. If possible, have them classify the plants and animals according to the kind of wetland in which they would be found. State or federal wildlife officials and representatives of private conservation or nature-related organizations can be helpful.

5.) Next provide the students with background information to serve as an overview of the basic ecological activities that characterize the wetland habitat. For example, educators might include the following:
- sponge effect—absorbs runoff
- filter effect—takes out silt, toxins, wastes, etc.
- nutrient control—absorbs nutrients from fertilizers and other sources that may cause contamination downstream
- natural nursery—provides protection and nourishment for newborn wildlife

Suggest that these activities and many more that they could probably this of are taking place in wetlands all the time.

6.) Now bring out the *"Mystery Metaphor Container."* Tell the students that everything in the container has something to do with a wetland. Have the students divide into groups of four. Announce that when it is their turn, a representative of each group will draw an object from the container. Then, as a group, they must figure out how the object could represent what a wetland is or does.

7.) Have the designated student reach into the container and withdraw one object. When each group has an object, ask them to work as a team to describe the relationships between their metaphoric object and the wetland. Encourage the students to build on each other's ideas. You can also assist by strengthening their connections.

NOTE*: Allow the students time to discuss their ideas with each other before doing so in front of the entire class.*

8.) Ask each group to report its ideas to the class.

9.) Following discussion and review of the functions represented by each metaphor, ask the students to summarize the major roles that wetlands perform in contributing to habitat for wildlife. List the ways in which wetlands are important to humans. Why do humans convert wetlands to other uses? Ask them if their own attitudes about wetlands are different now. If yes, how? If not, why not?

10.) For the final part of this activity, encourage the students' understanding of how the wetlands' condition depends upon each of us. Many kinds of wildlife depend upon wetlands. Our own well-being requires wetland ecosystems. Strengthen the students' understanding of how humans are connected to wetlands. Recreation, aesthetics, utilitarian uses, environmental quality and nature study are but a few of the connections we each have with wetlands.

Extensions

1.) Visit a wetland to verify the appropriateness of the metaphors explored in the classroom. Identify and discuss any limitations to the appropriateness of these metaphors. Identify what seem to be the most compelling attributes of the metaphors in helping you understand the characteristics and nature of the wetland. Expand on your understanding of these metaphors. Identify new and appropriate metaphors.

2.) Investigate local, county, state and federal regulations and laws that govern uses of wetlands.

Evaluation

1.) Explain why wetlands are among the world's most productive ecosystems.

2.) Wetlands are important to a range of organisms in the animal kingdom, from zooplankton to humans. Select five species of animals and describe how wetlands are important to each.

Duration: one or two 30–60 minute sessions
Group Size: any
Setting: indoors or outdoors
Vocabulary: wetlands, metaphor

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Cattails

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Glossary

Abiotic: Non-living factor in an environment.

Acquisition: As a management strategy, the process of protecting habitat through such transactions as purchasing critical habitats or exclusive water rights, or negotiating conservation easements.

Antlers: Skin-covered, bone projections found typically on the heads of male members of the deer family, that are shed and re-grown annually, in contrast to the **horns** of bighorn sheep, mountain goats, and pronghorn, which are not shed.

Aquatic: Associated with, or living in, water.

Biodiversity: Short for biological diversity, includes the variety of species, genetic diversity within a species, and the diversity of ecosystems within a recognizable area.

Biomass: Organic material.

Biome: A large geographic area with uniform climatic conditions and distinct vegetation.

Bioregion: An area whose physical, ecological, or cultural characteristics set it apart from surrounding areas.

Biotic: Living factor in an environment.

Browsers: Those species that mainly eat twigs and leaves of woody or brushy plants. Often contrasted with **grazers**.

Buck: Mature male of certain mammal species, including deer and pronghorn.

Bull: Mature male of certain species, including bison, cattle, elk and moose.

Cambium: A thin layer of living, dividing cells just under the bark of trees.

Camouflage: Protective coloration that helps species blend in with their surroundings.

Circumpolar: Occurring in the same habitats across the northern hemisphere, in both arctic and alpine tundra regions.

Climax community: A plant community at the end point of the successional sequence, that maintains itself if the environmental conditions stay the same.

Coevolution: Shared shaping of adaptations.

Commensalism: Literally "at table together", a relationship between two species where one benefits and the other remains relatively unaffected, neither significantly helped nor harmed. *See also* **symbiosis**.

Community: Species living and interacting in an area.

Composite organism: Organism composed of two or three species functioning as one, e.g., lichens.

Coniferous: Trees that keep their green needles throughout the year.

Consumers: Species that primarily eat or consume others.

Cooperative breeding: Survival adaptation in which the previous year's offspring help the parents raise the new brood.

Cultural diversity: The richness of human knowledge, beliefs, and traditions.

Deciduous: Trees that shed their leaves annually.

Decomposers: Species that help break down, or decompose, all others.

Delayed implantation: Reproductive strategy in which the attachment of the fertilized egg to the uterine wall is delayed.

Diurnal: Most active in the daytime.

Ecosystem: The sum of interactions between a community of species and the non-living components of the environment, such as temperature, soils, water, and elevation.

Ecotone: Area of transition between distinct ecosystems. *See also* **edge**.

Edge: Area of overlap between two ecosystems where parts of each surrounding habitat are present. *See also* **ecotone**.

Endangered species: A species or subspecies that is in jeopardy of becoming extinct.

Endemic species: A species found nowhere else in the world.

Enhancement: As a management strategy, the process of bettering an existing environment through such actions as plantings, providing nesting boxes for birds, or improving water quality.

Extirpated: Species absent from its native range but not extinct.

Fens: High elevation wetlands that form when groundwater seeps to the surface from enormous underground springs. Also known as **peatlands**.

Forbs: Non-woody, broad-leafed, flowering plants.

Furbearer: As a legal classification, an animal with marketable fur.

Game animal: As a legal classification, a wildlife species that can be hunted according to legal seasons and limits.

Grazers: Those species that mainly eat grasses and **forbs**. Often contrasted with **browsers**.

Habitat: Where organisms live and get the food, water, shelter and living space they need to survive.

Hibernaculum: Place where bats **hibernate**.

Hibernation: A state of winter dormancy.

Horns: Bone-like projections from the heads of bighorn sheep, mountain goats, and pronghorn that are not shed every year like the **antlers** of deer and elk.

Hydric: Oxygen poor soils characterized by, and showing the effects of, the presence of water.

Hydrophytes: "Water-loving" plants that have adaptations to thrive in oxygen-poor, or **hydric**, soils.

Indicator species: Species whose relative abundance and condition reveal much about the condition of the larger ecosystem.

Krummholz: Literally "crooked wood", the stunted, twisted trees that border the highest edge of the subalpine forest.

Landscape: A general term for an area that shares enough features to set it apart from another area.

Lek: Strutting ground of male grouse and prairie chickens.

Life zone: A band or belt of plant and animal life, usually on the side of a hill or mountain, which changes with elevation and latitude.

Macroinvertebrates: Animals lacking backbones but visible to the naked eye.

Mitigation: As a management strategy, constructing or creating wetlands to replace those lost to development.

Monoculture: The raising of a crop of a single plant species, generally even-aged.

Morphological: Pertaining to physical form and structure.

Mutualism: A mutually beneficial relationship between two species. *See also* **symbiosis**.

Myotis: The "mouse-eared" bats.

Niche: The function, opportunity, or "job" available to a living thing in an ecosystem.

Niche differentiation: Competitive strategy in which species restrict their activities to a specific time period or part of the environment. Also known as **specialization**.

Nocturnal: Most active at night.

Parasite: An organism that draws its needed nutrients from another.

Parasitism: A relationship between two organisms where one benefits and the other is harmed. *See also* **symbiosis**.

Peatlands: High elevation wetlands that form when groundwater seeps to the surface from enormous underground springs. Also known as **fens**.

Photosynthesis: The process by which green plants manufacture simple sugars in the presence of sunlight, carbon dioxide, and water.

Phytoplankton: Microscopic plants.

Pioneer: Early successional species that are often first to colonize habitats not yet suitable for other living things.

Pollination: The transfer of pollen from the male part of the plant (anther) to the female portion of the plant (stigma).

Pollinator: An organism that pollinates flowers.

Playas: Shallow, temporary lakes.

Precocial: Refers to young that are sufficiently developed at birth or hatching to function with a degree of independence from their parents.

Producers: Species that make their own food, and serve mostly as food for others.

Restoration: As a management strategy, the process of reestablishing the original condition of a degraded environment.

Riparian: Describing lands bordering bodies of fresh water, usually the banks of rivers, streams, and ponds.

Rut: Mating season of male moose, elk, deer, sheep, and goats.

Scat: Animal feces or droppings.

Specialization: Adaptive strategy in which species restrict their activities to a specific time period or part of the environment. Also known as **niche differentiation**.

Species: Populations of individuals that basically look alike, behave similarly, and are able to breed and produce fertile offspring under natural conditions.

Species abundance: The number of individuals of each species in a given area.

Species richness: The number of different species in a given area.

Sublimation: Process in which moisture from snow returns to the atmosphere directly as water vapor.

Succession: The natural process by which plant communities replace previous ones over time.

Symbiosis: Literally "living together", two organisms living closely associated for extended periods of time, with at least one species benefiting. *See also* **mutualism**, **parasitism**, and **commensalism**.

Taxonomist: Scientist who classifies organisms.

Threatened species: Species or subspecies in jeopardy of becoming endangered.

Torpor: A state of lowered metabolic rate. An animal in such a state is described as torpid.

Treeline: The transitional zone or edge between subalpine forest and alpine tundra, sometimes called timberline.

Trophic level: The role of a species in the food chain, or feeding level.

Wet meadows: Areas with soils that are saturated during a portion of the year, usually spring and early summer, just after snowmelts.

Zooplankton: Microscopic animals.

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Field Identification Manuals

Field Identification Manuals are an essential resource for exploring and understanding nature in Colorado and elsewhere. There are many excellent guides available at bookstores and libraries. Our suggested list is by no means exhaustive. The books or series that are marked with a "•" may be more useful to young or beginning naturalists.

Field Guide Series

The Audubon Society Nature Guides
The Audubon Society Pocket Guides
Golden Field Guides
Golden Guides •
National Audubon Society Field Guides
National Audubon Society First Field Guide Series •
National Audubon Society Regional Field Guide Series
Nature Finder Guides
Peterson Field Guides
Peterson Field Guides for Young Naturalists •
Peterson First Guides •
Peterson Flash Guides (Map-like, with 24 waterproof panels)
Readers Digest North American Wildlife Series
Simon & Shuster Guides
Smithsonian Kid's Field Guides •
Stokes Beginner's Guides •
Stokes Nature Guides

Other Field Guides

Field Guide to the Birds of North America, Second Edition; National Geographic Society, Washington, D.C.

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project WILD

A great way to spice up your teaching.

Three Project WILD activities are included in this guide:

Which Niche? (page 6)
The Edge of Home (page 52)
Wetland Metaphors (page 63)

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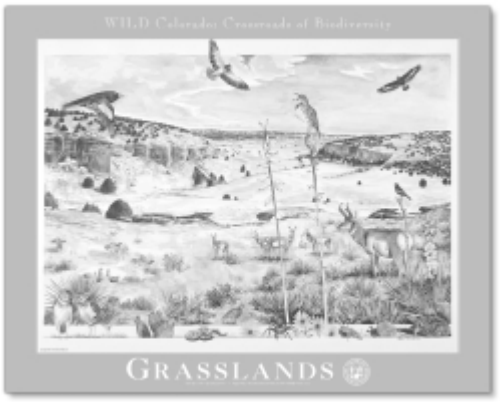

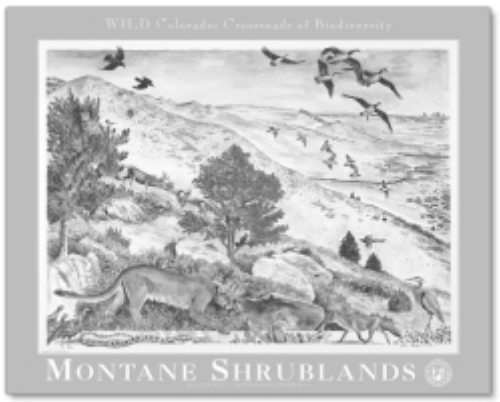

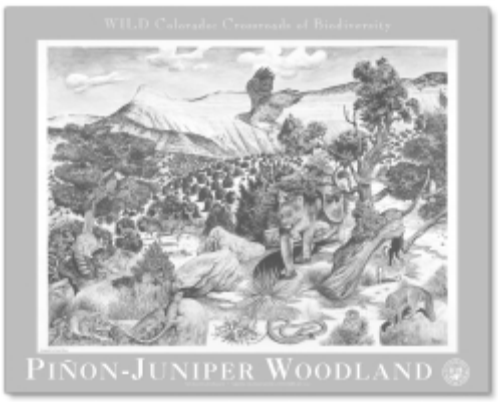

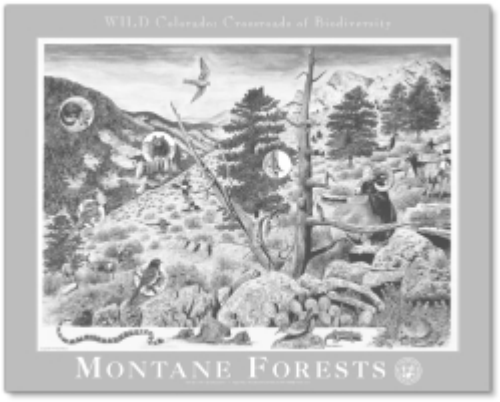

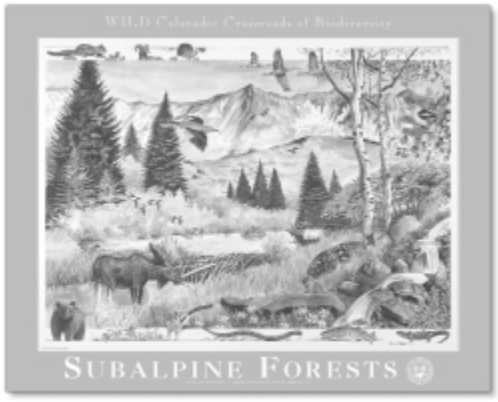

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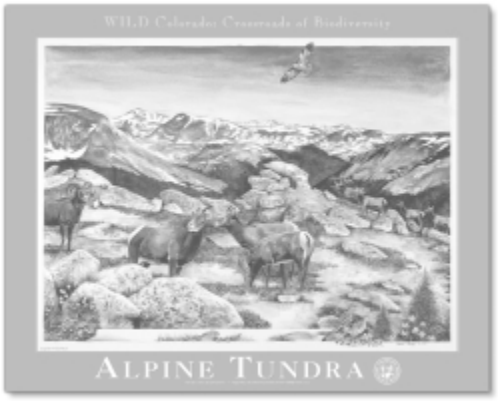

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