

Chapter 2: Biogeographic, Cultural, and Historical Setting

Hanna K. Olson and Don W. Fallon

Introduction

The Intermountain Adaptation Partnership (IAP) encompasses unique landscapes within the Intermountain Region of the U.S. Forest Service (USFS), from rugged mountains to deep canyons, from alpine snowfields to wild and scenic rivers (fig. 1.1). The area defined by the boundaries of the Intermountain Region contains both private and Federally owned lands, including 12 national forests and 22 national parks. Before Euro-Americans settled this area, Native American tribes occupied the land for thousands of years. With Euro-American settlement came timber extraction, mining, grazing, water extraction, and increased recreation to the region. Urban growth has increased significantly during recent decades, bringing new

businesses and development that affect socioeconomic and natural environments.

Climate, biogeography, natural resource conditions, and management issues differ considerably from Idaho to Nevada, and from western Wyoming to the southern border of Utah. To capture how these differences influence potential climate change effects and adaptation strategies, the IAP region was divided into six subregions that are detailed in this assessment: the Middle Rockies, Southern Greater Yellowstone, Uintas and Wasatch Front, Plateaus Great Basin and Semi Desert, and Intermountain Semi Desert subregions (fig. 1.1, table 2.1). The Intermountain Semi Desert contains no national forests, but is identified as a discrete area that may be of interest to those outside the USFS. Each subregion is briefly characterized in the next section.

Table 2.1—Subregions within national forests and national forests within subregions of the Intermountain Adaptation Partnership region.

National forest	Subregions	Number of subregions in a national forest
Ashley	Uintas and Wasatch Front, Plateaus	2
Boise	Middle Rockies	1
Bridger-Teton	Southern Greater Yellowstone	1
Caribou-Targhee	Middle Rockies, Southern Greater Yellowstone, Uintas and Wasatch Front	3
Dixie	Plateaus, Great Basin and Semi Desert	2
Fishlake	Plateaus, Great Basin and Semi Desert	2
Humboldt-Toiyabe	Great Basin and Semi Desert	1
Manti-La Sal	Uintas and Wasatch Front, Plateaus	2
Payette	Middle Rockies	1
Salmon-Challis	Middle Rockies	1
Sawtooth	Middle Rockies, Uintas and Wasatch Front	2
Uinta-Wasatch-Cache	Uintas and Wasatch Front, Plateaus, Great Basin and Semi Desert	3
Subregion	National forest	Number of national forests in a subregion
Middle Rockies	Boise, Caribou-Targhee, Payette, Salmon-Challis, Sawtooth	5
Southern Greater Yellowstone	Bridger-Teton, Caribou-Targhee	2
Uintas and Wasatch Front	Ashley, Caribou-Targhee, Manti-La Sal, Uinta-Wasatch-Cache, Sawtooth	5
Plateaus	Ashley, Dixie, Fishlake, Manti-La Sal, Uinta-Wasatch-Cache	5
Great Basin and Semi Desert	Dixie, Fishlake, Humboldt-Toiyabe, Uinta-Wasatch-Cache	4
Intermountain Semi Desert	None	0

Descriptions of Subregions

Middle Rockies Subregion

The Middle Rockies subregion is part of the Rocky Mountains and extends over 16 million acres of central Idaho (fig. 2.1). The subregion is characterized by rugged mountain ranges and intermontane valleys vegetated with coniferous forests, as well as sagebrush-steppe ecosystems in the lower elevations, particularly in the southern and eastern portions (fig. 2.2). The subregion includes the Payette, Salmon-Challis, Boise, and Sawtooth National Forests, and a small portion of the Caribou-Targhee National Forest. This area is bordered by the Centennial Mountains near the Montana-Idaho border, the Lemhi Mountains along the Continental Divide of the western Montana-Idaho border, the northeastern Beaverhead Mountains, and the Salmon River Mountains in the northern section of the subregion.

The area extends southward to the Intermountain Semi Desert subregion, which is dominated by geographic features associated with the Snake River Plains volcanic fields. Designated wilderness areas encompass almost 1.5 million acres of this subregion.

Geologically, the area is relatively young with emplacement of Cretaceous igneous intrusions (batholiths) roughly 120 million years BP, and younger Columbia basalts on the western boundary. During the Pleistocene (roughly 10,000 to 130,000 years BP), mountain glaciers carved and gouged the bedrock while depositing glacial till and associated river deposits in the intermontane valleys. The modern mountain ranges are characterized by high elevation ridges and deeply incised river valleys, such as those associated with the Salmon River in the Frank Church River of No Return Wilderness (Demarchi 1994).

Numerous rivers run through the Middle Rockies subregion. The Salmon River, flowing westward and spanning

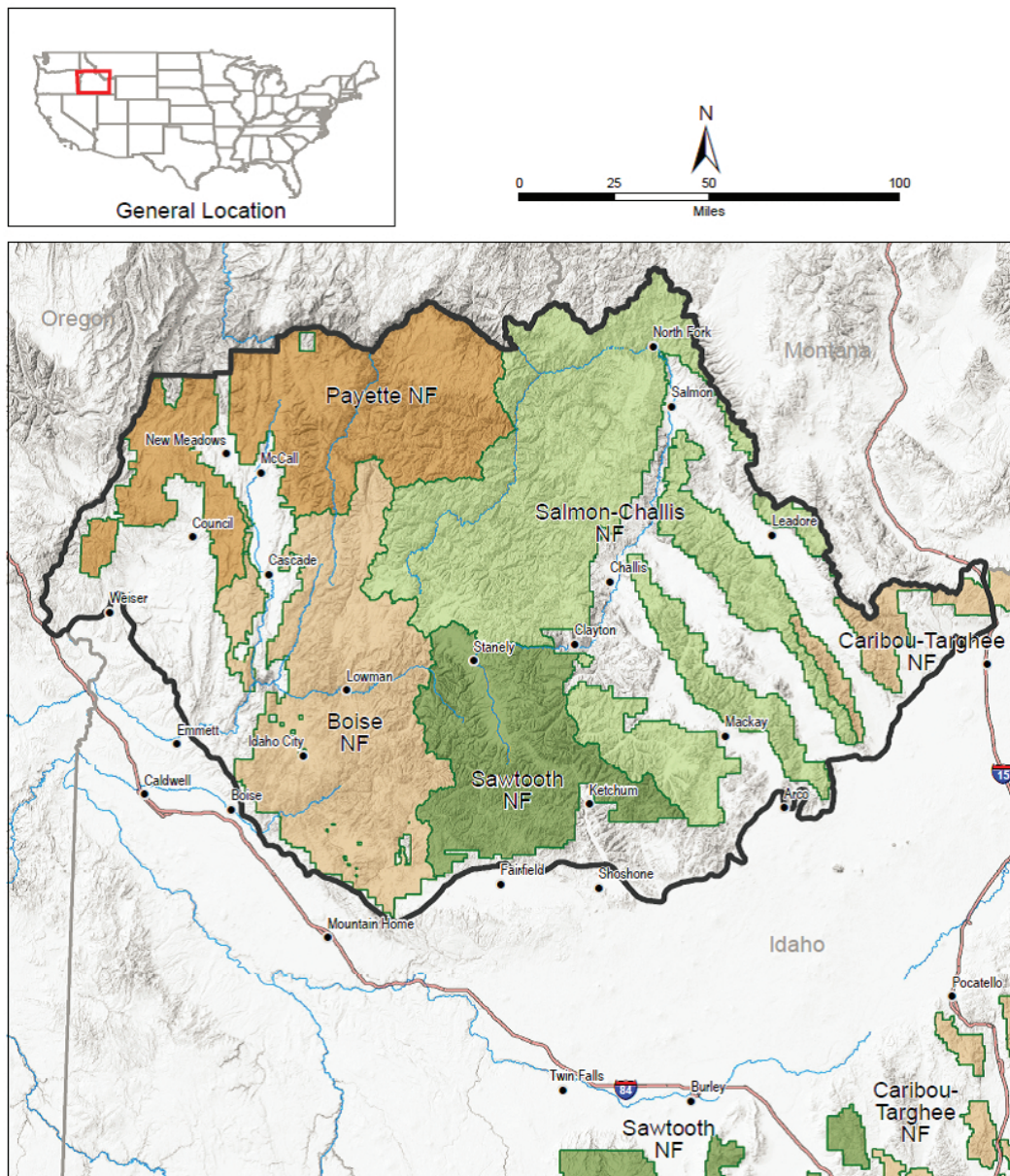


Figure 2.1—National forests within the Middle Rockies subregion of the Intermountain Adaptation Partnership region.

Figure 2.2—Rugged mountain topography in the Salmon-Challis National Forest. Subalpine forest and montane shrubs characterize the higher elevations (photo: U.S. Forest Service).



425 mi, divides northern Idaho from the remainder of the State. Major subbasins include the Little Salmon River, the Lemhi River, and the Big and Little Lost Rivers in east-central Idaho. Dry land farming occurs in valleys within the southeastern portion of central Idaho. The 1,000-mile-long Snake River enters the eastern edge of the subregion and is joined by the Salmon River near Riggins, Idaho, where river incision has created Hells Canyon, the deepest river gorge in North America. High flows of the merged rivers exceed those of the Colorado River (Idaho Department of Health and Welfare 1999). In the northwestern portion of the Middle Rockies subregion, the Boise River and Payette River are major tributaries of the Snake River. The Payette River leads to the popular recreation areas of Lake Cascade and Lake Payette. The Lemhi River is fed by the Bitterroot Range and the Big Lost River Range, and is a critical spawning habitat for Federally protected steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*) (Idaho Department of Health and Welfare 1999). The Big Lost River and the Little Lost River Range are named for their disappearance underground as they leave their valleys and flow into the Intermountain Semi Desert subregion.

Climate varies along a gradient between the western and eastern areas of central Idaho. Maritime atmospheric patterns are prevalent near the northwestern border of the subregion, delivering high precipitation that allows coniferous forests to thrive. Toward the southeastern border, the climate creates an arid environment that supports sagebrush and grassland ecosystems at lower elevations. Eastern Idaho experiences large temperature variation during the year, and

precipitation differs considerably from the western portions of the subregion, with monsoonal summer moisture and snowier winters. The abrupt elevation gradients associated with the steep mountain ranges of central Idaho creates an orographic (rain-shadow) effect in which condensed moisture is deposited on the western or windward mountain slopes, and reduced moisture falls on leeward valley sides of the mountains.

Mixed conifer and subalpine forests are the dominant vegetation in the Middle Rockies. Heavily forested areas are most common in the northern portion of the subregion, progressing to more arid lowlands in the southeast. Dominant species include Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta* var. *latifolia*), grand fir (*Abies grandis*), subalpine fir (*A. lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and quaking aspen (*Populus tremuloides*) (Brown and Chojnacky 1991). Of these species, Douglas-fir, ponderosa pine, lodgepole pine, grand fir, subalpine fir, and Engelmann spruce are commercially harvested (USDA FS 2016). Since 1952, ponderosa pine cover has decreased by 40 percent because of its high timber value (O’Laughlin et al. 1993). Conifer species with high ecological value but no commercial value include white-bark pine (*Pinus albicaulis* Engelm.), limber pine (*P. flexilis*), alpine larch (*Larix lyallii*), and western juniper (*Juniperus occidentalis*) (Brown and Chojnacky 1991).

Among the abundant shrub species are serviceberry (*Amelanchier alnifolia*), Rocky Mountain maple (*Acer glabrum*), tall Oregon-grape (*Berberis aquifolium*), snowbrush ceanothus (*Ceanothus velutinus*), and multiple species of sagebrush (*Artemisia* spp.) (Pyke et al. 2015; Robson and

Kingery 2006). Idaho fescue (*Festuca idahoensis*) and blue-bunch wheatgrass (*Pseudoroegneria spicata*) are common grassland species. Conservation of rare plant species in the subregion is an important management responsibility (Tilley et al. 2013).

Over 300 animal species live in the Middle Rockies. Large mammals include Canada lynx (*Lynx canadensis*), grizzly bear (*Ursus arctos*), elk (*Cervus elaphus*), gray wolf (*Canis lupus*), bighorn sheep (*Ovis canadensis*), and moose (*Alces alces*). Smaller vertebrates include American beaver (*Castor canadensis*), American pika (*Ochotona princeps*), snowshoe hare (*Lepus americanus*), yellow-bellied marmot (*Marmota flaviventris*), and Rocky Mountain tailed frog (*Ascaphus montanus*) (Link et al. 2000). The Middle Rockies are home to over 400 bird species, including bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), multiple owl species, trumpeter swan (*Cygnus buccinator*), greater sage-grouse (*Centrocercus urophasianus*), and white-headed woodpecker (*Picoides albolarvatus*).

Fish rearing and spawning sites of both native and nonnative fish species are common in the rivers, lakes, and ponds of the Middle Rockies. Steelhead trout, cutthroat trout (*O. clarkii*), and bull trout (*Salvelinus confluentus*) are sensitive species found throughout the subregion. Nonnative lake trout (*S. namaycush*) and brook trout (*S. fontinalis*) were introduced into Idaho's lakes and streams during the 1900s and continue to thrive (Dillon and Grunder 2008). Since the 1880s, dams and reservoirs have altered water flows and decreased water quality in some rivers, leading to declines in the white sturgeon (*Acipenser transmontanus*) population (Dillon and Grunder 2008).

Before the 1900s, wildfires in the Middle Rockies subregion maintained grasslands and open forests in lower elevation and drier portions of the landscape. Historical fire frequencies were 10 to 20 years for ponderosa pine and dry Douglas-fir forests in Boise National Forest (Crane and Fischer 1986). In recent decades, grand fir and Douglas-fir have increased in ponderosa pine stands in response to decreased fire frequency. The resulting dense, multistoried stands are more susceptible to crown fires, insects, and fungal pathogens. Sagebrush communities generally have lower wildfire frequencies, but are increasingly affected by cheatgrass (*Bromus tectorum*) and other nonnative species. These annual species create fine fuels that facilitate more frequent fire, mostly to the detriment of native species.

Lodgepole pine, whitebark pine, and limber pine have undergone high mortality from mountain pine beetle (*Dendroctonus ponderosae*) outbreaks in much of central Idaho. A warmer climate has encouraged higher reproductive rates in the beetles and allowed them to survive at higher elevations (Gibson et al. 2008). Western spruce budworm (*Choristoneura occidentalis*) attacks Douglas-fir, grand fir, and pine, causing mortality and low vigor in host stands (Fellin and Dewey 1982). Balsam woolly adelgid (*Adelges piceae*) causes subalpine fir mortality and lower growth in grand fir (Lowrey 2015).

Forest diseases are especially prominent in conifer forests in the Middle Rockies. The nonnative fungus white pine blister rust (*Cronartium ribicola*) has caused extensive mortality in western white pine (*Pinus monticola*), whitebark pine, and limber pine (Cairns 2015). The formerly abundant western white pine has been mostly replaced by Douglas-fir and grand fir, driving forest succession toward more susceptible stand composition. Although efforts to eradicate blister rust have been unsuccessful, decades of natural selection have increased rust resistance in remnant western white pines, providing a foundation for regeneration of this species in the future (Schwandt et al. 2013). Parasitic dwarf mistletoe (*Arceuthobium* spp.) is also fairly common in coniferous forests. The spread rate of mistletoe has accelerated in dense, multistoried Douglas-fir stands because of the abundance of susceptible hosts and ease of mistletoe dispersal and regeneration. Long-term effects include growth reduction of the host and reduced forest productivity (Giunta et al. 2016).

No Native American communities or reservations reside within the Middle Rockies, although portions of national forests are traditional use areas. Historically, riverbanks in the Salmon-Challis National Forest provided fishing and foraging grounds for the Sheepeater Indians, the Nez Perce Tribe, and the Flathead Tribe. After the Lewis and Clark expedition during the early 19th century, assistance from Indian tribes opened the way for fur trappers, explorers, miners, ranchers, and settlers to populate what is now Lemhi County. Previously, the Whitebird band of the Nez Perce Tribe occupied portions of Payette National Forest, and utilized summer hunting and fishing grounds along the Little Salmon River. Other bands camped along the Little Salmon and Salmon Rivers as a primary source for salmon throughout the harvesting season. A wide variety of plant species provided materials for food and construction (Reddy 1993). In the mid-1800s, the Federal Government gained control of the land in Idaho, restricting the Nez Perce to the northwestern part of the State.

Resource-dependent economic activities in the Middle Rockies include livestock grazing, logging, recreation, and tourism. The gold rush of the mid-19th century brought settlers to the mountainous areas of the IAP region. The initial boom quickly died out, leaving only ghost towns to mark the once-promising gold and copper mines. Several mineral exploration projects are still operating and more have been recently proposed. Between the 1860s and 1870s, the livestock industry grew within the South Boise, Atlanta, and Deadwood mining districts (Jones 1990). After the gold rush, summer grazing activity extended beyond the outskirts of mining towns, and became established along the Boise and Payette river valleys (Jones 1990). The economic viability of livestock grazing has declined in recent decades, although large areas of national forest and other Federal lands still have grazing allotments. Exposure of bighorn sheep to cattle-borne diseases is a concern for wildlife managers, and programs are aimed at renewing the viability of bighorn sheep populations on Federal lands (USDA FS 2011).

Timber operations came to the IAP region during the "great buying rush" between 1899 and 1908. These

operations supported the expanding railroad system with railroad ties, as well as traditional building products. By 1902, the Payette Lumber and Manufacturing Company had been established, with ponderosa pine as the main commodity. The company continued to expand throughout the early 20th century, resulting in more sawmills, higher lumber production, and a growing economy. However, timber production has declined significantly in the past 30 years. Counties south of the Salmon River currently contribute up to 11 percent of Idaho's overall timber harvest and 45 percent of the State's timber exports. Valley County provides the largest annual timber harvest in the State: 65 million board feet (Brandt et al. 2012).

Travel and tourism support a significant portion of the subregional economy. A study conducted in the Sawtooth National Recreation Area found that 77 percent of visitors traveled to the forest for recreational purposes such as viewing natural features, hiking, and driving for pleasure

(Headwaters Economics 2014). In 2012, 6.5 million visitors to Idaho national forests (including outside the subregion) spent over \$300 million on recreation activities.

Southern Greater Yellowstone Subregion

The Southern Greater Yellowstone subregion covers 6.5 million acres of eastern Idaho, and western Wyoming (fig. 2.3). Bridger-Teton National Forest and Caribou-Targhee National Forests are the only national forests in this subregion. The Bridger-Teton spans the eastern portion of the Idaho-Wyoming border from Jackson Hole, Wyoming, eastward toward west-central Wyoming and contains 3.4 million acres of watersheds and wildlands. Approximately 2 million acres of wilderness land, as well as Grand Teton National Park, are contained within the subregion. There are several designated wilderness areas located on USFS lands in the subregion, including the Teton Wilderness and Wind

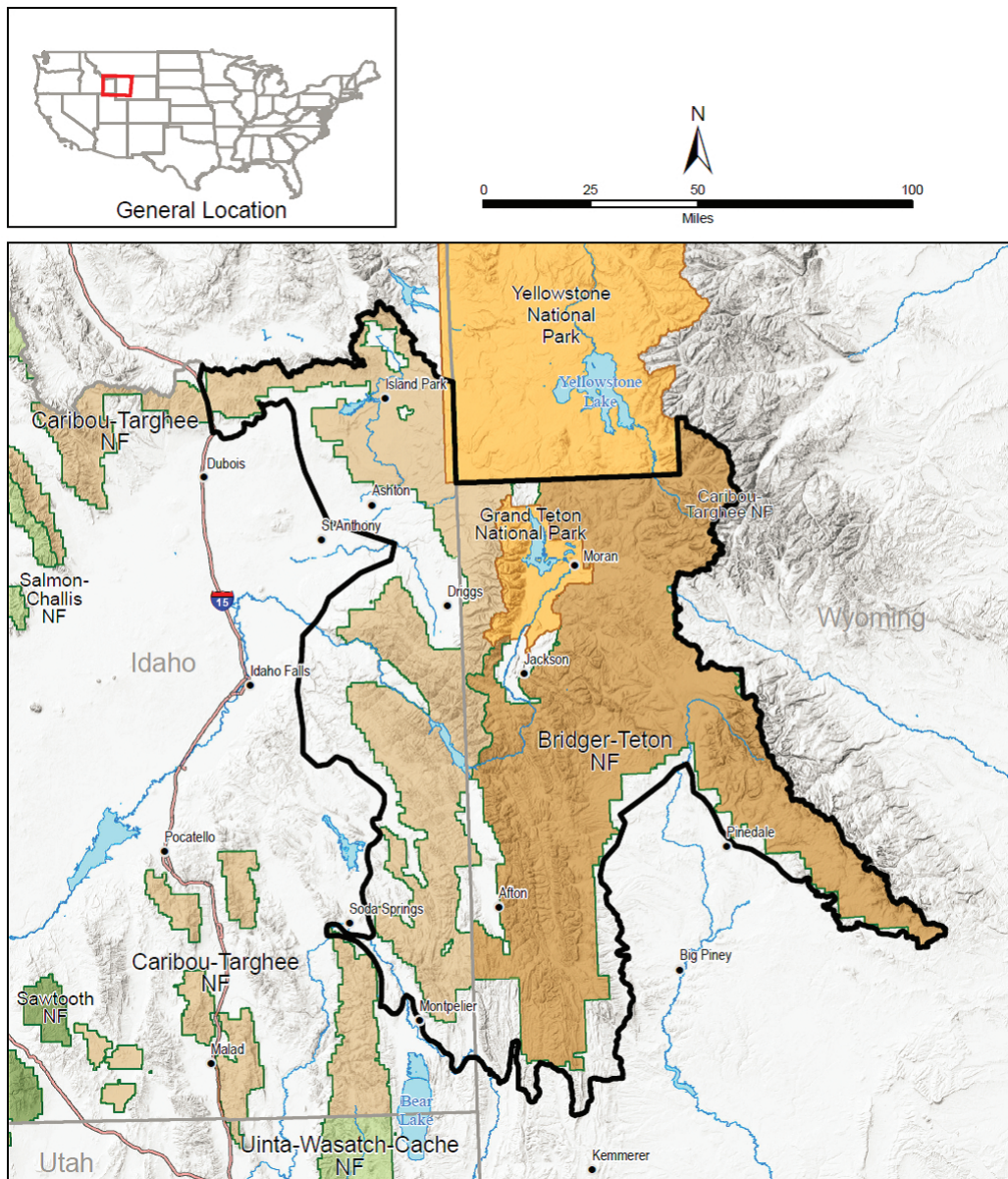


Figure 2.3—National forests and national parks within the Southern Greater Yellowstone subregion of the Intermountain Adaptation Partnership region.

River Range Wilderness in Wyoming, and two smaller wildernesses in Idaho: the Jedediah Smith Wilderness, known for karst limestone formations and caves, and the Wineger Hole Wilderness, which was set aside to protect grizzly bear habitat.

Physiography of this area reflects a wide variety of geologic mountain-building events. The subregion is part of the Greater Yellowstone Area, which extends south from the Centennial Mountains and Yellowstone National Park, through Grand Teton National Park, and southward to include the Wind River Range and Wyoming Range in Wyoming. The Centennial Mountains are a result of uplift and faulting that form steep, high-relief mountain ranges with sharp alpine ridges and cirques at high elevation. Faulting in the Centennial Mountains is fairly recent, and young faults are also present along the western border of Wyoming in the Teton Range, where active block faulting continues today. In the southeastern portions of the subregion, deformation and faulting produced the Wind River Range, with over 2,500 lakes in alpine and piedmont settings. Intermontane valleys include alluvial terraces and floodplains on the valley floor, and glacial till and moraines along the mountain flanks. The Wyoming Range, Caribou Range, and other smaller mountains of southeastern Idaho and western Wyoming were formed from low-angle thrust faulting associated with overthrust belt mountain building. Some smaller areas of volcanic activity produced lava flows and basalt in southeastern Idaho. The volcanic hotspot that underlies present-day Yellowstone National Park created volcanic tuff and tephra deposits in the Absaroka Range, and giant volcanic craters in the Island Park area. Glaciers covered most mountain ranges at times during the Pleistocene, carrying till and debris from the mouths of drainages to produce moraines that were dissected and buried by subsequent erosion and sedimentation from rivers and streams.

As elevation increases in the Southern Greater Yellowstone subregion, average temperatures decrease, and annual precipitation increases (Knight et al. 2014). Mountain ecosystems tend to be cool and moist, although mountain slopes facing south may experience dry environments similar to lower elevations. Direct solar radiation and increased rates of evaporation allow higher elevations to support more arid vegetation, such as mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and grassland species (Knight et al. 2014). Alpine ecosystems are found on the uppermost ridges and peaks, dominated by alpine vegetation and stunted conifers. Subalpine ecosystems are typically coniferous forests with wildflower meadows, lush wetlands, and arid shrublands along mountain flanks (fig. 2.4). Overall, the steep and rugged topography of the mountain ranges provides conditions with 60 to 80 inches of annual precipitation in higher elevations and as little as 15 inches of precipitation at lower elevations. This translates to heavy snowfall at high elevations throughout the subregion, with prevailing winds dispersing snow accumulations on exposed ridges and slopes.

The largest river system in the subregion is the Snake River, including the North, South, and Henry's forks. This system drains to the Columbia River through the Intermountain Semi Desert subregion. To the southeast, the Green River, Sandy River, and Newfork River drain southward to the Colorado River system and the Pacific Ocean, while a small area in the northeastern portion of the subregion drains to the Gulf of Mexico. Smaller rivers, such as the Greys River, Blackfoot River, Portneuf River, and Hoback River, emanate from surrounding mountains and join the larger rivers in the valleys. Numerous reservoirs and piedmont lakes are located along the river network, including Island Park Reservoir in eastern Idaho, Palisades Reservoir near the Idaho-Wyoming border, and several lakes at the base of the Wind River Range.

Vegetation in the Southern Greater Yellowstone subregion varies from high-elevation alpine grasslands and shrublands, through vast coniferous subalpine forests, to sagebrush shrublands and agricultural lands at the lowest

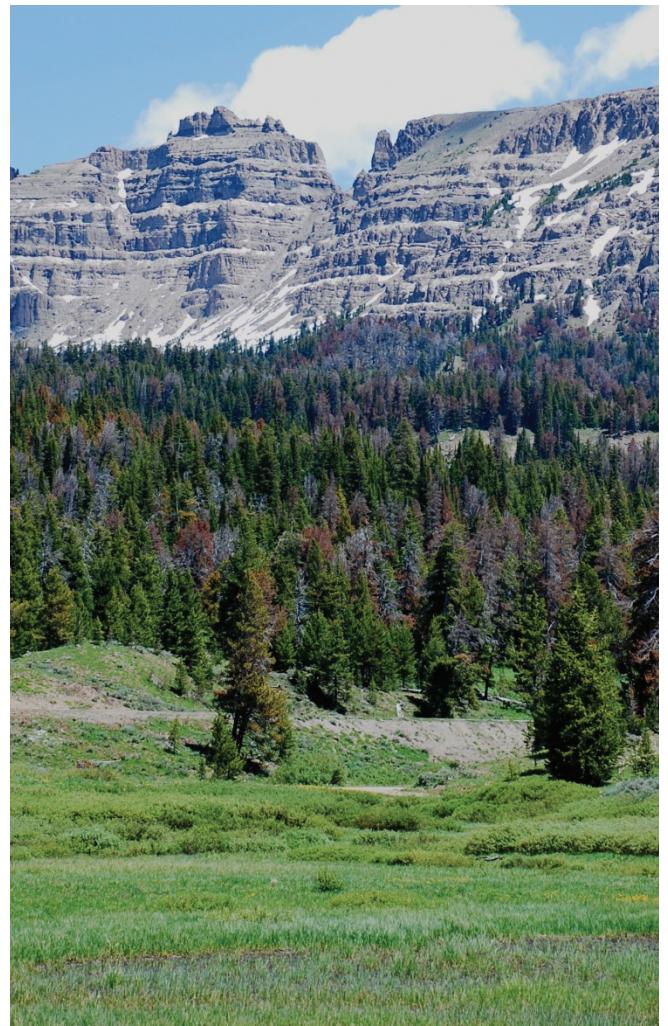


Figure 2.4—Complex mountain topography, alpine meadows, and dense coniferous forests, typical of the Southern Greater Yellowstone subregion of the Intermountain Adaptation Partnership region (photo: U.S. Forest Service).

elevations. At the uppermost elevations, high precipitation (mostly as snow), short growing seasons, and cold temperatures create a harsh environment where only stunted trees and hardy plants survive. Middle elevations are dominated by coniferous forests, typically Douglas-fir, lodgepole pine, Engelmann spruce, and subalpine fir. These forests were historically logged to provide railroad ties for the expanding railroad system to the south. Low elevations are dominated by several species of sagebrush. These areas are used as rangelands for small communities in the winter, as cold weather moves livestock to their lower elevation winter ranges (Blackwell and Reese 2001). In some cases, hay from surrounding agricultural areas is delivered to feed grounds in winter to reduce wildlife mortality. Stands of quaking aspen are found throughout middle elevations, providing important habitat for wildlife and subalpine herbaceous species.

Wildfire plays an important role in maintaining the biodiversity of terrestrial ecosystems. Since the big northern Idaho wildfires in 1910, fire suppression has been implemented to protect urban communities and other resources (Caribou-Targhee National Forest 2005). As a result, many conifer forests are relatively mature, in some locations blending with aspen woodlands, riparian zones, mountain meadows, and sagebrush-grassland habitats. Biodiversity in these ecosystems has decreased, promoting high-severity fires, loss of habitat for bighorn sheep and greater sage-grouse, and western balsam bark beetle (*Dryocoetes confusus*) outbreaks in subalpine fir. Prescribed fire has been implemented in some locations to reduce fuels, improve wildlife habitat, and increase habitat heterogeneity (Caribou-Targhee National Forest 2005).

White pine blister rust and mountain pine beetle have reduced whitebark pine populations near the northern border of the subregion. Whitebark pine provides forage for grizzly bear and black bear (*Ursus americanus*) during the winter. Mountain pine beetle has affected lodgepole pine populations, causing increased mortality throughout the Intermountain West. Douglas-fir and Engelmann spruce stands have suffered stunted growth and mortality from the spread of western spruce budworm.

About 100 species of mammals live within the subregion. Common rangeland and forest species include black bear, Rocky Mountain elk (*Cervus canadensis*), moose, mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), and bighorn sheep. Areas near Yellowstone National Park provide protection for grizzly bear and gray wolf. Small vertebrates include American pika, American beaver, wolverine (*Gulo gulo*), and numerous amphibians. Grassland ecosystems support large areas for livestock grazing. The National Elk Refuge was established in 1912 to provide feed, sanctuary, and habitat for one of the largest elk herds on Earth. In early fall, elk migrate from the surrounding uplands down to Jackson Hole, where hay from the surrounding communities is used as forage for the surviving elk.

Over 350 avian species reside within the subregion. Riparian and forest habitats provide nesting sites for bald eagle, golden eagle, peregrine falcon (*Falco peregrinus*), and other raptors. Greater sage-grouse occupies sagebrush-grassland ecosystems, and is a high-priority species for conservation. Trumpeter swan, sandhill crane (*Grus canadensis*), Canada geese (*Branta canadensis*), and many species of ducks are common in the wetlands of Bridger-Teton National Forest.

World-class fishing is supported along all rivers in the Southern Greater Yellowstone subregion. Cutthroat trout and mountain whitefish (*Prosopium williamsoni*) are indigenous species, whereas brook trout, brown trout (*Salmo trutta*), lake trout, and golden trout (*Oncorhynchus mykiss aguabonita*) have been introduced in many lakes throughout the river system.

Beginning around 11,000 years BP, bands of Shoshone, Blackfoot, and Bannock Indians occupied western portions of the subregion (State of Wyoming 2013). Farther east, nomadic hunters and gatherers migrated throughout the valleys and mountains of the Wind River and Absaroka Ranges. At the beginning of the 19th century, trappers and explorers began to frequent western Wyoming and started trading with the Indian tribes of the area. Over time, Native American tribes were confined to smaller portions of the subregion.

After the Lewis and Clark expedition, John Colter traversed the Continental Divide and descended into Jackson Hole during the winter of 1807–1808 (State of Wyoming 2013). Other settlers soon followed, establishing trading posts along the Wind River, Gros Ventre, Teton, and Wyoming Ranges. Wyoming became the focus for Governmental expeditions, fur trapping, and hunting for the next 30 years. Independent trappers began to appear in the Jackson Hole Valley, changing the socioeconomic trajectory of the area. With increasing settlement of western Wyoming, forest reserves were established to protect water, wood, wildlife, recreation, and forage. These reserves would eventually become the Caribou-Targhee and Bridger-Teton National Forests. The Civilian Conservation Corps contributed to an increase in national forest infrastructure and expansion of the timber industry. Timber has remained an important component of local economies, although the volume of harvests has decreased greatly in the past 30 years. Thinning is now used to reduce stand densities and improve wildlife habitat.

The gold rush of 1870, when gold was found near Caribou Mountain, sparked a 20-year run of gold mining in eastern Idaho and western Wyoming, after which mining of phosphate deposits for fertilizers was conducted in the Caribou-Targhee National Forest for 50 years. Recently, exploration for oil and gas reserves has been conducted along the southern portion of the subregion, mostly in the surrounding basins.

Tourism is a vital industry in the area, with Jackson Hole serving as a major entrance for millions of visitors each year to Grand Teton and Yellowstone National Parks. The Grand Targhee and Jackson Hole resorts attract skiers from around

the world. Other activities, such as camping, hunting, and fishing, are popular summer activities for visitors to the subregion.

Uintas and Wasatch Front Subregion

The northern portion of the Uintas and Wasatch Front subregion includes the Albion, Black Pine, Raft River, and Sublett Mountains along the Idaho-Utah border. Sagebrush and grasslands dominate the low to middle elevations that surround islands of higher elevation coniferous forests. Farther south, the rugged Wasatch Front is the western border of the subregion, with high ridges and an abrupt transition from high desert to alpine ecosystems (fig. 2.5). National forests in the subregion are the Uinta-Wasatch-Cache National Forest, Ashley National Forest, and southern portions of the Sawtooth and Caribou-Targhee National Forests (fig. 2.6). Over 600,000 acres are dedicated to wilderness, including the Wellsville Mountain Wilderness. The Curlew National Grassland encompasses over 47,000 acres.

The complex topography of the subregion has resulted from millions of years of mountain building, sedimentation, and erosion. Warm, shallow water once covered the area of the Wasatch and Uinta Mountains, depositing thick layers of fossil-bearing gray sediment. Once compression of the North American Plate began, thrust faulting and buckling on the eastern half of the Wasatch Front created highly deformed mountain ranges that shed sediment into the lower valleys to create the sandstone and limestone valleys of the present day (Atwood 2012). Local and regional uplift brought the landscape to its current position, allowing rivers and glaciers to carve steep slopes and deposit high volumes of sediment within the surrounding basins and ranges. The

Wasatch fault displays faulting along the base of the steep Wasatch Front where fault scarps have displaced beach deposits of ancient Lake Bonneville. This lake was the larger precursor to the present-day Great Salt Lake, forming from meltwaters during warming periods of the Pleistocene.

Near the southeastern corner of the subregion, the Green River flows into Flaming Gorge Reservoir, continuing southeastward and emerging near Vernal, Utah. Numerous tributaries that run through the Ashley and Uinta-Wasatch-Cache National Forests provide water for critical watersheds, including Strawberry Reservoir, where diversions and tunnels carry the water from the Uinta Basin and the Colorado River drainage to the Wasatch Front for agricultural and municipal use.

The northern portion of the subregion has hot summers with little precipitation and winters that receive high amounts of precipitation at higher elevations, but less at lower elevations. The southern portion experiences both dry summer and wet winter patterns, as well as wet summer and dry winter patterns (Shaw and Long 2007). The western portion of the subregion has average summer temperatures above 90 °F and average winter temperatures below 20 °F. The eastern portion typically experiences wet summers and dry winters, with annual precipitation as low as 7 to 10 inches at lower elevations.

Coniferous forests are prominent in the southern portions of the subregion, especially in the Wasatch and Uinta Mountains. Scattered patches of coniferous forests occur along the middle to high slopes of the northern mountain ranges, which are surrounded by sage-steppe ecosystems in valleys. Dominant conifer species, including subalpine fir, Engelmann spruce, lodgepole pine, and Douglas-fir, account for a large proportion of the forest types (Heyerdahl et



Figure 2.5—U-shaped valleys, rugged mountain ranges, scattered alpine lakes, and dense coniferous forests, which are common in the Uintas and Wasatch Front subregion of the Intermountain Adaptation Partnership region (photo: U.S. Forest Service).

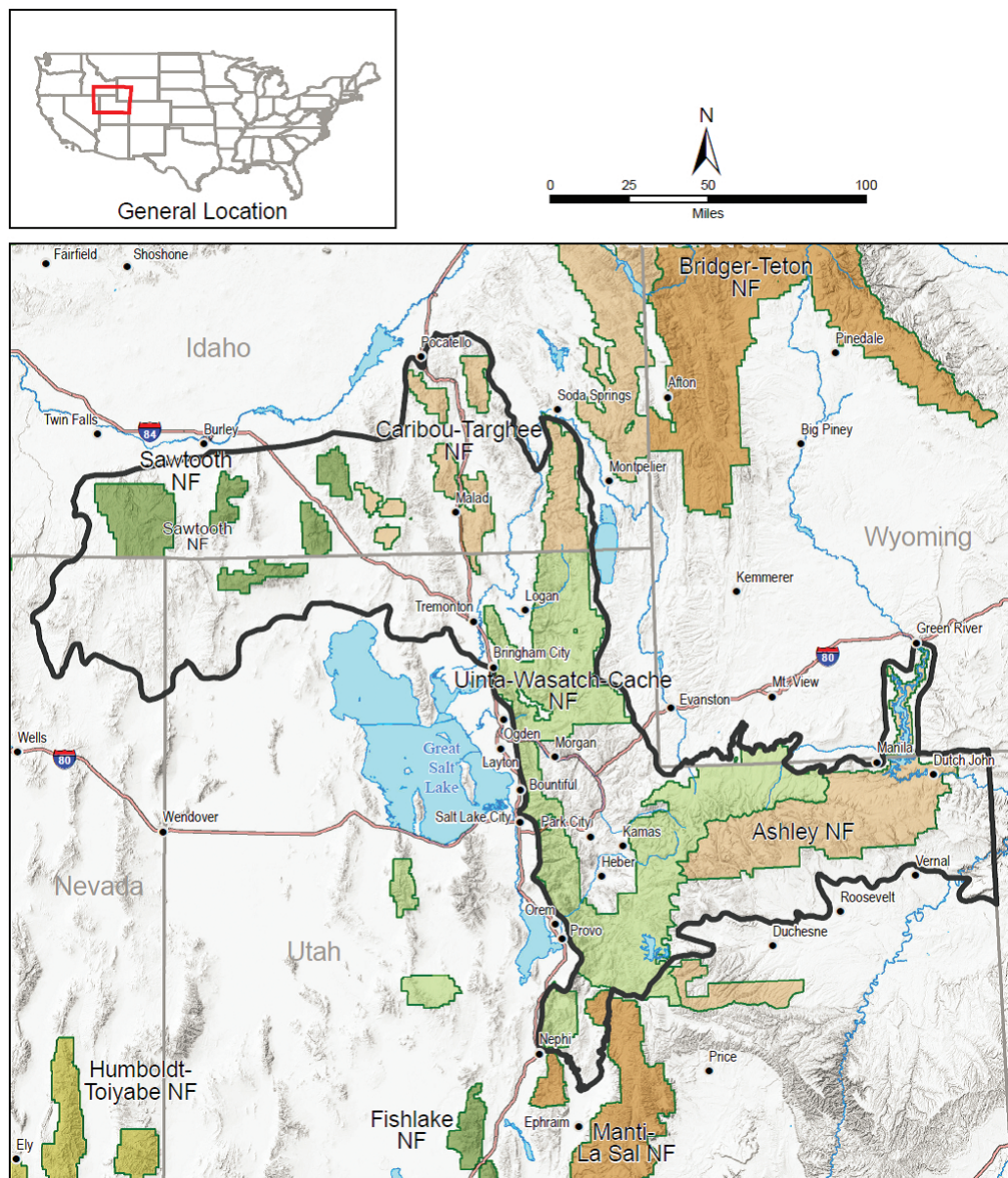


Figure 2.6—National forests within the Uintas and Wasatch Front subregion of the Intermountain Adaptation Partnership region.

al. 2011). Utah juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulis*) occupy arid, shallow, and rocky soils at lower elevation. Lower elevations also provide habitat for Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and mountain big sagebrush, as well as bluebunch wheatgrass, bottlebrush squirreltail (*Elymus elymoides*), Sandberg bluegrass (*Poa sandbergii*), and Thurber's needlegrass (*Achnatherum thurberuanum*). These shrub-steppe systems provide habitat for small fauna, ungulates, and local populations of greater sage-grouse.

Wildfire regimes influence the overall health and biodiversity of all ecosystems, with most fires occurring during July through October (Morris 2006). Fire exclusion in the Wasatch Range and Uinta Mountains has mixed conifer forests that are relatively mature and dense with high fuel loadings, making them susceptible to crown fire. Low-vigor stands in Uinta-Wasatch-Cache National Forest provide suitable conditions for bark beetle outbreaks, such as the

outbreak in 1980 when beetle populations were extremely high and conditions for beetle survival were optimum (Shaw and Long 2007). These forests have been subject to outbreaks by mountain pine beetle and other beetle species during the past 15 years.

Moose are common in wetlands of most intermontane valleys. Mountainous topography provides habitat for elk, black bear, bighorn sheep, mule deer, and small populations of mountain goats (*Oreamnos americanus*). Sensitive species within the Albion Range include mountain lion (*Felis concolor*) and Canada lynx. Small vertebrates include lizards, rattlesnakes, sagebrush vole (*Lemmyscus curtatus*), and muskrat (*Ondatra zibethicus*).

Rivers, streams, creeks, and reservoirs throughout the Uintas and Wasatch Front subregion support both native and nonnative fish. Colorado River cutthroat trout (*O. clarkii pleuriticus*) is native to the Green River watershed, and the Bonneville cutthroat trout (*O. c. utah*) is native to

other drainages. These species attract anglers from around the world for recreational fishing. Nonnative fish include numerous trout and bass species, kokanee salmon (*O. nerka*), walleye (*Sander vitreus*), and yellow perch (*Perca flavescens*).

Numerous avian species inhabit various ecosystems of the subregion. Olive-sided flycatcher (*Contopus cooperi*), chipping sparrow (*Spizella passerina*), and chickadees (*Poecile* spp.) are common in subalpine forests. Raptors, including red-tailed hawk (*Buteo jamaicensis*), golden eagle, and bald eagle, populate low rangelands that border the mountains. Along the Wasatch Front, hermit thrush (*Catharus guttatus*), fox sparrow (*Passerella iliaca*), mountain bluebird (*Sialia currucoides*), and sandhill crane are common near small reservoirs and streams. In the Uinta Mountains, alpine habitat is occupied by pine grosbeak (*Pinicola enucleator*), three-toed woodpecker (*Picoides dorsalis*), and gray jay (*Perisoreus canadensis*). Many species of shorebirds and waterfowl populate reservoirs across the subregion.

Native American tribes once lived throughout the area. In 1500, the Northern Utes occupied central Utah, western Colorado, southern Wyoming, and northern New Mexico. Utah Valley with its abundant supply of fish and other natural resources supported most of the population (Simmons 2000). With the acquisition of horses in 1600, the Utes were able to extend their range and travel to the Great Plains to hunt American bison (*Bison bison*). The Uintah and Ouray Indian Reservation is now home to the Ute Tribe and is situated south of the Ashley National Forest.

Agriculture accounts for a large portion of the economy. The animal industry is the single largest sector of farm income in Utah. River valleys and cultivated fields provide fertile soils for the production of hay, corn, barley, and a variety of fruit. Orchards of apples, apricots, and peaches are scattered throughout the subregion and concentrated along the Wasatch Front. In the southeastern portion of the subregion, melons and other fruits provide economic benefits to smaller communities. Specialty products such as soap and honey also contribute agricultural income in some communities.

Watersheds throughout the subregion are an important source of water for municipal, industrial, and recreational use, and for hydroelectric power. Flaming Gorge National Recreation Area, Strawberry Reservoir, and other smaller reservoirs provide these water resources, as well as popular destinations for recreation. Watershed and groundwater management are a component of resource management for urban populations along the Wasatch Front; water supplies are decreasing with increasing urban populations, making water conservation a significant concern. The Bear River, Jordan River, Weber River, and Ogden River are sources for this water, relying on dams and diversions to create power and allocate water resources. Regulations restricting construction, wastewater, and livestock operations help ensure adequate water supplies and water quality, although

overdraft has occurred in aquifers in northern Utah since 1985 (Burden 2015).

Mining projects have been proposed throughout the subregion, including sites that are focused on hard rock such as gold or copper mining, and soft rock such as phosphate mining. Drilling for oil and gas has expanded, including proposed drilling of up to 400 new wells over a 20-year period in the Vernal Basin area. About 50 active oil and gas wells are currently in national forest lands within the subregion. Coal mining is a major industry, with coal fields scattered throughout the subregion. Tourism continues to provide economic stimulus to many mountainous areas along the Wasatch Front. Several world-class ski resorts such as Snowbird, Alta, and Park City serve local and international enthusiasts. Snowbasin and Park City hosted the 2002 Olympic Games.

Plateaus Subregion

The Plateaus subregion covers the southern half of Utah and a small portion of western Colorado, including Ashley, Manti-La Sal, Fishlake, and Uinta-Wasatch-Cache, Dixie National Forests, as well as Zion, Bryce Canyon, Capitol Reef, Arches, and Canyonlands National Parks (fig. 2.7). Rugged mountain landscapes contrast with the red-rock desert of Utah badlands, where millions of years of erosion have carved steep canyons and intricate rock formations through the sandstone and carbonate composition of the Colorado Plateau. About 150,000 acres are devoted to wilderness. Mountain ranges, plateaus, cliffs, and canyons characterize the rugged landscape (fig. 2.8), providing recreational and economic benefits for surrounding communities.

In the northwestern portion of the Plateaus subregion, Manti-La Sal National Forest contains the La Sal, Manti, North Horn, and Abajo Mountains. Rugged topography, alpine meadows, and forests cover these north-south trending ranges. The Tushar Mountain Range in Fishlake National Forest provides the basin for Fish Lake, which is a popular location for summer activities. Dixie National Forest contains white cliffs, red canyons, and several mountain peaks covered by dense forests and desert shrublands. Sedimentary rocks are pronounced at Cedar Breaks National Monument and at adjacent national parks, Glenwood Canyon National Recreation Area, and Grand Staircase-Escalante National Monument.

The major river network in the Plateaus subregion belongs to the Green and Colorado River system. Major tributaries flow through the surrounding lowlands and empty into Lake Powell. The Dirty Devil, Virgin, and San Juan Rivers are smaller tributaries that are locally important. The north-to-south running Green River joins the Colorado River in Canyonlands National Park. The Colorado River then flows to the southwest, carving steep cliffs through sandstone bedrock and continuing into Arizona. Glen Canyon National Recreation Area contains the second largest reservoir in the United States, providing hydroelectric power, water resources, and recreation. The westerly

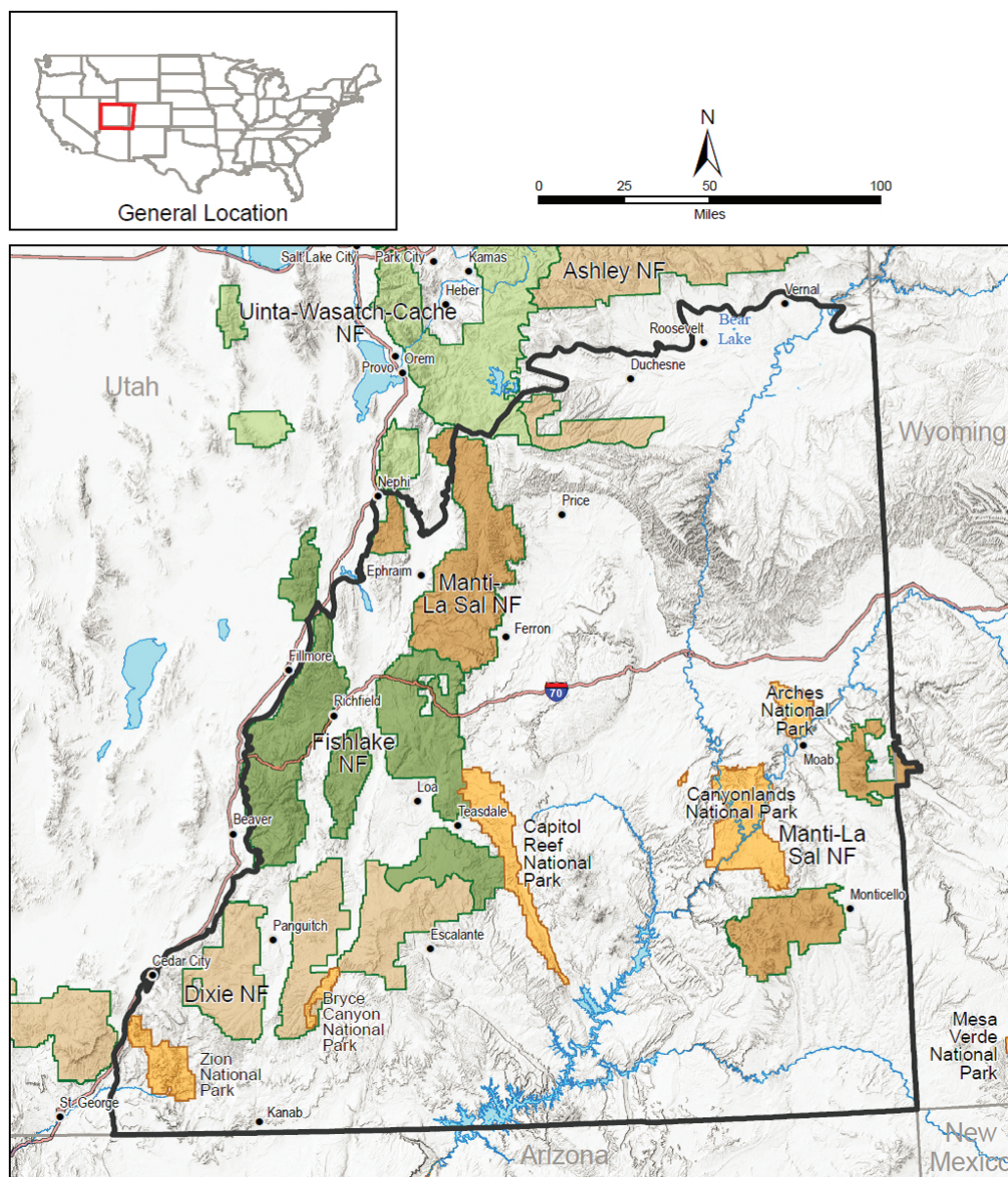


Figure 2.7—National forests and national parks within the Plateaus subregion of the Intermountain Adaptation Partnership region.



Figure 2.8—A red-rock landscape in the Plateaus subregion of the Intermountain Adaptation Partnership region. Steep cliffs line canyons that have been powerfully eroded throughout geologic history (photo: U.S. Forest Service).

flowing San Juan River begins in southwestern Colorado, flowing southeast until it meets the Colorado River near the mouth of Glen Canyon.

The Colorado Plateau is the dominant physiographic feature of this area, characterized by isolated buttes, mesas, plateaus, steep escarpments and cliffs, and gently folded sedimentary rocks. Several small mountain ranges such as the La Sal Mountains and Henry Mountains provide higher elevations from the surrounding lowlands, supplying water to the tributaries. Millions of years of evaporate deposition, folding, wind and water erosion, and salt deformation formed the diverse landscape. Between 70 and 265 million years BP, a shallow marine depositional environment covered the Colorado Plateau, forming limestone, sandstone, shales, marine fossils, and salt deposits (Harris et al. 1997).

Erosion processes, such as by wind and rivers, shaped the bedrock and topography of this area. Stream incisions dissect this relatively flat area through down-cutting and headward erosion processes. Melting of Pleistocene glaciers provided large volumes of water to be carried throughout the Colorado River network, and incised drainages. As uplift continued, river incision further carved deep canyons throughout the flat landscape, creating landmarks that can be observed today (Harris et al. 1997). Strong winds have eroded the smooth arches and other geologic formations in Arches National Park and Natural Bridges National Monument (Harris et al. 1997).

Dominant ecosystems of the Plateaus subregion include coniferous and deciduous forests at higher elevations, and woodlands, mountain shrub communities, sagebrush shrublands, grasslands, and desert ecosystems at lower elevations. Other more isolated ecosystems are also important including riparian wetlands, and unique niches within the associated canyons, cliffs, and talus slopes. High mountain ranges support subalpine ecosystems of coniferous and deciduous forests throughout the western portion of the subregion and in the La Sal and Henry Mountains. Coniferous forests of ponderosa pine, Douglas-fir, white fir (*Abies concolor*), Engelmann spruce, and limber pine occupy mid- to upper slopes. Mountain shrub communities intermix with forests, and are dominated by understory layers of mountain big sagebrush, Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), common snowberry (*Symphoricarpos albus*), and serviceberry (*Amelanchier alnifolia*). Deciduous woodlands of pinyon pine, Utah juniper, quaking aspen, and Gambel oak (*Quercus gambelii*) exist throughout the subregion and mix with the sagebrush shrublands and agricultural grassland ecosystems at lower elevations. These stands contain understory layers of black sagebrush (*Artemisia nova*), mountain big sagebrush, and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) (Mohlenbrock 2006). Utah juniper has encroached into sagebrush areas, depleting habitat of greater sage-grouse. Riparian areas create hotspots of biodiversity for flora and fauna, and help moderate flooding, sediment deposition, and water temperature (Knight et al. 2014). Riparian ecosystems are vulnerable to damage from livestock grazing and construction activities for roads and

other infrastructure (Utah Division of Wildlife Resources 1991).

Some 480 plant species are found in the subregion. Common shrubs include mountain big sagebrush, black sagebrush, greenleaf manzanita (*Arctostaphylos patula*), fourwing saltbush (*Atriplex canescens*), rubber rabbitbrush (*Ericameria nauseosa*), antelope bitterbrush (*Purshia tridentata*), Mormon tea (*Ephedra viridis*), and greasewood (*Sarcobatus vermiculatus*) (Mohlenbrock 2006). Grasses include Salina wildrye (*Leymus salinus*), galleta (*Hilaria jamesii*), and purple three-awn (*Aristida purpurea*) (West 1983). Many of these species are tolerant of high salt concentration in low-elevation soils, especially ancient lake beds.

A particularly fragile feature of desert ecosystems is known as a “cryptobiotic crust.” Cyanobacteria and other organisms create these crusts on the soil surface where they live and retain carbon, fix nitrogen, and stabilize soil. These crusts thicken through time, providing nutrients to the dry soil below. The crust is vulnerable to disturbances (e.g., human footprints, vehicles) that disrupt its structure and reduce plant growth.

Large mammal species include mule deer, bighorn sheep, elk, mountain lion, black bear, and coyote (*Canis latrans*). Smaller vertebrates include red squirrel (*Tamiasciurus hudsonicus*), hoary bat (*Lasiurus cinereus*), pinyon mouse (*Peromyscus truei*), and desert cottontail (*Sylvilagus audubonii*). Bird species include red-tailed hawk, northern goshawk (*Accipiter gentilis*), Cooper’s hawk (*A. cooperi*), wild turkey (*Meleagris gallopavo*), boreal owl (*Aegolius funereus*), and numerous warblers. Amphibians and reptiles include tiger salamander (*Ambystoma tigrinum*) and milk snake (*Lampropeltis triangulum*) (West 1983).

The Plateaus subregion contains diverse fisheries in streams, lakes, and reservoirs. Common species of fish include rainbow trout (*Oncorhynchus mykiss*), cutthroat trout, lake trout, brook trout, speckled dace (*Rhinichthys osculus*), desert sucker (*Catostomus clarki*), and yellow perch. The Virgin River system provides habitat for the rare Virgin River chub (*Gila seminuda*), Virgin River spinedace (*Lepidomeda mollispinis*), and woundfin (*Plagopterus argentissimus*). Nonnative fish, stream diversions, and poor water quality have reduced the abundance of these species.

Native Americans arrived in the Plateaus subregion around 12,500 years BP. Hunting of mammoths, giant sloths, and American bison sustained these peoples until the megafauna became extinct around 8,000 years BP, when the Puebloan people emerged and populated the entire region (Hatt 2014). Native Americans had diverse lifeways focused on hunting, fishing, food gathering, and eventually agriculture. Near the end of the 19th century, pioneers began to settle southeastern Utah for mineral extraction, farming, and ranching (Hatt 2014). Native American populations were greatly reduced following Euro-American contact. Currently, the Ute Indians and Navajo Nation have large reservations within the subregion.

Geologic evolution of the subregion created extensive deposits of coal, oil, gas, tar sands, oil shale, uranium, and

potash (Hatt 2014). Coal beds have allowed the subregion to become a major contributor to U.S. energy production. On a local scale, coal, oil, and gas industries support economic development. Renewable energy sources include wind, hydroelectric, geothermal, and solar (Hatt 2014). In 2010, Ashley National Forest sold more than 1.3 million cubic feet of timber (Ashley National Forest 2010), representing a significant source of income for local communities.

National parks, national forests, and other lands contribute significantly to the tourism economy of the Plateaus subregion, attracting millions of visitors, of which two-thirds are from out of state. Diverse landscapes from alpine forests to the red-rock deserts provide a wide range of attractions for recreation and tourism. Summer offers hunting, fishing, hiking, mountain biking, and off-road travel, and winter attracts skiers, snowmobilers, and other winter sport enthusiasts.

Great Basin and Semi Desert Subregion

The Great Basin and Semi Desert subregion is the largest subregion, occupying over 100 million acres, and covering most of Nevada, the western half of Utah, small sections of southern Idaho, and portions of east-central California (fig. 2.9). Sections of Humboldt-Toiyabe National Forest are distributed throughout Nevada and parts of east-central California. The western half of the Dixie National Forest and the northern tip of the Fishlake National Forest are included near the eastern border of the subregion.

Between 300 and 800 million years BP, deep oceans covered western Utah, depositing limestone and dolomite sediments. These deposits were buried by thick layers of shale, forming large coal beds that underlie much of the subregion. Between 18 and 40 million years BP, volcanism formed large calderas, cinder cones, and lava flows throughout Nevada and western Utah. Large areas of mineral deposits (silver, gold, molybdenum, zinc, beryllium, iron, and copper) were formed in hydrothermal veins and host rock. Around 65 million years BP, Utah began to

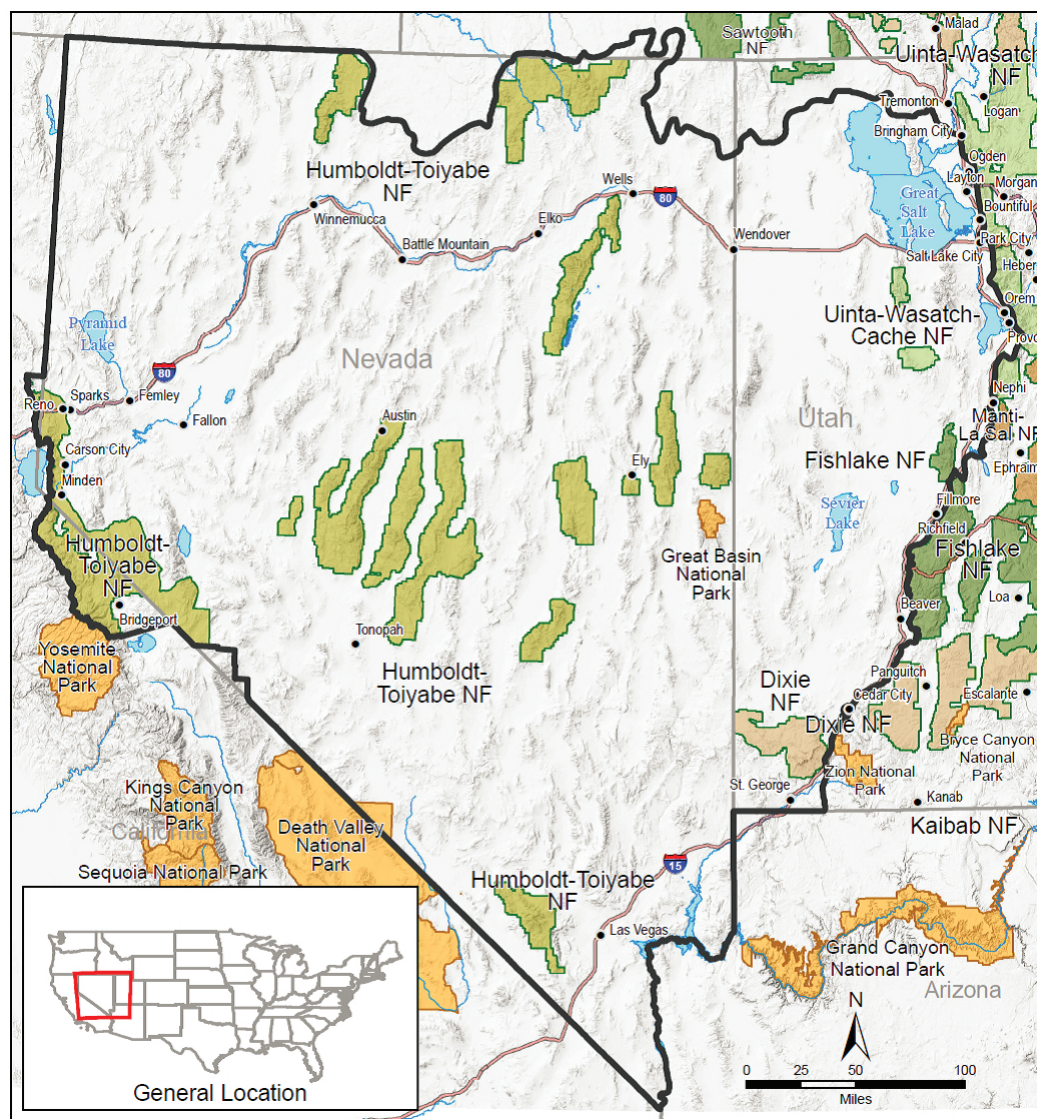


Figure 2.9—National forests and national parks within the Great Basin and Semi Desert subregion of the Intermountain Adaptation Partnership region.

sink and extensional faulting produced the basin-and-range topography of the Great Basin (Black 2011). More than 150 different mountain ranges are scattered throughout Nevada and Utah, including the Schell Creek Range, Toiyabe Range, Ruby Mountains, Shoshone Mountains, and Snake Range. These mountains are typically isolated and surrounded by intervening lowlands.

Around 10,000 years BP, melting glaciers of the Rocky Mountains and Sierra Nevada filled valleys of the Great Basin (Black 2011). Lake Bonneville and Lake Lahontan formed, covering most of western Utah. As climate warmed, both lakes evaporated and left remnant lakes (e.g., Sevier Lake and the Great Salt Lake from Lake Bonneville), as well as numerous dry playas.

Climate in the Great Basin and Semi Desert subregion is mostly desert and semiarid. The high Sierra Nevada traps moisture coming from the Pacific Ocean, creating a significant rain-shadow effect that makes Nevada the driest State in the United States. Average temperatures in northwestern Nevada are about 50 °F, with hot, dry summers and moderately cool winters (WRCC 2016). Farther south, average temperatures are about 65 °F; summers are long and hot, and winters are short and mild. Little precipitation falls in the southern part of the subregion, whereas the northwestern portion receives more precipitation because of proximity to the Sierra Nevada.

The Humboldt, Colorado, Sevier, and Truckee Rivers are the major river networks in the subregion. Smaller river networks include the Carson and Walker Rivers. Supplied with water from the Rocky Mountains to the north and east, the Colorado River flows in the southeastern portion of the subregion. The Humboldt River runs 290 miles through northern Nevada (the longest U.S. river that exists entirely within one State), and drains into the Humboldt Sink, a playa in western Nevada. The headwaters of the Humboldt River drain the East Humboldt and Jarbidge Ranges, and

the river continues westward, gathering water from scattered tributaries along the way during the spring and losing surface water to groundwater during much of the rest of the year. The Sevier River is Utah's longest river, flowing 279 miles through western Utah and emptying into the nearly dry Sevier Lake (Seligman et al. 2008).

With elevations ranging from 4,100 to 13,065 feet, the Great Basin and Semi Desert subregion exhibits a broad spectrum of ecosystems. High elevations contain a mixture of alpine, subalpine, woodland, riparian, and shrub habitats. Subalpine ecosystems include quaking aspen woodlands, coniferous forests, pinyon-juniper woodlands, and mountain shrublands. Aspen woodlands dominate more than 250,000 acres and are commonly found between 5,200 and 10,500 feet, providing wildlife habitat, areas for livestock grazing, and recreation opportunities. Lower elevations are dominated by sagebrush-steppe ecosystems (fig. 2.10), which encompass most of the subregion, and include numerous small spring-fed riparian and wetland areas.

Mountain shrub communities of mountain big sagebrush, serviceberry, Gambel oak, and many other species occupy mountain slopes at 5,000 to 9,000 feet elevation. These are the most widespread communities in the subregion, providing nesting, food resources, and shelter for many vertebrate and invertebrate species. Riparian zones are common along the lower portions of the mountain ranges in Humboldt-Toiyabe National Forest. Springs, rivers, creeks, and lakes offer moist conditions for grasses and forbs and habitat for mammals, migratory songbirds, and wildflowers.

Coniferous forests, including bristlecone pine (*Pinus longaeva*), limber pine, whitebark pine, and ponderosa pine, occur at mid- to high elevations. In the eastern Sierra Nevada, coniferous forests also include Jeffrey pine (*Pinus jeffreyi*), lodgepole pine, western white pine, Douglas-fir, white fir, and Shasta red fir (*Abies magnifica*). Pinyon-juniper woodlands exist at middle elevations, dominated

Figure 2.10—Sagebrush and desert shrub habitats characteristic of the Great Basin and Semi Desert subregion of the Intermountain Adaptation Partnership region (photo: U.S. Geological Survey).



by pinyon pine and Utah juniper. These woodlands provide habitat for mule deer, desert cottontail, pinyon jay (*Gymnorhinus cyanocephalus*), and Clark's nutcracker (*Nucifraga columbiana*). Expansion of pinyon-juniper woodlands has displaced some shrub-steppe habitat, and cutting and mechanical treatments are used to control the extent of woodlands in some locations.

Sagebrush is common throughout the Great Basin and Semi Desert subregion, providing habitat for sage sparrow (*Artemisiospiza belli*), sage thrasher (*Oreoscoptes montanus*), loggerhead shrike (*Lanius ludovicianus*), burrowing owl (*Athene cunicularia*), and greater sage-grouse. Both large and small vertebrates, including pronghorn and mule deer, inhabit sagebrush ecosystems.

Other large mammals in this subregion include desert (*Ovis canadensis nelsoni*), California (*O.c. californiana*), Rocky Mountain (*O.c. canadensis*), and Sierra Nevada (*O.c. sierra*) bighorn sheep; elk; mountain goat; black bear; and mountain lion. Small mammals include several species of rabbits, Sierra Nevada red fox (*Vulpes vulpes necator*), coyote, bobcat (*Lynx rufus*), Palmer's chipmunk (*Tamias palmeri*), American marten (*Martes americana*), and numerous bat species. Wild horses and burros are common across the entire State, competing with wildlife and livestock for scarce forage. Birds in the subregion include greater sage-grouse, goshawk, California spotted owl (*Strix occidentalis occidentalis*), great gray owl (*Strix nebulosi*), flammulated owl (*Psiloscops flammeolus*), burrowing owl (*Athene cunicularia*), red-tailed hawk, golden eagle, prairie falcon (*Falco mexicanus*), and Cooper's hawk.

Many fish species occupy streams and major rivers in the subregion. Rivers and streams of eastern Nevada contain Bonneville cutthroat trout, interior redband trout (*Oncorhynchus mykiss gairdneri*), and bull trout. The Sevier River contains primarily brown trout, rainbow trout, and cutthroat trout. Lahontan cutthroat trout (*O. clarkii henshawi*), a Federally listed threatened species, occurs in isolated mountain streams throughout much of Nevada. Silver King Creek in California contains the only population of Paiute cutthroat trout (*O. clarkii seleniris*).

Desert ecosystems support Pacific tree frog (*Hyla regilla*), Columbia spotted frog (*Rana luteiventris*), and red-spotted toad (*Bufo punctatus*). The mountain yellow-legged frog (*R. muscosa*) and Yosemite toad (*B. canorus*) occupy the higher elevations in the far western part of the subregion. Reptiles include side-blotched lizard (*Uta stansburiana*), zebra-tailed lizard (*Callisaurus draconoides*), Great Basin collared lizard (*Crotaphytus bicinctores*), coachwhip (*Masticophis flagellum*), speckled rattlesnake (*Crotalus mitchellii*), and Gilbert's skink (*Plestiodon gilberti*) (Knight et al. 2014). Many species of hummingbirds and small songbirds populate both desert and mountain ecosystems (Knight et al. 2014).

Wildfire regimes in the subregion have been altered where nonnative species have proliferated following fire. At the end of the 19th century, cheatgrass was introduced to the shrublands. This species is highly flammable, increases the

spread rate of wildfires, and regenerates quickly after fire, outcompeting sagebrush and other perennial species (Blank et al. 2008). Public policy has encouraged fire suppression throughout the subregion, which has resulted in single-age sagebrush habitats that lack herbaceous and perennial grass species (Blank et al. 2008). Some shrub cover is so dense that biodiversity is low within these habitats.

Before Euro-American settlement, Native American tribes claimed lands that are now in Humboldt-Toiyabe and Dixie National Forests. In the Nevada portion of the area, the ancestral land of the Southern Paiute, Northern Paiute, Western Shoshone, and Washoe Indians has been inhabited for over 4,500 years. The Fremont, Anasazi, and Paiute Indians inhabited what is now Dixie National Forest. Several Indian reservations occupy the area, including those for the Summit Lake Paiute Tribe, Pyramid Lake Paiute Tribe, Walker River Paiute Tribe, Moapa Band of Paiute Indians, Goshute Confederated Tribes, Te-Moak Tribe of Western Shoshone Indians-South Fork band, Skull Valley band of Goshute Indians, Paiute Indian Tribes-Shivwits band, and a portion of the Shoshone-Paiute Tribe.

The 19th-century California gold rush brought Euro-American settlers to the area. Emigrant roads and trails connected mining towns, logging sites, and stagecoach stops throughout the region. Industries and economic pressure grew with continued settlement of the American West throughout the 19th century. Nevada leads the country in production of gold, barite, diatomite, and mercury, and is the only State that produces magnesite, lithium, and specialty clays (Price 2004).

Oil and gas reserves lie below the eastern part of the subregion. The National Forest System evaluates lands for drilling potential in accordance with the Federal Onshore Oil and Gas Leasing Reform Act of 1987 (Dixie National Forest 2011). Drilling is allowed within some areas of Dixie National Forest and Humboldt-Toiyabe National Forest, excluding designated wilderness, although no drilling has been conducted on Dixie National Forest since 1987. Most expressions of interest in drilling have been processed by the Bureau of Land Management for its lands adjacent to national forests.

Several prominent conservation issues influence resource management in this subregion. Humboldt-Toiyabe National Forest is home to over 800 wild horses and burros. The Wild Free-Roaming Horses and Burros Act of 1971 (Public Law 92-195) protects wild horses and burros of the American West, but competition for forage and water resources with domestic livestock is controversial. Fragmentation and loss of sagebrush habitat have made the Columbia spotted frog a candidate endangered species, susceptible to extirpation in some areas. Protection of the species has been implemented in the greater Humboldt River watershed of central and northeastern Nevada. Conservation of greater sage-grouse, one of the highest profile natural resource issues in the West, is influenced by the loss of sagebrush ecosystems, with declining populations of sage-grouse in Nevada and Utah. Methods to sustain both the habitat and population of

sage-grouse include restoration of shrub-steppe ecosystems and control of nonnative species (Nevada Department of Wildlife 2013).

Intermountain Semi Desert Subregion

The Intermountain Semi Desert subregion covers 5.5 million acres. No national forests are located here, although 500,000 acres of wilderness area have been reserved, along with Craters of the Moon National Monument and Idaho National Laboratory in the north-central part of the subregion (fig. 2.11).

The western half of the subregion contains the Snake River Plain and Camas Plain. Uplands consist of the Owyhee Plateau located along the Idaho-Nevada border, and the Blackfoot Mountains. Flat plateaus and volcanic plains dotted with cinder cones and other volcanic remnants characterize the landscape. Deep river canyons, granite domes, and rugged peaks distinguish the Owyhee Mountains from the low-lying areas along the Snake River to the north, where basalt sheets underlie the irrigated plains. The eastern half of the subregion begins just north of the junction with Idaho, Utah, and Wyoming, extending west into the Great

Basin. Desert habitats are uniformly distributed throughout the plains and plateaus.

The northwestern corner of the subregion typically has the same maritime climate trends as northern and central Idaho. Within the Snake River Plain, the climate is influenced by warm, dry Pacific air masses and cold, moist Arctic air masses that converge from western and northern directions, respectively. This interaction allows for freezing winter temperatures, summer thunderstorms, and hot, humid summers. The Snake River Plain and the area south to the Nevada/Idaho border receive an average of 10 to 15 inches of precipitation annually (Chandler 2003). However, the higher elevation Owyhee Mountains receive more precipitation and prolonged freezing temperatures during the winter. The Blackfoot Mountains have cool, dry winters and hot, dry summers.

The South Fork of the Boise River runs westward across the northwestern corner of the Intermountain Semi Desert subregion, joining the North and Central Forks of the Boise River at Arrow Rock Reservoir. Originating from the north-eastern corner of the subregion, the Snake River cuts across the middle of the Snake River Plain from the Southern Greater Yellowstone subregion to the Oregon-Idaho border.

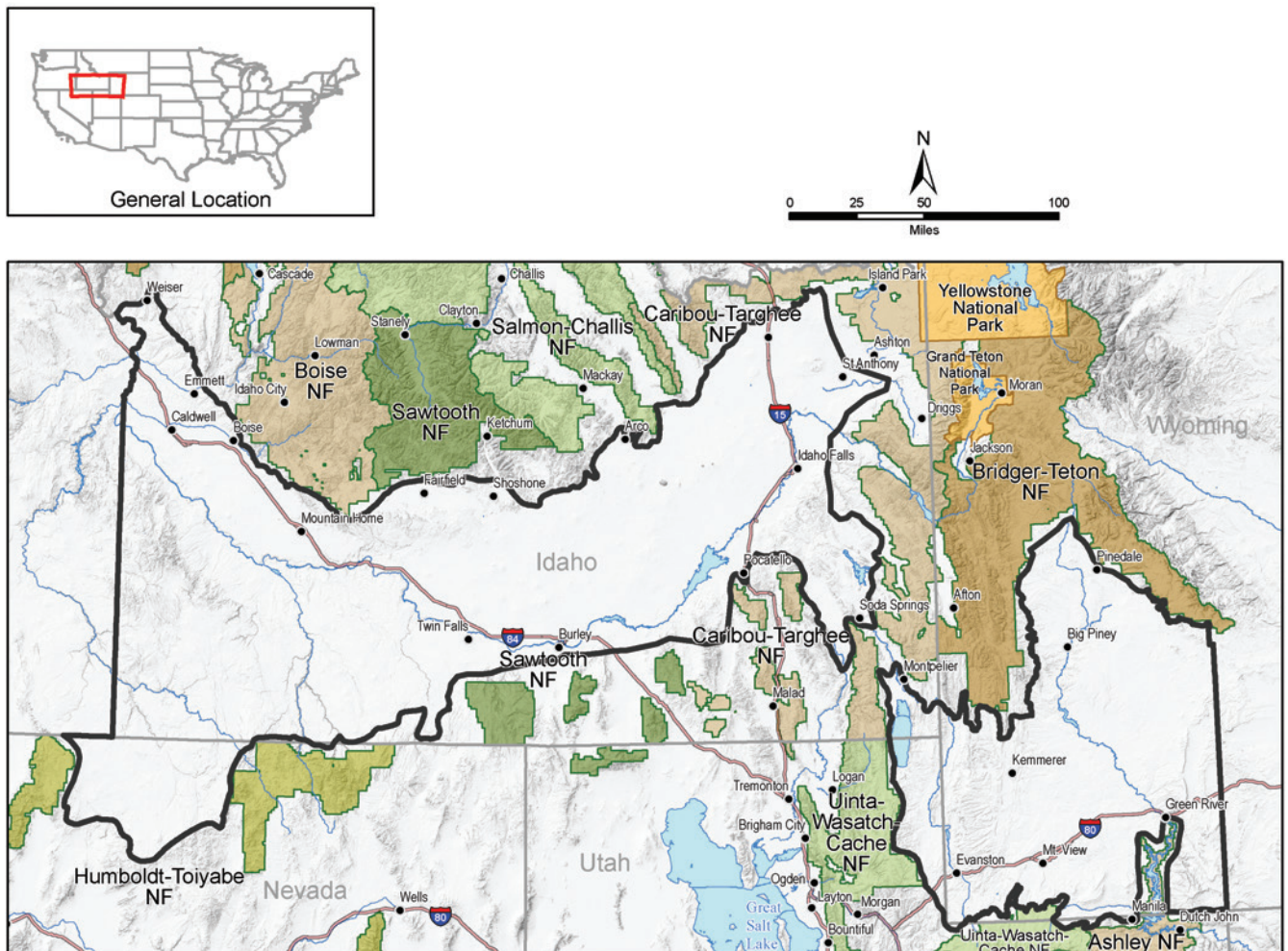


Figure 2.11—Location of the Intermountain Semi Desert subregion of the Intermountain Adaptation Partnership region.

Impoundments to the Snake River, such as those at Lake Walcott and American Falls Reservoir, provide hydroelectricity and irrigation water for nearby agriculture. In the northeastern areas, the Big Lost River disappears from its central Idaho source, drains to the Snake River aquifer below the surface of the volcanic rocks, and re-emerges near Thousand Springs Creek. Incising through canyons of the Owyhee Mountains, the Owyhee River flows generally northward to the Snake River near the Oregon-Idaho border, forming one of the largest subbasins of the Columbia River system.

The Snake River Plain is believed to have originated 16 to 17 million years BP as a hotspot of the Earth's crust moved from west to east, producing lava flows and basalt throughout the subregion. Large basalt flows erupted onto the surface in volcanic rift zones. Between 12,000 and 15,000 years BP, powerful floods cut through the Snake River basin from Lake Bonneville to the south, depositing alluvial sediments derived from adjacent mountain ranges. The Owyhee Plateau marks the highland portions of the subregion, characterized by warped volcanic deposits that eventually converge with the lower plains (Chandler 2003).

Sagebrush-steppe ecosystems are distributed throughout lower elevations in the subregion, giving way to mountain big sagebrush and other subalpine systems at higher elevations (fig. 2.12). The northern border of the western section of the subregion is dominated by subalpine ecosystems similar to those of the Middle Rockies subregion. Farther to the south, the high desert habitats of the Great Basin become more prevalent with more arid vegetation.

High desert habitats are dominated by open desert with low-lying sagebrush and grasslands. As the Snake River flows along the natural arc-shape of the plain, riparian zones are plentiful and contain habitat for willows (*Salix* spp.), quaking aspen, narrowleaf cottonwood (*Populus*

angustifolia), and chokecherry (*Prunus virginiana*). Sagebrush shrublands, including mountain big sagebrush, greasewood, and shadscale (*Atriplex confertifolia*), cover most of the central and southern portions of lower elevations (Chandler 2003). Nonnative Russian thistle (*Salsola kali*), cheatgrass, and other species have degraded the once productive grazing land that lies between Twin Falls and the Boise River.

Wildfire frequency in the subregion has increased since the early 1900s. Before European settlement, fire intervals were 60 to 110 years, allowing for productive native grasslands to thrive (Manier et al. 2011). Introduction of cheatgrass has reduced intervals to less than 5 years in some places. After fires occur, cheatgrass regenerates quickly, limiting the growth of native vegetation and providing fuel for subsequent fires. Addressing this change in ecology and disturbance regimes is a major challenge for resource management in the Snake River Plain. In addition, juniper woodlands have expanded into sagebrush and grasslands of the lower plains, reducing wildlife habitat, water quality, and forage for grazing.

The subregion is home to a wide range of mammals, including mule deer, whitetail deer (*Odocoileus virginianus*), black bear, Rocky Mountain elk, bighorn sheep, pronghorn, and American bison. Smaller mammals include badger (*Taxidea taxus*), coyote, yellow pine chipmunk (*Tamias amoenus*), Great Basin pocket mouse (*Perognathus parvus*), and bobcat (Chandler 2003).

Greater sage-grouse can be found throughout the sagebrush-steppe ecosystem, especially in the Owyhee Canyonlands. Steeper cliffs of the Canyonlands provide important nesting and foraging habitat for raptor species, such as red-tailed hawk, golden eagle, and peregrine falcon. These species also populate the eastern and western plains, which are home to osprey, American kestrel (*Falco*



Figure 2.12—Highly incised river canyons, flat plateaus, and sagebrush-grasslands characteristic of the Intermountain Semi Desert subregion of the Intermountain Adaptation Partnership region, shown here in Birds of Prey National Conservation Area (photo: Natural Resources Conservation Service).

sparverius), bald eagle, and prairie falcon as well. In the juniper highlands and Blackfoot Mountains, iconic birds include common poorwill (*Phalaenoptilus nuttallii*), broad-tailed hummingbird (*Selasphorus platycercus*), bushtit (*Psaltriparus minimus*), and green-tailed towhee (*Pipilo chlorurus*).

Within the Snake River system, anadromous fish, including steelhead trout and Chinook salmon, arrive in the spring. Interior redband trout, bull trout, mountain whitefish, and other fish species inhabit the Owyhee River and Bruneau River. The Owyhee River contains large populations of non-native brown trout and rainbow trout.

The Fort Hall Reservation, located in southeastern Idaho, is home to the Shoshone-Bannock Indian Tribes. The Fort Bridger Treaty of 1868 and the Indian Reorganization Act of 1934 granted self-governing rights to the tribes (Shoshone-Bannock Tribes 2015). Historically, the tribes consisted of hunters and gatherers who traveled in spring and summer collecting winter supplies. Riparian zones along the Snake River provided a diversity of plant food sources. Abundant salmon in the river were harvested year round, along with mammals that inhabited the river banks. American bison was valued as a primary food and raw material for tribal communities. By 1864, bison had vanished from the area, and land ownership changed from ancestral tribal lands to the reservation system. Resource management and land ownership policies in the surrounding area of the current-day reservation are administered by U.S. and Tribal Governments.

References

- Ashley National Forest. 2010. Ashley National Forest: 2012 year in review. Vernal, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region, Ashley National Forest.
- Atwood, G. 2012. Geology of Utah. In: Powell, A.K., ed. Utah History Encyclopedia. Utah Education Network. http://www.uen.org/utah_history_encyclopedia/uheindex.html [Accessed June 19, 2016].
- Black, D.V. 2011. The geologic history of Utah. Provo, UT: Walden School of Liberal Arts. 26 p. https://elementsunearthed.files.wordpress.com/2010/12/utah_geology.pdf [Accessed July 12, 2016].
- Blackwell, J.; Reese, J. 2001. Draft environmental impact statement for the Caribou National Forest: Draft revised forest plan. Idaho Falls, ID: U.S. Department of Agriculture, Forest Service, Intermountain Region.
- Blank, R.; Burkhardt, W.; Chatterton, W.; [et al.]. 2008. Great Basin wildfire forum: The search for solutions. Wildfire Forum for the Great Basin. Reno, NV: University of Nevada, Nevada Agricultural Experiment Station.
- Brandt, J.P.; Morgan, T.A.; Keegan, C.E.; [et al.]. 2012. Idaho's forest products industry and timber harvest, 2006. Res. Bull. RMRS-RB-12. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Brown, M.J.; Chojnacky, D.C. 1991. Idaho's Forests, 1991. Res. Bull. INT-RB-88. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.
- Burden, C.B. 2015. Groundwater conditions in Utah, spring of 2015. Coop. Invest. Rep. 56. Salt Lake City, UT: U.S. Department of the Interior, U.S. Geological Survey; Utah Department of Natural Resources, Utah Department of Environmental Quality.
- Cairns, C., ed. 2015. Rocky Mountain Research Station: Looking back on 2014. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 4 p.
- Caribou-Targhee National Forest. 2005. Fire management plan, 2005. FMP-2005. Ashton, ID: U.S. Department of Agriculture, Forest Service, Caribou-Targhee National Forest. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5238562.pdf. [Accessed June 23, 2016].
- Chandler, J.A., ed. 2003. Feasibility of reintroduction of anadromous fish above or within the Hells Canyon Complex. Gen. Tech. Rep. FERC-GTR-1971: E.3.1-2. Boise, ID: Idaho Power Company. https://www.idahopower.com/pdfs/Relicensing/hellscanyon/hellspdfs/techappendices/Aquatic/e31_02_ch03.pdf. [Accessed June 15, 2016].
- Crane, M.F.; Fischer, W.C. 1986. Fire ecology of the forest habitat types of central Idaho. Gen. Tech. Rep. INT-GTR-218. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.
- Demarchi, D.A. 1994. Ecoprovinces of the central North American cordillera and adjacent plains. Gen. Tech. Rep. RM-GTR-254. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station.
- Dillon, J.; Grunder, S.A. 2008. Management plan for the conservation of Snake River white sturgeon in Idaho. Boise, ID: Idaho Department of Fish and Game. <https://fishandgame.idaho.gov/public/fish/planSnakeWhiteSturgeon.pdf>. [Accessed June 15, 2016].
- Dixie National Forest. 2011. Oil and gas leasing on the Dixie National Forest: Final Environmental Impact Statement. Cedar City, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region, Dixie National Forest. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5325181.pdf [Accessed on June 20, 2016].
- Fellin, D.G.; Dewey, J.F. 1982. Western spruce budworm. For. Insect Dis. Leaflet. 53. Missoula, MT: U.S. Department of Agriculture, Forest Service, Forest Health Protection.
- Gibson, K.; Skov, K.; Kegley, S.; [et al.]. 2008. Mountain pine beetle impacts in high-elevation five-needle pines: current trends and challenges. R1-08-020. Missoula, MT: U.S. Department of Agriculture, Forest Service, Forest Health Protection.
- Giunta, A.D.; Jenkins, M.J.; Hebertson, E.G.; [et al.]. 2016. Disturbance agents and their associated effects on the health of interior Douglas-fir forests in the Central Rocky Mountains. Forests. 7: 80.
- Harris, A.G.; Tuttle, E.; Tuttle, S.D. 1997. Geology of national parks, 6th ed. Dubuque, ID: Kendall/Hunt Publishing Company.
- Hatt, D.L. 2014. 2015–2019 Southeastern Utah economic development district comprehensive economic development strategy. Report prepared for the Southeastern Utah Economic Development District. Price, UT: U.S. Department of Commerce, Economic Development Administration. 150 p.

- Headwaters Economics. 2014. High Divide region: Summary of recreation economy. Report written for the High Divide region. Bozeman, MT: Headwaters Economics. http://headwaterseconomics.org/wphw/wp-content/uploads/High_Divide_Outdoor_Rec_Economy.pdf [Accessed June 20, 2016].
- Heyerdahl, E.K.; Brown, P.M.; Kitchen, S.G.; [et al.]. 2011. Multicentury fire and forest histories at 19 sites in Utah and Eastern Nevada. Gen. Tech. Rep. RMRS-GTR-261WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 192 p.
- Idaho Department of Health and Welfare. 1999. Lemhi River Watershed TMDL: An allocation of nonpoint source pollutants in the water quality limited watersheds of the Lemhi River Valley. Boise, ID: Idaho Department of Health and Welfare, Division of Environmental Quality. http://www.deq.idaho.gov/media/454821_water_data_reports_surface_water_tmdls_lemhi_river_lelem_river_entire.pdf [Accessed June 14, 2016].
- Jones, M. 1990. History of settlement and early livestock grazing in the area of the Boise National Forest. R4-1680-95-0001-14-8. U.S. Department of Agriculture, Forest Service. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_042215.pdf [Accessed June 22, 2016].
- Knight, D.H.; Jones, G.P.; Reiners, W.A.; [et al.]. 2014. Mountains and plains: The ecology of Wyoming landscapes, 2nd ed. Laramie, WY: University of Wyoming Biodiversity Institute.
- Link, P.; Welhan, J.; Peterson, C.; [et al.]. 2000. Digital atlas of Idaho: Idaho's natural history online. Boise, ID: State of Idaho, Board of Education. <http://imnh.isu.edu/digitalatlas/aboutus/about.htm>. [Accessed June 15, 2016].
- Lowrey, L.L. 2015. Evaluation of the extent of the non-native insect, balsam wooly adelgid, south of the Salmon River in Idaho from 2006–2014 by ground delimitation and aerial detection surveys. BFO-PR-2015-01. Boise, ID: U.S. Department of Agriculture, Forest Service, Forest Health Protection. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3834265.pdf. [Accessed June 9, 2016].
- Manier, D.J.; Aldridge, C.; Anderson, P.; [et al.]. 2011. Land use and habitat conditions across the southwestern Wyoming sagebrush steppe: Development impacts, management effectiveness and the distribution of invasive plants. Natural Resources and Environmental Issues. 17: Article 4. <http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1749&context=nrei>. [Accessed July 13, 2016].
- Mohlenbrock, R.H. 2006. This land: A guide to Western national forests. Berkeley, CA: University of California Press.
- Morris, L.A. 2006. Fire history of the City of Rocks National Reserve from 1926 to 2005. Cooperative Agreement H8R07010001. Boise, ID: Idaho State Parks and Recreation.
- Nevada Department of Wildlife. 2013. Sage-grouse conservation. Reno, NV: Nevada Department of Wildlife. http://www.ndow.org/Nevada_Wildlife/Sage_Grouse [Accessed June 20, 2016].
- O'Laughlin, J.; Adams, D.L.; Bunting, S.C.; [et al.]. 1993. Forest health conditions in Idaho. Rep. RP-11. Boise, ID: Idaho Forest, Wildlife and Range Policy Analysis Group. <http://www.idahoforests.org/health3.htm> [Accessed June 17, 2016].
- Price, J.G. 2004. Geology of Nevada. Proceedings, 39th forum on the geology of industrial minerals; 2003 May 19–21; Reno, NV. Proc. NBMG-P-33. Reno, NV: Nevada Bureau of Mines and Geology.
- Pyke, D.A.; Chambers, J.C.; Pellant, M.; [et al.]. 2015. Restoration handbook for sagebrush steppe ecosystems with emphasis on greater sage-grouse habitat: Part 1, concepts for understanding and applying restoration. Circ. 1416: 44. Reston, VA: U.S. Department of the Interior, U.S. Geological Survey.
- Reddy, S.D. 1993. The empty land: The search for the Nez Perce on the Payette National Forest. McCall, ID: U.S. Department of Agriculture, Forest Service, Heritage Program. http://www.fs.usda.gov/detailfull/payette/learning/history-culture/?cid=fsm9_031023&width=full [Accessed June 18, 2016].
- Robson, S.; Kingery, J. 2006. Idaho native plants for roadside restoration and revegetation programs: A report for the Idaho Transportation Department. Moscow, ID: University of Idaho, Idaho Transportation Department. http://itd.idaho.gov/highways/ops/maintenance/roadside/documents/RP171Roadside_RevegReveget.pdf [Accessed June 13, 2016].
- Schwandt, J.; Kearns, H.; Byler, J. 2013. White pine blister rust: General ecology and management. Insect Dis. Manage. Ser. 14.2. Boise, ID: U.S. Department of Agriculture, Forest Service, Forest Health Protection. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5415080.pdf [Accessed June 18, 2016].
- Seligman, D.; Peterson, M.; Price, S.; [et al.]. 2008. World's major rivers: An introduction to international water law with case studies. Las Vegas, NV: Colorado River Commission of Nevada. http://crc.nv.gov/docs/Worlds_Major_Rivers.pdf [Accessed June 18, 2016].
- Shaw, J.D.; Long, J.N. 2007. Forest ecology and biogeography of the Uinta Mountains, U.S.A. Arctic, Antarctic, and Alpine Research. 39: 614–628.
- Shoshone-Bannock Tribes. 2015. History of the Shoshone-Bannock Tribes. Fort Hall, ID: Shoshone-Bannock Tribes of the Fort Hall Reservation. <http://www.shoshonebannocktribes.com/shoshone-bannock-history.html> [Accessed June 18, 2016].
- Simmons, V.M. 2000. The Ute Indians of Utah, Colorado, and New Mexico. Boulder, CO: University Press of Colorado.
- State of Wyoming. 2013. Wyoming history. Cheyenne, WY: State of Wyoming. <http://www.wyo.gov/about-wyoming/wyoming-history> [Accessed June 24, 2016].
- Tilley, D.; Ogle, D.; St. John, L.; [et al.]. 2013. Threatened, endangered, and candidate plant species of Idaho. Tech. Note TN-51. Boise, ID: U.S. Department of Agriculture, Natural Resources Conservation Service.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2011. Payette National Forest land and resource and management plan: Five-year evaluation report 2004–2008. McCall, ID: U.S. Department of Agriculture, Forest Service, Intermountain Region. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5292644.pdf [Accessed June 22, 2016].
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2016. Cut and sold (new). CUTS203F. Quarterly report prepared for the Forest Service. Quart. Rep., FY 2016, Q1. Washington, DC: U.S. Department of Agriculture, Forest Service.
- Utah Division of Wildlife Resources. 1991. Utah's wildlife habitats. Utah Nongame Leaflet 2(1). Salt Lake City, UT: Utah Department of Natural Resources. <http://digitallibrary.utah.gov/awweb/awarchive?type=file&item=29617> [Accessed June 22, 2016].

- West, N.E. 1983. Southeastern Utah galleta-threeawn shrub steppe.
In: West, N.E., ed. *Ecosystems of the world: Temperate deserts and semi-deserts*. Amsterdam, The Netherlands: Elsevier: 413–421.
- Western Regional Climate Center [WRCC]. 2016. Climate of Nevada. Reno, NV: Western Regional Climate Center. <http://www.wrcc.dri.edu/narratives/NEVADA.htm> [Accessed November 19, 2016].