Chapter 2: Biogeographic, Cultural, and Historical Setting of the Northern Rocky Mountains

S. Karen Dante-Wood

The Northern Rockies Adaptation Partnership (NRAP) includes diverse landscapes, ranging from high mountains to grasslands, from alpine glaciers to broad rivers (fig. 1.1). This region, once inhabited solely by Native Americans, has been altered by two centuries of settlement by Euro-Americans through extractive practices such as timber harvest, grazing, and mining, water diversions, and other activities. Although relatively little urbanization is present in this region, paved and unpaved roads and electrical transmission wires permeate much of the landscape. Federal agencies own and manage a significant portion of the Northern Rockies, including 15 national forests and 3 national parks.

Resource conditions, resource management issues, effects of climatic variability and change, and climate change adaptation options differ greatly from Idaho to North Dakota and from the Canadian border to Wyoming. To capture these differences, the NRAP climate change vulnerability assessment and adaptation strategy were conducted for each of five subregions: Western Rockies, Central Rockies, Eastern Rockies, Greater Yellowstone Area, and Grassland. These subregions are briefly described next.

Western Rockies Subregion

The Western Rockies subregion occupies about 17 million acres across portions of Idaho and Montana, including the Idaho Panhandle, Kootenai, and Nez Perce-Clearwater National Forests and several Native American reservations (e.g., Nez Perce Indian Reservation, Coeur d'Alene Indian Reservation). Most of this subregion is extremely mountainous and heavily forested; the mountains are broken by river and stream valleys and two large grassland ecosystems, Big Camas Prairie and Palouse country. The subregion also includes 1.7 million acres of wilderness lands.

The Rocky Mountains encompass a large area of Idaho and extend from the Idaho panhandle along the Wyoming border. To the west of the Rockies lie the prairie lands of Washington and Oregon, and the east is home to mountainous western Montana. A distinguishing feature of this region is the rugged mountains that extend lengthwise along the panhandle. The Bitterroot Mountains occupy the Idaho panhandle along the Montana/Idaho border, the Coeur d'Alene Mountains lie in the northern portion of the panhandle from Lake Pend Oreille in the north to Lake Coeur d'Alene in the south, and the Clearwater and Salmon River Mountains are located south of the Coeur d'Alene Mountains.

Continental glaciers shaped the topography of this panhandle region by excavating lake basins and depositing glacial till and outwash. The bedrock found here is composed of sedimentary rocks of the Belt Supergroup, deposited 1,470 to 1,400 million years B.P. Deposition took place in a large basin where space was not a limiting factor and the sediment was able to build up vertically (Idaho State University 2014a). This process created large deposits of silver, lead, and zinc in the Coeur d'Alene area.

The Western Rockies subregion contains many large rivers. Commonly referred to as the "River of No Return," the Salmon River winds 425 miles through central Idaho and divides the northern and southern part of the State. The canyon gorge is deeper than the Grand Canyon of Arizona. It is one of the longest rivers in the State and renowned for its spawning beds for Pacific salmon species. The Clearwater River, also in Idaho, is fed by the Bitterroot Mountains and was preferred by explorers, trappers, miners, and loggers because it was easier to navigate than the turbulent Salmon River (Idaho State University 2014b). Other rivers include the Kootenai and Pend Oreille, which flow into the Columbia River. The Clark Fork of the Columbia River feeds into Lake Pend Oreille; and the Saint Maries, Saint Joe, and Coeur d'Alene Rivers flow into Lake Coeur d'Alene. Priest Lake and Hayden Lake near Pend Oreille are heavily used for recreation because of their scenic setting among forested mountains (Idaho State University 2014b).

Idaho is only 300 miles from the Pacific Ocean, so its climate is affected by a maritime atmospheric pattern that brings more precipitation to northern Idaho than to southern Idaho. Summers are typically hot and dry, and winters are relatively cold due to the high amount of moisture carried through the Columbia River Gorge.

The most actively managed forests in the Western Rockies are found in northern Idaho, which is characterized as a steppe-coniferous forest alpine meadow province (Schnepf and Davis 2013). A 2012 Forest Service, U.S. Department of Agriculture (USFS) report used Forest Inventory and Analysis data to describe various forest cover types in the subregion. The six most common forest

groups are Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*)/Engelmann spruce (*Picea engelmannii*)/mountain hemlock (*Tsuga mertensiana*), lodgepole pine (*Pinus contorta* var. *latifolia*), ponderosa pine (*Pinus ponderosa*), western hemlock (*Tsuga heterophylla*)/Sitka spruce (*Picea sitchensis*), and quaking aspen (*Populus tremuloides*)/paper birch (*Betula papyrifera*) (Sullivan et al. 1986). Commercially harvested coniferous species in this area include Douglas-fir, Engelmann spruce, grand fir (*Abies grandis*), lodgepole pine, ponderosa pine, subalpine fir, western hemlock, western larch (*Larix occidentalis*), western redcedar (*Thuja plicata*), and western white pine (*Pinus monticola*). Other species not used for wood products include whitebark pine (*Pinus albicaulis*), limber pine (*Pinus flexilis*), alpine larch (*Larix lyallii*), mountain hemlock, and western juniper (*Juniperus occidentalis*). Quaking aspen, black cottonwood (*Populus nigra*), and paper birch are also commonly found.

Western white pine is an important tree species to this region. It grows on a variety of soil types and slopes and can regenerate across a broad range of environments. Western white pine forests usually originate from wildfires and when the species matures, it can survive fire better than nearly all of its shade-tolerant competitors. Although the species can survive to an age of 300 to 400 years, it is declining due to white pine blister rust (causal agent: *Cronartium ribicola*).

Common shrub species in the subregion include western serviceberry (*Amelanchier alnifolia*), red osier dogwood (*Cornus sericea*), oceanspray (*Holodiscus discolor*), Lewis mockorange (*Philadelphus lewisii*), huckleberry (*Vaccinium membranaceum*), and smooth sumac (*Rhus glabra*). Evergreen shrubs include Oregon-grape (*Berberis aquifolium*), snowbrush ceanothus (*Ceanothus velutinus*), and mountain lover (*Paxistima myrsinites*); evergreen groundcovers include kinnikinnick (*Arctostaphylos uva-ursi*), and twinflower (*Linnaea borealis*) (Sullivan et al. 1986).

Ecologically diverse habitats in the Western Rockies subregion also support a large number of rare plant species. The warm, dry grassland areas in the western part of the subregion harbor populations of Spalding's catchfly (*Silene spaldingii*), a Federally threatened species, and Palouse goldenweed (*Pyrrocoma liatriformis*). In contrast, the much wetter forests in the Clearwater River drainage contain several narrowly endemic plants such as Constance's bittercress (*Cardamine constancei*), as well as a number of disjunct species that are geographically isolated from their main ranges in the Cascade Mountains, such as Pacific dogwood (*Cornus nuttallii*). In the northern part of the subregion, fens (groundwater-dependent wetlands where peat has accumulated) are uncommon habitats that support peripheral populations of more-northern plant species such as spoon-leaved sundew (*Drosera intermedia*) and small cranberry (*Vaccinium oxycoccos*).

The Western Rockies provide habitat for more than 300 animal species. Large mammal species include woodland caribou (*Rangifer tarandus caribou*), black bear (*Ursus americanus*), grizzly bear (*U. arctos*), white-tailed deer (*Odocoileus virginianus*), mule deer (*O. hemionus hemionus*), elk (*Cervus elaphus*), moose (*Alces alces*), coyote (*Canis latrans*), gray wolf (*Canis lupus*), bobcat (*Lynx rufus*), cougar (*Puma concolor*), and wolverine (*Gulo gulo*). Smaller vertebrates include Coeur d'Alene salamander (*Plethodon idahoensis*) and pygmy shrew (*Sorex hoyi*).

Among the broad range of avian taxa are bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), many species of owls, wild turkey (*Meleagris gallopavo*), California quail (*Callipepla californica*), greater sage-grouse (*Centrocercus urophasianus*), blue jay (*Cyanocitta cristata*), and calliope hummingbird (*Stellula calliope*).

Both native and nonnative fish are found in many Western Rockies rivers and lakes, making it a popular area for angling and spawning. Fish species include native cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*O. mykiss*), the Federally threatened bull trout (*Salvelinus confluentus*), and nonnative brook trout (*Salvelinus fontinalis*). The Kootenai River is home to the endangered white sturgeon (*Acipenser transmontanus*) and threatened burbot (*Lota lota*).

Wildfire is a dominant influence on the structure, function, and productivity of forest ecosystems in the Western Rockies. Fire frequency varies greatly depending on biogeographic conditions, with stand replacement fires occurring at 50- to 500-year intervals, and surface fires occurring in dry forests at 2- to 50-year intervals. Frequent fires keep many forests in the early stages of succession, as indicated by high numbers of western larch and pine (Schnepf and Davis 2013). In contrast, fire exclusion during the past 80 years or so has reduced fire frequency in lower-elevation dry forests, resulting in dense stands and elevated accumulation of surface fuels.

Mountain pine beetle (*Dendroctonus ponderosae*) kills large numbers of lodgepole pine, often in outbreaks of thousands of acres, and it increasingly kills whitebark pine and limber pine at high elevations as the climate continues to warm. Western spruce budworm (*Choristoneura occidentalis*) causes sporadic outbreaks in Douglas-fir and true firs (*Abies* spp.), and Douglas-fir tussock moth (*Orgyia pseudotsugata*) is a prominent defoliator of Douglas-fir.

White pine blister rust, a nonnative fungus, causes mortality in five-needle pines (western white pine, whitebark pine, limber pine), and has greatly reduced the dominance of western white pine (Schwandt et al. 2013). Forests dominated by Douglas-fir and grand fir have increased as a result, accelerating forest succession toward shade-tolerant, late-successional true firs, western hemlock, and western redcedar (Bollenbacher et al. 2014). Attempts to control the spread of blister rust through removal of currant (*Ribes*), its alternate host, were mostly unsuccessful (Russell and Jain 2007).

Various root diseases kill and reduce the vigor of Douglas-fir and grand fir, especially north of the Salmon River. Parasitic dwarf mistletoes (*Arceuthobium* spp.) reduce the vigor of and sometimes kill several species of conifers,

including western larch, Douglas-fir, ponderosa pine, and lodgepole pine (Idaho Forest Products Commission 2011).

Several silvicultural treatments are used to reduce the effects of these disturbances and stressors, including thinning, mechanically mixing the soil, and prescribed burning to favor the regeneration of different species and reduce surface fuels (Graham and Jain 2005). Treatments can be targeted to modify different portions of forest stands, from the soil to the upper canopy. Harvesting larger trees can create canopy openings, and encourage regeneration. Thinning to remove the mid-story of forests can result in various species combinations. Ground-level vegetation treatments can increase the density of small trees, creating a continuous distribution of low-stature fuels.

The economic structure of the Western Rockies integrates northern Idaho, northeastern Washington, and western Montana as "the inland empire." In the early 1950s, the timber industry was the second largest industry after agriculture. Large-scale lumbering operations did not occur until after Weyerhauser Corporation opened plants near Sandpoint and Moscow in northern Idaho. Before 1900, timber was used locally for lumber, fuelwood for homes, railroad ties, and fence posts. After outside markets developed, operating sawmills produced various products such as 2 x 4 studs, plywood, oriented strand board, particleboard, house logs, posts, poles, pulp and paper, wood beams, mobile homes, roof supports, and much more. Although the forest industry maintains a significant presence in the Western Rockies, it has declined in the past 20 years because of changing economic conditions, competition with other markets, and greatly reduced harvest on Federal lands.

Agriculture is a dominant industry on private lands, and cultivation and livestock grazing have occurred continuously on fertile prairie lands since the 1860s. Mining, which began in the 1880s, is another important industry in some areas, especially the Coeur d'Alene region, which leads the Nation in silver production and produces other nonferrous metals such as lead and zinc. Water that originates in high mountains of the Western Rockies is an extremely important resource because of its value for agriculture, hydroelectric power, industry, and municipal consumption. Forests are increasingly recognized and managed for their capacity to produce large amounts of clean water and to reduce erosion that would degrade water quality.

As extractive industries have declined in the past 30 years and affluence of human populations has increased, recreation and aesthetically based activities have increased in popularity and economic importance. Rugged topography, forests, lakes, and streams are a major attraction for primary residences, seasonal residences, and recreational travel (fig. 2.1). Hunting, fishing, hiking, mountain biking, off-road vehicle use, and snow skiing are popular activities for local residents and visitors from throughout North America. Federal management increasingly focuses on providing opportunities for a broad range of recreational activities.

The Western Rockies have large populations of the Nez Perce, Kalispel, Kootenai, and Coeur d'Alene Tribes, who have lived for thousands of years in the terrestrial ecosystems, and more recently urban areas, of this subregion. Most tribes in this area had many villages and camps. They lived in teepees during the warmer months, and in large camps with primarily underground houses during the winter. Hunting, fishing (especially for salmon), and gathering of wild foods occurred year round, and men and women typically had separate duties. Men hunted and fished, and women gathered vegetables and fruits such as chokecherry (*Prunus virginiana*), huckleberry, wild strawberry (*Fragaria virginiana*), and common camas (*Camassia quamash*). Native people in this subregion excelled at making baskets, which were used for collecting nuts, storing fruits and roots, and cooking food. Federal agencies increasingly collaborate with tribal partners to ensure that tribal values (including cultural values) and access to resources are considered in land management planning.

Central Rockies Subregion

The Central Rockies subregion occupies about 12 million acres across portions of western Montana and Idaho and includes the Bitterroot, Flathead, and Lolo National Forests; Glacier National Park; and Flathead Indian Reservation (fig. 1.1). The subregion contains steep mountains, rolling meadows, large rivers and lakes (fig. 2.2), and alpine ecosystems that span the Sapphire Mountains, Bitterroot Mountains, Mission Mountains, and many other ranges. It also contains the largest contiguous area of designated wilderness in the United States outside of Alaska. The northern portion of the Central Rockies is referred to as "the Crown of the Continent," and includes Glacier National Park and the Flathead National Forest.

Figure 2.1—Highly dissected watersheds with mixed conifer forest adjacent to streams are common in the Western Rockies subregion (photo: USDA Forest Service).

Figure 2.2—Glacially carved landscapes, dense coniferous forest, and deep lakes are common in the Central Rockies subregion (photo: National Park Service).

The Bitterroot and Missoula Valleys located in west-central Montana have an inland mountain climate. Air masses that develop over the Pacific Ocean release moisture in the Cascade Range and over the mountains of northern Idaho. West-central Montana occupies the rain-shadow area, which receives dried-out Pacific air and little moisture in the valley bottoms—about 13 inches annually (Lackschewitz 1991). Humidity is high in this region, except during the summer months, and winters are cold and moist. Similarly, the climate in the Flathead and Glacier region is influenced by the Pacific Maritime atmospheric pattern, with warm, dry summers and wet, cold winters.

Alluvial sediments filled the Bitterroot River Valley during the Tertiary period, and glacial Lake Missoula drained and refilled several times as a section of a continental glacier repeatedly washed out and redeveloped. Glacial lake sediments of various depths and qualities cover the slopes, bottomlands, and terraces in west-central Montana today (Lackschewitz 1991). During the Pleistocene era, low elevation valleys were scoured by continental glaciers, while the mountains were shaped by alpine glaciers in the Flathead and Glacier region (Newlon and Burns 2009).

In the Central Rockies, microclimate has a big effect on the distribution, abundance, and productivity of vegetation. For example, steep south-facing slopes with low retention of snow and soil moisture in summer are generally less productive and have different species composition than north-facing slopes. The bottoms of mountain canyons support lush vegetation due to the high level of moisture, whereas ridgetops support vegetation that requires little moisture for growth and survival.

Due to the Pacific-influenced climate, forests found in the west-central region (Bitterroot and Missoula Valleys) are drier than those in Idaho and northwestern Montana. Only a few species typical of the Pacific Coast are found here, such as western redcedar, western white pine, Pacific yew (*Taxus brevifolia*), bride's bonnet (*Clintonia uniflora*), American trail plant (*Adenocaulon bicolor*), and threeleaf foamflower (*Tiarella trifoliata*). Intermountain forest species dominate the west-central Montana landscape, including western larch, subalpine larch (*Larix lyallii*), ponderosa pine, mock azalea (*Menziesia ferruginea*), Hitchcock's smooth woodrush (*Luzula hitchcockii*), and common beargrass (*Xerophyllum tenax*). Bottomland ponderosa pine and hardwood species are commonly found in moist sites, whereas different types of bunchgrass species (*Agropyron* spp. and *Festuca* spp.) and a mixture of ponderosa pine and bunchgrasses is found in dry sites. Douglas-fir, grand fir, and subalpine fir dominate at higher elevations (Lackschewitz 1991). Extensive stands of lodgepole pine are present at mid-to-upper elevations. Much of the native vegetation in the lower Bitterroot and Missoula Valleys has been lost to pasture or urban development.

In the Flathead Valley and Glacier National Park, lower elevations are dominated by Douglas-fir, ponderosa pine, grand fir, Engelmann spruce, and western redcedar. Douglas-fir, western larch, and subalpine fir are common at midelevations, and whitebark pine is found at high elevations (Newlon and Burns 2009). Black cottonwood (*Populus trichocarpa*) and quaking aspen are common deciduous trees found at lower elevations near Glacier National Park, often along lakes.

Wildfire is a major disturbance in the Central Rockies. Fires were fairly regular at lower and middle elevations in the Bitterroot and Missoula Valleys before 1900. Seral western larch and lodgepole pine previously dominated north-facing slopes, but fire exclusion has led to increased dominance of shade-tolerant species. As a result, silvicultural and prescribed burning treatments are being used to increase the distribution and abundance of seral tree and shrub species (Lackschewitz 1991).

The Central Rockies contain more than 60 species of mammals, with wilderness locations having relatively intact populations. Species include gray wolf, Canada lynx (*Lynx canadensis*), cougar, elk, mountain goat (*Oreamnos americanus*), bighorn sheep (*Ovis canadensis*), northern bog lemming (*Synaptomys borealis*), grizzly bear, golden-mantled ground squirrel (*Callospermophilus lateralis*), and pygmy shrew. Canada lynx and grizzly bear are on the threatened species list, and gray wolf, bald eagle, and

peregrine falcon (*Falco peregrinus*) have been removed from the Federal threatened and endangered species list.

Hundreds of bird species are found in the Central Rockies, including killdeer (*Charadrius vociferus*) and spotted sandpiper (*Actitis macularius*) in riparian areas, song sparrow (*Melospiza melodia*) in grassland, willow flycatcher (*Empidonax traillii*) and MacGillivray's warbler (*Geothlypis tolmiei*) in shrubby habitat, and bald eagle and Bullock's oriole (*Icterus bullockii*) in mature forest canopy.

Diverse native cold-water fish and nonnative fish are abundant in Central Rockies rivers. For example, Flathead National Forest is well known for its populations of native bull trout and westslope cutthroat trout (*Oncorhynchus clarki lewisi*), which are found in Flathead Lake and the Flathead River. The Bitterroot River is home to many native fish species including bull trout, westslope cutthroat trout, northern pike minnow (*Ptychocheilus oregonensis*), and largescale sucker (*Catostomus macrocheilus*). As a result of the diversity and abundance of fish species, angling is a popular recreational activity in this area.

Wildfires and insect outbreaks are disrupting ecosystems in the Central Rockies. Although wildfires play an important ecological role, recently there have been more occurrences of larger wildfires and longer wildfire seasons because of warmer spring and summer temperatures. These fires are becoming increasingly expensive to control as they make their way across the forested landscape but also as they enter the wildland-urban interface, the zone where housing borders forests and woodlands. Insect invasions in this subregion have also damaged and killed trees.

Mountain pine beetle is one of the most destructive bark beetles in North America and has caused severe damage and mortality to whitebark pine in this subregion. Lodgepole pine in the forests of Idaho and Montana were affected by the beetle between 1911 and 1942. These outbreaks originally occurred at lower elevations and moved upward into whitebark pine habitat. This occurred in the Flathead National Forest in the 1970s, where the mountain pine beetle invaded lodgepole pine forests first and then moved upward into whitebark pine (Bartos and Gibson 1990). White pine blister rust has caused extensive mortality in whitebark pine in the Central Rockies, especially in Glacier National Park and adjacent areas, where more than 70 percent of the trees are infected and 30 percent have died.

Many of the aforementioned flora and fauna were documented by Meriwether Lewis and William Clark during their expedition in the early 1800s. The explorers traveled across the Bitterroot River and Lolo Creek Valley twice and never passed through the Flathead Valley. Other early explorers to the region included fur companies and independent trappers. Fur companies obtained fur by trading goods for furs with Native Americans, employing hunters and trappers, and trading furs with hunters and trappers at trading posts (McKay 1994). Hudson's Bay Company had a good rapport with the Flathead, Pend d'Oreille, and Kootenai Tribes, trading products for bison (*Bison bison*) provided by Native Americans.

In 1855, the Hellgate Treaty established the Flathead Indian Reservation for the Flathead, Pend d'Oreille, and Kootenai Tribes. As the tribes began to live on the reservation, Euro-American settlement accelerated. Initially inhabited by quartz miners, fur trappers, and French Canadians, the Upper Flathead Valley was settled more heavily after the Northern Pacific Railroad connected with Missoula in 1883.

Timber harvest was a primary extractive activity in the Central Rockies in the late 1800s. With the passage of the 1891 Forest Reserve Act, the President had authority to create forest reserves to revise public land laws (McKay 1994), and various protections gradually spread across Federal lands. Yellowstone was the first forest reserve established by President Harrison. In 1897, the Flathead, Bitterroot, Lewis and Clark, and Priest River became the first four reserves in the Northern Region established by President Cleveland. Much of the lower elevation land in the Central Rockies today has been converted to agriculture and urban and suburban development. The major industries are agriculture, ranching, forestry, and recreation/tourism.

Eastern Rockies Subregion

The Eastern Rockies subregion occupies about 12 million acres in central, west-central, north-central, and southwestern Montana (fig. 1.1). Included in this area are the Beaverhead-Deerlodge (eastern portion), Helena, and Lewis and Clark National Forests. These forests are mostly found on the eastern side of the Continental Divide. The subregion extends from high mountains (often exceeding 11,000 feet) in the west to broad plains in the east, including several large wilderness areas. It contains numerous mountain ranges—the Beaverhead, Bitterroot, Pioneer, Centennial, Bridger, Madison, Absaroka, Beartooth, Crazy, Gallatin, Elkhorn, and Big Belt Mountains—most of which have reasonably intact ecosystems at higher elevations.

Climate in the Eastern Rockies varies considerably, depending on location relative to the Continental Divide. The western side receives more precipitation as air masses from the west cool and release moisture over the mountain ranges; on the eastern side, the air becomes warmer and drier, often accompanied by downslope air movement known as "Chinook winds," which create a more moderate climate than that of the Great Plains (Phillips 1999). In general, the eastern portion of the subregion experiences a drier continental climate.

The Rocky Mountains were developed from intense plate tectonic movement during the Jurassic, Cenozoic, and Laramide orogeny periods. The Laramide orogeny, which took place approximately 70 to 40 million years B.P., is responsible for elevating the Rocky Mountains. California, Oregon, and Washington were added to North America during the Mesozoic Era, whereas the Rockies were added to the continent much later (70 million years B.P.). Although mountain building usually occurs 200 to 400 miles inland

from the boundary of a tectonic plate (the subduction zone), the Rocky Mountains are several hundred miles inland. In the Rockies, the oceanic plate sank beneath the continental plate at a flat angle that led to mountain building farther inland than might be expected (U.S. Geological Survey 2014).

Numerous rivers flow through the Eastern Rockies, including the Missouri, Blackfoot, and Smith Rivers. The longest river in North America, the Missouri begins at the confluence of the Jefferson and Madison Rivers near Three Forks, Montana and includes three reservoirs (Canyon Ferry, Hauser, and Upper Holter). The Smith River is a tributary of the Missouri River and flows between the Little Belt and Big Belt Mountains. The Blackfoot River, a snow- and spring-fed river, begins at the Continental Divide in Lewis and Clark County, and is the river featured in the book *A River Runs Through It* by Norman Maclean. These rivers are known for their blue ribbon trout fishery status, scenic floats, and other water-based recreational activities.

Vegetation in the Eastern Rockies varies primarily as a function of elevation and aspect. Lower elevations are dominated by grassland and sagebrush steppe that include needle-and-thread grass (*Hesperostipa comata*), Idaho fescue (*Festuca idahoensis*), sagebrush (*Artemisia* spp.), rabbitbrush (*Chrysothamnus* spp.), milkvetch (*Astragalus* spp.), and wildflowers such as lupine (*Lupinus*) and balsamroot (*Balsamorhiza* spp.). Fremont's cottonwood (*Populus fremontii*), yellow willow (*Salix lutea*), coyote willow (*S. exigua*), woods rose (*Rosa woodsii*), and golden currant (*Ribes aureum*) are commonly found along rivers and streams. Dominant species in foothills and woodlands include limber pine, Rocky Mountain juniper (*Juniperus scopulorum*), Douglas-fir, and ponderosa pine. Understory species include antelope bitterbrush (*Purshia tridentata*), curl-leaf mountain mahogany (*Cercocarpus ledifolius*), and skunkbrush sumac (*Rhus aromatica* var. *simplicifolia*). Douglas-fir and ponderosa pine dominate upper montane slopes, and lodgepole pine and Engelmann spruce are common at high elevations (Phillips 1999).

Common wildlife species in the Eastern Rockies include mountain goat, bighorn sheep, elk, cougar, Canada lynx, wolverine, and black bear. Hunters from around the world purchase tags to hunt in this subregion for many of these big-game species. Also common are bald eagle, greater sage-grouse, peregrine falcon, and red-tailed hawk (*Buteo jamaicensis*). Fly fishing opportunities are plentiful due to abundant populations of westslope cutthroat trout, rainbow trout, brook trout, and northern pike (*Esox lucius*). There are a few populations of grizzly bear and gray wolf in the region, but these species are concentrated in the western section of the Eastern Rockies, particularly in wilderness areas.

Forests in the Eastern Rockies have been subject to widespread drought, wildfire, and insect outbreaks over the past 20 years (Montana Department of Environmental Quality 2013). Several large wildfires have burned with uncharacteristic intensity because the absence of fire for several decades has resulted in elevated accumulation of fuels. Mountain pine beetle has led to extensive mortality of lodgepole pine and some ponderosa pine as older, non-vigorous stands succumb to attacks by elevated beetle populations caused by warmer temperatures. Western spruce budworm has caused mortality and stunted growth in Engelmann spruce and Douglas-fir in some areas.

The travels of Meriwether Lewis and William Clark through the Eastern Rockies have created a prominent historical legacy (fig. 2.3). Their expedition began in 1804 near St. Louis, Missouri and in the spring of 1805, they traveled to Three Forks, Montana, via the Jefferson River. On this route, the explorers interacted with Shoshone Indians, and after passing over the Bitterroot Mountains, they made their way down to Fort Clatsop on the Oregon side of the Columbia River. The Lewis and Clark National Forest and other place names commemorate the expedition.

Figure 2.3—Populations of the grizzly bear, an iconic species in the Greater Yellowstone Area subregion, have increased over the past several decades as a result of successful conservation efforts (photo: U.S. Fish and Wildlife Service).

Thousands of years before Euro-Americans arrived, the Blackfoot, Sioux, Cheyenne, Flathead, and Crow Indians used the area as hunting grounds and a place to winter. Prior to 1806, the Blackfoot had exchanged wolf and beaver pelts with Canadian and English settlers for guns and ammunition. The livelihoods and cultures of these tribes were highly dependent on hunting the American bison, which provided food, shelter, and clothing. After horses were introduced to the region in the mid-1700s, hunters had much greater mobility to pursue bison, and horses themselves became part of the livelihood, commerce, and culture. The decimation of bison herds by Euro-Americans in the mid-1800s contributed to a rapid decline in Native American populations.

In the mid-1800s, mining for gold and other precious minerals was a common activity along the Continental Divide, particularly near the town of Helena, which was founded in 1864 and had the second largest placer gold deposit in Montana. Within 4 years, Last Chance Gulch (the original name for Helena) produced $19 million of gold. Because of its location adjacent to major transportation routes, the mining town was able to persist through the gold rush (A&E Television Networks 2009).

Agriculture is the largest industry in Montana, and Beaverhead County is the leading producer of cattle in the State, followed by Gallatin County, Jefferson County, and Madison County (Ranch and Recreational Group 2011). In the past several years, ranchland has been increasingly at risk to subdivision development. The wave of development in this region has transformed the landscape of forests and grasslands into one of towns, farms, and increasingly fragmented forested areas. Several organizations such as The Nature Conservancy are working with private landowners to add conservation easements on their lands to restrict subdivision, thereby limiting the fragmentation of wildlife landscapes and deleterious effects on ranching operations. The USFS often coordinates with the U.S. Department of the Interior (DOI), Bureau of Land Management (BLM) and Montana Department of Fish, Wildlife and Parks on natural resource issues related to landscape connectivity and restoration.

Greater Yellowstone Area Subregion

The Greater Yellowstone Area (GYA) subregion occupies about 23 million acres, extending across portions of Wyoming, Montana, and Idaho (fig. 1.1). It includes both the United States' first national park (Yellowstone) and first national forest (Shoshone), in addition to Grand Teton National Park and portions of Bridger-Teton, Caribou-Targhee, Gallatin, Custer, and Beaverhead-Deerlodge National Forests. One of the defining features of the subregion is a group of 24 conterminous mountain ranges that wrap around the Yellowstone Plateau (Morgan 2007).

The Yellowstone "hotspot" and associated geological activity have shaped the geography, topography, climate, soils, and biota of the GYA. The hotspot is a thermal disturbance fixed in the Earth's mantle below the North American continental plate, moving to the northeast at the rate of 1 inch per year (Morgan 2007). This volcanic hotspot is responsible for eruptions that have left calderas in Oregon, Nevada, and Idaho and for creating the eastern Snake River plain. Volcanism formed the Yellowstone rhyolite plateau, and faulting formed sediment-filled basins and steep mountains such as the Teton Range/Jackson Hole and Madison Range/Madison Valley. Uplift contributed to the high altitude of the GYA and associated deep valleys (Morgan 2007). The heat of eruptions that created calderas is also the source of heat for hot springs and geysers. These features are a primary reason that Yellowstone National Park was established; more geysers are found here than anywhere else in the world (National Park Service [NPS] 2015a).

The GYA is the source of three major river systems—the Missouri/Mississippi, Snake/Columbia, and Green/Colorado. The Missouri River begins in the northwest corner of the GYA and merges into the Mississippi River, the Snake River begins in the southeast corner of the GYA and merges into the Columbia River, and the Green River is the main tributary of the Colorado River. Anglers are drawn to these river systems for their blue ribbon fishing streams.

The GYA is one of the largest relatively intact and functional natural ecosystems in the temperate zone (Keiter and Boyce 1991). Abiotic factors such as topography and soils strongly influence vegetation composition and structure of the area. Differences in elevation greatly affect local climate, with valley bottoms having substantially higher annual temperatures than higher elevations. Soils are deeper in valley bottoms than on the Yellowstone Plateau, which is more affected by nutrient-poor soils derived from the Yellowstone Caldera (Hansen et al. 1999). Valley bottoms are generally occupied by lodgepole pine (NPS 2013). Lower slopes and richer soils (on basaltic or andesitic volcanic rocks, sedimentary rocks, and Precambrian crystalline rocks) support Engelmann spruce, subalpine fir, and Douglas-fir (Morgan 2007).The highest elevations are dominated by whitebark pine (NPS 2012). Quaking aspen, willows, and cottonwoods are also found on richer soils, such as valley toe slopes and bottoms.

In lodgepole pine forests, elk sedge (*Carex geyeri*) and grouse whortleberry (*Vaccinium scoparium*) are dominant understory plants, whereas understories of Douglas-fir forests are dominated by pinegrass (*Calamagrostis rubescens*). Utah honeysuckle (*Lonicera utahensis*), snowberry (*Symphoricarpos albus*), and buffaloberry (*Shepherdia canadensis*) are dominant understory species around the edge of the northern range of the GYA. Mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*) and Idaho fescue dominate lower elevation grassland and meadows (NPS 2012).

The GYA appears to have retained most of its historical complement of vertebrate wildlife species (NPS 2013). The largest elk and bison herds in North America and the United

Figure 2.4—A rich diversity of grasses and forbs, often mixed with ponds and lakes provide excellent habitat for waterfowl in the Grassland subregion (photo: Jim Ringelman, Ducks Unlimited).

States, respectively, are found in the area. The northern range—the grassland in the northern part of Yellowstone National Park—sustains large populations of these animals. This ecosystem supports other charismatic megafauna such as grizzly bear (fig. 2.4), moose, white-tailed deer, gray wolf, and coyote; distinctive avifauna such as trumpeter swan (*Cygnus columbianus*) and bald eagle; several hundred species of other small mammals and birds; and thousands of species of insects and other invertebrates (Keiter and Boyce 1991). This rich diversity of fauna allows for intact predator-prey interactions and other aspects of trophic dynamics.

Of the many fish species found in the GYA, westslope cutthroat trout and Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) are keystone species preyed upon by many wildlife species, including grizzly bears. Cutthroat trout are currently at risk from hybridization and competition with nonnative lake trout (*Salvelinus namaycush*) (NPS 2012). Apart from fishing pressure, water resources will become increasingly important if the population of the 21 counties in the GYA continues to increase.

Climate, soil, and plant productivity are some of the many factors that influence where organisms are found. For example, many bird species are predominantly found at lower elevations, because primary productivity is highest there and climate is moderate (Hansen et al. 1999). In the GYA, plant assemblages dominated by lodgepole pine, cottonwood, quaking aspen, and willow have high bird abundance and diversity.

The topography of the GYA has influenced human use of the region for more than 10,000 years. Native Americans entered the Greater Yellowstone region soon after they entered North America 13,500 to 12,800 years B.P. For their survival, hunter-gatherer groups would forage for seeds, fruit, and animals at lower elevations and follow the maturation of plants and migration of animals into mountainous areas. Around 1872, Native Americans were moved to a reservation in central Wyoming. Soon after, roads were developed for gold camps in Montana. During the development of roads, Native Americans tried to protect their hunting grounds. Pioneering ranchers eventually settled in the lower valleys of the region. It was the construction of the railroad from Livingston, Montana, to Yellowstone National Park that brought increasing numbers of tourists to the area (Morgan 2007).

Current land allocations and land use in the GYA indicate that human activities are more prevalent at low elevations than at higher elevations. From the Yellowstone Plateau to the Gallatin Valley, land use changes from timber management, grazing, and agriculture to rural and urban residences. Development in urban areas such as Bozeman has increased in the past several years, with most of the population concentrated along the foothills, near streams, or along transportation routes (Hansen et al. 1999).

The GYA has faced many land use changes and disturbances, both natural and human caused. Wildfire has had an enormous impact, especially the fires of 1988, which burned more than 1.2 million acres. These fires helped change how scientists, resource managers, and the public think about the role of large fires in the fire ecology of Western forests. Mountain pine beetle has killed thousands of acres of lodgepole pine in the GYA, although the outbreaks have not been as extensive as in other areas of North America.

One of the most controversial issues in the region to date involves the restoration of wolves to the area. Many scientists consider the reintroduction of wolves to be successful in restoring ecological completeness in the GYA (NPS 2013). However, others consider it to be a disruption to existing conditions and local resources, including big-game species such as elk, and livestock on adjacent private and public lands. As of September 2014, the western gray wolf has been removed from the endangered species list and listed as a nonessential experimental population in Wyoming.

The Yellowstone grizzly bear population is also important to this subregion (fig. 2.4). The U.S. Fish and Wildlife Service listed grizzly bears as a threatened species in 1975 as the species range was reduced to 2 percent of its former range. To help the population recover, Federal and State agencies implemented many actions such as placing a stop on grizzly hunting seasons, establishing a Yellowstone grizzly bear recovery area, and forming two interagency teams—Interagency Grizzly Bear Study Team and Interagency Grizzly Bear Committee—to coordinate management and increase communication. Although the population has recovered to some extent, the species is back on the threatened species list today. Managers and scientists continue to monitor the population and strive to maintain a viable population (NPS 2015c).

The GYA attracts visitors from all over the world to tour the national parks and participate in recreational activities such as fishing, hunting, skiing, and hiking. The economy of the area is therefore driven by the character and quality of the natural and social environment, which draws permanent residents as well as visitors to the area. Communities such as Gardiner and West Yellowstone depend on Yellowstone National Park for economic activity, whereas communities such as Bozeman, Livingston, and Cody are less dependent on the park and have more diverse economies (Graff 2005).

Grassland Subregion

The Grassland subregion occupies 119 million acres, extending across portions of Montana, Wyoming, North Dakota, and South Dakota (fig. 1.1). The area includes portions of Custer National Forest, all of the Dakota Prairie National Grassland and several Indian reservations including the Crown Indian, Fort Peck, Standing Rock, Blackfoot, Cheyenne River, and Spirit Lake Reservations.

The Wisconsinan glacier shaped the rolling and flat plains of North Dakota at the end of the last glacial period, about 12,000 years B.P. The southwestern corner of North Dakota was untouched by the glacier, which in turn led to the formation of the Little Missouri Badlands. Although this ice age glacier did not help shape the badlands, a previous glacier did. The Little Missouri River flowed northward until 600,000 years B.P., when a glacier blocked its path and diverted its flow east (Herman and Johnson 2008a). The resulting cycle of erosion and downcutting led to the development of badlands.

Sedimentary layers found here are primarily continental sediments deposited by rivers and streams. Siltstone, claystone, sandstone, and lignite coal are common sediments in this environment (Bluemle 1996). Clinkers (or scoria), rocks produced by burning coal beds, are also commonly found in the Badlands. They are mostly reddish but also include shades of pink to black. The landforms found in the Badlands—hills, valleys, cliffs, buttes—are a result of the differential hardness of minerals and their resistance to erosion (Bluemle 1996). As Theodore Roosevelt remarked, "The Badlands grade all the way from those that are almost rolling in character to those that are so fantastically broken in form and so bizarre in color as to seem hardly properly to belong to this earth."

The rugged badlands were carved from rocks from the Late Cretaceous through the Eocene period. Cretaceous and Tertiary sedimentary formations mark the period when dinosaurs became extinct. The Hell Creek formation, located in the southern portion of the Little Missouri Badlands, has remnants of the last species of dinosaurs that existed on Earth, the most common of which were *Triceratops* species (Bluemle 1996). Along with dinosaur remains, other common fossils found in the area include those of fish, turtles, alligators, birds, and small mammals. Fossils of broadleaf trees, cycads, palms, and ground ferns are also present, indicating the presence of a subtropical coastal plain environment during the Cretaceous period. Petrified wood is commonly found in the Badlands and is thought to be the remains mostly of dawn redwood (*Metasequoia glyptostroboides*) (Bluemle 1996).

The Missouri, Red, and Souris (or Mouse) Rivers are the three major river systems in the Dakota Prairie portion of the Grassland subregion. The Missouri River is the largest and longest in North Dakota. The Red River borders North Dakota and Minnesota, and the Souris River begins in eastern Saskatchewan and flows into North Dakota, after which it loops back into Canada. The Tongue and Powder Rivers are the major river systems that flow into the Yellowstone River in the southern portion of the Grassland subregion.

The subregion is characterized by three very different ecosystem types: badlands, prairie, and ponderosa pine forest. The badlands are located mostly along the Little Missouri River. Sioux Indians, who lived in the region before Euro-American settlement, called the badlands "makosika" (land bad), and the French explorers called it "les mauvais terrers a traverser" (bad lands to travel across) (Bluemle 1996). The pine forests are found in "islands of green in a sea or rolling prairie" (Herman and Johnson 2008a). Most of the ponderosa pine forest in the Custer National Forest burned in the last decade.

Most of the vegetation found in the badlands is native and consists of grasses, forbs, trees, and shrubs. Shortgrasses are dominant because average precipitation is only 10 to 12 inches annually. Common bunchgrasses include little bluestem (*Schizachyrium scoparium*), blue grama (*Bouteloua gracilis*), and needle-and-thread grass. In areas where precipitation reaches close to 15 inches, western wheatgrass (*Pascopyrum smithii*) is fairly common. Open areas that can retain moisture throughout the year can support trees and shrubs. Deciduous trees include eastern cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), boxelder (*Acer negundo*), and American elm (*Ulmus americana*). Ponderosa pine and Rocky Mountain juniper (*Juniperus scopulorum*) are common in some locations. Drainages dominated by trees also provide habitat for shrubs such as western serviceberry, chokecherry (*Prunus virginiana*), currant species, and American plum (*P.*

americana). Shrubs found in drier locations include sagebrush, winterfat (*Krascheninnikovia lanata*), rabbitbrush, and buckbrush (*Ceanothus cuneatus*). Prairie wildflowers include gumbo lily (*Mentzelia decapetala*), scarlet globemallow (*Sphaeralcea coccinea*), soapweed yucca (*Yucca glauca*), and brittle pricklypear cactus (*Opuntia fragilis*) (Herman and Johnson 2008a).

The badlands landscape provides wildlife habitat in native prairie, sagebrush, woody draws, shrubby areas, and buttes. Large animals include bighorn sheep, pronghorn (*Antilocapra americana*), elk, white-tailed deer, and mule deer. When Lewis and Clark passed through North Dakota in 1804, the most abundant animal they encountered was bison, followed by pronghorn. Populations of wildlife considered food and game species were greatly reduced after Euro-American settlement. Other mammals found in the Grassland include black-tailed prairie dog (*Cynomys ludovicianus*), cougar, porcupine (*Erethizon dorsatum*), cottontail rabbit (*Lepus sylvaticus*), and bobcat. Common reptiles include prairie rattlesnake (*Crotalus viridis*), bullsnake (*Pituophis catenifer*), and sagebrush lizard (*Sceloporus graciosus*). Common amphibians include Woodhouse's toad (*Anaxyrus woodhousii*), Great Plains toad (*A. cognatus*), and plains spadefoot toad (*Spea bombifrons*) (Herman and Johnson 2008a).

The badlands support a diversity of bird species such as long-billed curlew (*Numenius americanus*), yellow-breasted chat (*Icteria virens*), mountain bluebird (*Sialia currucoides*), rock wren (*Salpinctes cabanis*), western kingbird (*Tyrannus verticalis*), eastern kingbird (*T. tyrannus*), black-billed magpie (*Pica hudsonia*), prairie falcon (*Falco mexicanus*), and burrowing owl (*Athene cunicularia*). Greater sage-grouse is found in southwestern North Dakota and depends on sagebrush habitat, which is in decline; sharp-tailed grouse (*Tympanuchus phasianellus*) is found in similar sagebrush and prairie habitat (Herman and Johnson 2008a).

The native prairie component of the Grassland subregion is dominated by grasses and forbs (fig. 2.5) that tolerate low precipitation, strong winds, cold winters and hot summers, frequent fire, and herbivory. Native grasses have deep and extensive connected root systems that allow them to persist under stressful conditions (Herman and Johnson 2008b). Native prairie is divided into tallgrass, mixed grass, and shortgrass. Tallgrass prairie, which dominates eastern North Dakota, requires the most moisture, and shortgrass prairie requires the least.

The largest remaining tallgrass prairie is in the Red River Valley, dominated by big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum* spp.), and prairie dropseed (*Sporobolus heterolepis*) (North Dakota Game and Fish Department 2012). Humus, which develops as grasses and forbs decompose, helps retain soil moisture. This fertile soil led to the near extinction of the tallgrass prairie as farmers cultivated the land for wheat and other crops. The Sheyenne National Grassland contains most of the remaining tallgrass prairie in North Dakota today. Cedar River National Grassland, which connects with Grand River National Grassland in South Dakota, contains both tallgrass and shortgrass species. Warm- and cool-season grasses dominate this area, such as prairie junegrass (*Koeleria macrantha*), crested wheatgrass (*Agropyron cristatum*), green needlegrass (*Nassella viridula*), needle-and-thread grass, blue grama, little bluestem, and needleleaf sedge (*Carex duriuscula*). Dominant forbs include eastern pasque flower (*Anemone patens*), western wall-flower (*Erysimum asperum*), prairie smoke (*Geum triflorum*), blacksamson (*Echinacea angustifolia*), and common yarrow (*Achillea millefolium*) (Herman and Johnson 2008b).

Shortgrass prairie, found in the higher elevation region of the Missouri Slope of North Dakota, is dominated by warm-season species that require little rainfall, including spikemoss (*Selaginella* spp.), blue grama, needleleaf sedge, threadleaf sedge (*Carex filifolia*), buffalo grass (*Urochloa mutica*), and needle and thread. These grasses are 3 to 7 inches tall. The Little Missouri National Grassland contains both mixed and shortgrass prairie. Common prairie forbs include wild prairie rose (*Rosa arkansana*), blacksamson, showy milkweed (*Asclepias speciosa*), soapweed yucca, gumbo lily, and tenpetal blazingstar (*Mentzelia decapetala*) (Herman and Johnson 2008b).

American bison was formerly the iconic "ruler of the prairies," and Native Americans depended on bison for their livelihood. However, Euro-American settlement and hunting nearly drove the bison to extinction. Other mammals found in prairie habitat of the Grassland subregion include elk, red fox (*Vulpes vulpes*), coyote, American badger (*Taxidea taxus*), several species of ground squirrel (*Spermophilus* spp.) and pocket gopher (*Thomomys* spp.), white-tailed jackrabbit (*Lepus townsendii*), eastern cottontail (*Sylvilagus floridanus*), and meadow vole (*Microtus pennsylvanicus*) (Herman and Johnson 2008b).

Reptiles found in the prairie include garter snakes (*Thamnophis* spp.), smooth green snake (*Opheodrys vernalis*), and western hognose snake (*Heterodon nasicus*). Bird species include greater prairie chicken (*Tympanuchus cupido*), sharp-tailed grouse, greater sage-grouse, upland sandpiper (*Bartramia longicauda*), nonnative ring-necked pheasant (*Phasianus colchicus*), and many songbird species (Herman and Johnson 2008b).

The Grassland subregion is home to more than 100 species of fish, including northern pike, walleye (*Sander vitreus*), and sauger (*Sander canadensis*). Walleye inhabit large reservoirs such as Lake Sakakawea and Lake Oahe, whereas sauger are found mostly in the Missouri River (Herman and Johnson 2008c). In addition, this subregion contains a variety of endemic prairie fish assemblages, including sensitive species such as northern redbelly dace (*Phoxinus eos*) and associated native macroinvertebrates such as fatmucket mussels (*Lampsilis siliquoidea*).

The Sioux, Assiniboine, Cheyenne, Mandan, Hidatsa, and Arikara were the first inhabitants of the land. In 1910,

approximately 6,000 Native Americans lived in North Dakota. That number increased to more than 25,000 in 1970 and more than 30,000 today. Today, Federally recognized tribes live in five reservations in North Dakota: Fort Berthold, Lake Traverse Indian Reservation, Standing Rock Indian Reservation, Spirit Lake Reservation, and Turtle Mountain Reservation.

With the majority of the Grassland subregion located on fertile soil, agriculture drives the economy. Wheat, flaxseed, canola, peas, lentils, and oats are some of the many products grown here, especially in the Red River Valley (also known as "the Breadbasket of the World"). Livestock production occurs on the less suitable lands and includes beef, dairy cattle, and hogs. North Dakota is currently in a boom phase of oil production, focused on the Bakken and Three Forks formations, making it the second largest oil-producing State. Petroleum refining and food processing are also major industries.

The declining sage-grouse population is of extreme concern to western States. Over half of the greater sage-grouse habitat has been lost, resulting in sage-grouse population numbers of 200,000 to 500,000. The BLM, USFS, U.S. Fish and Wildlife Service, and the Natural Resources Conservation Service are working together to conserve the western sagebrush habitat. These agencies have developed several environmental impact statements to incorporate sage-grouse conservation measures into land use plans (USDOI BLM 2015). Although agencies continue to monitor and evaluate the western landscape, the U.S. Fish and Wildlife Service determined in 2015 that protection of the species under the Endangered Species Act was not warranted (USFWS 2015).

Many organizations such as the USFS, U.S. Fish and Wildlife Service, The Nature Conservancy, North Dakota Game and Fish Department, and Ducks Unlimited are working to protect existing grassland and aquatic habitat. Although most of the land is under private ownership, many landowners have converted cropland to grassland under the Conservation Reserve Program, in which the Federal government pays farmers to plant grass on less fertile lands. In many cases, reserve lands produce higher populations of white-tailed deer, ducks, ring-necked pheasant, and many nongame species. Unfortunately, West Nile virus (*Flavivirus* spp.), oil and gas development, and conversion of sagebrush land to cropland have reduced greater sage-grouse range habitat and populations (U.S. Fish and Wildlife Service 2014).

References

A&E Television Networks. 2009. This day in history: The city of Helena, Montana, is founded after miners discover gold. http://www.history.com/this-day-in-history/the-city-of-helena-montana-is-founded-after-miners-discover-gold [Accessed April 19, 2015].

Bartos, D.L.; Gibson, K.E. 1990. Insectes of whitebark pine with emphasis on mountain pine beetle. In: Schmidt, W.C.; McDonald, K.J., comps. Proceedings-symposium on whitebark pine ecosystems: Ecology and management of a high-mountain resource; 1989 March 29–31; Bozeman, MT. Gen. Tech. Rep. INT-GTR-270. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 171–179.

Bluemle, J.P. 1996. North Dakota's Badlands. Geology Today. 12: 217–223.

Bollenbacher, B.L.; Graham, R.T.; Reynolds, K.M. 2014. Regional forest landscape restoration priorities: Integrating historical conditions and an uncertain future in the Northern Rocky Mountains. Journal of Forestry. 112: 474–483.

Graff, J. 2005. Economic development in environmental economies of the Northern Greater Yellowstone Region. Bozeman, MT: Montana State University, Department of Political Science. http://www.npca.org/assets/pdf/Graff_Econ_YNP_2005.pdf [Accessed February 13, 2015].

Graham, R.T.; Jain, T.B. 2005. Silvicultural tools applicable in forests burned by a mixed severity fire regime. In: Taylor, L.; Zelnik, J.; Cadwallader, S.; [et al.], eds. Mixed severity fire regimes: Ecology and management: Symposium proceedings; 2004 November 17–19; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension Service: 45–58.

Hansen, A.J.; Gallant, A.; Rotella, J.J.; Brown, D. 1999. Natural and human drivers of biodiversity in the Greater Yellowstone Ecosystem. In: Sisk, T. Land use history of North America: Providing a context for understanding environmental change. Washington, DC: U.S. Geological Survey: 61–70.

Herman, G.S.; Johnson, L.A. 2008a. Habitats of North Dakota. Bismarck, ND: North Dakota Center for Distance Education, North Dakota Game and Fish Department. 76 p.

Herman, G.S.; Johnson, L.A. 2008b. Prairie. Bismarck, ND: North Dakota Center for Distance Education, State Game and Fish Department. 68 p.

Herman, G.S.; Johnson, L.A. 2008c. Riparian areas. Bismarck, ND: North Dakota Center for Distance Education, State Game and Fish Department. 78 p.

Idaho Forest Products Commission. 2011. Overall summary of insect and disease in Idaho. 2011 Forest Health Highlights. http://www.idahoforests.org/img/pdf/id_fhh_2011.pdf [Accessed March 25, 2015].

Idaho State University. 2014a. Geology—Mesoproterozoic Belt Supergroup. Boise, ID: Digital Atlas of Idaho. http://geology.isu.edu/Digital_Geology_Idaho/Module2/mod2.htm [Accessed March 25, 2015].

Idaho State University. 2014b. Hydrology—Lakes, Rivers & Reservoirs. Boise, ID: Digital Atlas of Idaho. http://imnh.isu.edu/digitalatlas/hydr/laksrvrs/lrrfr.htm [Accessed March 25, 2015].

Keiter, R.B.; Boyce, M.S. 1991.The greater Yellowstone ecosystem: Redefining America's wilderness heritage. New Haven, CT: Yale University Press.

Lackschewitz, K. 1991. Vascular plants of west-central Montana—Identification guidebook. Gen. Tech. Rep. INT–277. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 648 p.

McKay, K. 1994. Trails of the past: Historical overview of the Flathead National Forest, Montana, 1800–1960. Kalispell, MT: U.S. Department of Agriculture, Forest Service, Flathead National Forest. 351 p.

Montana Department of Environmental Quality. 2013. Climate change and forestry: Montana's forests in an era of climate change. Helena, MT: Montana Department of Environmental Quality. http://deq.mt.gov/ClimateChange/NaturalResources/Forestry/forestryClimateChangeEra.mcpx [Accessed April 6, 2015].

Morgan, L.A., ed. 2007. Integrated geoscience studies in the greater Yellowstone area—Volcanic, tectonic, and hydrothermal processes in the Yellowstone geoecosystem. U.S. Geological Survey Professional Paper 1717. Washington, DC: U.S. Geological Survey. 532 p.

National Park Service [NPS]. 2012. Yellowstone resources and issues handbook: 2012. Yellowstone National Park, WY: U.S. Department of the Interior, National Park Service, Yellowstone National Park. http://s3.documentcloud.org/documents/357352/yellowstone-resources-issues-2012.pdf [Accessed February 3, 2015].

National Park Service [NPS]. 2013. Yellowstone resources and issues handbook: Greater Yellowstone Ecosystem. Yellowstone National Park, WY: U.S. Department of the Interior, National Park Service, Yellowstone National Park. http://www.nps.gov/yell/planyourvisit/upload/RI_2014_05_GYE.pdf [Accessed January 8, 2015].

National Park Service [NPS]. 2015a. Geysers and how they work. Yellowstone National Park, WY: U.S. Department of the Interior, National Park Service, Yellowstone National Park. http://www.nps.gov/yell/naturescience/geysers.htm [Accessed January 8, 2015].

National Park Service [NPS]. 2015b. Glacier National Park, Montana – mammals. West Glacier, MT: U.S. Department of the Interior, National Park Service, Glacier National Park. http://www.nps.gov/glac/learn/nature/mammals.htm [Accessed March 18, 2015].

National Park Service [NPS]. 2015c. Grizzly bears and the Endangered Species Act. Yellowstone National Park, WY: U.S. Department of the Interior, National Park Service, Yellowstone National Park. http://www.nps.gov/yell/learn/nature/bearesa.htm [Accessed June 2, 2015].

Newlon, K.; Burns, M.D. 2009. Wetlands of the Flathead Valley: Change and ecological functions. Report to the Montana Department of Environmental Quality and U.S. Environmental Protection Agency. Helena, MT: Montana Natural Heritage Program. 38 p.

North Dakota Game and Fish Department. 2012. Vegetation. Bismarck, ND: North Dakota Game and Fish Department. http://gf.nd.gov/wildlife/plants-habitat/habitats/vegetation [Accessed March 5, 2015].

Phillips, W. 1999. Central Rocky Mountain wildflowers: Including Yellowstone and Grand Teton National Parks. Guilford, CT: Globe Pequot Press. 232 p.

Ranch and Recreational Group. 2011. Southwest Montana agriculture. http://montanaranchandrecreation.blogspot.com/2011/03/southwest-montana-agriculture.html [Accessed April 19, 2015].

Schnepf, C.; Davis, A.S. 2013. Tree planting in Idaho. Tree Planters Notes. 56: 19–26.

Schwandt, J.; Kearns, H.; Byler, J. 2013. White pine blister rust—General ecology and management. Insect and Disease Management Series 14.2, Web 2013. Washington, DC: U.S. Department of Agriculture, Forest Service, Forest Health Protection and State Forestry Organizations. 25 p.

Sullivan, J.; Long, L.E.; Menser, H.A. 1986. Native plants from northern Idaho. Bulletin 657. Moscow, ID: University of Idaho, College of Agriculture. 7 p.

U.S. Department of the Interior, Bureau of Land Management [USDOI BLM]. 2015. Sage-grouse and sagebrush conservation. http://www.blm.gov/wo/st/en/prog/more/sagegrouse.html [Accessed June 3, 2015].

U.S. Fish and Wildlife Service [USFWS]. 2014. Greater sage-grouse—North Dakota. Washington, DC: U.S. Department of the Interior, U.S. Fish and Wildlife Service. http://www.fws.gov/greatersagegrouse/northDakota.php [Accessed April 15, 2015].

U.S. Fish and Wildlife Service [USFWS]. 2015. Endangered and threatened wildlife and plants; 12-month finding on a petition to list greater sage-grouse (*Centrocercus urophasianus*) as an endangered or threatened species. Federal Register 80(191): 59857-59942. https://www.federalregister.gov/documents/2015/10/02/2015-24292/endangered-and-threatened-wildlife-and-plants-12-month-finding-on-a-petition-to-list-greater [Accessed October 24, 2016].

U.S Geological Survey. 2014. Geologic provinces of the United States: Rocky Mountains. Washington, DC: U.S. Department of the Interior, Geological Survey. http://geomaps.wr.usgs.gov/parks/province/rockymtn.html [Accessed April 3, 2015].