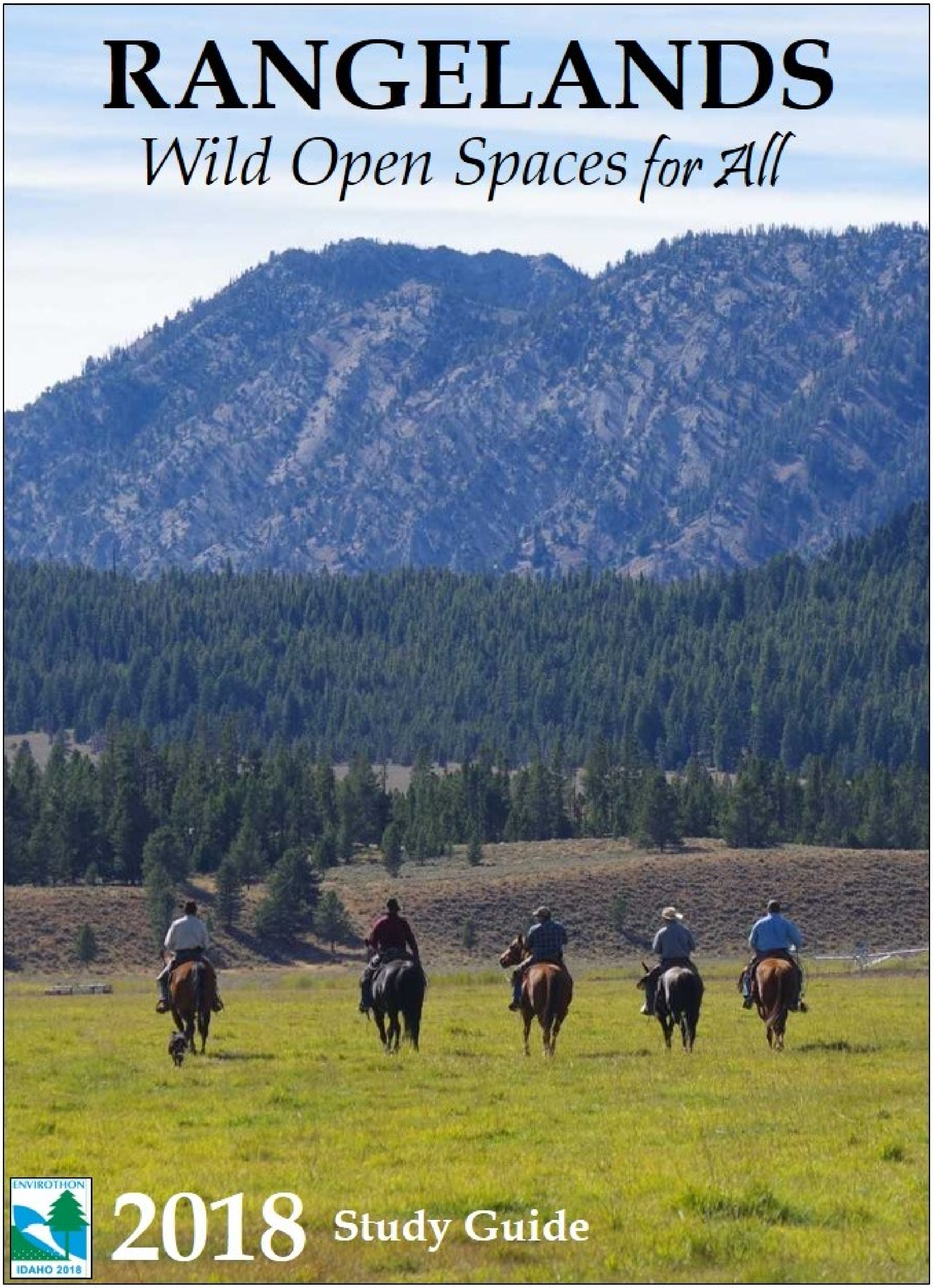
RANGELANDS

Wild Open Spaces for All



2018 Study Guide

This Study Guide is to be used to help Envirothon teams prepare for the 2018 Envirothon Program

Idaho Rangeland Resource Commission

University of Idaho

This 2018 Envirothon Rangeland Study Guide draws on numerous documents and other sources, most notably *Wild Open Spaces* and the high school curriculum created by the University of Idaho (UI) and the Idaho Rangeland Resource Commission (IRRC), plus course materials for REM151: Rangeland Principles (UI). We thank the many talented and dedicated UI faculty and staff, past and present, who contributed to these materials.

We have set up a central clearinghouse of references for students at idrange.org/Envirothon-rangeland-resources. There you will find links to a host of resources, including videos, websites, information packets and more, to help students and their instructors prepare for the 2018 Envirothon in Pocatello, Idaho.

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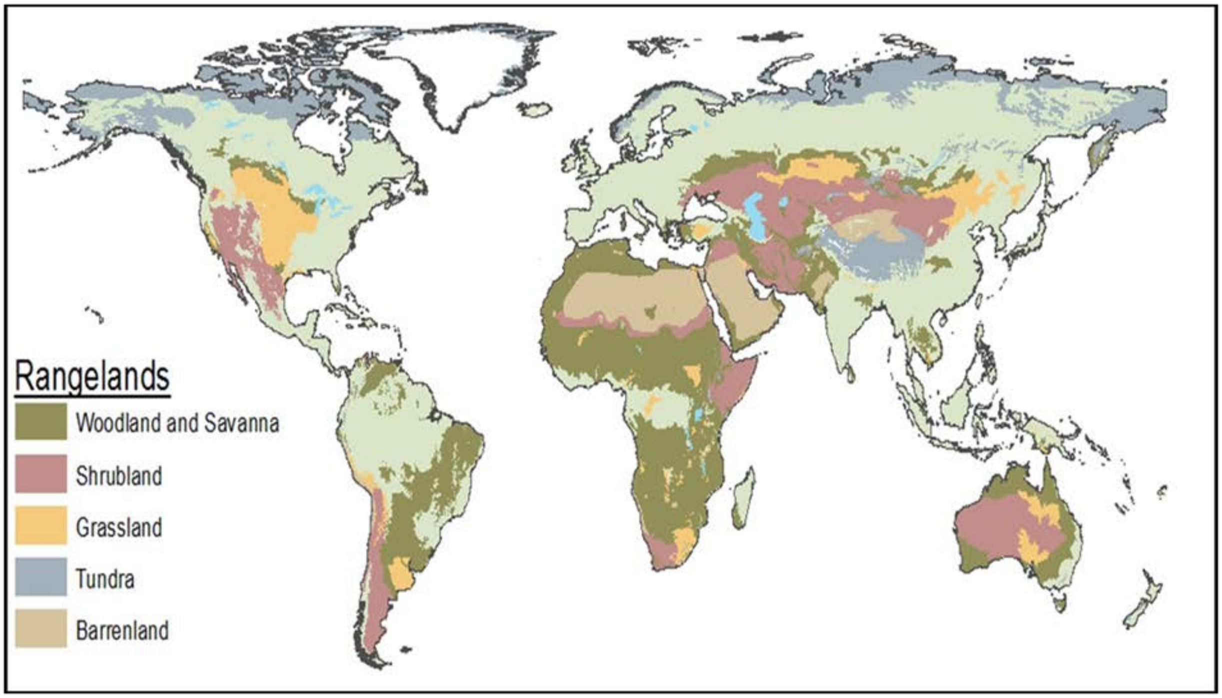
1.2. *Learning Objectives*

- Describe the biotic and abiotic characteristics of rangeland biomes.
- Discuss rangeland history and how it influences decisions today.
- Describe the various entities responsible for managing rangeland—private, state and federal agencies, and non-governmental organizations (NGOs).
- Demonstrate an understanding of multiple use on rangeland (social, economic and ecological values).
- Demonstrate knowledge of rangeland plants (including identification, growth form, life span, season of growth, origin, and forage value).
- Demonstrate knowledge of grazing systems.
- Demonstrate knowledge of how abiotic and biotic factors affect range conditions/health and strategies and tools that promote sustainable rangelands.
- Demonstrate awareness of career opportunities in rangeland ecology and management.

1.3. *Get to Know Rangelands*

What Are Rangelands?

Understanding what rangelands are begins with knowing what they are not. Rangelands *are not* lands that are farmed, densely forested, entirely barren, or covered with solid rock, ice or pavement. Rangelands *are* grasslands, shrublands, woodlands, and deserts. Rangelands are usually characterized by limited precipitation, often sparse vegetation, sharp climatic extremes, highly variable soils, frequent salinity, and diverse topography. From the wide open spaces of western North America, to the Asian steppe, to the Australian deserts, to the vast plains of Africa and the pampas of South America, rangelands are found all over the world and encompass almost half of the earth's land surface. Because rangeland landscapes are diverse and complex, you will hear them called by various names around the world, including prairies, plains, grasslands, swards, steppes, pampas, shrublands, scrublands, woodlands, savannas, deserts, semi-deserts, and arid lands.



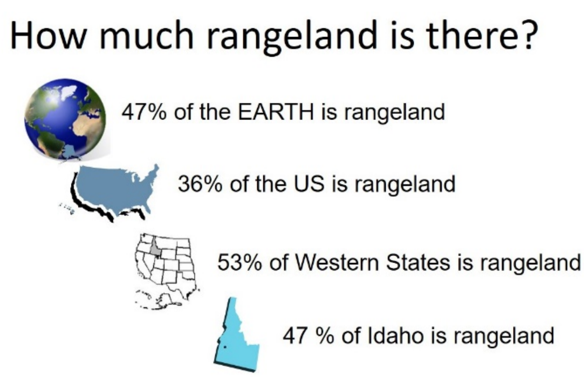
Rangelands of the World. Map created by Eva Strand, Karen Launchbaugh, and Christopher Bernau of the University of Idaho based on a global database created by the World Wildlife Fund http://www.worldwildlife.org/science/ecoregions/item1847.html

Rangelands are a type of land, not a specific land use.

- Rangelands are non-cultivated land. Rangelands typically cannot sustain farming because of low precipitation, shallow soils, and rugged topography.
- Rangelands may have scattered trees, such as juniper or aspen, but they do not include dense forests. Rangelands are typically dominated by low-growing, diverse plant communities of grasses and shrubs intermixed with flowering plants (forbs).
- Rangelands provide essential habitat for livestock and wildlife. Their rich ecological diversity provides food, cover and rearing-ground necessary for healthy fish, birds, wildlife, and livestock.

How Much Rangeland Is There?

Of the Earth's total land surface, 47% is rangeland. In the U.S., 36% of the land area (nearly 1 billion acres) is rangeland. A total of 53% of the 19 states west of the Mississippi is rangeland. The state of Idaho encompasses about 53 million acres. Of that, nearly 26 million acres, or 47%, is classified as rangeland.



Not All Rangelands Look Alike

Grasslands, as the name implies, are ecosystems that are dominated by grasses. Throughout the world, grasslands go by names like prairie, steppe, pampas, sward, meadow and veld. In North America, grassland biomes include the tallgrass prairie, shortgrass, prairie, alpine meadows, California annual grasslands, palouse prairie, southern mixed prairie, marshes, wet meadows, tundra grasslands, and desert grasslands.

Shrublands are lands with abundant stands of shrubs with an understory of grasses and forbs—but shrubs dominate these ecosystems. Shrublands across the world are called chaparral, cerrados, shrub-steppe, maquis, and scrublands. In North America, shrubland biomes include chaparral, sagebrush-steppe, salt-desert shrublands, tundra shrublands, and mountain browse.

Woodlands and Savannas are dominated by widely-spaced trees including juniper, oak, mesquite and pine, with an understory of grasses and forbs. Woodland ecosystems across the world take the names of the trees that dominate the landscape. In North America, the largest woodland biome is the pinyon-juniper woodland. Other woodland and savanna ecosystems include oak woodlands, aspen savannas, and mesquite woodlands.

Deserts are the driest rangelands; they experience extreme water shortage and unpredictable precipitation. These ecosystems are dominated by shrubs and succulent cactus plants. Deserts and arid lands cover massive areas and include the Saharan, Namib, Arabian, Atacama, Australian, and Kalahari deserts. The hot desert biomes in North America are found in the southwestern United States and northern Mexico, including the Mojave, Sonoran, and Chihuahuan deserts.

Rangeland Regions of North America

The rangelands of the continental United States occur in roughly five geographic zones that vary in topography, climate, and soil type. On the southwest coast, along the Pacific Ocean, lies the ***Mediterranean Region***, with a climate similar to the lands that surround the Mediterranean Sea between southern Europe and northern Africa. A Mediterranean climate is characterized by hot, dry summers and mild, wet winters. More than 90% of the annual precipitation in this region occurs during the winter months.

Figure by K. Launchbaugh

In the northwest corner of the United States is a region also heavily influenced by the Pacific Ocean. Known as the ***Pacific Northwest***, it is characterized by cool, dry summers and cool, wet winters. The Pacific climate is very similar to the Mediterranean region but with greater precipitation and slightly wetter summers.

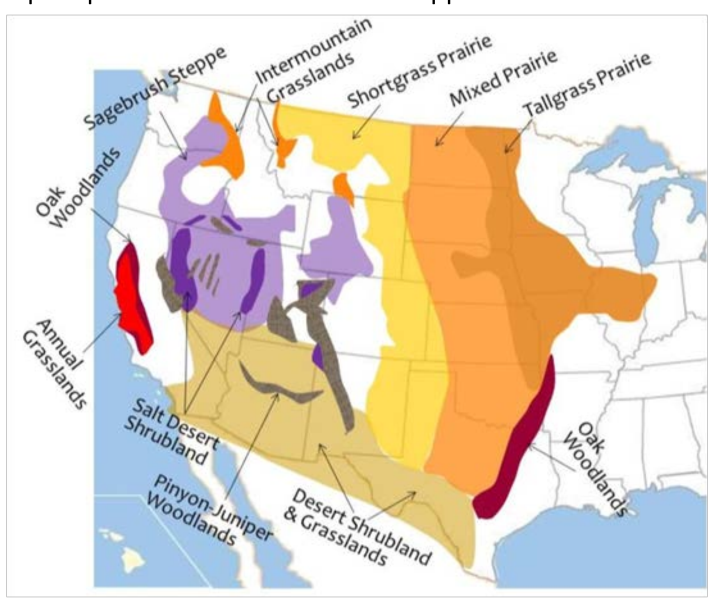
The Great Basin Region, as its name suggests, is a large dish or basin. It is bounded by two mountain ranges: the Rockies on the east and the Sierra Nevada on the west. Nearly all the moisture that falls in the region does not flow to an ocean; rather, it settles in lowlands throughout the basin. As water accumulates in the lower flat valleys, the moisture evaporates, leaving areas with salty (and often alkaline) soils. For example, the Great Salt Lake is a large lake that accumulates water and soil salts that never flow to the ocean. The climate of this region is strongly influenced by the Pacific Ocean, so it shares the cool, wet winters and dry summers of the Mediterranean and Pacific Climates. However, the Sierra Nevada Mountains form an orographic barrier, intercepting moisture heading east from the Pacific Ocean and creating a dry area on the east or leeward side of the mountains. This effect is known as a "rain shadow." Because the Great Basin is set in this rain shadow, it receives very limited precipitation—just 8 to 20 inches a year in most areas.

The Southwestern Desert Region includes the Mojave, Sonoran, and Chihuahuan deserts. These deserts are collectively known as the "hot deserts" because they are characterized by hot, dry summers and warm winters. Most areas of the region receive less than 15 inches of rain per year; some areas receive rain only once every few years. The Southwest Desert Region experiences a monsoon season of rains from July through September. After a dry spring and early summer, the prevailing winds change from westerly to southerly, bringing moisture in from the Pacific Ocean and Gulf of Mexico. This leads to almost daily thundershowers that may occur in one location while an area a short distance away remains dry.

East of the Rocky Mountains lies the ***Great Plains***: vast flat or rolling landscapes that fall away from the mountains and stretch to the Mississippi River. The Rocky Mountains intercept moisture from the Pacific Ocean and create a strong rain shadow such that the driest part of the Great Plains is directly east of the Rockies. The amount of annual precipitation increases from west to east across the Great Plains so that areas receiving the most annual precipitation are near the Mississippi River. Moisture in the Great Plains falls mainly during the spring and summer.

Rangeland Vegetation Types of North America

The grasslands, shrublands, woodlands, and deserts that dominate North American landscapes take many different forms. Each of the five rangeland regions in North America has characteristic vegetation adapted to its unique combination of climate and soils. A.W. Kuchler, an American geographer and naturalist, is recognized as having produced one of the first reliable maps of vegetation in the continental United States.



Simplified map of major rangeland vegetation types based on A.W. Kuchler's Potential Natural Vegetation (K. Launchbaugh).

Kuchler produced his map by looking at existing maps and photos and by visiting many sites across the country. His work is still widely used today. However, most modern vegetation maps are created by remote sensing technology that takes pictures and collects light waves (spectral characteristics) using cameras mounted on satellites orbiting the earth. Different vegetation types have unique spectral characteristics that can be classified using geographic information systems (GIS) and mapped.

Mediterranean Region

Annual Grasslands

Before European settlement, the annual grassland region in California was a bunchgrass prairie dominated by needlegrasses. Exotic annual plants such as cheatgrass and medusahead were introduced at a time when heavy grazing was occurring in an effort to produce meat to feed miners of the gold rush and homestead era. These plants from Eurasia were well-adapted to California's Mediterranean climate. The region quickly transitioned from native perennial bunchgrasses to annual plants. Nearly all of the range plants in unfarmed areas of this region today are annuals and exotics.

The region is characterized by mild, wet winters and long, dry summers. Annual precipitation varies greatly from 30 or more inches near the ocean to as little as 8 inches in the foothills of the Sierra Nevada Mountains. Soils range from prairie soils (called mollisols) to desert soils (called aridisols). Many of these soils are excellent for farming. More than half of the region today is farmed and is important for truck crops such as tomatoes, grapes, strawberries, apricots, and asparagus.

Oak Woodlands and Savannas

Several plant communities across western North America are dominated by oak trees or shrubs. These include the oak savannas in California and Texas, oak woodlands in southern California and central Texas, and oak shrublands in northern Texas and New Mexico and at the lower elevations of the Rocky Mountains in New Mexico and Colorado. These oak-dominated vegetation types vary significantly, depending on the species of oak present. All oak communities share mesic, or mild, climates with 20 to 31 inches of precipitation each year.

The oak savanna type is a true savanna with an overstory of oak trees and an understory of grasses and low-growing shrubs. The mid-elevation savannas surrounding the California central valley are composed of Blue Oak. In southern California, the major oak species is interior live oak, and the plant communities take a more woodland form with shrubs in the understory. Texas also has several important oak types, including the post oak savanna of east-central Texas and the live oak woodlands of central Texas.

Pacific Northwest

Intermountain Grassland

This region includes a diversity of grasslands dominated by bunchgrasses including the Palouse Prairie and Canyon Grasslands of Idaho, Washington, Oregon and Montana. Major grasses include bunchgrasses such as bluebunch wheatgrass and Idaho fescue. These grasslands receive from 12 to 25 inches of precipitation annually, mostly as spring rain. Late summer rains are uncommon in this region and therefore lightning-ignited wildfires historically were also uncommon. Long, dry summers limited the invasion of trees and shrubs into the grasslands.

The Palouse is a unique grassland type within the Intermountain Grasslands. The soils of the Palouse are mostly windblown soils, called loess, that are excellent for farming. Consequently, only about 1% of the original Palouse prairie exists today. Nearly all of the land was plowed to create the most productive non-irrigated cropland in the world for growing dry-land wheat, lentils, and dry peas.

Great Basin

Sagebrush Steppe

The sagebrush steppe is one of the most extensive range types in western North America. The term "steppe" refers to dry grasslands and treeless regions. Therefore, the sagebrush steppe is a region with an overstory of shrubs, mostly sagebrush and rabbit-brush, and abundant stands of bunchgrasses, mostly bluebunch wheatgrass, Idaho fescue, and Sandberg bluegrass, between shrubs. There are about 20 different species of sagebrush found in the sagebrush steppe, though big sagebrush (*Artemisia tridentata*) is by far the most common.

The sagebrush steppe has a semiarid climate, with 8 to 20 inches of precipitation per year, characterized by wet springs and long, dry summers. Fires were historically patchy: small areas of shrubs would burn and perennial grasses would grow for several years in the burned areas until shrubs became reestablished. At lower elevations in the sagebrush steppe regions, invasive annual grasses like cheatgrass have created a fine fuel, leading to more frequent and more damaging fires. Where wildfires historically occurred once in several decades, fires may now return every few years in areas where annual grasses have taken over because annual grasses senesce early in the summer, increasing ignition risk and creating continuous fuel beds. A shortened fire regime has created a situation where native grasses and shrubs have difficulty becoming reestablished between fires, and exotic annual grasses now dominate some areas. Sagebrush steppe areas at higher elevations have a different relationship with fire. On these colder, high elevation sites, annual grasses do not grow as well and are less invasive than at lower, warmer elevations. However, juniper and other evergreen plants can invade sagebrush communities. In these regions, prescribed fire is an important tool to reduce evergreen encroachment and allow sagebrush and grasses to grow and dominate, as they have historically.

Salt Desert Shrublands

In the Great Basin at level areas in the lower elevations of the landscape, salt accumulates and supports salt desert shrublands that are well adapted to dry, salty soils. This region has a very dry climate with only 3 to 10 inches of precipitation each year. Dominant shrubs include shadscale, saltbrush, and winterfat. Like most shrubs, these plants are nutritious in the winter and provide important forage for wildlife, sheep and cattle. Invasive annual plants pose the greatest threat to this vegetation type.

Pinyon-Juniper Woodlands

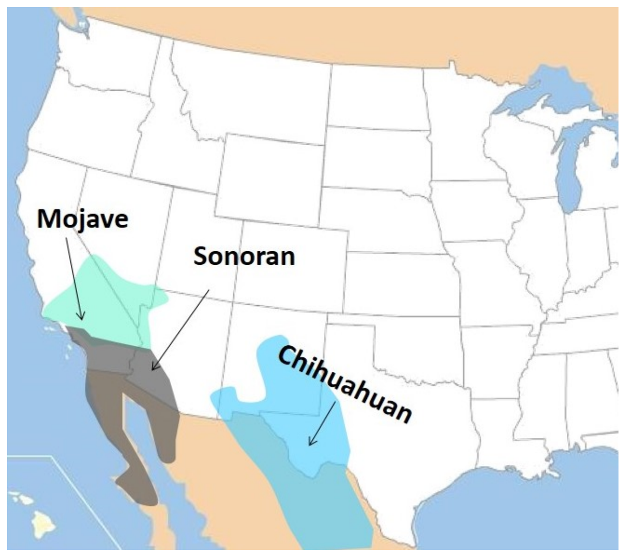
Woodland communities made up of pinyon (*Pinus* ssp.) and juniper (*Juniperus* ssp.) are widely spread across the mid-elevation lands west of the Rocky Mountains and are collectively called the Pinyon-Juniper (or P-J) woodlands. This woodland type takes many forms, from nearly solid stands of Pinyon pine to stands of Western, Utah, or Rocky Mountain juniper. Precipitation averages 12 to 20 inches annually in these communities. This vegetation type is important because it provides good cover and forage for wildlife and livestock.

However, expansion of P-J woodlands in recent decades has caused concern because sagebrush steppe plant communities can be diminished and eventually replaced by encroaching pinyon and juniper trees. Why is that important? Approximately 90 bird species and 85 kinds of mammals use sagebrush lands for food and cover. Additionally, P-J encroachment leads to increased erosion, loss of native understory plants and seedbank. That in turn opens the way for increasing weed dominance and a buildup of fuels that leads to catastrophic wildfires. People generally suppress wildfires to protect human lives and property, and this suppression inadvertently allows pinyon and junipers to spread. Using prescribed fire intentionally ignited and carefully timed and controlled could restore fire at a frequency such as occurred historically across these landscapes and reduce pinyon and juniper encroachment.

Southwest Desert

Desert Shrublands and Grasslands

The Desert Southwest includes three major desert types, aligning with three major deserts: Mojave, Sonoran, and Chihuahuan. The three deserts are collectively called the "hot desert" or, for our purposes, desert shrublands and grasslands. The regional temperatures are indeed hot, with several weeks or months of daily high temperatures exceeding 100° F. The amount of precipitation ranges from 5 to 20 inches per year, and this varies from year to year and from place to place.



The plant communities in the Mojave are dominated by creosote bush and a mix of other shrubs and warm-season grasses. Large succulent plants such as the saguaro and other upright cactus plants are the iconic species of the Sonoran Desert. The Chihuahuan Desert is a mix of shrubs, such as mesquite and creosote bush, with stretches of grasslands common on deeper soils. A few centuries ago, more of this area was dominated by warm season grasses such as black grama. Heavy grazing and severe drought converted much of the area from grasslands to shrublands.

Great Plains

Tallgrass Prairie

This productive prairie is dominated by tall grasses, including big bluestem and Indian grass. The growth of these large grasses during the early formation of this region created very productive soil, in the mollisol soil order, that was easily plowed and converted to croplands. Consequently, most of the original tallgrass prairie region is now cropland and only about 5% of the tallgrass prairie remains today. The Konza Prairie in Kansas is one of the largest remnants of the tallgrass prairie.

This region receives 20 to 30 inches of precipitation each year, occurring mostly as spring and summer rains. The tallgrass prairie region is one of the most mesic, or moist, grassland types. Without fire and drought periods, these grasslands are quickly taken over by shrubs and trees. Grasses are well adapted to fire, while woody plants in this region are generally killed by fire. Therefore, occasional fires reduce invasion by woody plants, leading to the use of prescribed fire as an important management tool for tallgrass prairies. Drought or unusually dry summers reduce survival of shrub and tree seedlings and thus slow invasion by woody plants. Grazing by large ungulates, such as bison, was also an important ecological force during the development of this prairie, and its major grasses are adapted to grazing.

Mixed Prairie

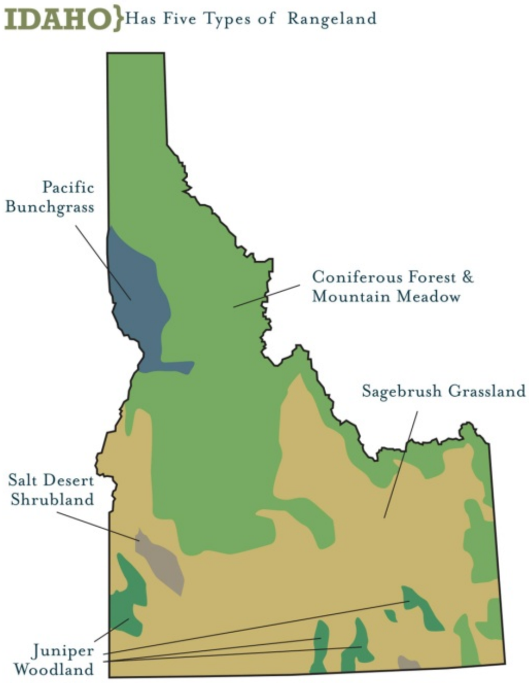
As the name suggests, this is a mix of grasses: tallgrasses and mid-grasses, and cool-season and warm-season grasses. The landscapes in the mixed prairie can also appear quite patchy, as a variety of plant communities exist across the rolling plains. Plants here evolved with grazing bison, so most are well adapted to grazing. Wildland fires were also common on the mixed prairie, and prescribed fire is often used as a management tool to reduce shrub invasion and improve the forage value of grasses.
In the Mixed Prairie, precipitation ranges from 14 to 20 inches per year and falls mainly as spring and summer rains. The soils are mostly mollisols but are not as fertile or productive as the tallgrass prairie. Therefore, much of this region was not plowed into farmlands and exists as native prairie today. This region also includes many shallow wetlands that are important for migratory waterfowl, including ducks and geese. For example, the Prairie Pothole region is found within this mixed prairie.

Shortgrass Prairie

The shortgrass prairie is dominated by low-growing, wide-spreading grasses that are adapted to low precipitation. In the rain shadow of the Rocky Mountains, this region receives only 12 to 20 inches of precipitation each year. The shortgrass prairie also received heavy grazing by bison as it formed on the plains. Native grasses in this region, such as blue grama and buffalograss, are well-adapted to drought and heavy grazing. Fire is not common in the shortgrass prairie because plant biomass is not sufficient to carry extensive fires.

Types of Rangeland in Idaho

Rangelands in Idaho include canyon grasslands, palouse prairie, sagebrush-steppe, cold desert shrublands, juniper woodlands, aspen savannas, mountain meadows, and streamside riparian communities. Idaho's climate and geography vary significantly across the state, creating distinct plant communities adapted to these particular conditions. Some of Idaho's rangelands receive as little as 10 inches of precipitation per year, so plants have adapted to survive long, hot, dry summers. For example, rangeland plants tend to have extensive root systems that effectively gather soil moisture even in the driest conditions.



In Idaho, the vegetation communities can be grouped into five ecoregions that share similar types of soils, climate, geology, and ecological processes: sagebrush grasslands, juniper woodlands, salt-desert shrublands, Pacific bunchgrass, and coniferous forests and mountain meadows.

Sagebrush Grasslands

When people think of "the West," they often envision miles and miles of sagebrush. This classic western rangeland type is a mix of sagebrush and bunchgrass that dominates about 18.5 million acres in southern Idaho. These rangelands stretch across the plains, plateaus, and valleys south of the Salmon River. Lower elevations support stands of shorter and smaller shrubs compared to taller "savanna-like" stands at higher elevations. Precipitation ranges from about 10 to 18 inches per year.

Big sagebrush is the main type of sagebrush in Idaho, but a keen observer may notice that there are about a dozen different species of sagebrush. The shrub-grass mix provides good spring and fall grazing for livestock and wildlife. Sage grouse, pronghorn, deer, and black-tailed jackrabbits call sagebrush grasslands home and rely on this type of ecoregion for survival. Therefore, they are often referred to as sagebrush obligate or sagebrush dependent species.

Common plants in the sagebrush grasslands region include sagebrush, primarily big sagebrush, and other shrubs such as rabbit-brush and bitterbrush. Perennial grasses found here include native and introduced grasses such as bluebunch wheatgrass. Common forbs include arrowleaf balsamroot, mules ear and tapertip hawksbeard that paint the landscape with their bright yellow flowers.

Juniper Woodlands

In southern Idaho, two kinds of small evergreen trees, Western juniper and Utah juniper, create a kind of "pygmy forest" that covers about 1.6 million acres. Juniper woodlands usually occur on the rougher terrain and can be dense or open, depending on soils and topography. These woodlands usually occur in scattered patches rather than dense stands. Annual precipitation in this area ranges from 12 to 30 inches a year.

Juniper woodlands are important watersheds that yield water for agriculture and other human uses. The woodlands are also important winter range for wildlife, especially deer and songbirds. Plus, the juniper trees are often harvested for fence posts, firewood and other wood products.

Western and Utah juniper both are common types of juniper found on these rangelands. Big sagebrush is usually found growing in the understory. Grasses typically found on sagebrush grassland, including bluebunch wheatgrass, bottlebrush squirreltail, and Sandberg bluegrass, are also present on juniper-woodland landscapes.

Salt-Desert Shrublands

"Desert" usually brings to mind hot, dry places with lots of blowing sand. In southern Idaho, equally dry deserts are created by salty soils and cold temperatures. Shrubs that are able to live in these salty soils dominate this "cold desert" that covers 1.5 million acres. As the name suggests, soil salinity is a characteristic feature of this rangeland area. These shrublands get very little annual precipitation, usually 10 inches or less. Shrubs are generally better suited for these harsh conditions than grasses or forbs because of their deep root systems. Because these shrubs have high nutritive value in winter, salt deserts are excellent winter range for pronghorn and are considered some of the world's best range for winter sheep grazing.

Some shrub species that dominate this region are shadscale and fourwing saltbush, low sagebrush, and greasewood. You are likely to see some native grasses like bottlebrush squirreltail or Indian ricegrass, and half-shrubs (sub-shrubs) such as winterfat or the non-native forb, Russian thistle.

Pacific Bunchgrass

When settlers arrived in northern Idaho in the 1880s, they found mostly forest with a few rolling prairies of bunchgrass that dominated 1.2 million acres. These exploring farmers found the deep rich soils and moist climate of the Palouse and Camas prairies favorable for growing wheat and other crops. Precipitation in this area ranges from 12 to 30 inches per year.

Today most of the prairies have been converted to farmland, and very little of the native bunchgrass remains. The existing canyon and foothill grasslands continue to provide high quality spring forage for sheep and cattle and good winter habitat for deer and quail.

Predominant native grasses in the Pacific bunchgrass region are bluebunch wheatgrass, Sandberg bluegrass, and Idaho fescue. Snowberry, a shrub of the honeysuckle family, is also found in this type of environment, along with wild rose. Forbs found here include arrowleaf balsamroot, biscuitroot, lupine and wild geranium. The camas that gave the prairie its name served as an important food source and trade good for the Nez Perce and other Native Americans, who dug the flowers' bulbs and roasted them in pits.

Coniferous Forest and Meadow

Most of northern and central Idaho is dominated by evergreen coniferous forest totaling about 22 million acres. The forested ecosystems are much more moist than the shrublands and grasslands of southern Idaho, receiving 40 or more inches of snow and rain each year. Most of this area is dominated by dense forest interspersed with natural openings called meadows. In between the trees are grasses, forbs and shrubs (rangeland plants) that provide valuable habitat for a variety of grazing animals. Shrubby vegetation near the forest edge is especially important for deer and elk, and the meadows are important summer range for both wildlife and livestock.

Ponderosa pine and Douglas fir are common tree species dominating Idaho's forests. On the forest floor or open meadows, you can typically find elk sedge and pinegrass, which are similar in appearance in that they have fine leaves and are often found together. Other grasses such as mountain brome and tufted hairgrass can also be found. It is common to see woody plants such as antelope bitterbrush, ninebark, chokecherry, or wood's rose. Wild geranium and fireweed are among the many types of bright wildflowers that grow in this environment.

1.4. History of Western Rangelands

When you think about the history of the West, you may think first of Native Americans, early explorers, pioneers, miners and stockmen. But using the sciences of paleontology and geology, we can learn about the evolution of these rangeland ecosystems before humans arrived. The fossil record tells us that large ungulates roamed western North America for several million years, up until about 10,500 to 7000 years ago. The Pleistocene megafauna included woolly mammoths, musk oxen and brush oxen, and species of bison, horses, burros and camels. These large grazing and browsing animals began to appear at about the same time as the flora of the region transitioned from a wetter, forest type to the grasses and shrubs typical of today's rangelands. The mountain-building processes that lifted the Cascade and Sierra Nevada ranges (10 to 2.5 million years ago) increased the rain shadow effect, creating a more xeric climate on the leeward side of the mountains. Thus, as the landscape of western North America evolved to resemble what we see today, animal species coevolved to take advantage of the ecological niche, grazing and browsing on the rangeland vegetation.

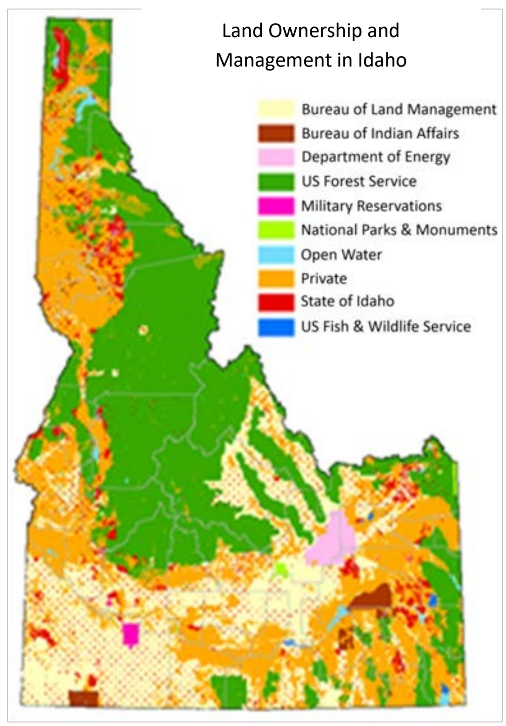
George Catlin, *Prairie Meadows Burning*, 1861/1869

When the first people came to this part of the world about 12,000 years ago, some of those woolly mammoths, giant bison and other grazers still roamed the range. Archaeological evidence indicates that Native Americans hunted the large ungulates, as well as the saber tooth cat and other carnivores that preyed on the herbivores. These hunter-gatherers of the Clovis culture learned to use fire to drive animals, from bison to rabbits, as part of their hunting technique. They also discovered that the use of fire on rangelands increased the availability of desirable plants and maintained habitat for game animals. After Spanish explorers Cortez and Coronado brought domesticated horses to the southwest in the 1500s, Native Americans obtained and bred horses, built up their herds, and once again, equines joined the ranks of animals grazing western rangelands.

American explorers Meriwether Lewis and William Clark first documented western rangelands and the Native Americans living here. On their epic journey from St. Louis to the Pacific Ocean and back from 1804-06, Lewis and Clark reported on many different grasses, forbs, and woody plants on the range. In fact, Lewis described prairie dogs, sage grouse and other animals still common today on rangelands. Lewis's woodpecker, Clark's nutcracker and several plant species bear the names of the intrepid explorers.

Lewis and Clark's reports of their discoveries sparked increased interest in these uncharted lands. The idea of making dreams come true in the boundless west appealed to many easterners. As a result, the first wagon-traveled road, called the Oregon Trail, crossed the country in the 1840s. Over the next twenty years, an estimated 400,000 pioneers traveled the Oregon Trail and other trails in a mass western migration. The discovery of gold in California in 1849 helped to spur thousands of people to head west to seek their fortunes. Gold was first discovered in Idaho on the Clearwater River in 1860, but the bigger strike came a year later in the Boise River Basin of southwestern Idaho. In just five years, miners took nearly $24 million in gold from the Boise Basin around what is now Idaho City. All those miners flooding into the western territories meant there were lots of mouths to feed, creating a booming market for livestock. Entrepreneuring livestockmen responded, driving cattle herds to the West and grazing them on the unclaimed open range.

In 1862, the Homestead Act helped to motivate major settlement on rangelands by offering 160 acres to any U.S. citizen over the age of 21 who would "prove up" on the land for at least five years. Most of these homesteads were located near rivers, creeks and springs where water was available for drinking and household use, to irrigate crops, and to provide for livestock. Geologist and explorer John Wesley Powell was among the first to recognize that, in the semiarid regions west of the 100th meridian that bisects the Great Plains, 160 acres was not enough land to support a family. He foresaw that settlers would fight over water rights, much as miners would squabble over mining claims. Powell's predictions proved accurate and, in 1909, the Enlarged Homestead Act increased the size of a homestead to 320 acres. The Stockraisers Act of 1916 doubled it again, allowing 640 acres to anyone with at least 50 head of cattle.



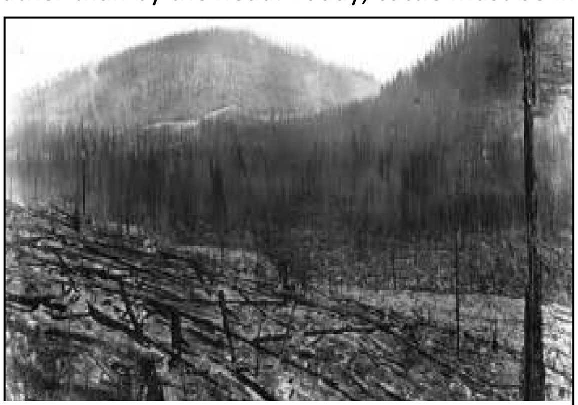
In the same year that Congress passed the Homestead Act, it enacted another piece of legislation that further began to segment the vast public lands. The Morrill Act of 1862 granted a portion of land in every state to the states to fund colleges that would foster the teaching of agricultural and mechanical arts. The Morrill Act sought to make higher education available to a broader population, and the colleges established under this system are known as land grant universities. When Idaho became a state in 1890, it received approximately 3.6 million acres of land to be used to generate money for higher education and other specific purposes. Idaho set aside two sections of each township, or 1/18th of the state's land base, to fund public schools. This contributed to the checkerboard pattern of land ownership across much of Idaho that is visible on this map. The Idaho

Constitution stipulates that these lands must be managed in a way that best secures the maximum long-term financial return for the beneficiaries. That means the lands can be sold, or they can be used for timber harvest, grazing, mining or other purposes that raise money for Idaho's schools and other institutions. The University of Idaho, Lewis-Clark State College, and Idaho State University all receive funds from the endowment.

Between 1870 and 1900, rangelands were seen primarily as land well-suited for livestock production. The wide open spaces of western rangelands provided forage and habitat for sheep, cattle, and wildlife. By the late 1880s, when the western livestock production industry peaked, more than 26 million cattle grazed in what are now the 17 western states. During this era, large ranches running thousands of cattle and sheep dominated the business sector of western North America. Unfortunately, the notion of land stewardship did not exist. It was "every man for himself," as stockmen simply wanted to be the first to get their animals out on the open range. This free-for-all resulted in range wars—cattlemen vs. sheepmen and cows vs. crops—as operators competed for grass and water.

http://www.waymarking.com/waymarks/WMJNZN_Rang ...

In addition, in the years following the Civil War, cattle were sold by the head, not by the pound, as the beef was merely a by-product; the hides were more valuable for the production of leather goods. This market provided an incentive for ranchers to maximize the number of cattle on the range, rather than concerning themselves with the condition of their animals or the common rangelands. You can imagine what these massive numbers of cattle did to the range: The severe degradation came to be known as the Tragedy of the Commons. By 1886, several years of drought, bad winters and depressed cattle markets finally brought an end to unmanaged open range. Eventually, the market shifted to selling cattle by the pound rather than by the head. Today, cattle must be in good condition to bring a good price on the market. And raising healthy cattle goes hand-in-hand with sustaining healthy rangelands.



Burned timber on Rainey Creek in Lolo National Forest, Montana following 1910 fires. http://www.foresthistory.org/ASPNET/Policy/Fire/FamousFires/1910Fires.aspx

The Forest Reserve Act of 1891 set aside about 47 million acres of National Forest to preserve forests and grazing lands. This act served as the basis for the U.S. Forest Service, created in 1905, to provide for management of rangelands and grazing practices. Then, a firestorm in 1910 became one of the most influential events in the history of the Forest Service. (https://vimeo.com/135837489). In just two days, a raging wildfire burned 3 million acres and claimed 85 lives in northern Idaho and western Montana. The Big

Burn of 1910 shaped public opinion and land management policies for nearly a century, including the effort to suppress all fires, as Smokey Bear educated generations of Americans that “Only you can prevent forest fires.” Only in recent decades have we recognized the ecological benefits of fire, including the use of prescribed burning to manage fuel loads.

In 1934, the Taylor Grazing Act recognized the importance of controlling use on public grazing lands and providing for their improvement. This led to the formation of the Grazing Service, which eventually was combined with the General Land Office to form the Bureau of Land Management in 1946. The Dust Bowl, sometimes called “The Dirty Thirties,” gave rise to the Soil Conservation Act of 1935, aimed at reducing soil erosion. This Act created the Soil Erosion Service, later renamed the Soil Conservation Service that became what is now the Natural Resources Conservation Service (NRCS). Part of the U.S. Department of Agriculture, NRCS helps private landowners reduce soil erosion through technical assistance and financial incentives or cost-share for the implementation of best management practices (BMPs).

The 1960s saw the birth of the Environmental Policies Era that continues today. During this time, Congress has passed numerous pieces of legislation aimed at managing public lands and resources in a sustainable manner for today and for future generations. Here are some key environmental laws enacted in the last sixty years that affect the use, management and stewardship of rangelands:

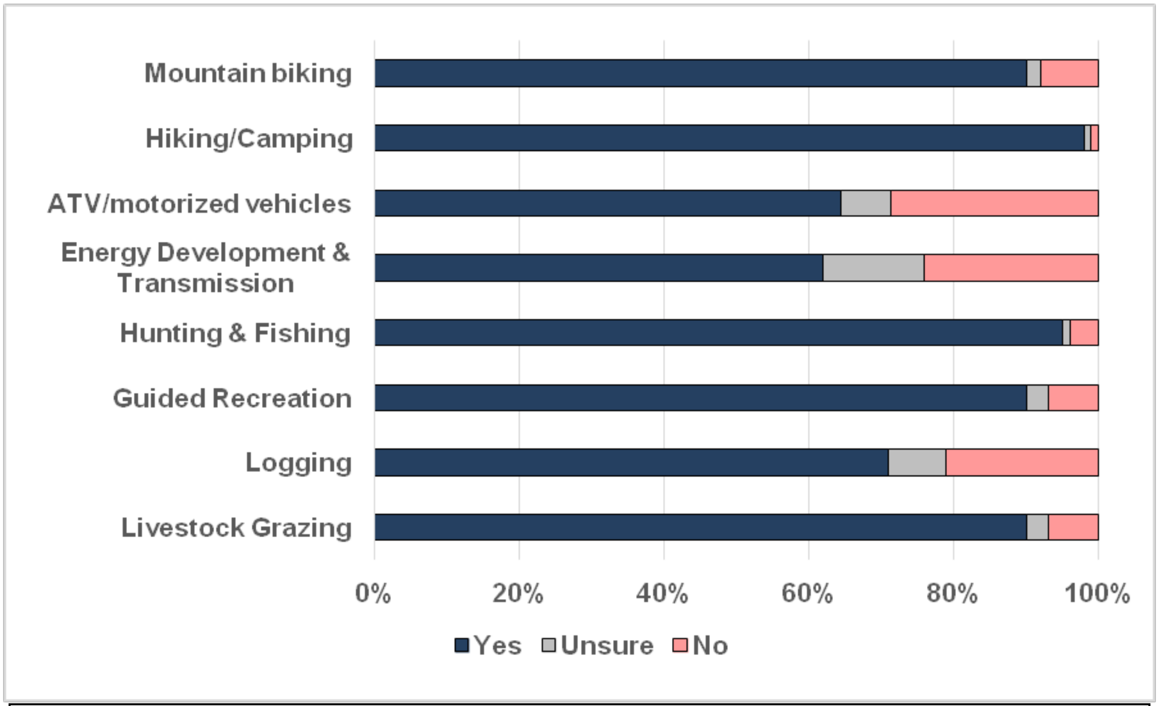
- <u>Multiple Use and Sustained Yield Act of 1960</u>: Defined multiple use as the management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people.
- <u>Wilderness Act of 1964</u>: Created a way for Congress and Americans to designate **"**wilderness areas" that represent the nation's highest form of land protection. No roads, vehicles or permanent structures are allowed in designated wilderness. A wilderness designation also prohibits activities like logging or mining.
- <u>National Environmental Policy Act of 1969</u>: NEPA requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. Using the NEPA process, agencies evaluate the environmental and related social and economic effects of their proposed actions. Agencies also provide opportunities for public review and comment on those proposals.
- <u>Wild Free-Roaming Horse and Burros Act of 1971</u>: Protects wild horses and burros from capture, branding, harassment, or death, and considers wild horses and burros in the area where they are presently found as an integral part of the natural system of the public lands.
- <u>Endangered Species Act of 1973</u>: The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. The Interior Department’s U.S. Fish and Wildlife Service (FWS) and the Commerce Department’s National Marine Fisheries Service (NMFS) administer the ESA.
- <u>Federal Land Management and Policy Act of 1976</u>: Requires BLM to establish a planning process and to accommodate multiple uses of the land and its resources to achieve sustained yields of natural resources.
- <u>Clean Water Act of 1977</u>: Establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.

Since the late 1800s, livestock grazing has been the predominant economic use of public rangelands, while hunting and fishing remained the main recreational uses until the mid-1900s. The 1990s brought ever more people to western landscapes. This increasing western population, greater individual wealth, leisure time and a high degree of mobility has created demands for other forms of recreation on public lands beyond the traditional ones. Since 1960, considerable conflict has occurred over the use of and access to public lands.

1.5. Why Rangelands Matter: The Multiple Use Paradigm

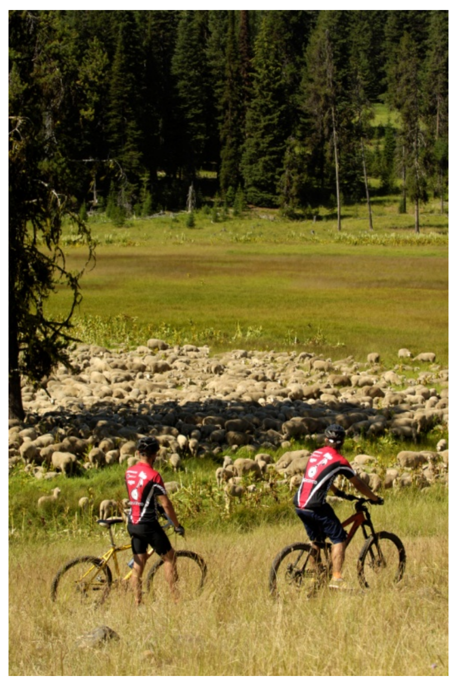
Rangelands provide a number of social, ecological and economic values. Many people appreciate rangelands for their natural beauty, diversity of wildlife, and recreational opportunities like hunting, hiking, bicycling and camping. Rangelands also contribute important economic values, including ranching, mining, and energy production. Historically, the primary function of rangeland has been as forage for livestock and wildlife. However, the importance of rangeland for recreation and water production is growing. The soils, vegetation, and water of rangelands are important to the ecological and economic health of all regions in which they dominate. Therefore, most rangelands today are managed under principles of multiple use, which means that several uses or values of rangeland are managed simultaneously, with care taken to avoid overuse or destruction of natural resources.

In a study conducted by the Social Science Research Unit (SSRU) at the University of Idaho, Idaho residents were asked whether they approve or disapprove a series of specific uses that occur on public lands. Results suggest that the public values multiple uses and is interested in a balanced management approach.



Approval of Specific Activities on Public Lands
SOURCE: UI SOCIAL SCIENCE RESEARCH UNIT TECHNICAL REPORT 14-02-05

Access to such a wide variety of activities on a single landscape is possible because much of America's rangeland is managed by the federal government on behalf of the American people. Federal public land is to be managed for multiple use and for the greatest good of all Americans. Individual states manage grazing lands to protect and enhance their value so they can achieve financial returns that benefit education and various state institutions. This is quite a change from a century ago, when most citizens considered rangelands "wasteland" and thought that meat production was the best use for rangelands. Currently, more and more people are enjoying rangelands for recreation and aesthetics. What might the next generations want from rangelands?



Multiple Use: Recreation

Have you ever gone hiking or camping on rangeland? How about mountain biking, rock climbing, or fishing in a rangeland stream? If so, you're not alone. Nearly half of all Americans over the age of six participated in outdoor recreation in 2016, according to the Outdoor Industry Association. That's more than 144 million people looking for places to get outdoors and have fun. And many of those folks are finding their playground on America's rangelands.

Expect the number of recreationists to continue to rise, based on data collected by the USDA National Survey on Recreation and the Environment. Between 1982-83 and 2005-09, day hiking in the U.S. increased by 210% (24.3 to 75.3 million participants); driving off-road increased by 142% (19.1 to 46.2 million participants); fishing and hunting grew by 30% (79.8 million to 104.6 million participants); and the number of people viewing or photographing birds soared by an astounding 287% (20.8 to 80.5 million participants). Just like other uses of public land, recreation has an impact on rangelands. The degree of impact varies by activity, of course; some pursuits can be relatively benign, while others have more lasting impacts. And even activities that leave a light footprint, when repeated by increasing numbers of people over time on the same ground, can have cumulative effects on a given landscape.

Outdoor recreation brings with it both positive and negative effects on rangelands and surrounding communities. On the plus side, recreation can provide an economic boost to rural economies when people spend money in the areas they visit. That revenue adds up, in the form of hunting and fishing license sales, camping and access fees, and the cost of guided adventures, plus the sales tax collected on money spent in local shops and restaurants. In addition to helping rural businesses, some of those funds may get channeled into restoration and improvements to rangeland recreation facilities or wildlife habitat. The increase in business activity, in turn, creates local jobs. It’s harder to measure the psychological and health benefits that people enjoy from engaging in physical activity and getting back to nature. Some might say it’s priceless.

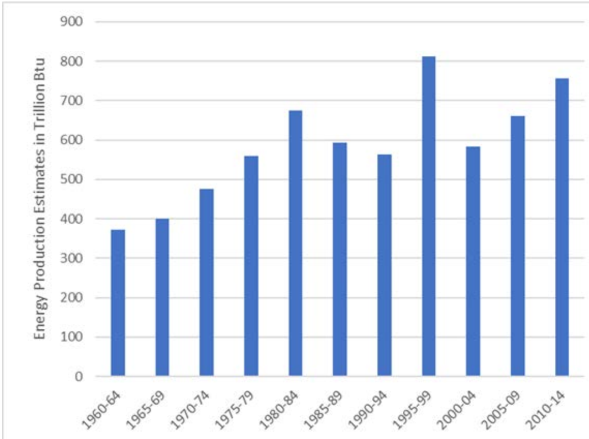
On the flip side, recreational activities can disturb or displace wildlife, cause compacted soils and erosion, and trample sensitive vegetation. Conflicts can arise among users seeking different kinds of recreation experiences within the same area, such as motorized vs. non-motorized activities, or hunting vs. wildlife viewing, or large family gatherings vs. quiet, solitary outings. Conflicts can also arise between recreationists and livestock. For example, hikers with dogs may not know what to do when they encounter sheepherding guard dogs. Not everyone is conscientious about packing out whatever they pack in, so cleanup can cost money. Furthermore, users may see their own pursuits as harmless and fail to recognize the cumulative effect of all the users who are recreating on the range. There’s also a cost to users, taxpayers or both to maintain facilities such as roads, trails, trailheads, campgrounds and other amenities. And a moment of carelessness can burn up everyone’s playground: More than half the wildfires that occur each year are human caused.

Rangeland managers have to take all the pros and cons into account when managing rangelands for multiple use. One of the best tools at their disposal is education—teaching recreationists to care for the resource and share it respectfully with others. Managers may also consider restricting access to certain areas during critical times for wildlife, such as deer fawning season or winter, when animals can’t afford to expend energy avoiding people. Another option is to designate specific areas for particular kinds of recreation, such as off-road vehicle trails. Signage and maps can help users get off the beaten path but still stay on designated trails to minimize damage to resources. At some point, it may be necessary to provide more facilities to accommodate growing demand. As our population continues to grow and more and more people want to take to the hills, it will be incumbent on managers and recreationists alike to tread lightly to sustain rangeland health.

Multiple Use: Energy Development

Rangelands can also prove to be a significant source of energy and other natural resources. Rangelands are home to hard rock mining for gold, copper, silver, and zinc that are used in manufacturing the products we use in our everyday lives. Mining benefits the economy of surrounding communities. Water coming from rangelands generates hydroelectric power. Mining and extraction of coal, oil, and natural gas are important energy resources accessed from rangelands. Woody plants are also used for fuel, while grasses and other plants on rangelands can be harvested for ethanol and biodiesel production. Rangelands can serve as suitable sites for establishing solar power facilities and wind power farms. The graph below illustrates how the amount of energy produced in Idaho from renewable sources—biofuels, solar, wind, water and geothermal—has continually increased over the last 64 years. The multiple-use character of rangelands will become more valuable and appreciated as the demand for energy increases, especially clean renewable energy.

Wind farm in Power County, ID. U.S. Dept. of Energy.



US Energy Information Administration

Multiple Use: Wildlife Habitat

A diversity of wildlife thrive in rangeland habitats. Mammals, birds, amphibians, reptiles, fish, and insects make their home in these complex ecosystems. Plants, water, and soils on rangelands provide unique environments for wild animals and plants, including threatened and endangered species. Some rangelands are designated as special protection areas for wildlife or rare plants. Learn more about wildlife habitat under the "Habitat Needs of Rangeland Animals" section.

Multiple Use: Livestock Grazing

Rangelands provide important grazing habitat for domestic livestock, including cattle, sheep, goats, and horses. Most of the world's livestock live on rangelands and serve as a highly significant and necessary source of food and livelihood for people all over the globe. Ranching is an important endeavor that uses livestock to convert the nutritious and renewable grasses and other plants on rangelands into food, fiber, and other animal-based products for humans. Livestock have been grazing on North American rangelands since the mid-1800s, and they still exist today in familiar scenes on range landscapes.

Rangelands are the primary source of our meat supply:

- Most calves and lambs fattened in feedlots are born and raised on range and pastureland.
- Nationwide, range and pasture provide 83% of nutrients consumed by beef cattle, 91% of nutrients for sheep and goats, and 72% of nutrients for horses and mules.
- Rangeland and pastureland in the 19 western states are home to 58% of all beef cattle in the U.S.
- Western rangelands harbor 79% of sheep and 88% of goats in the U.S.
- Range livestock production is economically vital to western states in terms of land used and cash receipts.

Considerable progress has been made since the Taylor Grazing Act concerning the management and sustainability of grazing practices. Today, ranchers are allowed to graze livestock on public lands under a permit system. First, land management agencies—BLM, USFS, and states—determine through their land use planning process which lands are suitable for grazing. The BLM administers approximately 18,000 grazing permits, while the USFS administers about 6500 leases nationwide. Each permit stipulates the area to be grazed, called an allotment. Additionally, the permit states the number of livestock that can graze on the allotment, or the stocking rate, as well as the timing or season of use. Permits generally cover a 10-year period and can be renewed if permit requirements are being met and the land is in acceptable condition. Ranchers and agency range conservationists monitor the range to ensure the resources are not being degraded. Ranchers pay a fee per animal unit month (AUM) for using public lands, and that fee is set by the government using a formula established by Congress, based on economic conditions and the price of raising livestock.

Even with these controls in place, however, livestock grazing on federal lands has been controversial for many years. Still, livestock production on rangeland remains a vital element in today's food supply chain, producing meat for American and world populations.

Multiple Use: Water Supply

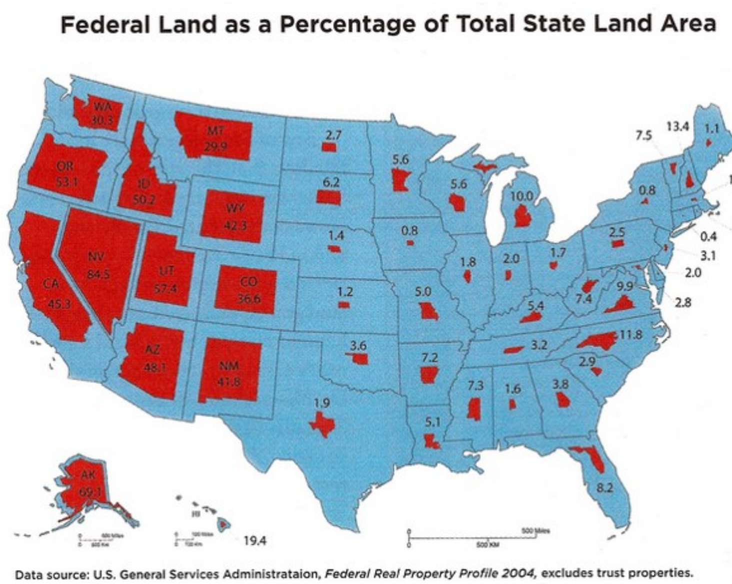
Though rangelands might appear to be dry, unyielding landscapes, in different seasons they provide important contributions of water to the streams, lakes, and aquifers that they contain. In the western states, forested and alpine rangelands are the primary source of water for agricultural, industrial, and

domestic use. Because rangelands are located mostly in arid climates with relatively low precipitation, water is doubly precious. The many miles of streams, lakes, and reservoirs scattered throughout rangelands become a water source for irrigation and urban areas. As human populations grow, and water consumption increases, the high-quality water produced by healthy rangeland ecosystems is becoming increasingly important. You may not think of the collection, storage, and release of water as a "use" of rangelands, but the multiple uses of rangelands must be compatible with continuing to provide a source of clean water. And without water, no other uses of rangeland would be possible.

1.6. Who Manages Rangelands?

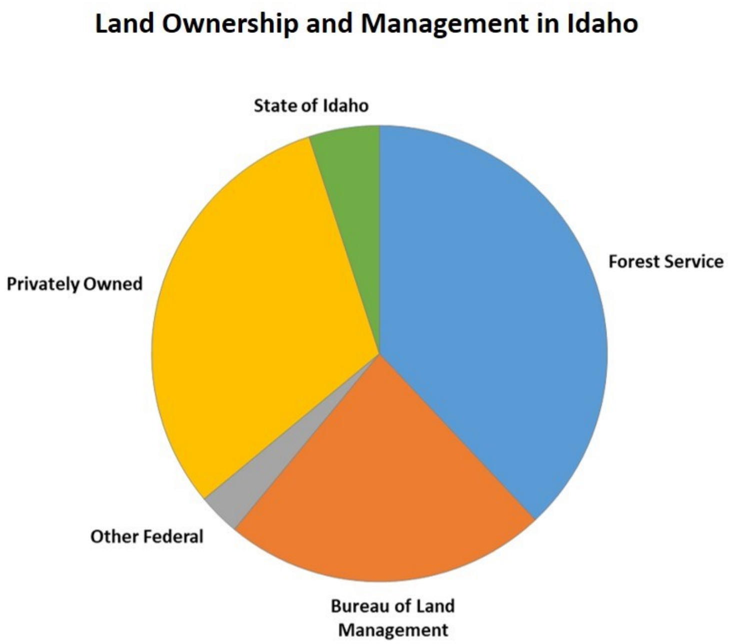
The question of who owns and manages land can be examined in three categories: Federal, State and Private. Public lands include both federal and state lands; private lands include those owned by individuals, corporations, tribes, or non-governmental organizations (NGOs).

Federal lands are those managed by federal agencies such as the Bureau of Land Management (BLM), U.S. Forest Service (USFS), National Park Service (NPS), National Wildlife Refuge System managed by the U.S. Fish and Wildlife Service (FWS), Army Corp of Engineers, and U.S. Military bases. Federal lands are 26.0% (about one-quarter) of U.S. lands. However, it is clear from this figure entitled "Federal Land as a Percentage of Total State Land Area" that almost half (48.6%) of the thirteen western states are federal lands.



These federal lands belong to all U.S. citizens and they are managed and cared for on our behalf by various federal agencies. The BLM manages the greatest area, overseeing 31.4% of all federal land, or more than one in every 10 acres of land in the U.S. The USFS manages 24.5% of federal land (8.5% of the U.S.). The NPS oversees 22.2% of federal lands (7.7% of the U.S.) and National Wildlife Refuges account for 11.3% federal land (3.9% of the U.S.).

State-owned lands include state wildlife refuges, state parks, state school lands, and other land parcels owned and managed by the individual states. Lands managed by states account for 8.7% of all land in the U.S. These lands are managed by land-care professionals in agencies such as Fish and Game agencies, State Departments of Land, and State Parks and Recreation.



Private lands are those to which individuals, tribes, companies or NGOs hold legal title, just as people own their homes and yards in the city. But on the range, it is not always easy to tell where public land ends and private land begins. Often, there are no fences, gates or signs dividing public land from private land. Ranchers may graze livestock on the private rangeland they own in combination with federal or state land for which they hold a permit and pay annual grazing fees.

Land ownership and management in Idaho is similar to the U.S. land numbers above. In Idaho, the U.S. Forest Service manages 38% of the land. The Bureau of Land Management manages about 23% of Idaho lands. Private ownership makes up 31% of Idaho. Other federal agencies (3%) and the State of Idaho (5%) round out the land management in Idaho.

1.7. Rangeland Management

Rangeland management is the careful use and stewardship of rangelands to meet the diverse needs and desires of those who live on and care about these lands. Rangeland management is different from agricultural management because rangeland plants and animals are not managed in isolation or solely for production purposes. Management decisions about rangelands are made with ecological properties in mind, such as soil health, vegetation, wildlife, invasive plants, and water quality. Range managers also need to consider the multiple uses of rangelands including things such as livestock production, open space, recreation opportunities, wildlife habitat or energy production.

Rangeland management presents challenges because many land resources and ecological forces that affect rangelands do not respect fences or property boundaries: think fire, invasive plants, wildlife, and water resources. Furthermore, even a single pasture used to manage livestock can include land owned by a rancher, the U.S. Forest Service, Bureau of Land Management and a state’s Department of Lands. This can often be the case when land parcels are not productive or sizeable enough to be managed on their own; they are more productive when managed in conjunction with adjoining ownerships and/or management agencies. Many people do not realize that one pasture may include public land and privately owned land. This creates a challenge in rangeland management because different agencies and individuals may have different goals and regulatory requirements for what they want to, or can, achieve on the land.

Because manipulating these intricate ecosystems requires a mix of science-based knowledge, practical experiences and common sense, rangeland management is described as both a science and an art. Although management decisions stand on scientific principles, there is no "silver bullet," nor are there pre-determined "correct" solutions that can apply to *all* rangeland management situations. This is why rangeland management is an art: it includes becoming familiar with various land elements, weather situations, plants and animals depending on the land, and having the knack for administering land management decisions based on what is known or understood about that rangeland. A successful range manager embraces learning through experience built upon a solid foundation of scientific knowledge.

Land Ownership Distinctions

It is easy to categorize lands simply as private or public. But this distinction can hide the important reality that private and public lands are inextricably tied. For example, many ranchers in western states graze their herds and flocks on their private land and also hold permits for grazing on state, BLM or USFS land. Thus, an individual ranch (the amount of land *used* to care for the livestock) often includes both private and public lands. In addition, wild animals use both public and private lands for habitat. Weeds, wild fires, and streams don't stop at the border between private and public land. In fact, there often is not even a fence or boundary marker between public and private lands. Thus, it is important to be aware of land ownership and management boundaries when recreating or working on rangelands. It is also important to realize that many aspects of rangeland management will require that public land managers and private land owners work together for the good of the land, water, and animals as well as the people who inhabit these spaces.

Rangeland Principles

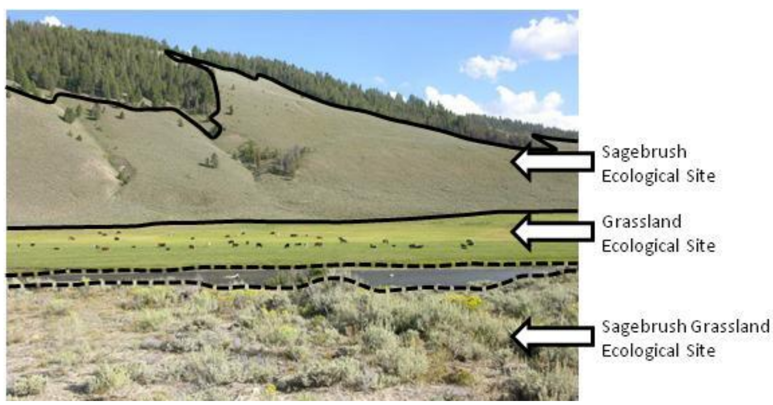
The planning process for sustaining healthy rangelands that support multiple use is based upon six concepts:

1. Rangelands are renewable resources; they can produce on a sustained yield basis if properly managed.
2. Rangelands supply man with food and fiber at very low energy costs compared to those of cultivated land.
3. Energy from the sun can be captured by green plants, which can be harvested most efficiently by grazing animals.
4. Rangeland production is determined by abiotic factors including soil, topography, and climatic.
5. Rangelands produce a variety of products (I.e. forage, recreation, water); therefore, principles of multiple use are important in range management.
6. Rangeland must be managed to maintain soil and water quality.

1.8. Rangeland Ecology

Rangelands are vast landscapes that are composed of differing abiotic and biotic components. Abiotic elements are the non-living chemical and physical parts of the environment, such as slope, aspect, minerals, precipitation and temperature. Biotic components include the living or once-living plants, animals, bacteria, and fungi species. Biotic components also include human activities (e.g., recreation, urbanization, energy development). Rangeland ecosystems change subtly or dramatically from month to month and year to year, primarily due to abiotic factors that cannot be managed. Hence, one of the great challenges for scientists and rangeland managers is to understand the interactions between abiotic and biotic factors and determine how to manage biotic factors to compliment variable climatic (precipitation and temperature) patterns. Being good land stewards requires sound methods for describing rangeland conditions and monitoring their change over time in order to make wise management decisions that will sustain rangeland health for the multiple uses rangelands provide.

Ecological Sites



For the purposes of inventory, evaluation, and management, rangeland landscapes can be divided into ecological sites. An ecological site is a distinctive kind of land with specific landscape and soil and plant characteristics that differ from other kinds of land. The classification of ecological sites allows a land manager to map large areas into units with similar potential to grow specific kinds and amounts of plants and to respond similarly to disturbances and management activities. This might involve viewing shrublands differently than grasslands, such as illustrated in the figure to the right.

An ecological site is the product of all the environmental factors responsible for its development. These include differences in soil, slope, aspect, and place on the watershed. Each ecological site has a set of key attributes that are included in the ecological site description. These include site characteristics (physiographic, climate, soil, and water features), plant communities (plant species, vegetation states, and ecological dynamics), and site interpretations (management alternatives for the site). Site descriptions are available through the Natural Resource Conservation Service.

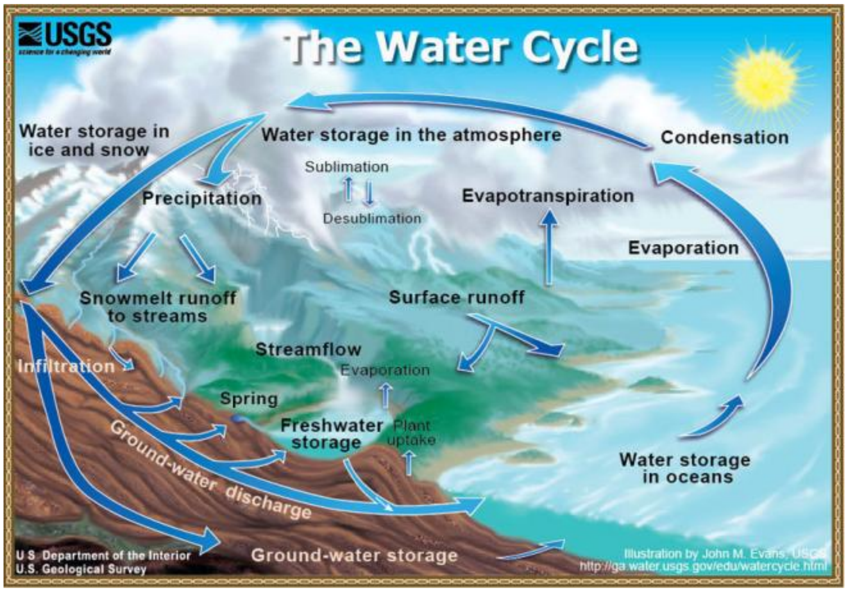
Topography and Watersheds

What is a Watershed?

A watershed is an area of land that drains water to the same endpoint. Watersheds can be defined at almost any scale, as small as a single hill or as large as the Mississippi River and all its tributaries. Watershed boundaries are determined by topography of the landscape. The highest features on the land, like ridgetops, form the perimeter of the drainage area or basin through which water travels as it makes its way to the lowest point. All the water within a region, including lakes, rivers, streams, and subsurface water flows, are part of the watershed classification.

Satellite image of the Pashimeroi River watershed boundary and the local rivers and streams.

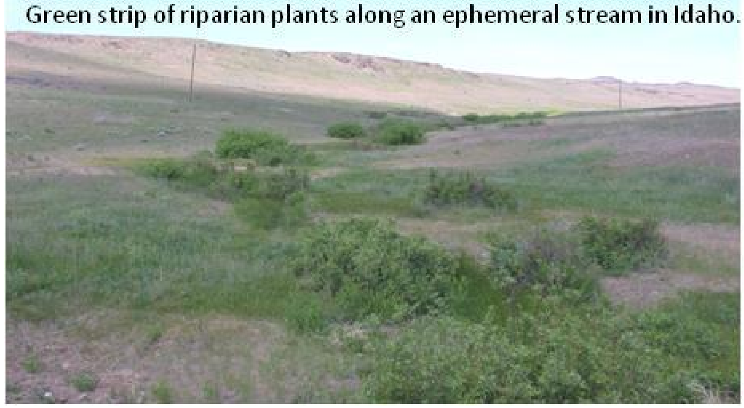
Watersheds serve three primary functions in the hydrologic cycle: the *capture*, *storage*, and *release* of water. Capture refers to how water from the atmosphere gets into the soil. The amount of water that is captured and infiltrates into the soil is related to the amount of both vegetated and non-vegetated ground cover (i.e., organic debris, rock), and the soil type. For example, in dense grasslands, infiltration rates are high because of the amount of plant cover and leaf litter that shelters the soil from the impacts of falling precipitation. However, many rangeland types include bare ground and exposed soils that can have low infiltration rates and result in the movement of soil and water across the ground surface as overland flow**.** Unhealthy or degraded sites can have elevated erosion rates that reduce the hydrologic function of a site. Land managers can indirectly manage infiltration and erosion by managing the structure and density of vegetation.



Water that is captured by the soil is stored between the soil particles. The amount of water stored in the soil depends on the soil depth, texture, and structure. Soil moisture is lost through surface evaporation, plant uptake, or percolation through the soil where it continues to move through the watershed as subsurface flows. Mesic soils have more moisture present closer to the surface than those areas that have drier or more xeric soils. The amount and kind of plants growing on a rangeland site can greatly influence the amount of water stored in the soil. For example, an infestation of leafy spurge, a noxious weed, can have a high density of plant roots deep into the soil profile that will extract soil moisture, resulting in the loss of soil water from a rangeland site. Another example is cheatgrass, an invasive annual grass with shallow rooting systems that uptake moisture near the soil surface before it can reach the deeper roots of other plants such as native grasses and sagebrush seedlings.

Once moisture enters the soil it can move deep into the rocky substrate below the soil where it is held in aquifers that can be tapped into with wells. Moisture can also move horizontally within the soil profile as subsurface flow, ultimately flowing into springs, streams, rivers or lakes. Vegetation management at the transition zones where subsurface groundwater flows meet surface waters is important to maintaining good water quality. These transition zones are also where overland flows meet surface waters, and managing for adequate ground cover provides a filter to prevent excess sediment from entering surface waters.

Green strip of riparian plants along an ephemeral stream in Idaho.



Uplands vs. Riparian

Rangelands are generally classified into three types of areas (*upland*, *riparian*, and *wetlands*), each having a distinct hydrologic regime and plant community. Uplands are drier and only wet for short periods after precipitation events, resulting in water restricted systems. A riparian zone is adjacent to surface waters, such as stream banks and shorelines. Riparian vegetation can be either associated with channels that have flowing water (lotic systems) or standing water (lentic systems). Wetlands are areas with hydric soils that are permanently or seasonally saturated by water. Wetland and riparian areas naturally function as water filters, removing sediment and pollutants from water. Riparian areas and wetlands stay green much longer into the season and produce more biomass than adjacent uplands.

Plant species that occur in wetlands and riparian areas require frequent water and are not killed when inundated by water (as in a flood). These species include cottonwoods, willows, alders, rushes, and sedges. Species found in the floodplain – an area above the stream channel that experiences periodic flooding – require less water and are less tolerant to inundation than species found growing close to or in the channel. Willows, maples, oaks, ash, snowberries, currants, ninebark, elderberries and many other species are frequently found in floodplains. Healthy riparian vegetation is important to sustain the function of streams, as the plants shade the water to maintain the cooler temperatures required by some fish and other aquatic species, while the plants' roots help hold soil in place and reduce erosion.

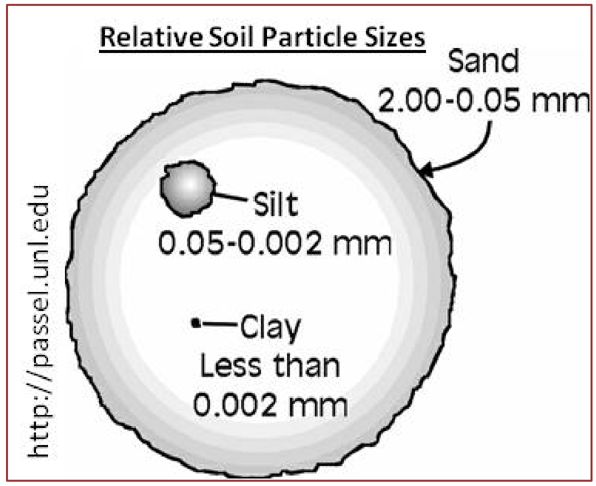
Upland sites are composed of species that have adapted to survive with minimal water in line with the average precipitation of the region. Depending on location, moisture levels can fluctuate from fewer than 10 inches a year in some arid rangelands, to greater than 30 inches on mountain meadows and the tall grass prairie. Moisture levels can vary greatly from year to year, and precipitation is often received only during a single period of the year. Many rangeland plants have evolved strategies to maximize extraction of available soil water, such as the very deep root systems found in desert shrubs or the abundance of small roots of grasses found near the surface which capture rainfall as it soaks into the soil. Upland plants also have strategies to conserve moisture once it is absorbed, such as waxy layers on the stems and leaves, narrow leaves, and the ability to go dormant during the hottest and driest season of the year.

Rangeland Soils

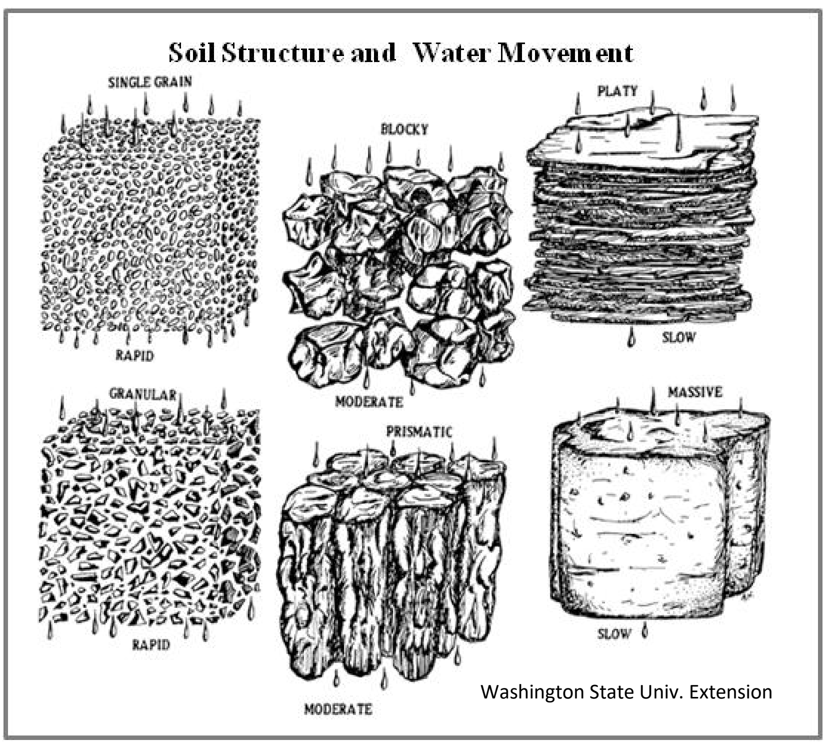
Soil is defined as a complex mix of ingredients: minerals, air, water, and organic matter—countless organisms and the decaying remains of once-living things (Soil Science Society of America). Soil is such an important aspect of rangeland communities that you will receive an entire study guide devoted to soil formation and function. But let's take a few minutes to introduce you to the subject of soil.

Ecological sites have characteristic soils that have developed over time. Factors affecting soil development are: climate, living organisms, topographic relief or landscape position, parent material, and time. These factors lead to soil development or degradation through the processes of loss, addition, translocation, and transformation. Soil forming processes create horizons in the soil that are layers distinguishable from other layers by a change in composition of abiotic and biotic components. Two key physical characteristics of soil, texture and structure, strongly influence the vegetation type that occurs at a particular rangeland site, and have a strong influence on plant water availability.

Texture class is an important aspect of soils, and is related to weathering and parent material. The differences in horizons are due, in part, to the differences in texture of their respective parent materials. The texture of a soil depends upon the relative proportions of each type of soil particle within the soil. The three basic soil particles are *sand*, *silt*, and *clay*. Sand particles are the largest of the three particles. They are between 0.05 and 2.00 mm in diameter and are coarse and gritty. When they are moist, individual grains can be seen. The presence of sand particles within a soil decreases the capacity of soil to hold both water and nutrients. Silt particles are medium in size and range between 0.002 and 0.05 mm in diameter. Silt particles feel smooth and velvety. The presence of silt particles in soils increases water-holding capacity and nutrient capacity. Clay particles are the smallest of the soil particles and have a diameter of less than .002 mm. Clay particles have the greatest ability to hold both water and nutrients. Sometimes, however, clay can bond very strongly with nutrients, making it difficult for plants to extract nutrients from the soil. Clay particles can also form very strong aggregates, decreasing the ability of water to penetrate and drain from the soil.



Soil particles seldom occur as separate units in the soil; rather, they often combine to form larger aggregates that are primarily held together by the binding forces of clay and organic matter. Soil structure is a term which describes the arrangement of soil particles. The five major structural classes of soil are *blocky*, *platy*, *granular*, *prismatic* or *columnar*, and *massive*.



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The texture and structure of soil directly influence the amount of air (pore) spaces found within the soil. These are important conveyors of water, nutrients, and air, as well as providing spaces for roots to grow. In some locations, the soil will form impenetrable barriers that may substantially impede water infiltration and root penetration. These restrictive layers may be inherent (natural) or induced by land management practices. For example, a soil may become compacted due to excessive traffic on the land which in turn may alter the hydrologic function of that site.

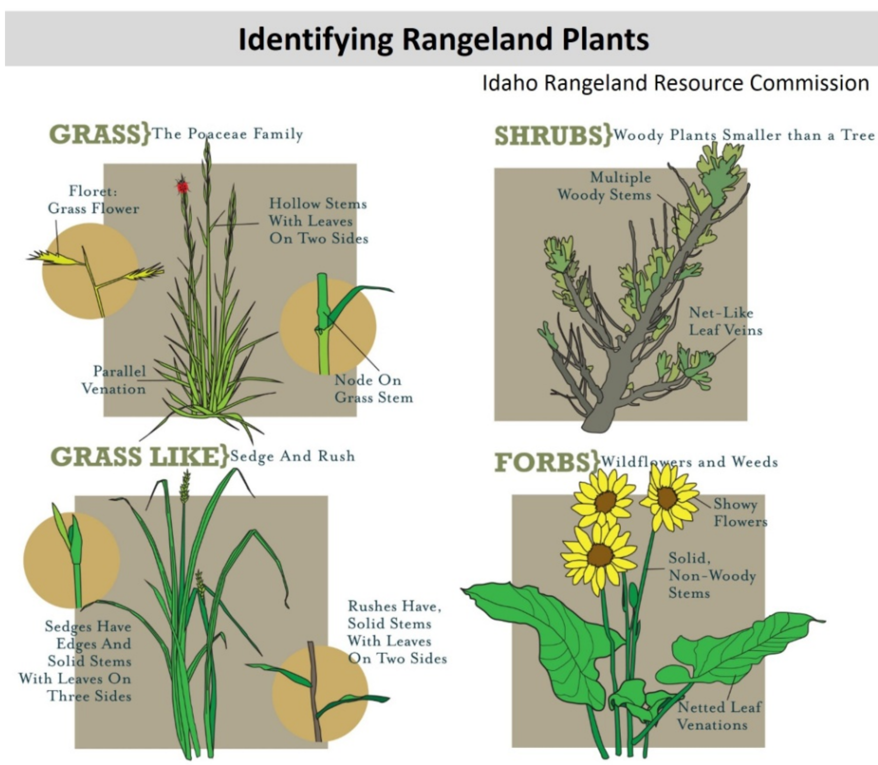
It is normal for wind and water to move soil around a landscape. This soil loss is called erosion**.** Some natural erosion can be expected; however, erosion can become excessive if vegetation is removed from the soil surface by overgrazing or other impacts such as high off-road vehicle use. It is important to manage vegetation so as to keep soil in place.

Rangeland Plants

Most management decisions on rangelands are made by first knowing the various plants inhabiting rangelands and knowing their growth habits. Correctly identifying rangeland plants requires knowledge of plant characteristics and plant types. One of the most important identifying characteristics of plants is the shape of a plant's leaf. Other important distinguishing characteristics include the margins (edges) and venation (pattern of veins) of leaves.

Range plants can be classified and grouped in many different ways, including growth form, life span, season of growth, origin, and forage value.

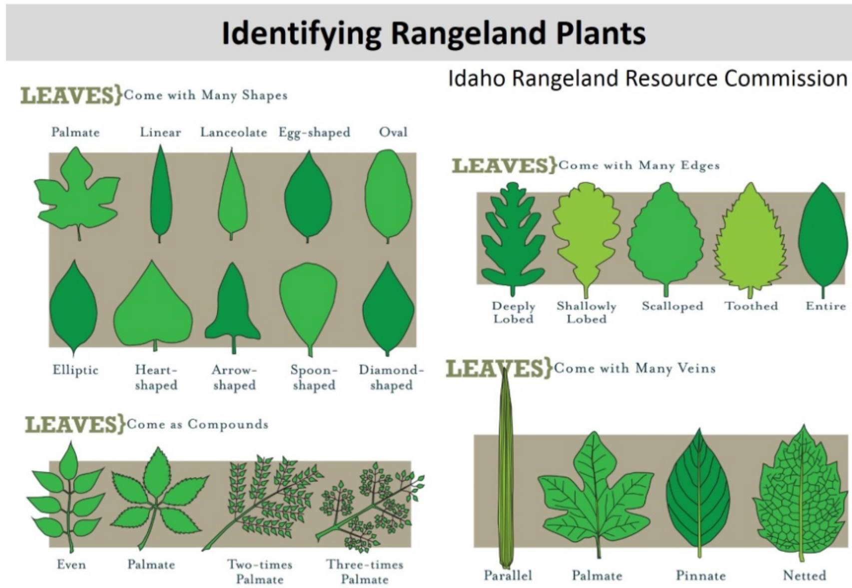
Plant Type or Growth Form



Grasses are plants with long narrow leaves and hollow, jointed stems. Leaves on grasses are in two rows on the stem with veins that are parallel. Grasses do not have colored flowers and they produce grain-like seeds. Ecosystems dominated by grasses are called grasslands and cover more than one-fifth of the earth's land surface.

Grass-like plants look like grasses but have solid stems (not hollow) without joints. Stems are often triangular. Veins in the leaves are parallel. Sedges and rushes are in this group of plants.

Forbs are herbaceous (non-woody) plants that usually have broad leaves and showy flowers. Forbs have leaves and stems that die back to the ground each year. Most forbs have pinnate, palmate, or netted veins in the leaves, but a few have parallel veins. Most of the plants commonly called wildflowers and range weeds are forbs.



Shrubs are woody plants that usually have broad leaves. Shrubs are different from trees because they do not have a main trunk; instead, they have several main stems. Some plants can take both a tree and a shrub form, but most shrubs never grow up to be trees. The term browse is used to describe the small stems and leaves of shrubs used for forage by wildlife and livestock. The term mast is used to describe the seeds and berries that shrubs produce and is especially important as wildlife forage.

Life Span

The life span of a plant refers to the length of time from the germination and sprouting of the plant to the natural death of the plant. In other words, this is how long it takes the plant to grow, flower, produce seeds, and die. Rangeland plants can be classified as annuals, biennials, or perennials.

Annual plants live only one growing season. There are two types of annuals, depending on when they begin growth. Winter annuals germinate in the fall and form a small rosette of leaves through the winter. The following growing season, the plant continues to grow, flowers, produces seeds in the summer, and then dies. Summer annuals germinate in the spring, complete all growth by the end of the summer, and then die.

Biennial plants live for two growing seasons. During the first growing season, these plants normally form a basal cluster or rosette of leaves. During the second year, they send up a seed stalk that flowers before the plant dies back to the ground at the end of the growing season.

Perennial plants live for several years, and some live up to hundreds of years. The plants produce leaves and stems from the same crown for more than two years. Most range plants are perennials.

Growth Season

The season of growth refers to when plants make their principle growth. Rangeland plants are categorized as cool season species or warm season species.

Cool season plants make their principle growth during cool weather. These plants are sometimes called "C3 plants" because they have a specific photosynthetic pathway that first yields a 3-carbon sugar. At lower elevations, these plants grow in the spring, set seed in late spring or early summer and new growth appears in the fall if moisture is adequate. Plants that grow at high elevations are usually cool season plants because of cool temperatures throughout the growing season. Evergreen plants are woody plants that retain leaves throughout the year. They are cool season plants (photosynthesizing in winter) and are important forage in drought and winter.

Warm season plants make most of their growth during late spring and summer. These plants are also called "C4 plants" because a 4-carbon sugar is the first compound produced from the specific type of photosynthesis of these plants. Seeds in warm-season plants develop in mid-summer and early fall. Southern states such as Texas and New Mexico have nearly all warm season plants. There is another pathway for photosynthesis called CAM (Crassulacean Acid Metabolism) that is common in plants such as cacti which grow in warm desert regions.

Origin

The "origin" of a rangeland plant is the area where it developed and evolved. Knowing the origin of a plant is important because it can affect the way the plant responds to the environment or help predict spread of species. Rangeland plants can be characterized as either native or exotic.

Native plants are those that originated and evolved in North America.

Exotic or introduced plants are those that were brought to North America from another continent, either on purpose or by accident. Several plants were intentionally introduced to rangelands because they have good forage value. Others were accidentally introduced, usually as contaminants in crop seeds, packing materials or other imported items. Some weedy introduced plants were brought to this continent for their ornamental value, but then escaped into rangelands. When these become widespread and problematic, they are known as invasive species. We will talk more about invasive species later in this study guide.

Woody or Herbaceous

Rangeland plants can also be described in terms of how much woody tissue they contain. This is important because it affects forage value, watershed characteristics of the landscape, habitat characteristics, and fire fuel loads.

Herbaceous plants include grasses, grass-like plants, and forbs. These plants contain little or no wood and they die back to the ground each year.

Woody plants are shrubs, trees, and woody vines that have woody stems. Wood is created by the binding of plant fiber (i.e., cellulose) with lignin, a strong and indigestible compound.

Trees are different from shrubs because they generally have a single main stem or trunk. Shrubs generally have several main stems. Woody plants can be deciduous**,** which means they lose their leaves every fall, or evergreen because they maintain some live leaves throughout the year, even winter.

Forage Value

The forage value of a plant refers to how well it provides nutrients to grazing animals. The forage value of a plant varies depending on which animal is eating it because nutritional needs and dietary preferences of grazing animals differ by species. For example, a plant could have excellent forage value for cattle and poor forage value for deer. Range plants can be classified as having high, medium, or low forage value or be poisonous.

High forage value designates plants that are nutritious, palatable, and produce abundant forage. High forage value plants are high in crude protein, low in crude fiber, and are non-toxic.

Medium forage value plants will provide adequate nutrients if eaten, but are not preferred by animals because they are not high in nutrients, are not highly digestible, or are relatively small plants and do not produce an abundant amount of forage.

Low forage value describes plants that simply do not provide adequate nutrients to the grazing animal. Low forage value plants are high in crude fiber, low in nutrients (including crude protein, minerals, etc.), have limited digestibility, and may be somewhat toxic.

Poisonous plants are rangeland plants that contain natural plant compounds that are toxic or poisonous to herbivores. These compounds include alkaloids, essential oils, tannins, and glycosides. When grazing animals eat excessive amounts of poisonous plants, they suffer ill effects that can include bloat, nausea, low intake, muscle tremors, skin sensitivity, birth defects, or death. Each year 3 to 5% of livestock grazing on rangelands suffer illness, reproductive problems, or death from toxic plants.

Rangeland Animals

Rangelands provide habitat for countless mammals, birds, amphibians, reptiles, fishes, and insects. A great majority (84%) of mammals found in North America spend at least a portion of their life in rangeland ecosystems. Large hoofed animals, called ungulates**,** are perhaps the most iconic rangeland animals. Wild grazing animals such as bison, elk, pronghorn, and deer, as well as livestock species including cattle, sheep, goats, and horses, all inhabit rangeland landscapes. Other mammals commonly found on rangelands include rodents and rabbits.

A variety of birds make their home on the range, either seasonally or year-round. Large game birds such as grouse, quail, pheasants, and turkeys call rangelands home. Migratory songbirds including meadowlarks, buntings, sparrows, and doves fill the grasslands, shrublands, and woodlands with color and song. Raptors such as hawks and falcons can often be found in the rangeland skies. Some birds are







so attached to rangelands that vegetation types are in their name: prairie falcon, meadow lark, sage thrasher, and scrub jay.

Insects are productive inhabitants of rangelands, as diverse as the grasses, forbs, and shrubs on which they live. Insects play many ecological roles on rangelands, which can be either beneficial or detrimental. Periodic large outbreaks of certain insects, such as grasshoppers or Mormon crickets, can cause great devastation to rangeland ecosystems when they eat rangeland plants and adjacent croplands. Even in unremarkable years, many insects eat plants that could be used as forage by wildlife and livestock. However, because of their small size and inconspicuous nature, they are often overlooked in both stocking rate estimates and forage assessments. Insects also play a vital role in decomposing dead plant material by incorporating it into the soil and improving soil aeration. In addition, insects pollinate plants, thus sustaining genetic diversity among flowering rangeland plants. Of course, insects make up an important part of the diet of many birds, reptiles, and mammals.

Many insects are completely dependent on a single plant species for their survival; these insects are called “host-specific.” If an exotic plant is invading into rangelands and becoming a pest, it is sometimes possible to identify host-specific insects in its country of origin that can be introduced here to bring the weed under control. Introducing a host-specific insect to control a weed is a process known as biocontrol.

Diet Selection: Plants, Animals or Both

Animals that live on rangeland can be categorized based on their foraging habits. Classification is first based on whether the animals eat plants, other animals, or both.

Herbivores are animals that eat only plants. They can be classified further:

Grazers, such as cattle, elk and bison, eat mostly grasses.

Browsers include deer and goats that eat some grasses, but mostly shrubs. The leaves and small stems of woody plants are called "browse" so these animals are called browsers.

Intermediate feeders eat a mix of grasses, forbs and shrubs depending on which is most nutritious at the time. Sheep and pronghorn are examples of these opportunistic feeders that eat grasses and forbs in the spring and summer and then switch to shrubs in the winter.

Carnivores eat other animals. Their diet can include insects, birds, reptiles, and/or mammals.

Omnivores are animals such as humans or bears that eat a combination of animals and plants**.**

Digestion Strategies of Herbivores

Herbivores can be further classified based on how they digest the grasses and forbs that dominate rangelands. These plants have large amounts of cellulose-containing fiber. Cellulose is a type of carbohydrate that cannot be digested by mammals. However, most grazing and browsing mammals have both a specialized fermentation organ and a symbiotic relationship with bacteria, protozoa, and fungi that can break down cellulose and turn it into nutritional compounds that can be used by the grazing animal.

Ruminants include cows, sheep, goats, deer, elk, and moose. These animals have specialized digestive systems, including a rumen to ferment the cellulose abundant in the cell walls of rangeland plants.

Hind-gut fermenters include rodents, rabbits, and horses. These animals have an enlarged cecum or colon that houses microbes that ferment forage particles and release energy compounds that can be absorbed and used by the animal. The cecum and colon are located past the true stomach in the digestive track (i.e., behind the gut) –these animals are therefore called "hind-gut fermenters."

Concentrate-selectors are animals that do not have a way to digest fiber and so must avoid cellulose by foraging carefully, selecting berries, seeds, or roots that are low in cellulose. These animals include birds and bears that find an adequate diet on rangeland by carefully selecting plants and plant parts low in cellulose.

Wild, Domestic, and Feral Animals

Humans have developed varying levels of relationships with animals over time. Our influence over animals can vary from strong and close to weak and distant.

Wild animals or **wildlife** are animals whose behavior, physiology, and genetics are largely not influenced by humans. There is a huge variety of wildlife species that inhabit rangelands including elk, deer, rabbits, insects, reptiles, and birds.

Domestic animals are those that have been strongly influenced by their relationship with humans. The behavior and breeding of these animals has been modified by humans, creating new species from their wild ancestors. Domestic animals include cattle, sheep, goats, horses, pigs, geese, chickens, dogs, cats, and honey bees.

Feral animals are those that were once domesticated but have severed their ties with humans and gone back to a “wild” lifestyle. Wild horses and burros are examples of feral animals on rangeland.

Habitat Needs of Rangeland Animals

All wildlife and livestock require four basic habitat elements in order to survive, thrive and reproduce: food, water, cover, and space. The specific combination of food, water, cover, and space required by a given species, called its niche, is unique to every species that lives on rangelands. Because of these specific and varied requirements, any time the habitat is altered, it improves for some species but worsens for others. Additionally, because each species’ niche is different, it is impossible to maximize the habitat quality of all wildlife at the same time. Therefore, trade-offs must be considered when managing habitat quality for wildlife and livestock.

Certain wildlife species depend solely on rangeland habitats, such as sagebrush obligates**.** These animals cannot exist without the habitat elements found only in sagebrush steppe communities. The sage grouse, Brewer’s sparrow, and pygmy rabbit are examples of sagebrush obligate species.

A habitat is basically the home of a species, including all biotic, climatic, topographic, and edaphic (soil) factors that affect life

Food requirements for all animals, including those on rangelands, include energy, nutrients, and minerals**.** Energy in plants comes from starches, sugars, fats, and cellulose. Nutrients needed include mostly protein and vitamins. Mineral requirements include phosphorus and potassium. The types of vegetation present, the diet preferences of animals, and the spatial arrangement of available food plants must be assessed to determine the food or forage value of rangeland habitat.

Different types of animals require different amounts of food each day. As a general rule, ruminants like bison, deer, cattle, and sheep will eat about 2.5% of their body weight per day (in dry weight of forage); hind-gut fermenters such as horses and rabbits will eat about 3.0% of their body weight each day; and concentrate selectors such as birds, bears, and mice will eat about 0.25% of their body weight daily.

Water requirements vary depending on the animal species and weather conditions. In general, sheep and goats require 1-1½ gallons of water once every two days; donkeys require 3-4 gallons of water every day; horses require 5-8 gallons of water each day; and cattle and bison require 8-10 gallons of water every day or two. Rangeland animals meet their water requirement by drinking fresh water and obtaining water from forage. Plants can contain significant amounts of water. For example, immature grasses may be up to 75% water by weight. If an animal eats 28 pounds of immature forage, it will consume about 2.5 gallons of water.

Cover is required for shelter from weather conditions and from predators. Plants provide thermal protection by shading animals in the summer and sheltering them from cold in the winter. Thermal cover for rangeland animals is provided mostly by trees and shrubs. Plants can also offer hiding cover for animals to protect them from predators. Many animals use large plants to hide under or to gain protection through visual obstruction. However, other animals, like pronghorn and prairie dogs, gain protection from predators by a lack of visual obstruction. These animals prefer to be out in the open where they can see predators coming and escape by running away or retreating underground.

Space is an important consideration for breeding and nesting, home range, social intolerance, and disease transmission. An animal's home range is the area in which an individual animal conducts its normal daily and yearly activities. This area can be shared with members of its own species, or with other species. The home range of an animal is directly related to its body weight: larger animals generally have a larger home range. Home ranges also vary by foraging habits: carnivores have very large home ranges, while the home ranges of herbivores are comparatively smaller.

Factors Limiting Habitat

Limiting factors such as water, food, climate, and topography determine the size and location of home ranges and habitats. These factors are basic requirements that restrict the size, growth, and/or vigor of an animal population. Rangeland habitats can be influenced by human activities that either add or remove limiting factors. For example, when ranchers add water tanks to pastures, they may remove a habitat-limiting factor (i.e., access to water) for wild and domestic animals. On the other hand, building roads and housing subdivisions may create factors that limit access to food and cover. However, habitat modification does not always affect a wildlife species' ability to survive, thrive, and reproduce.

Think of habitat as resources that are held in a wooden barrel, as in this figure. The limiting factor is determined by the height of the lowest plank in the barrel: in this example, food is limiting the animal's ability to survive, thrive, and reproduce. If improvements to water, cover, or space occur, the species' population will not be affected. Similarly, degradation to water, cover, or space will not affect the population unless the degradations are so severe that one of these habitat essentials replaces food as the limiting factor. Habitat changes only affect a population when the species' limiting factor is enhanced or degraded. Therefore, if food is degraded in this example, the species

will be negatively impacted and if improvements to food occur, the species will benefit.

Stocking Rates and Carrying Capacity

The number of animals a piece of land can support on a long-term basis without causing damage to the range resource is the carrying capacity (or grazing capacity) of the land. Stocking rate**,** on the other hand, is the number of animals a land manager places or maintains on a piece of land over a specified period of time. Thus, carrying capacity is set by Mother Nature, through soil and climate characteristics, while stocking rate is set by humans, through livestock or wildlife management.

The currency of stocking rates is the animal unit (AU). An AU is 1,000 pounds of grazing animal. In other words, a 1,000 pound cow equals 1 AU, a 1,200 pound bison is 1.2 AUs, and a 150 pound mule deer equals 0.15 of an AU. An animal unit month (AUM) is the amount of forage an AU can eat in a month. Recall that a ruminant animal eats about 2.5% of its body weight each day. Therefore AUM equals 750 pounds of forage (1,000 pounds of animal × 2.5% × 30 days = 750 pounds).

The terms AU and AUM are widely used in rangeland management, but there is not universal agreement on the quantities each term expresses. Usually, 1,000 pounds of grazing animal equals an AU and an AUM is generally about 750 pounds. Some range managers use estimates of 780 or 800 pounds for an AUM. Stocking rate is often stated as the number of AUMs/acre or acres/AUM. For example, if the stocking rate of a pasture is 4 acres per AU per month (i.e., 4 ac/AUM) then it requires 4 acres to provide enough forage for 1 AU, such as a 1,000 pound cow, for a month.

Rangeland Animal Interactions

Rangelands are very diverse habitats with a wide variety of plants and geographic features. Livestock and wildlife often occupy the same area of rangeland. Interactions among livestock and wildlife on rangelands can be somewhat or mostly harmful, somewhat or mostly beneficial, or benign (no effect on either).

Any of the following relationships can exist depending on the animal and its habitat requirements:

- **Mutualism** (or Protocooperation): a relationship between two animals in which both benefit from the association. *For example: Cattle egrets (a type of bird) often perch on the backs of cattle or bison and eat insects and grubs. The insects benefit the birds as a food source. The cows and bison get the benefit of getting rid of the bothersome insect pests.*
- **Commensalism**: a relationship between two individuals in which one derives some benefit while the other is unaffected. *For example: Dung beetles eat the feces of ruminant animals like cows or elk. The dung is a food source for the beetles (a benefit), but this activity has no effect on the ruminant animals.*
- **Antagonism**: one species benefits at the expense of another (i.e., predation/parasitism). *For example: When a coyote eats a rabbit or lamb, the coyote gets the benefit of a food source, but the rabbit or lamb is harmed (i.e., killed).*
- **Amensalism**: a relationship between two animals in which one is adversely affected and the other is unaffected by the association. *For example: Bison can carry brucellosis (a bacterial disease) with no apparent symptoms. When bison interact with domestic cattle they can infect*

the cattle with brucellosis which can cause spontaneous abortion. The cattle are therefore harmed and bison are unaffected.

- **Competition**: if two animals use the same resource (such as food or water) and if that resource is in limited supply, this may cause harm to both animals because neither will have enough to meet its requirement. *For example: When elk and cattle eat the same forage and it becomes limited, both the elk and cattle may be harmed: they may not have enough to eat and may become thin. Animals are "competing" for a resource only if there is not enough for both of them to meet their requirements. Just because animals are using the same resource doesn't mean that they are in competition with one another. If the resource is abundant, competition is not occurring.*
- **Neutralism**: a relationship between two species that interact or share the same habitat but do not affect each other. *For example: Meadow larks or bluebirds have no effect on cattle or elk, and cattle and elk have no real effect on meadow larks or bluebirds.*

Livestock and Wildlife Interactions

Ranch management and subsequent grazing management strategies can negatively or positively impact wildlife that inhabit landscapes also used by livestock. Livestock can be also an important management tool for improving wildlife habitat. In other words, livestock grazing can be used to purposefully manipulate forage to improve wildlife habitat for a chosen wildlife species. Livestock managers can alter the timing, frequency, intensity, and type of livestock grazing to achieve wildlife habitat management goals. For example, spring grazing by cattle on the mountain benches, such as those above Boise or Salt Lake City, encourages the growth of shrubs that are important winter forage for deer and elk. This process is referred to as prescribed or targeted livestock grazing and is the strategic use of livestock grazing to achieve specific landscape goals.

In other situations, livestock grazing can damage habitat value if it is not carefully applied and purposefully planned with wildlife habitat in mind. Potentially negative impacts of livestock and wildlife interaction include parasite/disease transmission, reduction of cover, or changes of the types of plants available as forage. Several aspects of ranching such as fences and roads can also be detrimental to wildlife species.

Good land stewardship and conscientious grazing management strategies that account for wildlife can be used to limit negative interactions, enhance habitat quality, and promote complementary relationships between wildlife and livestock on rangelands.

Measuring and Monitoring Plant Communities

Assessment and Monitoring

Rangeland ecosystems are dynamic and change constantly as a result of nature's driving forces, including climate, fire, insect outbreaks, flooding, wildlife foraging, and weed invasion. Human induced disturbances—including urban expansion, domestic livestock grazing, recreational use, energy development, mining, road building, and landscape manipulations (e.g., disking, chaining, seeding) also impact soil, plant composition, and wildlife habitats on rangelands. Rangeland monitoring is a systematic approach to document vegetation changes over time. Data derived from monitoring can help land managers determine the effectiveness of their management practices and help them select appropriate future management strategies based on objectives.

Monitoring objectives are defined for individual sites, habitats or pastures, each with a focus on specific attributes. For example, a rancher may plant willows or sedges along a stream to improve the stability of the stream banks. The rancher may then implement a monitoring protocol to determine if a new grazing system is affecting establishment of the sedges or willows. If the grazing system is not leading to the desired condition, the grazing plan could be changed, or the stream could be fenced to exclude grazing. Monitoring can also quantify how natural forces are affecting rangeland plant communities over time. For example, a land manager may implement a monitoring program to determine if and when a burned area recovers to the level of a similar plant community in an unburned area.

The first step to an effective monitoring plan is to establish a baseline of data – a point of reference from which managers can base decisions about the land use. This is accomplished through a rangeland assessment, providing a "snapshot in time" of the current conditions of the soil, plant community, site productivity, and wildlife habitat uses. Rangeland site assessments include specific attribute data and capture specific information about the site such as elevation, map coordinates (e.g., latitude and longitude or UTM), slope, aspect, soil texture and structure, watershed unit, and land ownership. It is also important to document evidence of wildlife, livestock, and human use (e.g., scat, ORV tracks, hoof prints, etc.) and hydrologic characteristics (e.g., rilling, gullying, soil pedestals, etc.).

Attributes

Though there are many ways to measure plants, there are only six basic attributes that are commonly measured for rangeland monitoring. Vegetation attributes are characteristics of vegetation that can be measured or quantified according to how many, how much, or what types of plant species are present. These six most commonly used attributes are:

- **Plant Species or Type** - What kind of plant was it?
- **Frequency** - Was the plant present in a sampled area?
- **Density** - How many plants were there in a specified area?
- **Biomass** - How much did the plants weigh?
- **Cover** - How much space did the plants cover?
- **Structure** - How tall were the plants and how were branches and leaves arranged?

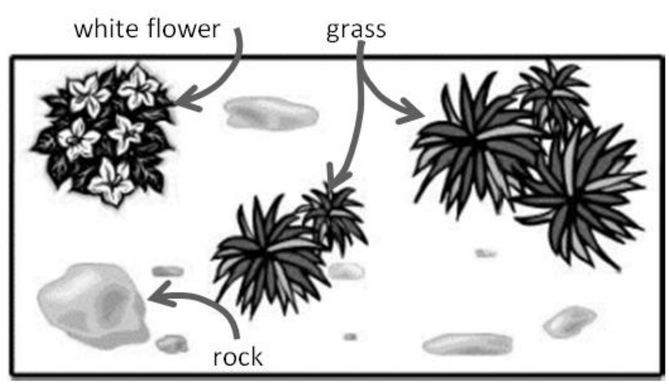
The most valuable skill that rangeland managers possess is the ability to differentiate between different plant species. Therefore, plant identification is essential to effective monitoring on rangelands. Remember that plant species found on rangelands fall into five major types, or **life form** categories: grasses, grass-likes, forbs, shrubs and trees.

Frequency describes how often a plant occurs within a sampled area. For example, if a grid were laid out over a sample area, the frequency of a target species would be expressed as the percentage of the cells where the species was present out of the total number of cells possible. Because large plots are more likely than small plots to capture the presence of a species, frequency measurements are dependent on plot size and shape. Therefore, frequency values between different sites or years are not comparable unless identical plot sizes are used. Frequency is most often used to compare plant communities and to detect changes in vegetation composition over time. In this way frequency can be used to assess vegetation trend.

Density is the number of individual plants per unit area (i.e., plants/ft^2 or plants/m^2). From a management perspective, density measures can be used to detect the response of plants to a given management action. In particular, density measurements provide evidence of plant mortality or recruitment on rangeland sites over time. For example, the density of a particular weed could be monitored over time to determine if an integrated weed management strategy is working. Because density is a count of plants per unit area, it is not affected by plot size and can be a useful measurement to compare different sites.

Determining the biomass of plants on a site is important for setting proper stocking rates, determining hydrological characteristics, and monitoring the effects of climate variation on a site. Biomass, or vegetative production, is expressed as weight per unit area (i.e., pounds/acre or kg/hectare). Total annual production is the production (growth) of all plants, whereas total forage production is the total amount of plants that could be used as forage by grazing animals. Biomass can be determined by clipping grasses, forbs, and browse to determine composition and weights. Or, if the ecological site is known, site guides can be consulted to obtain estimates of production in years of favorable, normal, or unfavorable precipitation. Experienced range managers can also accurately estimate the weight of forage on a site just as a good livestock manager can skillfully estimate the weight of a cow. Being able to estimate biomass is a useful skill, and can be honed through experience.

Cover is a description of the amount of ground surface covered by vegetation or other objects, including rocks, litter (dead plant matter), moss, or bare ground. Cover measurements are most often used to assess which plants dominate the solar, water, soil and nutrient resources on a site. Vegetative cover also influences the hydrologic function of a site and cover measurements may be used to interpret how well a rangeland site is able to capture, store, and safely release water from rainfall and snow. Cover is also an important management indicator, providing a variety of interpretations of direct concern to rangeland management, including erosion potential, the value of wildlife habitat, availability of forage, and trends in range condition.



Cover is expressed as a percentage. For example, if you look directly over this illustration of a plot of vegetation, you might estimate that the area is covered by 35% grass, 12% white flower, and 15% rock. Subtracting the totals from 100% yields the amount of bare ground, 38%. Cover can be measured for the entire sample area (i.e., “total vegetative cover was 47%”), or can be applied to individual species (i.e., “grass cover was 35%”).

Vegetation **structure** describes the three-dimensional arrangement of a plant community. Structure measurements are primarily used to evaluate wildlife habitat elements (i.e., nesting cover, screen or hiding cover). Techniques used to quantify vegetative structure are generally applicable in a wide variety of vegetation types and are useful in evaluating changes over time. For example, the same method used to determine vegetation structure for sage grouse brooding habitat may also be used to quantify the amount of hiding cover for mule deer.

In addition to measuring vegetation attributes to determine the effectiveness of management strategies, rangeland monitoring also helps managers make observations about the health or vigor of plants and communities. In assessing and defining sites, we can combine the above attributes to create variables such as *species composition*, *biodiversity* of the site, or *similarity* with historic measurements.

Rangeland **plant composition** is the proportion (%) of various plant species (or life forms) in relation to the total plant species (or life forms) in a given area. Plant composition is important to measure in range management because traditional range ecological site descriptions are based on plant composition. Measurement of composition over time can be used to determine if range condition is improving or declining in relation to potential composition as outlined in an ecological site description. Finally, assessing composition helps to estimate the forage available for herbivores with differing feeding habits. Range managers commonly calculate composition from biomass or cover data.

Biodiversity refers to the total amount of different organisms found within a certain area. Benefits of diverse rangeland plant communities are that they contain a variety of forages that are available to insect and vertebrate species, they contain more species that are capable of surviving disturbance, and they are theoretically less likely to be invaded by noxious or opportunistic species. Measures of diversity can be derived from cover and/or density data.

The measure of similarity between communities based on species composition, or calculating a similarity index, is useful for comparing communities under different management or comparing communities over time. Similarity can be calculated from cover and/or density data.

Forces of Ecological Change

Rangelands are incredibly dynamic ecosystems. Drastic changes can be observed among seasons within a year and across years and decades. There are five major factors that cause rangelands to change over time – grazing, fire, invasive plants, weather and climate, and fragmentation due to human influences. These factors change the plants and animals that inhabit rangeland sometimes in ways that land managers and users find desirable and other times in ways that are considered adverse.

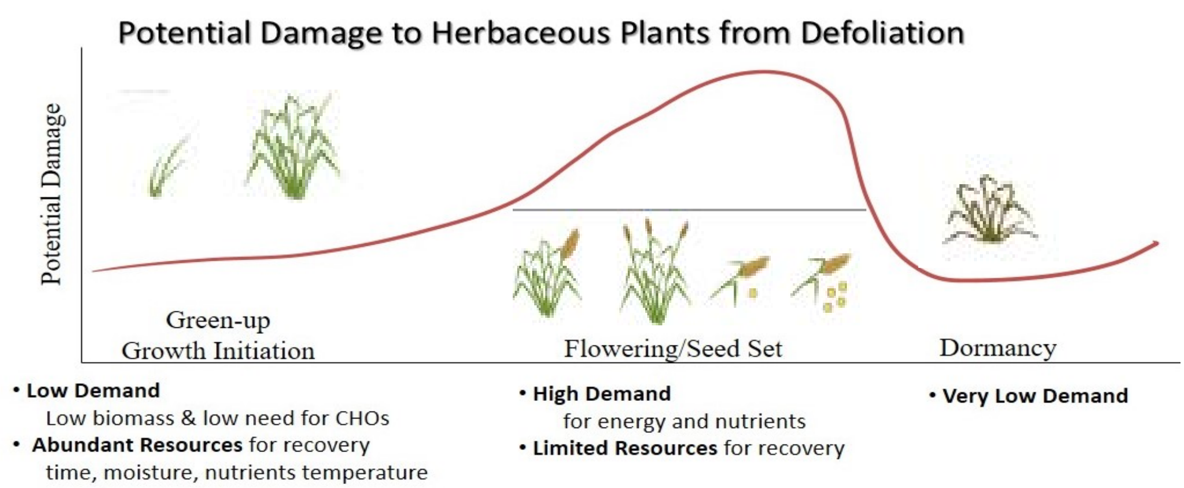
Grazing

The grasses, forbs, and shrubs that grow on rangelands are important sources of forage for grazing animals. Rangeland plants photosynthesize, using energy from the sun to turn carbon dioxide, water, and nutrients into organic compounds such as carbohydrates and proteins. When herbivores consume plant material, these compounds are digested, providing energy and nutrients for herbivores. Grazing is a natural ecological process that occurs on all rangelands.

Plant Response to Grazing

Rangeland plants live in ecosystems full of herbivores that range from small insects to large grazing animals. Losing leaves or stems to herbivores is a common event in the life of a rangeland plant. For these plants to remain healthy and productive, enough vegetation must remain after grazing so plants can photosynthesize and manufacture energy to produce more leaves, stems, and seeds. Plants also need to produce and store a little energy as starches and sugars in roots and crowns to successfully start the next season of growth. When too much of the plant is removed, the plant suffers in a way that yields lasting detrimental effects. Substantial damage to rangeland plants generally only occurs under repeated and heavy grazing.

The impact of grazing on plant growth depends greatly on *when* the grazing occurs during the growing season and *at what stage* of the plant's life cycle. Plants are generally less damaged by grazing early in the season when time, soil moisture, and nutrients needed for regrowth are abundant, or very late in the season once necessary growth has taken place. Plants are most likely to be damaged by grazing when the plant is beginning to produce flowers and seeds. This is when the plant has high energy demands to produce seeds, complete growth for the season, and store energy to get through the dormant season. Plus, this generally occurs at the peak of summer when the environment is hot and dry and not favorable for regrowth. Once the plant produces seeds and turns brown (i.e., begins to senesce and becomes dormant), the leaves are not photosynthesizing and are no longer being used by the plant. At this time, it is no longer sensitive to grazing.



Because plants evolved with grazing animals, it is not surprising that plants have attributes and processes to reduce the potential of being eaten, and to recover from the loss of plant material after grazing. One way that plants can reduce the impacts of grazing is to have characteristics that reduce the likelihood that herbivores will even take a bite. These characteristics that reduce the probability or severity of grazing are called mechanisms for grazing avoidance. These include physical features like thorns, prickles, and spines that make plants less likely to be grazed by large herbivores such as cattle or elk. Similarly, a hairy or waxy leaf surface may be avoided by insect herbivores. The size, shape, or arrangement of leaves may also make it difficult for animals to access and graze the plant.

The buds or growing points (meristems) of a plant are especially important to protect from grazing because they will be the source of new stems and leaves for continued growth after grazing. Grasses have a unique strategy of protecting meristems – they are kept near the ground surface (within the crown of the plant) while the leaves and sheaths grow upwards. Some forbs also adapt this tactic by forming a basal rosette of leaves that photosynthesize right near the ground surface, out of the reach of grazing animals. The meristems of these rosette- forming plants are kept in the center of the rosette and are not elevated and made accessible to grazing animals until later in the growing season.

Some plants also contain toxic compounds that are harmful to the grazing animal. These compounds, called secondary compounds, can cause illness, neurological disorders, birth defects, or even death. Secondary compounds such as alkaloids, tannins, and essential oils are common in plants. Most often these compounds do not kill the animal, but simply make it feel sick or nauseated so that the plant becomes distasteful and undesirable to the herbivore. Some plants, however, contain toxic compounds that are very powerful even in small amounts. For example, tall larkspur contains a mixture of alkaloids that, if eaten, can cause muscular paralysis, leading to respiratory failure, bloat and often death.

Plants also have attributes that facilitate their re-growth and recovery after grazing. The morphological and physiological characteristics that promote rapid plant growth are termed mechanisms of grazing tolerance**.** For instance, some plants have a higher potential to mobilize stored energy sources and replace leaves after defoliation.

Plants vary in how well they can tolerate and avoid grazing. In fact, many plants can benefit from the effects of grazing. For example, grazing animals can remove the older and less efficient leaves, making space and resources for younger more efficient leaves. Grazing can also stimulate the plant to produce more seeds and stems than if it had never been grazed. So, the effects of grazing can be detrimental or beneficial depending on the: 1) plant species, 2) season when grazing occurs, and 3) intensity of grazing (how many leaves remain after grazing).

Impacts of Grazing on Ecosystems

Just as they can impact individual plants, grazing animals' direct and indirect impacts can also improve or degrade rangelands, depending on the timing and intensity of grazing. Foraging animals affect rangelands by removing vegetation, roughing up and compacting soil through hoof action, and depositing minerals and nutrients in the form of urine, feces, or the animal's carcass. Appropriate and well-managed grazing can favor desirable plants, improve habitat for wildlife, reduce weed invasion, reseed areas for restoration, reduce mulch accumulation, increase soil organic matter, and reduce fuel loads that promote wildfire. Overgrazing and prolonged poorly managed grazing can remove desirable plants, decrease water infiltration into soil, increase soil erosion, reduce water quality, increase weed invasion, and alter the plant community composition to a less desirable state. Therefore, the impacts of grazing depend on when and how it occurs.

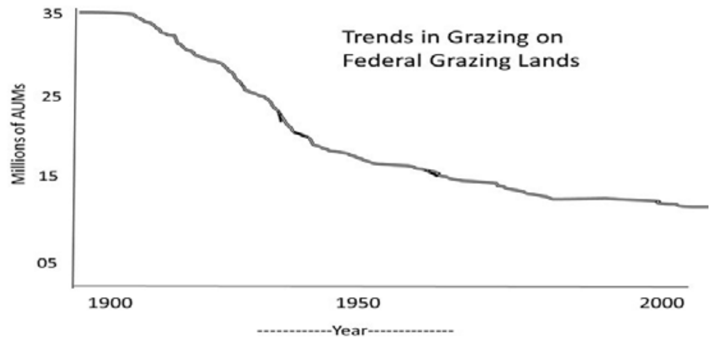
What is Overgrazing?

Many people are concerned that excessive grazing by livestock or wildlife creates rangelands that are "overgrazed." Overgrazing is defined as repeated heavy grazing that results in deterioration of the plant community. We need to be careful about declaring a range overgrazed because this is a very difficult assessment to make. Pastures can be heavily grazed without leading to land degradation. In fact, some grazing systems designed to improve and restore rangelands are accomplished by grazing a pasture very heavily once and then giving the pasture several years of rest (e.g., Rest-Rotation or Management-Intensive Grazing). True overgrazing is when continued grazing exceeds the recovery capacity of the plant community and causes a shift in plant composition and soil condition away from a desired condition. Overgrazing normally can be attributed to heavy, repeated grazing over several years. Overgrazing can be difficult to recognize because not all rangelands are equally productive. Differences in soils and the presence of rocky subsurface layers can create significant differences in the kinds and quantities of plants. The differences can create visible contrasts on the landscape. Therefore, a low amount of plant biomass or large proportion of bare soil does not necessarily indicate overgrazing. Bare spaces are, in fact, an important characteristic of many healthy plant communities. Such open spaces usually have roots from adjacent plants under the soil to capture precipitation and support plant growth.

Truly overgrazed rangeland is often characterized by an increase in less palatable plants, increased soil erosion, an increase in weedy species that thrive under disturbance, and decreased production of important forage plants. Rangeland deterioration results from animals continually and closely eating the most palatable plants until those plants are stressed so much they die or fail to reproduce. Overgrazing can also correspond with soil compaction or disruption of soil crusts, resulting in decreased water infiltration and increased erosion. Due to the complex nature of animal preferences, highly desirable areas in a pasture may experience overgrazing while other regions experience little or no use.

Nearly all range plants evolved to withstand grazing and can endure a heavy grazing event if it occurs in the right season and if plants are given enough time to recover after grazing. Most rangeland grasses and forbs can have 40-50% of their leaves and stems removed every year and still remain healthy and productive. In general, light use is considered less than 40%, moderate 40-65%, and heavy greater than 65% of biomass removed. The season during which the grazing occurs is also very important. As described above, plants are most sensitive to grazing when they are flowering and forming seeds. After plants go dormant they are affected little by grazing. When considering effects of grazing on shrub species, one must look at the amount of usage of current year's growth of leaves and young stems that are important for photosynthesis. The current year's growth of shrubs is the most digestible part of the plant and is the portion generally removed by browsing animals such as deer and goats. In winter, shrubs survive by using energy compounds (i.e., starches and sugars) stored in the stems. Thus, though the shrub is dormant, it is still important to monitor browsing of these stems. An indicator of overgrazing of shrubs is moderate or heavy hedging (i.e., growth of lateral stems just below a grazed point), and a lack of new or juvenile plants.

Many of the signs of overgrazing seen on Idaho rangelands today occurred 75 to 125 years ago when much of Idaho was "open range" and livestock numbers were not controlled. The era of controlled and managed grazing was signified by the passing of the Taylor Grazing Act in 1934. This act was passed to "*stop injury to public grazing lands and provide for their orderly use, improvement and development*." Idaho rangelands are in better condition today than a century ago because they are now managed and monitored. A skilled rangeland manager can recognize overgrazing and take steps to correct it.



Invasive Plants

One of the most serious threats to the health and sustainability of rangeland ecosystems in Idaho is exotic invasive plants. As European settlers explored, homesteaded, and developed the West, they brought with them many plants that have colonized and taken up residence on Idaho rangelands. Some of these plants were introduced deliberately as ornamental plants, such as leafy spurge and purple loosestrife. Others, like cheatgrass, came in accidentally in grains and feed. Some of the plants the people brought to Idaho have a malicious attribute of invading native rangelands, forests, and croplands, choking out the desirable native plants or crops.

Invasive Plant Terminology

The term "weed" can mean different things to different people. Basically, a weed is a plant in a place where it is not wanted, or a plant of little value. Others describe weeds as plants that compete with crops and native plants or as troublesome pests that reduce the health of land and its value for livestock or wildlife. Ross & Lembi, in their book Applied Weed Science (1999), define weeds as "*plants that interfere with the growth of desirable plants and that are unusually persistent and pernicious. They negatively impact human activities and as such are undesirable*."

Exotic, **alien**, or **nonindigenous** plants are not native to a region and have been brought into the region either by accident or for a specific purpose. These exotic species often have an advantage over native plants because they lack the natural predators and diseases that keep them in check in their native environment. For example, spotted knapweed seldom dominates native communities in its homelands in Eurasia. In its native habitats, knapweed is naturally suppressed by insect predators that feed on the roots and seeds. When the plant made the trip across the ocean, these native insects were left behind. However, not all exotic plants are invasive or bad. Many plants were introduced as forages for livestock, like crested wheatgrass, or as agricultural commodities such as the plants we eat. These are exotic species but they seldom take over native rangelands and become weeds.

Invasive plants are those that exhibit "weedy" or aggressive growth characteristics:

- Abundant seed producers
- Long-term survival of seeds
- Rapid population establishment
- Occupy disturbed sites
- Competitive
- Lack of natural enemies

Once established, invasive species will out-compete native species, and often spread throughout and dominate wildland plant communities. Invasive species are not limited to any one particular plant life form, and can be grasses, forbs, shrubs, or trees. Common examples of invasive plants in western North America include cheatgrass, leafy spurge, spotted knapweed, and salt cedar. Invasive plants may persist at relatively insignificant densities for a period of time until ideal conditions occur and then the plant will spread and dominate a site. Most invasive plants of concern are exotic. However, some native plants, like western juniper, can become invasive and start to dominate plant communities when climatic or fire conditions change.

Scientists have identified three phases of pinyon/juniper encroachment. In phase one, trees begin to establish, with seedlings and saplings scattered among the sagebrush, grasses and forbs. In phase two, the number and size of trees increases until pinyon/juniper codominate with shrubs and herbs. In phase three, trees dominate the landscape and the canopy closes. At this latter stage, the frequency of shrubs, grasses and forbs plummets, as the trees outcompete for sunlight, space, water and nutrients.

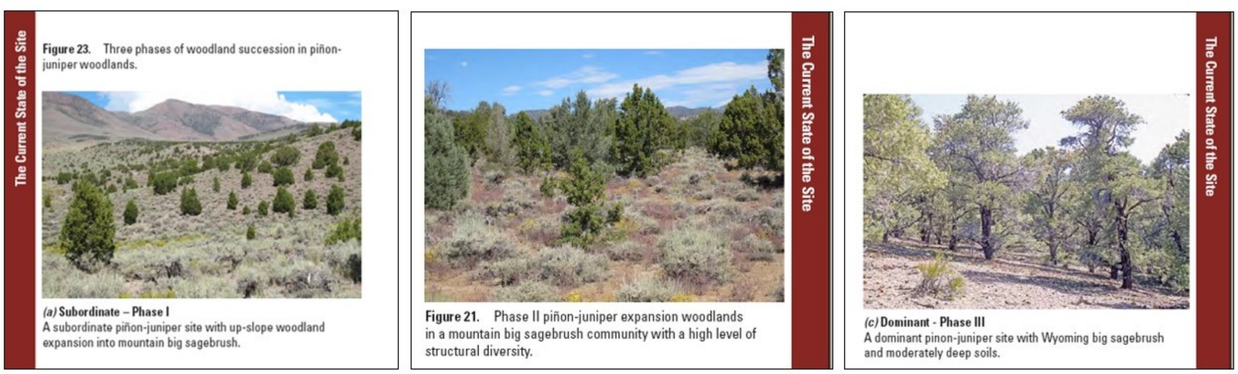


Figure modified from: Tausch, R.J., Miller, R.F., Roundy, B.A., and Chambers, J.C. 2009. Pinon and juniper field guide: Asking the right questions to select appropriate management actions: U.S. Geological Survey Circular 1335, 96p. https://pubs.usgs.gov/circ/1335/circ1335.pdf

Noxious weed is a specific term for particularly problematic plants that are recognized by the county, state, or federal government as so serious that they need to be controlled or contained. Noxious is therefore a legal definition used to describe weeds that have been recognized by the government as injurious to public health, agriculture, recreation, wildlife, and/or property. Idaho state law has recognized 67 noxious weeds (as of Sept. 2017), and requires that landowners attempt to control or contain these weeds when they occur on their property. If a landowner chooses not to take action, counties can treat the infestation and bill the landowner for incurred expenses.

Why Are Weeds Bad?

Exotic invasive plants can have many detrimental effects on healthy rangeland ecosystems. The negative ecological effects can include:

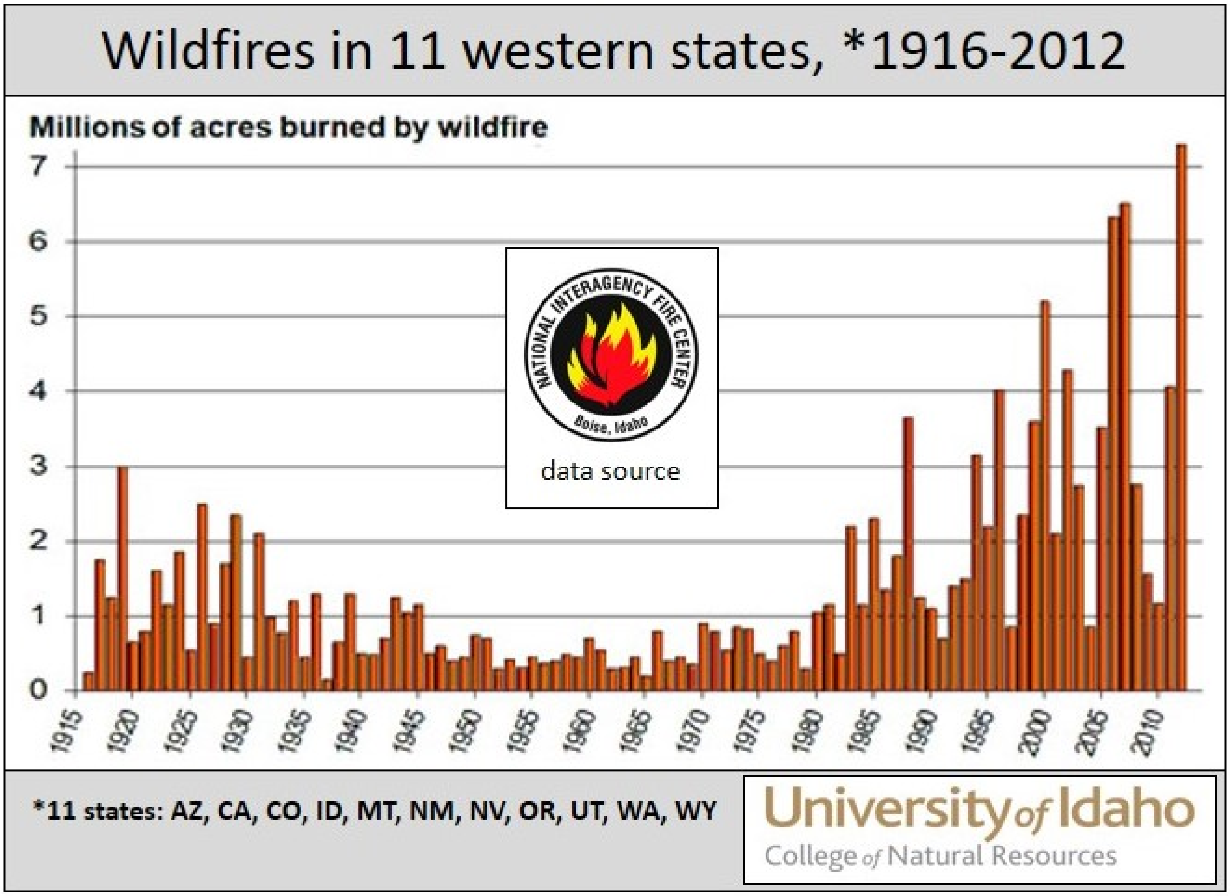
- Reducing the abundance of native plants and animals – even rare plants can be displaced.
- Replacing diverse communities containing many species with a monoculture where only one species dominates.
- Reducing water infiltration and changing the hydrologic characteristics of the land.
- Altering soil characteristics and increasing soil erosion and runoff.
- Altering fire intensity and frequency.

Weeds can also have serious impacts on human activities and economic profitability. Some weeds such as Scotch thistle and yellow starthistle can form dense, nearly impenetrable stands which reduce the value of land and inhibit recreation such as hiking and hunting. Weeds can also reduce the abundance of forage plants on rangelands, thereby reducing their value for grazing. Additionally, the cost and time spent controlling weeds and keeping them in check can seriously reduce the profitability of ranchlands.

Wildland Fire

Wildfires are a natural occurrence on rangelands and have helped shape the plant and animal communities that we recognize today. Fire naturally served a role in maintaining rangeland health, plant composition and diversity in some rangeland biomes. Plants, animals, and insects in fire-adapted ecosystems have evolved mechanisms to tolerate or even benefit from fire. Adaptations include: long-lived seeds that are activated by fire; quick germination and regrowth after fire; thick bark resilient to fire; and, seed production activated by fire. For example, plants in the *Ceanothus* genus (a rangeland shrub) contain a waxy coating on the seed surface that is dependent on heat treatment from fire to break seed dormancy and promote germination. Antelope bitterbrush, rabbit-brush, and several other rangeland shrubs have adapted to sprout quickly after a fire, utilizing the increase of minerals and nutrients that are present in the ash. Grasses often come to dominate shrublands and woodlands after fire because the woody plants are removed and the grasses are better adapted to fire.

Fire is also one of nature's tools for consuming the dead and decadent biomass that can accumulate in rangeland plant communities. Most rangelands are characterized by dry climates which can slow biological decomposition – the rate at which plant material is incorporated into organic matter in the soil. Fire rapidly converts that dead and decadent plant growth into inorganic ash that frees nutrients and minerals for new plant growth. However, if fires are too frequent or intense, plant cover and organic matter at the soil surface can be reduced. Fire almost always results in a loss of nutrients through volatilization, oxidation, ash transport, and erosion. However, fires can also convert nutrients to inorganic forms that are more available to plants for growth. Fire also increases soil nutrient turnover rates and affects the distribution of nutrients in the soil horizons. Of course, the potential damage to plants and amount of dead plant material that is converted to bio-available nutrients depends on how hot the fire burned. Generally, low-intensity burns increase plant productivity, while high-intensity burns result in decreased productivity and plant diversity.



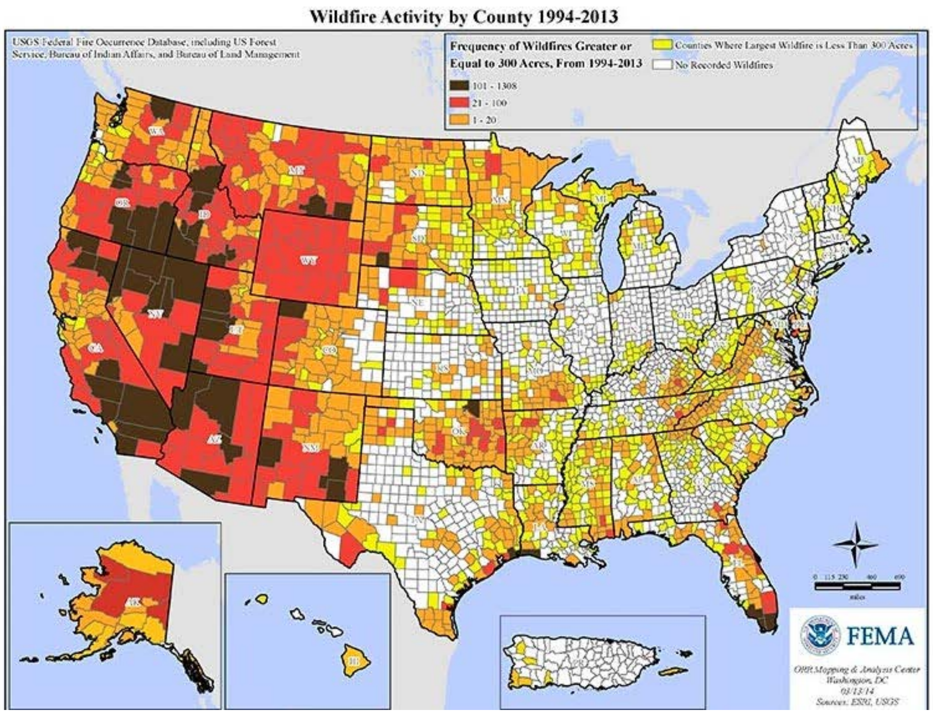
Wildfire vs. Prescribed Burning

All fires need heat or a source of ignition, oxygen, and fuel. However, fires can occur under two scenarios: a wildfire or prescribed burning. The main difference between a wildfire and a prescribed burn lies in how and when they are ignited. Wildfires could be naturally caused through lightning, or man-made through foolish actions such as unattended or improperly extinguished campfires, lit cigarettes that are discarded, and arson. Prescribed burns are set for specific reasons, at a certain time of year when the environmental conditions will accomplish desired management goals and allow containment. Prescribed burns avoid hot, dry, windy conditions that can cause the rapid and unmanageable spread of fire which poses a serious threat to life and property.

Effects of Fire on Plants

The effect of fire on rangeland plants depends largely on the growth form (i.e., bunchgrasses, forbs, and shrubs), plant adaptations, and season of burning. Many native rangeland plants are well adapted to fire; thus, plants that return quickly after fire are termed *fire resistant*. These plants will often have their meristems (i.e., plant growing points) located just below the soil surface so that they are not damaged by the heat of fire. This adaptation allows the plants to re-sprout from the base, unlike less fire resistant plants that have elevated meristems which can be removed or damaged by the heat of the fire. Burning during the hot, dry, summer months is the most harmful to plants because of the high intensity fires, while late summer and fall burns are the least harmful because of increased moisture and cooler temperatures.

Fire Return Intervals
A change of fire interval (i.e., the time between fires) or improper timing of fire during the season can deplete native plant communities of desirable perennial plants. Over time, repeated burning can result



in severe impacts, including loss of perennial plants, an increase in weedy plants, increased erosion, and a change in nutrient cycling. Many weedy plant species are able to take advantage of the available soil nutrients, water, and growing conditions after a fire and outcompete more desirable plants. In Idaho and many other western states, land managers are concerned about cheatgrass invasion and its ability to shorten the interval between fire events. When cheatgrass goes dormant it creates a bed of fine fuels that are easily ignited and burn rapidly and frequently across the landscape. Perennial grasses and shrubs find it difficult to recover and grow when wildfires occur every few years, as can happen on cheatgrass-dominated rangelands.

Fire suppression or the exclusion of fire can also impact landscapes over time. Fire suppression policies and actions over the past century were aimed at controlling fires when they occurred on rangelands. Fire suppression can result in an unnatural accumulation of fuels that may increases the probability of large, high-intensity wildfires that pose a threat to the long-term sustainability of the ecosystem. Fire suppression has also led to an increase in woody species and problems with the invasion of juniper and other evergreen trees onto rangelands naturally dominated by shrubs and grasses. Thus, a lack of fire can upset the balance between shrubs, grasses, and trees, giving the trees a competitive edge to dominate landscapes.

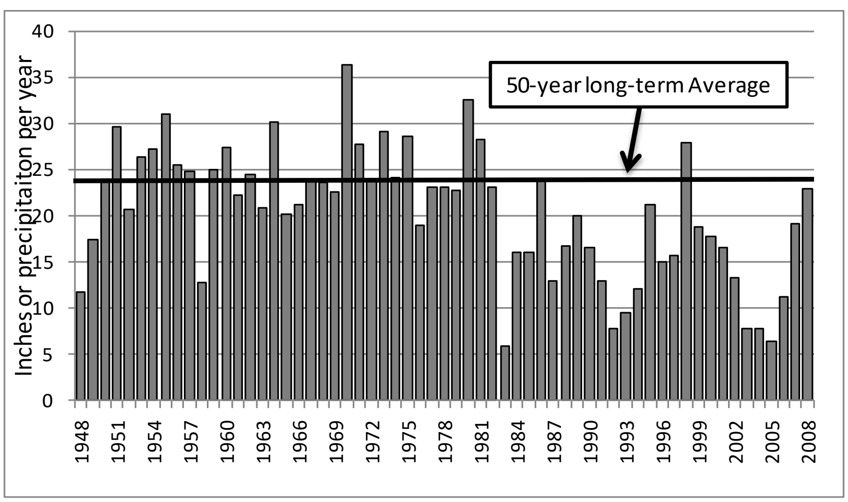
Positive Aspects of Wildfire

Fire can have some positive impacts on range livestock and wildlife management. The flush of nutritious and digestible green plant growth following fire creates patches of nutrient-rich habitat that draw domestic and wild animals. Wildfires and prescribed burns can also create patchy landscapes of grasslands, shrublands, and woodlands that provide a diversity of habitats for wildlife, allowing for both feeding and secure cover in a relatively small area.

West Cinder prescribed burn, Twin Falls, ID.
National Interagency Fire Center

Weather and Climate

Weather and climate are highly influential factors determining how rangelands change over time. Water is the primary limiting resource on rangelands, and vegetation production depends heavily on both water availability and suitable growing temperatures. Idaho's rangelands, while for the most part very dry and cool, can experience great variation in moisture and temperature depending on region, slope, and aspect. Idaho landscapes vary greatly depending on their aspect and elevation, which in turn affects the amount of solar radiation and moisture loss. Precipitation that is received on a landscape can vary substantially from year to year. For example, on this site near New Meadows, ID (see chart), the long-term precipitation average is about 24 inches per year. However, that annual amount can vary from 6 to 36 inches per year. In other words, there can be a 6-fold increase or decrease in the precipitation that occurs from year to year. These vast swings in the precipitation that a site receives each year result in massive variation in the amount of biomass that the site can produce annually.



The role of global climate change on rangelands has been a topic of debate and consternation. It is clear that climate is changing. But the specific role that climate change will have on any specific rangeland ecosystem is uncertain. Concerns include the role that warmer winters might play on reduced snow pack or enhanced growth of winter annuals like cheatgrass. There is also concern over whether climate change will lead to more frequent droughts or hotter, drier summers that will encourage wildfires. Still other climate models call for areas of greater precipitation and cooler temperatures in some rangeland regions. All of these changes in climate are of great concern to land managers and those who live on rangelands because they will change the type of plants and animals that will dominate an area and alter how invasive plants or fire might affect these sites. Unfortunately, it is almost impossible to control or predict climate and weather. Land managers are tasked with finding strategies to accomplish sustainable management in dynamic ecosystems by anticipating change and thinking through possible responses.

Fragmentation of Rangelands

The western United States is experiencing rapid population growth, with many people drawn by the appeal of open space, dry climates, and an abundance of public rangelands and forests on which to recreate. The dream of many westerners is a house and a few acres of land on which to enjoy western landscapes and wildlands. "Ranchette" is a term used to describe a small parcel of land created by the splitting up of larger ranches. An increase in rural subdivision has resulted in a drastic fragmentation of rangelands in many areas. The same geographic features that make the land appealing to wildlife, such as proximity to streams, gentle slopes, and timbered draws, also make the land appealing to developers and people wanting to live here.

The increase in roads, buildings, and human activity has had several major impacts. Rural subdivision and fragmentation usually lead to an increase in weeds, a loss of biodiversity, and degradation of pasture lands. Wildlife still inhabit fragmented landscapes, but the species present change from specialists like moose, mountain lions, and buntings to more generalist species like deer, coyotes, and robins. Roads also become more dangerous to wildlife as the number and speed of vehicles increases. Houses built on wildlife winter habitat prevent animals from moving down in winter months, or result in increased stress from interactions with humans and their pets. Loss of key areas such as migration corridors, wintering habitat, or nesting and breeding areas can have drastic impacts upon animals and humans.

The effects of rural subdivision on plant communities can also be devastating. Ranchettes have a higher frequency and density of exotic invasive species in comparison to adjacent ranches. Roadways and paths are areas of disturbance for invasive species to establish. Small horse pastures are frequently overgrazed and highly degraded, resulting in loss of habitat and increased soil erosion. Many rare and sensitive species that are specific to certain ecological sites may find themselves in danger. However, more resources are being made available by university Extension agents, conservation districts, NRCS, and other entities to help small land owners learn about land management and how best to conserve their meadows and pastures.

1.9. Grazing Management

America's rangelands are in much better condition today than they were one hundred years ago, when uncontrolled, first-come-first-served access to open range led to overgrazing. Since the passage of the Taylor Grazing Act in 1934, ranchers, land managers, researchers and rangeland specialists have worked together to develop grazing practices that sustain healthy ecosystems while supporting livestock production.

In order to design a sustainable grazing plan for a given landscape, managers need to answer some fundamental questions:

- Which animals?
- How many animals?
- When to graze? For how long? When to rest?
- Where to graze?

Remember that different species of herbivores have different dietary needs and preferences. Consequently, the type of forage available will help determine which species is best suited to a given range. Besides choosing the appropriate livestock species—cows, sheep, goats, or horses—a manager will want to consider the class of animal: pregnant or unbred, young or mature, lactating or dry, as well as the size of the individual animals. Breed is a factor, too. Black Angus cattle, for example, are known for their winter hardiness, while Brahman cattle can survive harsh weather and inadequate food supplies.

Once you've determined the best species of grazers for your rangeland, you need to determine the stocking rate, as discussed earlier: How many animals will the forage support over a given period of time? Then you're ready to design a grazing system (a planned effort to leave some grazing areas unused for at least part of the year) that will be best suited for the kinds of plants present and the soil conditions of your range.

Stocking Rate: Balance forage supply with forage demand

A grazing system is a set of management practices that systematically control periods of grazing, deferment, or rest. A good grazing system should account for plant physiology and life history. It should be adapted to soil conditions, and improve range conditions and forage production by favoring desired plants. This is often accomplished through good grazing distribution. Animals typically graze in a patchy manner; herbivores select areas with vegetation that best meets their nutritional needs. However, we can entice animals to use different areas or forages; for example we can improve water distribution across the landscape, provide supplemental feed/mineral licks, and utilize fences. No matter the grazing system chosen, it needs to be practical to implement in a ranching operation and not be detrimental to animal gains. Hence, the objectives for good grazing systems include:

- Restoration of forage plant vigor
- Allowing plants to produce seeds
- Increasing animal production

There are several different types of grazing systems that are strongly dependent on grazing season (or season of use) which is based on climate factors (precipitation and temperatures). Yearlong grazing, or continuous grazing for the whole calendar year, is used primarily in tropical and sub-tropical climates. Seasonal grazing, or grazing during the growing season, typically occurs in temperate to cold climates, where grazing in dormant season is restricted by snow. Deferred grazing refers to a delay of grazing (or period of non-grazing) in a pasture until the key forage species set seed and seeds mature. A rest grazing system means a period of non-grazing for a full year.

There are pros and cons to each grazing system. Continuous grazing systems are simple and require low input. Animals get maximum choice of forage and have high animal performance. However, continuous use can have negative effects on plants, and areas that livestock prefer can be excessively used and become degraded. Deferred rotation means that grazing does not occur on at least one pasture until after it has set seed. In subsequent years, the deferred pasture is rotated among the other pastures so they all have a chance to produce seed. This type of grazing system can reduce animal performance a little because animal opportunity to choose among plants and places is restricted. This system does allow rangeland conditions to improve because pastures are occasionally not grazed when they are most sensitive to grazing. Rest rotation means that you do not graze at least one pasture for a whole year. In subsequent years, the pasture rested is rotated among all the pastures. This system can also reduce animal performance because stocking rate is increased on grazed pastures (since at least one pasture is not grazed), and animals are always moved into pastures that were not recently grazed and have dormant stems mixed with green growth (less nutritious and palatable). Rangeland condition can improve under this system because pastures are allowed to be rested and set seed every few years.

Other grazing systems include short-duration, where each pasture in the unit is grazed for a short time and animals are rotated through all available pastures so that each pasture is grazed at least two times per year. Another grazing system is seasonal suitability that requires you to move livestock to different areas of range depending on growth patterns of different vegetation types. This is often referred to as "following the green." In the spring/summer, livestock are gradually moved up in elevation and then moved back down in the fall/winter. Finally, there is the decisional or management intensive grazing system. In this system, management decisions are based on available forage, available water, and cover for calving and lambing. This type of system is probably the most common in the world; however, the success depends on the experience and timely decisions of the manager.

So which grazing system is the best? There is no "silver bullet" system that will work everywhere, and there are thousands of variations on the systems described above. At the end of the day, all systems need to be flexible to manage for unexpected disturbance such as fire or weed invasion. The success of the grazing system will depend on the type of forage, terrain, weather patterns, and the skill of the manager.

No matter the system, remember that stocking rate, species of grazing animal, and distribution patterns are important in determining how the systems affect vegetation communities.

1.10. Careers in Range

Who works on the range? If you said ranchers, cowboys and sheepherders, you're right, of course. But that's just a small sample of the numerous career opportunities available to people who want to work outdoors, like to hike and ride horses or off-road vehicles, enjoy studying and interacting with nature, and want to have a positive influence on range stewardship. The world needs botanists, wildlife biologists, hydrologists, soil scientists, livestock managers, rangeland ecologists, and recreation specialists, just to name a few. A career in range can take you as far as you want to go, from the Curlew National Grasslands of southern Idaho, to the Australian Outback, to the pampas of Argentina, to the plains of Africa. Remember, rangelands cover nearly 47% of the earth's land surface. Talk about a world of opportunity!

Who hires range professionals? Perhaps the first employers who come to mind are the federal land management agencies such as the BLM, FWS, USFS and the Park Service, along with the Natural Resources Conservation Service (NRCS) that helps landowners implement best management practices on private property. It's true; they do need lots of trained rangeland specialists. But so do state agencies like departments of lands, agriculture, fish and wildlife, environmental protection, and parks and recreation. Some local soil and water conservation districts hire conservationists. The government isn't the only outfit that's hiring: Think about environmental consulting firms, energy companies, and tribal agencies. Non-governmental organizations (NGOs) employ rangeland professionals, too—groups such as The Nature Conservancy, Rocky Mountain Elk Foundation, Pheasants Forever, and local and national land trusts.

What does it take to become a range professional? Most rangeland management positions require a four-year college degree with a strong foundation in natural and physical sciences. To become a range technician requires at least one year of study in animal or natural sciences, engineering or mathematics. You can hear from recent college graduates regarding careers in range and find colleges and universities that offer range-related degrees by visiting https://rangelandswest.org/careersandeducation/.

Images courtesy of https://rangelandswest.org/careersandeducation/

1.11. Glossary

ANIMAL UNIT – Considered to be one mature (1,000lb.) cow or the equivalent based upon average daily forage consumption of 26 lbs. dry matter per day. Abbr., A.U. cf. *animal-unit conversion factor*.

ANIMAL-UNIT MONTH – (1) The amount of feed or forage required by an animal-unit for one month. (2) Tenure of one *animal-unit* for period of one month. Not synonymous with *animal-month.* Abbr., A.U.M.

ANNUAL PLANT – A plant that completes its life cycle and dies in one year or less.

ARID – A term applied to regions or climates where lack of sufficient moisture severely limits growth and production of vegetation. The limits of precipitation vary considerably according to temperature conditions, with an upper annual limit for cool regions of 10 inches or less and for tropical regions as much as 15 to 20 inches. cf. *semi-arid*.

ASPECT- The direction in which a slope faces.

BROWSE – (n) That part of leaf and twig growth of shrubs, woody vines and trees available for animal consumption. (v) To consume, browse. cf. of *graze*.

BUNCHGRASS – A grass that grows in tufts, or bunches. Its roots extend downward and outward from the base of the bunch, but do not sprout laterally like sodgrasses.

CARRYING CAPACITY – The maximum *stocking* rate possible without inducing damage to vegetation or related resources. It may vary from year to year on the same area due to fluctuating forage production. Syn. *grazing capacity*.

CLIMATE – The average weather conditions of a place over a period of years.

CONSERVATION – The use and management of a natural resources according to principles that assure their sustained, highest economic and/or social benefits without impairment of environmental quality.

CONTINUOUS GRAZING – The grazing of a specific unit by livestock throughout a year or for that part of the year during which grazing is feasible. The term is not necessarily synonymous with *yearlong grazing.*

COOL-SEASON PLANT – A plant which generally makes the major portion of its growth during the winter and early spring, because it is adapted to climates with winter precipitation and summer drought. *cf. warm-season plant*.

DECREASER – Plant species of the original or climax vegetation that will decrease in relative amount with continued *overuse*.

DEFERMENT – Delay or discontinuance of livestock grazing on an area for an adequate period of time to provide for plant reproduction, establishment of new plants, or restoration of vigor of existing plants. cf. *deferred grazing*.

DEFERRED GRAZING – The use of *deferment in grazing management of a management unit*, but not in a systematic rotation including other units. Cf. *grazing system*.

DESERT – Land that experiences extreme water shortage and unpredictable precipitation, dominated by shrubs and succulent plants such as cacti.

DROUGHT – Prolonged dry weather, generally when precipitation is less than the average annual amount.

ECOLOGY – The study of the interrelationships of organisms with their environment.

ENVIRONMENT – The sum of all external conditions that affect an organism or community to influence its development or existence.

EROSION – (v) Detachment and movement of soil or rock fragments by water, wind, ice or gravity. (n) The land surface worn away by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

FINE FUEL – Light, thin plant material with high surface area, typically grasses, that fire can easily ignite and consume quickly.

FIRE REGIME – The frequency, intensity, and severity that fire burns.

FIRE RETURN INTERVAL – The time interval between wildfire occurrences.

FORAGE – (n) All browse and herbaceous foods that are available to grazing animals. It may be grazed or harvested for feeding. Cf. *concentrating feed* and *cured* and *range forage*. (v) Act of consuming forage. Syn., *graze*.

FORAGE PRODUCTION – The weight of forage that is produced within a designated period of time on a given area. The weight may be expressed as either green, air-dry or oven-dry. The term may also be modified as to time of production, such as annual, current year's or seasonal forage production.
FREQUENCY OF GRAZING – The recurrence of grazing—how soon animals are put back in a pasture after grazing it previously. Or, how soon an animal takes a second or third bite from the same plant during a grazing period.

FORB – "Weeds and wildflowers." A broad-leaved flowering plant that is not a *grass* or *grass-like plant*, often having netted leaf venation and solid non-woody stems. These plants die back to the ground every year.

FREQUENCY OF GRAZING – How often or the number of times animals return to the pasture or allotment in one year or growing season.

FUEL – Living or dead plant material, which provides organic matter for fire to consume.

FUEL LOAD – The amount of fuel present on a specified land area.

GRASS – A member of the plant family *Poaceae (Gramineae*). Grass has round, hollow stems with leaves that connect to stems (jointed).

GRASS-LIKE PLANT – Herbaceous plants that look similar to grasses; members of the sedge or rush family. They typically grow in moist environments like forest floors or riparian areas.

GRASSLAND – Land on which grasses are the dominant plant cover. Syn., *grassveld*.

GRAZE – (1) The consumption of standing forage by livestock or wildlife. (2) To put livestock to feed on standing forage.

GRAZING PERIOD – The length of time that livestock are grazed on a specific area.

GRAZING SEASON – On public lands, an established period for which grazing permits are issued. Also, on private land in a grazing management plan.

GRAZING SYSTEM – A specialization of grazing management which defines systematically recurring periods of grazing and deferment for two or more pastures or management units. Descriptive common names of different grazing systems such as "Merrill," "Hormay," "South African switchback," etc., may be used. Cf. *deferred grazing*, *intermittent grazing*, *deferred-rotation grazing*, and *short duration grazing*.

GROWTH FORM – The characteristic shape or appearance of an organism.

HABITAT – An area that provides forage, water, cover, and space; the "home" of a species

HEAVY GRAZING – A comparative term which indicates that the stocking rate of a pasture is relatively greater than that of other pastures. Often erroneously used to mean overuse. cf. *light and moderate grazing*.

HERBACEOUS PLANT – A non-woody plant (cultivated or non-cultivated) that has leaves and stems, such as grasses and forbs.

INCREASER – Plant species of the original vegetation that increase in relative amount, at least for a time, under *overuse*.

INTENSITY OF GRAZING – The level of grazing a pasture experiences. This takes into account stocking rate, and frequency and duration of grazing.

INTRODUCED SPECIES – A species not part of the original fauna or flora of the area in question. cf. *native* and *resident species*.

INVADER – Plant species that were absent or present in very small amounts in undisturbed portions of the original vegetation of a specific range site and will invade following disturbance or continued *overuse*.

LIGHT GRAZING – A comparative term which indicates that the stocking rate of one pasture in relatively less than that of other pastures. Often erroneously used to mean *underuse*. cf. *heavy* and *moderate grazing*.

NATIVE SPECIES – A species which is part of the original fauna or flora of the area in question. cf. introduced and resident species. Syn., *indigenous*.

NOXIOUS WEEDS – A subset of invasive plants that are recognized and designated by local, state, and federal governments as requiring control or attention.

OPEN RANGE – (1) Range which has not been forced into management units. (2) All suitable range of an area upon which grazing is permitted. (3) Untimbered rangeland. (4) Range on which the livestock owner is not required to confine his livestock.

OVERGRAZING – Continued overuse creating a deteriorated range.

OVERSTOCKING – Placing a number of animals on a given area that will result in overuse if continued to the end of the planned grazing period. Not to be confused with *overgrazing* because an area may be overstocked for a short period, but the animals may be removed before the area is overused. However, continued *overstocking* will lead to *overgrazing*.

OVERUSE – Utilize an excessive amount of the current year's growth, which, if continued, will result in *overgrazing* and range deterioration. Syn., *overutilization*.
PASTURE – (1) A grazing area enclosed and separated from other areas by fence. (2) Forage plants used as food by grazing animals.

PASTURELAND– Grazing lands, planted to primarily introduced or domesticated native forage species that receive periodic renovation and/or cultural treatments such as tillage, fertilization, mowing, weed control, and irrigation.

PERENNIAL PLANT – A plant that has a life cycle of three or more years.

POTENTIAL NATURAL COMMUNITY (PNC) – A historical term originally defined by A. W. Kuchler as the stable vegetation community which could occupy a site under current climatic conditions without further influence by people; formerly called "climax".

PRAIRIE – An extensive tract of level or rolling land that was originally treeless and grass-covered.

PRESCRIBED BURNING – The use of fire as a management tool under specified conditions for burning a predetermined area. Cf. *maintenance burning* and *reclamation burning*.

PRIMARY SUCCESSION – The process of initial plant establishment and growth upon bare rock or soil that has never had plants before—ever.

PROPER GRAZING – The act of continuously obtaining proper use.
PROPER STOCKING – Placing a number of animals on a given area that will result in proper use at the end of the planned grazing period. Continued proper stocking will lead to proper grazing.

PROPER USE – A degree and time of use of current year's growth, which, if continued, will either maintain or improve the range condition consistent with conservation of other natural resources. Syn., *proper utilization*.

RANCH – An establishment with specific boundaries, together with its lands and improvements, used for the grazing and production of domestic livestock and/or wildlife.

RANGE – Embraces *rangelands* and also many *forest lands* which support an understory or periodic cover of herbaceous or shrubby vegetation amenable to certain range management principles or practices. Syn. *veld*. cf. *grazable woodland*.

RANGE CONDITION – The current productivity of a range relative to what the range is naturally capable of producing.

RANGE CONDITION CLASS – One of a series of arbitrary categories used to classify range condition and usually expressed as either excellent, good,

RANGE IMPROVEMENT – (1) Any structure or excavation to facilitate management of range or livestock. (2) Any practice designed to improve range condition or facilitate more efficient utilization of the range. (3) An increase in the grazing capacity of range, i.e., improvement in *range condition*.

RANGE INVENTORY – An itemized list of resources of a management area, i.e., range sites, range condition classes, range condition trends, range use, estimated proper stocking rates, physical developments and natural conditions such as water, barriers, etc.
RANGE MANAGEMENT – A distinct discipline founded on ecological principles and dealing with the use of rangelands and range resources for a variety of purposes. These purposes include use as watersheds, wildlife habitat, grazing by livestock, recreation, and aesthetics, as well as other associated uses.

RANGE SCIENCE – The organized body of knowledge upon which the practice of *range management* is based.

RANGE SITE – A distinctive kind of rangeland, which in the absence of abnormal disturbance and physical site deterioration, has the potential to support a native plant community typified by an association of species different from that of other sites. This differentiation is based upon significant differences in kind or proportion of species, or total productivity. Syn., *ecological site*.
RANGE TREND – The direction of change in an attribute observed over time, and is described as up, down, or not apparent.

RANGELAND – Land on which the indigenous vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed similarly. Rangeland includes natural grasslands, savannas, shrublands, many deserts, tundras, alpine communities, marshes and meadows. cf. *range*.

REST – Absence of grazing for the entire growing season for one year, instead of just a portion of the year.

RESTORATION – The process of a rangeland being improved in health and function after it has been degraded or largely disturbed.

RETROGRESSION – The change from a more highly developed plant community to a less developed plant community due to a physiological disturbance; *succession* that recedes from the *potential natural community*.

RIPARIAN AREA – Referring to or relating to areas adjacent to water or influenced by free water associated with streams or rivers on geologic surfaces occupying the lowest position on a watershed.

ROTATIONAL GRAZING – System of pasture utilization embracing short periods of heavy stocking followed by periods of rest for herbage recovery during the same season. Generally used on *pasture* or *cropland pasture*.

RUSH – A general type of grass-like plant that has a round, solid stem and two leaves clasped around it.

SAVANNA – A grassland with scattered trees, whether as individuals or clumps; often a transitional type between true grassland and forest. Syn. *bushveld*.

SECONDARY SUCCESSION – The development of a new plant community on a site following a disturbance.

SEDGE – A general type of grass-like plant. Instead of round, hollow stems, the stem is solid and has edges or has a triangular shape when a cross-section is viewed.

SHRUB – A plant that has persistent, woody stems and a relatively low growth habitat, and that generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature and non-tree form.

SHRUBLAND – Land that has shrubs as the dominant plant form.

SOIL – (1) The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (2) The unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro-and micro-organisms, and topography, all acting over a period of time and producing a product soil-that differs from the material from which it was derived in many physical, chemical, biological, and morphological properties and characteristics.

STOCKING RATE – The relationship between the number of animals and the grazing management unit utilized over a specified time period. May be expressed as animal units per unit of land area (animal units over a described time period/area of land). *cf. stocking density*.

SUCCESSION – The concept that vegetation communities change throughout time until a relatively stable plant community persists.

TARGETED GRAZING – "Prescription grazing." A special grazing system that involves the application of livestock grazing at a specified season, duration and intensity to accomplish specific vegetation management goals of reducing weeds.

TRANSFORMATION- A Chemical or biological process in which soil forming material is added to the soil profile. For example leaves falling from trees or tree roots dying beneath the soil.

TRANSLOCATION- Movement of soil forming element from the surface layer to the lower layers of the soil profile. This is done by burrowing animals, bacteria, leaching, and calcification.

UNDERSTOCKING – Placing a number of animals on a given area that will result in *underuse* at the end of the planned grazing period.

UNDERUSE – A degree of use less than desired.

USE – (1) The proportion of a current year's forage production that is consumed or destroyed by grazing animals. May refer either to a single species or to the vegetation as a whole. Syn., *degree of use*. (2) The putting of range to a purpose such as grazing, bedding, shelter, trailing, watering, watershed, recreation, forestry, etc.

VEGETATION – Plants in general, or the sum total of the plant life above and below the ground in an area. cf. *vegetative*.

WARM-SEASON PLANT – A plant which makes most or all of its growth during the spring, summer, or fall and is usually dormant in winter.

WATERSHED – (1) A total area of land above a given point on a waterway that contributes runoff water to the flow at that point. (2) A major subdivision of a drainage basin.

WILDLIFE – Undomesticated vertebrate animals considered collectively, with the exception of fishes. cf. *game*.

WOODLAND – Land dominated by widely-spaced trees including junipers, oaks, mesquite, and pines, with an understory of grasses and forbs.

Terms from A Glossary of Terms Used in Range Management 2nd edition, Society for Range Management, 1974.

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Internet Resources:

- Bureau of Land Management: blm.gov/public_land_statistics/
- Central Idaho Rangelands Network: idahorangelands.org
- Ecological Site Descriptions: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/ecoscience/desc/
- el.e.men'tal Idaho: http://elementalidaho.org/
- Great Basin Fire Science Exchange: http://greatbasinfirescience.org/
- Idaho Rangeland Resource Commission: idrange.org
- Landscape Toolbox, Tools and Methods for Effective Land Health Monitoring: http://www.landscapetoolbox.org/
- Life on the Range: Stories from the Hitching Post: http://www.lifeontherange.org/
- National Water-Quality Assessment Project/USGS: https://water.usgs.gov/nawqa/glos.html
- NRCS Plants Database: http://plants.usda.gov
- Rangeland Assessment and Monitoring Methods Guide: http://www.rangelandmethods.org
- Rangeland Principles: rangelandprinciples.wordpress.com/topics/
- Rangeland Recruitment Webpage: https://rangelandswest.org/careersandeducation/
- Revegetation Equipment Catalog: http://reveg-catalog.tamu.edu/index.htm
- Sagebrush Steppe Treatment Evaluation Project (SageSTEP): www.sagestep.org
- Wrangle, Explore Rangelands: http://wrangle.org/