3.0 EXISTING ENVIRONMENT

This chapter characterizes the existing environment of the Rawlins Resource Management Plan Planning Area (RMPPA). Although all environmental resources are described to some degree, emphasis is placed on those resources that are managed by the Bureau of Land Management (BLM) or on which BLM's management actions have some influence. Further, emphasis is placed on those resources that are, or are anticipated to be, impacted by one or more of the management alternatives that may be implemented by BLM in response to changes in land use.

To facilitate ease of reference, the sections below are arranged alphabetically, except that special management areas are presented at the end of the chapter

3.1 AIR RESOURCES

Climate

The climate of the Rawlins RMPPA is classified as semiarid steppe with areas of midlatitude highland or alpine (Trewartha and Horn 1980; Martner 1986).

Steppe climate is characterized by large seasonal variations in temperature (cold winters and warm summers) and by precipitation levels that are low but still sufficient for the growth of short sparse grass. The dryness of the midlatitude steppe climate of southeast Wyoming is due to the area's distance from the Pacific Ocean, the main source of precipitable water for North America. This aridity is intensified by the Sierra Nevada and Rocky Mountains, which block the eastward flow of humid coastal air. In addition, annual rainfall amounts can vary greatly from year to year.

Mountainous areas within the Rawlins RMPPA are classified as alpine. Alpine climate is characterized by large variations in local climates, depending on altitude and slope exposure, but is generally a similar but cooler version of the nearby lowland climate (Trewartha and Horn 1980). Temperature and precipitation vary as a function of several factors, including season, time of day, and elevation.

Weather stations in the Rawlins RMPPA include stations located in Rawlins in Carbon County and Centennial in Albany County, Wyoming. Rawlins is located at an elevation of 6,736 feet and is in the western part of the Rawlins RMPPA. Centennial is located at an elevation of 8,140 feet and is in the southeastern part of the Rawlins RMPPA. Meteorological data available for Rawlins from 1951 through 2000, and for Centennial from 1948 through 2000, form the basis of the climate characterization below.

Temperature

Diurnal (morning to night) and seasonal (summer to winter) ranges in temperature are greater in valleys than on slopes (Martner 1986). Mean annual temperatures range from 43 degrees Fahrenheit (^{o}F) in Rawlins to 40^{o}F in Centennial. Mean maximum summer temperatures are 80^{o}F in Rawlins and 74^{o}F in Centennial. Mean minimum winter

temperatures are 14°F in Rawlins and Centennial. Figure 3.1-1a shows mean monthly temperatures at Rawlins and Centennial (Western Regional Climate Center).

The mean maximum monthly temperatures in Rawlins and Centennial reflect a slight warming in Rawlins (Figure 3.1-1b) and a very slight cooling in Centennial (Figure 3.1-1c; Western Regional Climate Center).

Precipitation

High elevations generally experience greater amounts of precipitation than do lower elevations. Mean annual precipitation is 9 inches in Rawlins and 14.5 inches in the higher elevation Centennial. Mean annual precipitation in Rawlins ranges from 5 inches in dry years to 13 inches in wet years. Mean annual precipitation in Centennial ranges from 9 inches in dry years to 20 inches in wet years (Western Regional Climate Center).

Figure 3.1-2a shows the mean monthly water content of precipitation in Rawlins and Centennial. Mean monthly precipitation varies from 0.5 to 1.4 inches throughout the year in Rawlins, while precipitation in Centennial varies from 0.8 to 1.7 inches (Western Regional Climate Center).

Mean total snowfall is 4.3 feet in Rawlins and 9.5 feet in Centennial, with the greatest snowfall occurring from November through April. Figure 3.1-2b shows mean monthly winter snowfall to range from 7 to 8 inches in Rawlins and from 15 to 20 inches in Centennial (Western Regional Climate Center).

Data on the mean monthly water content of precipitation in Rawlins and Centennial since 1951 show a very slight precipitation increase (<0.3 inch) in most months in Rawlins (Figure 3.1-2c), and a variable pattern in Centennial (Figure 3.1-2d). Data on the mean annual total water content of precipitation in Rawlins and Centennial for the same periods (Figure 3.1-2e) show a very slight increase in precipitation in Rawlins and an extremely slight decrease in Centennial (Western Regional Climate Center).

Dispersion

Atmospheric stability is a measure of the atmosphere's capacity to disperse pollutants. Although stability data are not available for the Rawlins RMPPA, they are available for Rock Springs, Wyoming (about 100 miles west of Rawlins). Figure 3.1-3 shows that mean annual dispersion at Rock Springs is very strong to moderate less than 20 percent of the time, weak to very weak about 20 percent of the time, and fair more than 60 percent of the time (BLM 1999a).

Wind Velocity

Wind speed and direction are highly variable because of the effect of local topography in the Rawlins RMPPA. The annual average wind speed in Rawlins is 12 miles per hour (Martner 1986), and annual wind direction is generally from the northwest, west, or southwest.

Wind data are often presented graphically by a "wind rose," which shows the occurrence frequency of wind speeds and wind directions. Figure 3.1-4 shows a wind rose for Centennial, Wyoming. In mountainous areas like Centennial, local topography can strongly affect wind direction, particularly at night and under low wind speed conditions (Figure 3.1-4). Winds in Rawlins are relatively strong and are generally from the west and west-southwest (BLM 1999a).

Air Quality

Elements of air quality addressed in this analysis include concentrations of air pollutants, visibility, and atmospheric deposition. The regulations governing these elements of air quality are provided in Appendix J.

Pollutant Concentrations

The goal of the Prevention of Significant Deterioration (PSD) Program is to ensure that air quality in areas with clean air does not significantly deteriorate, while maintaining a margin for future industrial growth. PSD Class I areas within the Rawlins RMPPA region include the Savage Run Wilderness Area. Sensitive Class II areas include the Medicine Bow National Forest. The Rawlins RMPPA is also classified as PSD Class II (Map 3.1-1). PSD classes govern the incremental increases in pollutant concentrations that are allowed.

Pollutant concentration refers to the mass of pollutants present in a volume of air and can be reported in units of micrograms per cubic meter ($\mu g/m^3$) and parts per billion (ppb). Air quality in the Rawlins RMPPA is considered excellent; however, current and complete data on the concentrations of criteria air pollutants for the RMPPA are not available. The State of Wyoming has used monitoring to determine that the Rawlins RMPPA region is in compliance with Wyoming Ambient Air Quality Standards (WAAQS) and the National Ambient Air Quality Standards (NAAQS). Concentrations of criteria air pollutants are shown in Table 3.1-1 for the Rawlins RMPPA region.

Carbon Monoxide

Carbon monoxide (CO) data were collected in Colorado in conjunction with the proposed oil shale development of the 1980s. Because CO data are generally collected only in urban areas, where automobile traffic levels are high, recent data are often unavailable for rural areas.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentration data were collected at the Green River Basin Visibility Study site from January to December 2001. NO_2 concentrations were 3 percent of the WAAQS and the NAAQS. Monitoring of other nitrogen-containing pollutants in Centennial and Rocky Mountain National Park shows that concentrations of nitric acid (HNO_3), nitrate (NO_3^-), and particulate ammonium (NH_4^+) are fairly low and are not increasing over time.

The Clean Air Status and Trends Network (CASTNet) has measured concentrations of nitrogen-containing pollutants (HNO_3, NO_3^-, and NH_4^+), as well as sulfur-containing pollutants (sulfur dioxide [SO_2] and sulfate[SO_4^{--}]) and ozone (CO_3), in the United States since the late 1980s. There are three CASTNet stations in Wyoming (Centennial, Yellowstone National Park, and Pinedale) and several stations in Colorado, including one in Rocky Mountain National Park. CASTNet data are available for Centennial from 1990 through 1999 and for Rocky Mountain National Park from 1995 through 1999.

Figures 3.1-5a and b shows mean annual concentrations of nitrogen-containing pollutants in Centennial and Rocky Mountain National Park. Mean annual concentrations of HNO_3 are less than 0.6 ppb at Centennial (Figure 3.1-5a) and less than 1 ppb in Rocky Mountain National Park (Figure 3.1-5b). HNO_3 concentrations typically range from 0.02 to 0.3 ppb in remote areas and from 3 to 50 ppb in urban areas (Seinfeld 1986). Although HNO_3 concentrations are well below urban levels, concentrations are slightly above levels typical in remote areas.

Mean annual concentrations of NO_3^- are less than 0.25 ppb in Centennial and less than 0.4 ppb in Rocky Mountain National Park. NO_3^- concentrations are typically about 0.2 ppb in remote areas and 1 ppb in urban areas (Stern 1973). Although NO_3^- concentrations are well below urban levels, concentrations in Rocky Mountain National Park are above levels typical in remote areas.

Mean annual concentrations of NH_4^+ are 0.3 ppb in Centennial and 0.4 ppb in Rocky Mountain National Park. NH_4^+ concentrations are typically 0.3 ppb in remote areas and 1.4 ppb in urban areas (Stern 1973).

The Wyoming Air Resources Monitoring System (WARMS) has measured concentrations of NO_3^- and NH_4^+ in Wyoming since 1999. There are five WARMS stations in Wyoming: Centennial, Buffalo, Sheridan, Newcastle, and Pinedale. Figures 3.1-6a and 3.1-6b, respectively, show that in Centennial weekly concentrations of NO_3^- are below 1.5 $\mu g/m^3$ and weekly concentrations of NH_4^+ are below .5 $\mu g/m^3$.

Because the chemistry of nitrogen-containing pollutants is very complex, it would be inappropriate to infer NO_2 concentrations from concentrations of HNO_3, NO_3^-, and NH_4^+. But it is unlikely that high NO_2 concentrations would occur with low concentrations of other nitrogen-based pollutants.

Sulfur Dioxide

SO_2 data were collected in the LaBarge Study Area at the Northwest Pipeline Craven Creek site 1982-1983. More recent SO_2 data, as well as SO_4^{--} data, were collected by CASTNet in Centennial and Rocky Mountain National Park, and by WARMS in Centennial.

Figures 3.1-7a and b shows mean annual CASTNet concentrations of SO_2 and SO_4^{--} in Centennial and Rocky Mountain National Park. Concentrations of SO_2 are about 0.5 ppb in Centennial (Figure 3.1-7a) and less than 0.7 ppb in Rocky Mountain National Park (Figure 3.1-7b). SO_2 concentrations typically range from 1 to 10 ppb in remote areas and

from 20 to 200 ppb in urban areas (Seinfeld 1986). SO_2 concentrations in Centennial and Rocky Mountain National Park are consistent with concentrations typical of remote areas.

Mean annual concentrations of SO_4^{--} are below 1 ppb in Centennial and Rocky Mountain National Park. SO_4^{--} concentrations are typically about 0.6 ppb in remote areas and about 2.5 ppb in urban areas (Stern 1973). Although SO_4^{--} concentrations are well below urban levels, concentrations in Centennial and Rocky Mountain National Park are slightly above levels typical of remote areas.

Figures 3.1-8a and 3.1-8b, respectively, show weekly WARMS concentrations of SO_2 and SO_4^{--} in Centennial from mid-1999 through 2001 to be less than 1.5 $\mu g/m^3$; SO_4^{--} concentrations are also less than 1.5 $\mu g/m^3$ but are closer to that value. It would be inappropriate to compare weekly WARMS concentrations directly with mean annual concentrations.

Although it would not be appropriate to compare mean annual CASTNet SO_2 concentrations with national or Wyoming standards, the CASTNet and WARMS concentrations do suggest that SO_2 concentrations in Centennial and Rocky Mountain National Park are still well below the NAAQS and WAAQS.

Ozone

O_3 concentration data were collected at the Green River Basin Visibility Study site from June 10, 1998, to December 31, 2001. O_3 concentrations were 94 percent of the WAAQS and the NAAQS. O_3 data were also collected by the CASTNet stations in Pinedale, Centennial, and Rocky Mountain National Park. Figure 3.1-9 shows that mean annual O_3 concentrations in Centennial and Rocky Mountain National Park have remained steady from 1989 through 1999 and are typical for remote areas in the western United States (Singh et al. 1978).

Particulate Matter

Particulate matter (PM_{10}, $PM_{2.5}$) concentration data were collected in Cheyenne, Wyoming, in 2001. PM_{10} concentrations were 32 percent or less of the WAAQS and the NAAQS. $PM_{2.5}$ concentrations were 33 percent or less of the Wyoming and national air quality standards.

Visibility

Interagency Monitoring of Protected Visual Environments (IMPROVE) has measured visibility in national parks and wilderness areas in the United States since the 1980s. There are six IMPROVE aerosol monitoring stations in Wyoming: Brooklyn Lake (near Centennial), Bridger Wilderness (near Pinedale), Yellowstone National Park, North Absaroka Wilderness (near Dead Indian Pass), Cloud Peak, and Thunder Basin. The best visibility monitored in the contiguous United States is at the Bridger Wilderness station in western Wyoming. Visibility can be expressed in terms of deciviews (dv), a measure for describing perceived changes in visibility. One dv is defined as a change in visibility that is just perceptible to an average person, about a 10 percent change in light extinction.

Monitored aerosol concentrations are used to reconstruct visibility conditions for each day monitored, ranked from clearest to haziest; conditions are divided into three categories:

- 20 percent clearest: Mean visibility for the 20 percent of days with the best visibility
- Average: The annual median visibility
- 20 percent haziest: Mean visibility for the 20 percent of days with the poorest visibility.

Figure 3.1-10 shows annual visibility in Rocky Mountain National Park from 1988 through 1998. Visibility on the 20 percent clearest days varies from 6 to 4 dv (visual range of about 150 to 173 miles). Average visibility varies from 8 to 10 dv (about 112 to 126 miles). Visibility for the 20 percent haziest days varies from 12 to 14 dv (about 71 to 88 miles). Trend analysis of Rocky Mountain National Park visibility data reveals no significant worsening of visibility from 1989 through 1998.

Atmospheric Deposition

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited in terrestrial and aquatic ecosystems; it is reported as the mass of material deposited on an area (kilograms per hectare [kg/ha]). Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of particles and adherence of gaseous pollutants to soil, water, and vegetation). Substances deposited include—

- Acids, such as sulfuric acid (H_2SO_4) and HNO_3; this acid deposition is sometimes referred to as acid rain.
- Air toxics, such as pesticides, herbicides, and volatile organic compounds (VOC).
- Nutrients, such as NO_3^- and NH_4^+.

The estimation of atmospheric deposition is complicated by contribution to deposition by several components: rain, snow, cloud water, particle settling, and gaseous pollutants. Deposition varies with precipitation, which in turn, varies with elevation and time.

Wet Deposition

The National Atmospheric Deposition Program (NADP) assesses wet deposition by measuring the chemical composition of precipitation (rain and snow). There are eight NADP stations in Wyoming. Figure 3.1-11 shows the precipitation pH in the Snowy Range and South Pass City from 1987 through 2000. The natural acidity of rainwater is generally considered to be represented by a range of pH values from 5.0 to 5.6 (Seinfeld 1986). The mean annual pH in the Snowy Range and South Pass City was below this range from 1987 through 1989, indicating acidification of precipitation during that period. Mean annual pH ranged from 4.9 to 5.1 from 1990 through 2000.

Figures 3.1-12a and b shows mean annual wet deposition of NH_4^+, NO_3^-, and SO_4^{--} at the Snowy Range and South Pass City NADP stations. Wet ammonium deposition values are low: below 2 kg/ha in the Snowy Range and below 1 kg/ha in South Pass City.

Wet deposition of both NO_3^- and SO_4^{--} at the Snowy Range station is elevated. Wet NO_3^- deposition ranged from 3 to 13 kg/ha, and wet SO_4^{--} deposition ranged from 3 to 10 kg/ha (Figure 3.1-12a).

Wet deposition of both NO_3^- and SO_4^{--} is low (below 4kg/ha for both) at South Pass City (Figure 3.1-12b). Deposition values from 1985 through 2000 were low and steady, indicating that deposition did not worsened during that time.

Dry Deposition

Dry deposition refers to the transfer of airborne gaseous and particulate material from the atmosphere to the Earth's surface. CASTNet measures dry deposition of SO_2, HNO_3, SO_4^{--}, NO_3^-, and NH_4^+. Figures 3.1-13a and b shows mean annual dry deposition of sulfur- and nitrogen-containing compounds for Centennial from 1991 through 1999 (Figure 3.1-13a) and for Rocky Mountain National Park from 1995 through 1999 (Figure 3.1-13b).

Dry deposition values in Centennial have been low and steady for all pollutants except HNO_3. Dry HNO_3 deposition ranged from 3.5 to nearly 4.5 kg/ha. Dry deposition for other pollutants was less than 1 kg/ha.

Dry deposition values in Rocky Mountain National Park were also low and steady for all pollutants except HNO_3. Dry HNO_3 deposition ranged from 4.6 to 5.7 kg/ha.

Total Deposition

Total deposition refers to the sum of airborne material transferred to the Earth's surface by both wet and dry deposition. Total deposition guidelines have been estimated for several areas, including the Bridger Wilderness in Wyoming (USFS, 1989). Estimated total deposition guidelines include the "red line" (defined as the total deposition that the area can tolerate) and the "green line" (defined as the acceptable level of total deposition). Total nitrogen deposition guidelines for Bridger include the red line (set at 10 kg/ha/year) and the green line (set at 3-5 kg/ha/year). Total sulfur depositions guidelines for Bridger include the red line (set at 5 kg/ha/year) and the green line (set at 20 kg/ka/year).

Figure 3.1-14 compares total deposition in the Snowy Range near Centennial, Wyoming with the total deposition guidelines set for the Bridger Wilderness. Total nitrogen deposition has been well below the Bridger Wilderness red line in the Snowy Range from 1986 through 2000[1], although values exceeded the green line in 1996 and 1999 (Figure

[1] *Please note that wet deposition data are available from 1986 through 2000, while dry deposition data are available only from 1991 through 1999.*

3.1-14a). Total sulfur deposition has been well below both the red and green lines for the same period (Figure 3.1-14b).

Summary of Existing Air Quality

Air quality monitoring and dispersion modeling show that air quality in the Rawlins RMPPA region is generally good (Table 3.1-2).

3.2 CULTURAL RESOURCES

Introduction

Cultural resources may be defined as material remains of human life or activities. Approximately 11 percent of the Rawlins RMPPA has been inventoried for cultural resources at the Class III level. Approximately 2 percent has been inventoried at the Class II level. Approximately 12,485 cultural resource sites have been recorded in the RMPPA. The majority of these sites were documented during compliance-related activities. The Rawlins RMPPA contains many more undocumented sites.

Cultural resource sites within the RMPPA represent two broad overlapping periods: the prehistoric and the historic.

Prehistoric Period

The prehistoric period began with the first human occupation of the RMPPA area approximately 12,000 years ago and lasted into the late 1700s or early 1800s. (The period from approximately 1650 to 1850 A.D. is an overlapping period between the prehistoric and the historic.) Prehistoric sites represent the majority of the cultural resources recorded within the Rawlins RMPPA.

Prehistoric sites are generally characterized by lithic scatters, open camps, stone circle features, hearths and firepits, housepits, rockshelters, rock pile and alignment features, petroglyphs and pictographs, game drive lines, lithic material quarries, brush structures, burials, and game kills. Some of these site types may be interpreted as traditional cultural properties. Lithic scatters and open camps are the most common recorded site type within the RMPPA. Mass game kills and human burials are the least common.

Artifacts that help define site types include flaked stone tools and debris, ground stones, fire-cracked rock from hearths or cooking activities, and ceramics. Perishable remains that may help define site types include bone, seeds, and charcoal.

Prehistoric cultural resource sites occur in a variety of ecological and topographical settings across the RMPPA. Although many of the sites are limited to surface manifestations, intact stratigraphic subsurface cultural materials are found within colluvial, alluvial, and aeolian soils. Prehistoric sites are generally of interest in that they yield, or are likely to yield, information important in prehistory. Knowledge about the Native Americans who inhabited the region can be gained in such areas as settlement patterns, age of occupation, and subsistence.

Historic Period

The transformation from the prehistoric to the historic period is marked by increasing contact between Native Americans and Euro-Americans. The historic period generally is considered to have begun with the arrival of well-organized fur trading expeditions in the region in the early 1800s. The historic period is characterized by the major themes of the American West: early Rocky Mountain fur trading, military explorations, transcontinental emigration, mining (gold, silver, copper, and coal), open-range livestock grazing, transcontinental railroading, and energy exploration.

Historic cultural resources in the Rawlins RMPPA include emigrant trails, stage roads and stations, railroads, early automobile routes, cabins, ranches, settlements, mining operations, stockherder camps and trash scatters, corrals, irrigation ditches, and oil and gas facilities.

Historic sites generally are important because of associations with events that have made a significant contribution to the broad patterns of history. Such sites may be associated with the lives of persons significant in the past; may embody the distinctive characteristics of a type, period, or method of construction; may represent the work of a master or possess high artistic values; or may represent a significant and distinguishable entity whose components may lack individual distinction. Properties less than 50 years old are generally not considered to be historic cultural resources.

Although transportation routes are the most obvious historic sites in the RMPPA, other types of historic sites are also important. The primary transportation routes in the area include the Overland Trail, the Cherokee Trail, regional stage roads and stations, the Union Pacific Railroad, and the Lincoln Highway.

Explorers in the 1850s located what was to become the Overland Trail in an effort to identify a shorter route than the Oregon Trail between the Laramie Range and Fort Bridger. Construction along the trail (removal of obstacles and grading of stream banks) began in 1856. With its evolution from emigrant trail to stage and freight road, the trail played an important role in western migration and the development and settlement of southern Wyoming. Six segments of the Overland Trail within the Rawlins RMPPA were identified in the 1990 Resource Management Plan (RMP) as meeting the eligibility criteria for listing on the National Register of Historic Places (NRHP). The entire trail is now considered eligible for the NRHP. Although portions of the trail have been inventoried, the entire length of the trail through the Rawlins RMPPA has not been accurately inventoried or photographed. There are probably more than six segments of the trail that contain well-preserved swales and wheel ruts.

When news of the 1848 gold strike in California reached Oklahoma, several groups of Cherokee Indians left for California. The first known party to cross southern Wyoming on its way west in 1849 pioneered the Cherokee Trail. At least five other parties used the trail by 1850. Within the Rawlins RMPPA, the trail followed three main routes (portions of the northern route were also used as the Overland Trail). Due to light use of some portions of the trail and to the trail's varied routes, the Cherokee Trail is not always easy

to follow. Like the Overland Trail, portions of the main routes of the Cherokee Trail evolved from emigrant trails into stage and freight roads. As mentioned in the 1990 RMP, although short portions of the trail have been inventoried, the entire length of the various routes within the Rawlins RMPPA has not been accurately recorded. The Cherokee Trail is eligible for the NRHP.

Stage roads within the Rawlins RMPPA include a segment of the Overland Trail, the Cherokee Trail, along with the Rawlins to Fort Washakie Stage Road, the Rawlins to Baggs Stage Road, and the Rawlins to Sand Creek Stage Road. Less frequently used roads are also present. Along with the trails, the Rawlins to Fort Washakie and the Rawlins to Baggs Stage Roads are eligible for the NRHP. Although the Rawlins to Fort Washakie Stage Road was the only road mentioned in the 1990 RMP, other stage roads within the RMPPA were also important transportation routes for military, commercial, and public interests. The Washakie Stage Station, constructed in 1862 along the Overland Trail, is the only stage station within the RMPPA with standing ruins. The station was listed on the NRHP in 1978.

The *Pacific Railroad Act of 1862* made construction of a transcontinental railroad possible, and by 1868 construction of the Union Pacific Railroad reached Wyoming. The Lincoln Highway, constructed between 1919 and 1924, made possible transcontinental automobile travel. The Union Pacific Railroad and the Lincoln Highway traverse the Rawlins RMPPA. Both of these transportation routes are eligible for the NRHP, and segments have been recorded on a project-by-project basis.

3.3 FIRE

Fire in the Rawlins RMPPA falls into two categories: unplanned and planned. Unplanned fires are those that occur as the result of an act of nature, such as lightning, or are caused by humans either accidentally or with intent to cause damage. Planned fire is used for beneficial purposes, such as reducing hazardous fuel accumulation, in a controlled manner under a specific prescription or planned effort. Over the past 100 years, fire has been suppressed extensively in the Rawlins RMPPA, causing the general buildup of vegetative fuels and dead wood. In addition, extremely dry conditions over the past few years have made vegetation less resistant to fire.

Unplanned Fire

Lightning is the primary natural cause of fire. It accounts for most of the fires within the Rawlins RMPPA, and natural ignitions are widespread.

All of the human-caused fires in the RMPPA have been widespread, and no pattern exists to enable planning for future fire problems of this type. The majority of human-caused fires have been located along the I-80 and railroad corridors. Historically, wildfires have also occurred in camping and woodcutting areas from accidental ignition caused by fireworks, campfires, and machinery. Fireworks- and railroad-associated fires have the highest rate of occurrence in the RMPPA.

Planned Fire

Planned fires are used effectively in the Rawlins RMPPA to control the buildup of fuel, to rejuvenate areas where woody vegetation has become decadent, and to set back local succession so that diverse patches of habitat are present. For example, some areas of sagebrush that had become decadent were burned in the Muddy Creek drainage. Burns also tend to open the timber so that more grasses and forbs are available and areas are sufficiently open to be used by wildlife. In addition, fire provides a mechanism for controlling plant diseases and insect and parasitic infestations. In addition, aspen gradually succeeds to lodgepole pine, other conifers and sagebrush in the absence of fire. These types of successional processes are common throughout the Rawlins RMPPA, and can be influenced by fire management.

Types of Vegetation Susceptible to Fire

Fires along the I-80 and railroad corridors have primarily occurred in sagebrush and grassland communities. Fires in wooded areas generally involve conifer species, such as lodgepole and limber pine. Aspen is not as susceptible to fire as are conifers. However, aspen is dependent on fire for adequate regeneration to maintain vigorous and abundant communities. Pure stands of aspen do not burn well. The best burns occur when the percentage of conifer cover is 40-60%, or aspen cover is less than 40% and sage brush cover is at least 15%. In wooded areas, dead and downed timber, or standing timber with high fuel loading value because of a lack of fire in the past and dry weather conditions, can result in unplanned fires burning out of control.

Distribution of Fire in the Rawlins RMPPA

Fire in the Rawlins RMPPA is widespread, with concentrations along the I-80 and railroad corridors. Areas with improved campgrounds or popular unimproved areas also show some concentration of fire. Fires caused by lightning are more widespread and have fewer concentration areas. The locations of planned fires are carefully selected so that fire will improve rangeland health and can be appropriately contained and controlled.

Fuels

Decadent stands of brush can be regenerated through the introduction of fire to reduce fuels before wildfires can have a catastrophic affect on the environment. Unnatural fuel loading in forest stands and other vegetative types are being reduced through the use of prescribed fire and other means such as mechanical, and chemical for the purpose of restoring ecological conditions or other desired vegetative conditions.

3.4 FORESTRY

Forested areas within the Rawlins RMPPA boundaries are mainly located within several mountainous areas: Shirley Mountain, located in the north-central part of the RMPPA, and Elk Mountain, located in the south-central part of the RMPPA, Ferris Mountains WSA in the north-central part of the RMPPA, Seminoe Mountain, Bennett Mountain, and Powder Rim. There are also a number of forested areas on the fringe of the national

forest boundaries (Map 3.4-1). Acreage of forest area within the Rawlins RMPPA is small compared with the RMPPA's total area. The total number of forested acres managed by BLM within the Rawlins RMPPA is 1,483,203, or 13.2 percent of the total area.

The condition or health of forest stands varies by location. The general absence of large fires over the past 80 years, however, has made forests more susceptible to disease such as dwarf mistletoe and mountain pine beetle infestations, as well as newly introduced diseases such as white pine blister rust, which has increased the amount of dead wood on the forest floor. In addition, species such as lodgepole pine (see Table 3.4-1 for the scientific names of this and other species) have not experienced the natural regenerative properties of fire. Conifers are encroaching on aspen stands, limiting aspen regeneration. The disease known as bleeding rust is currently killing the older mature aspen clones. There has also been a decline in timber harvesting over the past decade, allowing for additional buildup of overall biomass.

Shirley Mountain Forest

The Shirley Mountains are a relatively isolated mountain range in the northern portion of Carbon County in south-central Wyoming. They are located entirely within the Rawlins RMPPA and contain a mixture of BLM-managed public lands and private land parcels. The Shirley Mountains provide diverse resource values and uses (such as forests, wildlife habitat, recreational opportunities, minerals, watershed, livestock grazing, communication sites, and cultural resources). This forest encompasses approximately 25,600 acres within the Rawlins RMPPA.

The condition of forest resources in the Shirley Mountain Forest is discussed below, by forest type. Because of differences in forest harvest practices, the condition of BLM-managed public parcels and private parcels that have been timbered differs markedly. Diversity is low, not only from the standpoint of relative acreage in the different forest types, but also from the standpoint of diversity within different successional stages for all of these forest types. This is primarily due to the lack of stand-replacing disturbances over the past 80 years.

Lodgepole Pine Forest

Comprising approximately 9,860 acres, the lodgepole pine forest type is the result of past, stand-replacing wildfires, dating from the 1860s to the 1910s. This forest type is generally healthy but will decline in vigor and productivity as the forest becomes more decadent. In addition, there are some insect and disease concerns that may compromise future health. Infestations of pine beetles and dwarf mistletoe are apparent. Current age class distribution is unbalanced heavily toward the mature, reflecting the long period since the last fires.

Spruce-Fir Forest

The major species component of the spruce-fir forest type is the subalpine fir, with occasional Engelmann spruce. This forest type is found on only about 330 acres of the

Shirley Mountain Forest. The forest type is even-aged and fairly young, considering the longevity of Engelmann spruce and subalpine fir. Spruce-fir exists as small, isolated stands away from the large acreages of dense lodgepole pine and has the same date of origin as its neighboring stands. Old, remnant lodgepole pine trees are not found in the spruce-fir stands. The occurrence of the spruce-fir forest type is probably a result of less intense wildfire in their particular area and an available seed source. There is also an established understory (more than 50 trees per acre) of young subalpine fir seedlings and/or saplings on about 5,877 acres of lodgepole pine and aspen forest. These forested areas will convert to subalpine fir forests, but this process may take 100 years or more and will only occur if there are no wildfires.

Aspen Forest

Comprising about 810 acres, the aspen forest type, like the spruce-fir type, is not well represented in the area. Because aspen are found mostly on steep, rocky slopes or in low wet areas, opportunities for management are limited. In addition, conifer invasion is occurring in most of the aspen stands, which could result in further reductions in aspen presence. Barring any major surface disturbance (e.g., fire, mechanical treatment), the majority of the aspen stands would eventually be replaced by conifers. However, this conversion is not anticipated to occur within the next 20 years. Aspen is a minor component in more than one-third of the lodgepole pine stands. Removal of the conifers would promote aspen regeneration.

Woodland Forest

The majority (14,600 acres) of the forested land in the Shirley Mountains is of the woodland forest type. The most common tree species is limber pine. Juniper woodlands also occur. The trend in this type of forest is toward gradually increasing tree density, as existing vegetation modifies site conditions and allows seedlings to establish in previously open areas. This “filling in” will increase crown cover and reduce forage for wild and domestic ungulates.

Elk Mountain Forest

Elk Mountain is located in the southeast quarter of Carbon County just north of the Medicine Bow National Forest. BLM administers approximately 5,670 acres of forested land in this area.

Forest types in this area change in relation to elevation. In the subalpine zone, at 9,000 to 11,000 feet, Engelmann spruce and subalpine fir are dominant. In the area below this level, the forest type is almost exclusively lodgepole pine. Below the lodgepole pine is an area of mixed lodgepole pine and Douglas fir. The foothills of Elk Mountain are predominantly covered by aspen, limber pine, scattered ponderosa pine, some Douglas fir, and lodgepole pine. More productive forest stands are located on the areas with north to northeast aspects. Stands that occur on the west and south slopes of the mountain are not as productive.

Forests on Elk Mountain are not in good condition. Past cutting practices, often in the form of high grading, along with past insect infestations and fire suppression, have resulted in a deteriorating forest resource on Elk Mountain on both public and private land. Many acres have had poor natural regeneration. Dwarf mistletoe occurs on all coniferous species on Elk Mountain, with considerable damage appearing in lodgepole pine. The condition of forest resources in the Elk Mountain Forest is discussed below, by forest type.

Lodgepole Pine Forest

On Elk Mountain, 1,083 acres consist of the lodgepole pine forest type. The majority of lodgepole stands have reached their recommended rotation age of 100 years; thus growth has slowed. There are patches that are in a severely deteriorated condition. Virtually all of the lodgepole stands owe their origin to fires that occurred in the 1800s. Because of this, extensive even-aged stands, many of which are overcrowded, are present. Lodgepole pine is generally considered a long-lived seral species, with subalpine fir and Engelmann spruce being the eventual climax species. Situations do exist, however, in which seral species remain on site, instead of being replaced by normal climax species. In such a situation, the lodgepole pine could be considered the climax tree species.

The Douglas fir forest type is generally found in association with lodgepole pine in this area, on the lower reaches of the mountain. Many of these trees are residual trees from prior stands.

Spruce-Fir Forest

Subalpine fir and Engelmann spruce are generally becoming established under much of the lodgepole pine, following forest succession into a climax forest. There are even large areas where subalpine fir constitutes a large portion of the overstory.

Engelmann spruce occupies a mixed conifer forest with subalpine fir, the latter being the first species to grow. Spruce stands make up approximately 2,486 acres of the Elk Mountain forest.

Aspen Forest

Aspen occupy wet draws and drainages on Elk Mountain. Aspen stands generally provide an overstory for subalpine fir seedlings, with the probability that the stand will eventually reach a spruce-fir climax condition. Many of the aspen stands are disease-ridden and of poor quality.

Woodland Forest

Limber pine occupies the more exposed and harsh sites throughout the area. The drier south-facing slopes on Elk Mountain are often covered with widely spaced limber pine. In some locations, the limber pine appears to be invading sagebrush-covered meadows, competing successfully with the deep-rooted sagebrush. After the limber pine has been established on a site for several decades, a desirable environment for other tree species,

such as lodgepole pine, seems to develop, and the species composition of the site changes.

3.5 HEALTH/SAFETY AND HAZARDOUS MATERIALS

Health and safety threats within the Rawlins RMPPA may affect workers, recreationists, and wildlife. Personal injury through vehicle accidents that poses the greatest threat and exposure to hazardous materials (a minor concern) are the common threats to health and safety in the RMPPA.

Sources of Threats to Health/Safety

Fire

Wildfires remove existing vegetation and create opportunities for new plant growth. Although wildfires are a natural process, large-scale wildfires can cause undesirable ecological, economic, and social impacts. Therefore, BLM conducts commercial timber harvesting and fuel reduction projects, such as prescribed burning, as a means of replacing mature forest stands, rejuvenating shrub communities, and reinvigorating forb and grass communities. Prescribed burns have a reduced potential for health and safety threats to nearby residents, destruction of homes and communities, and harm to wildlife. The areas subjected to prescribed burns in the Rawlins RMPPA are largely composed of sagebrush and grass. Prescribed burning of sagebrush communities with appropriate rest following treatment removes decadent stands, renews production of grasses and forbs, and eventually produces more vigorous diverse age sagebrush/grassland communities. . At the same time, excessive fuels are removed, thus, reducing the chance of an out-of-control fire.

Minerals Extraction

Leasing for exploration and development of oil and gas, coal, and mineral materials occurs throughout the Rawlins RMPPA. Exposure to hydrogen sulfide gas is a major hazard associated with the exploration and development of oil and gas. Leaks of hydrogen sulfide, a toxic byproduct of oil and gas drilling that attacks the central nervous system, have the potential to injure nearby humans and animals. The locations of the oil and gas well fields are generally remote within the Rawlins RMPPA, limiting the threat of human exposure for the most part to workers and recreationists. Some well fields, however, such as the Table Rock well field, are close to transportation corridors and present a potential risk of exposure to people traveling through the area.

Generally, oil and gas exploration and development consist of the drilling, completion, and production of wells, along with the associated construction of access roads, gas gathering lines, power lines, water discharge lines, and water discharge points. Associated construction activities increase particulate emissions from disturbed soils on roads, well pads, and infrastructure installation, as well as producing exhaust from equipment and vehicles. In addition, surface water discharges from oil and gas wells can be point sources of water pollution. Ground water produced during oil and gas extraction

can contain increased concentrations of metals, salts and other constituents and must be disposed. Depending on the disposal methods, such as deep well injection, on/off channel impoundments, and/or direct discharge to waterways, there is a potential to lower the quality of surface and ground water, increase erosion, salt and sediment loads in river systems. However, when these actions are authorized mitigation measure are put into place to minimize or eliminate hazardous risks. Hazardous materials, such as caustics and methanol, could be released during exploration and development of oil and gas. Hazardous materials that may be used or produced during construction, drilling, production, and reclamation operations associated with the oil and gas industry are listed in Table 3.5-1. Accidental hazardous material spills or pipeline ruptures could adversely affect air, soils, surface and ground water, and pose an exposure threat to nearby humans and wildlife.

Coal mining, especially older underground mines, may also be a source of health and safety hazards. Coal mining in the Rawlins RMPPA was started in the 1870s by Union Pacific along the railroad tracks. In the early years, coal mining was performed close to the surface (within approximately 50 feet). Because of the mines' proximity to the surface, the possibility of subsidence in these historic coal mines is a continuing hazard. Subsidence in abandoned coal mines occurs when an underground void created during historic mining activities collapses due to the weight of the overlying surface. These collapsed holes may have very steep sides and present fall hazards for passing people or wildlife. In addition, hazards may be posed by the unstable surfaces before the collapse of the underlying voids. The Wyoming Department of Environmental Quality's (DEQ) Abandoned Mine Land Program has identified many abandoned mine sites in Wyoming. However, additional unidentified sites are likely to exist in remote portions of the RMPPA.

Ranching Operations

On BLM-managed public land within the Rawlins RMPPA, ranching operations are managed through grazing allotments issued by BLM. There is a potential for accidents associated with ranching activities such as moving cattle, horses, or sheep through an area for grazing or otherwise handling these animals for inoculation and other care. Other ranching activities that may involve risk include work on range improvements, such as corrals, electric or barbed-wire fencing, water developments (reservoirs, spring developments, pipelines, wells, etc.), and land treatments (prescribed fire, herbicide treatment, mechanical treatment, etc.). To enable livestock grazing and repair of range improvements, permittees travel through the Rawlins RMPPA on roads of various quality or on trails in vehicles, on horseback, or on foot. Health and safety hazards associated with ranching operations on BLM-managed land within the Rawlins RMPPA include the potential for accidents during travel through the area and typical construction-related hazards associated with repair of range improvements.

Recreation

Recreational activities commonly pursued in the Rawlins RMPPA include hiking, boating, fishing, hunting, camping, cross-country skiing, mountain biking, wildlife

viewing and sightseeing. Travel by off-highway vehicle (OHV), including snowmobiles, is the primary means of accessing many recreation areas and is increasingly considered a recreational activity itself. Health and safety threats from recreational activities include the potential for vehicular accidents during OHV travel. Sandy areas are frequently used by OHVs, and the steep slopes found in such areas present especially hazardous driving conditions. Threat of injury associated with hunting accidents is another recreation-related health and safety hazard.

Aircraft Operation

Various types of aircraft are used in support of activities associated with BLM-managed lands. Helicopters are used by industry for seismic and geophysical exploration. Helicopters and fixed-wing aircraft are used by BLM staff for a variety of activities, including wild horse surveys and roundups, wildlife and fisheries management activities, grouse and other biology projects, fire fighting, fire observation and detection, and reservoir inventory and inspection.

Types of Threats

Personal Injury

Personal injury to workers or recreationists may occur within the Rawlins RMPPA. Fire fighting, and even controlling prescribed burns, has the potential to entail health and safety problems—burns, smoke inhalation, and even death. Personal injury can also result from construction-related accidents during industrial activities within the Rawlins RMPPA, such as oil and gas exploration and development, minerals extraction, and ranching operations. Buried or surface pipelines, which typically transport natural gas, represent an extreme explosion hazard if they are hit or dug into. Ranchers may be injured by the animals and machinery with which they work. Various products used on animals, from drugs to insecticides, may be unhealthful to humans if they are improperly handled. Ranchers may also be injured if caught by barbed-wire fences or barbed-wire/heavy gates and shocked by contact with high-voltage electric fences. In addition, aircraft use presents a potential for accidents and safety concerns.

The primary threat to recreationists in the Rawlins RMPPA is injury associated with OHV accidents. Other potential hazards include drowning, water-related hypothermia, exposure, and encounters with aggressive members of large game species or poisonous snakes. Insufficient water or ingestion of nonpurified water may cause health problems. In addition, recreationists engaged in hunting may accidentally injure themselves or others. Hunters, hikers, cave explorers and other recreationists are at risk of death or serious injury from falling into the open ground cavities that may be formed by coal mine subsidence. Livestock and wildlife are at risk of falling into these open ground cavities as well. Steps are clearly taken to avoid or minimize these risks.

Hazardous and Other Materials

All incidences of hazardous materials on public land will be handled as outlined in the Rawlins Field Office Oil, Gas, and Hazardous Substances Spill Plan of March 199. All

actions are reviewed both internally and externally (if appropriate) for compliance with federal and state regulations. Special stipulations are also developed as part of the permit or lease to safeguard human health, prevent environmental damage, and limit BLM liability.

In addition to hazardous materials, other types of waste may represent hazards or at least annoyances. Solid wastes and sewage from industrial facilities or recreational sites may occasionally be improperly disposed of on BLM-managed lands. Such wastes are cleaned up by BLM as rapidly as possible.

3.6 LANDS AND REALTY

The RFO manages approximately 3.5 million acres of public land. Uses of the land are diverse, ranging from oil and gas development to wildlife habitat and recreation. The current land use environment is characterized by an increase in development by the oil and gas industry and in private and urban development. The expected increase in oil and gas production, as well as the potential for development of alternative energy sources, such as wind energy, is likely to have a greater impact on land distribution and use in the near future. Changes in the ownership of surrounding private land also have an impact on the development of public lands. The most important characteristic of such ownership changes may be the resultant fragmentation and isolation of segregated parcels of public land.

Background and History

Land ownership within the Rawlins RMPPA is shown in Map 3.6-1. As this map shows, the most prominent land resource feature within the Rawlins RMPPA is a large swath of land that is divided into a checkerboard pattern of ownership. This swath of land is approximately 40 miles wide and runs from east to west across the entire RMPPA. The checkerboard pattern, with alternating sections of private and public land, runs 20 miles to the south and 20 miles to the north of the Union Pacific railroad line. Each section within the checkerboard is 1 mile square. Ownership is divided between private, BLM-managed, and state land. Little consolidation has taken place over the years, and the majority of this "checkerboard" remains intact.

Land and mineral ownership acreages and whether they are covered by RMP decisions are shown in Table 3.6-1. Generally, RMP decisions cover all BLM-managed federal surface lands and their underlying minerals, whether the minerals are federally or non-federally owned, and non-federal surface underlain by BLM-managed minerals. Federally owned mineral rights are shown in Map 3.6-2.

Evaluation Process for Land Tenure and Realty

Land Ownership Adjustment

Under the disposal criteria of the *Federal Land Policy and Management Act of 1976* (FLPMA), 66,000 acres were identified for consideration of disposal. However, that acreage figure was reduced to 48,493.27 because parcels that contain legal access across

them were eliminated from consideration for disposal. Exchanges are subject to the procedures outlined in the Code of Federal Regulations (CFR), Title 43, chapter II, part 2200 section 0-6.

Land exchanges are considered by the RFO staff from time to time as they are proposed. All lands considered for disposal must meet one or more of the criteria outlined in Section 203(a) of the FLPMA. These criteria characterize lands for potential disposal as lands that are difficult or uneconomical to manage; lands acquired for a specific purpose, but no longer required for that or another federal purpose; or lands that will serve important public objectives, including, but not limited to, expansion of communities and economic development, that outweigh other public objectives and values.

Withdrawals/Classifications

Withdrawals and classifications are typically placed on land or minerals to protect resource values or existing facilities, although they can selectively prohibit some management actions that would otherwise protect additional resource values. Most of the withdrawals and classifications that have been put in place at various times have prohibited mineral and agricultural entry and disposal, but some have also prohibited nonmetalliferous mineral entry and disposal of coal, limited rather than prohibited mineral entry, or protected water sources. Withdrawals and classifications are periodically reviewed to see whether they are serving their intended purpose, and may be revoked if they are not.

Current withdrawals of public land comprise more than 1,537,998 acres within the RMPPA (Valentine 2002). In the past, the largest withdrawals have been made for coal, oil shale, and stock driveways, respectively, with coal representing the largest withdrawal at over 600,000 acres. Bureau of Reclamation lands and public water reserves comprise more than 120,000 acres. The remaining acres that have been withdrawn include wildlife refuges, air navigation sites, power sites, and administrative sites.

Utility/Transportation System

Leases and permits are spread throughout the Rawlins RMPPA. The majority of leases and permits within the RMPPA are for of oil and gas development or wind energy rights-of-way. Surface acreage potentially associated with oil and gas development, as characterized by 11 projects proposed in the Rawlins RMPPA, is shown in Table 3.6-2. Wind energy rights-of-way on BLM-managed land comprise approximately 17,000 acres, with 35 turbines currently (mid-2002) on public land.

Land Consolidations

Land is consolidated through fee or easement acquisition, exchange, condemnation, and donation processes. Currently, there are no active efforts to consolidate land within the RMPPA. However, proposals are being currently evaluated, and the RFO staff will consider any proposal in relation to their land exchange criteria and determine future action based on the proposal's merits.

3.7 LIVESTOCK GRAZING

The livestock grazing on BLM-managed public lands are primarily cattle, but also include sheep, as well as some horses and bison. The relative numbers of these grazing livestock have varied in response to their economic value as a commodity (cattle, sheep, and bison) and their use in ranching operations (horses).

Historic Use

Historically, there have been much higher numbers of sheep on Rawlins RMPPA rangelands than cattle. But sheep numbers have steadily declined and now amount to nearly one-third of the current cattle numbers and to one-fifth of their former population in the 1920s. Table 3.7-1 outlines the livestock populations in Albany, Carbon, and Laramie Counties since approximately 1900. In 1920, the earliest year for which data are available for both cattle and sheep, 24.1 percent of the livestock were cattle. Based on the available data, this percentage dropped even further until 1940 (17.7 percent) and then rose rather consistently to 73.5 percent in the year 2000.

Current Use

The percentage of actual use by cattle and sheep over the past 10 years (1991-2000) is presented in Table 3.7-2. Even over the past 10 years, the shift from sheep to cattle has continued. The percentage of cattle use, in animal unit months (AUM) has increased from 84.5 percent in 1991 to 93.1 percent in 2000.

There are a total of 581 grazing allotments within the Rawlins RMPPA (Table 3.7-3, Map 3.7-1). These are spread across 3,409,260 acres of public land (53.8 percent), other federal land (0.9 percent), state land (5.6 percent), and private land (39.7 percent). They provide 448,850 permitted AUMs and an additional 3.5 percent AUMs that have been suspended. AUMs continue to fluctuate for a variety of reasons. Reductions occur as a result of such actions as sheep-to-cattle conversions, or wildlife/wild horse population objectives, and changes in season or duration of use. Over the past 15 years there have also been increases in AUMs, with an additional 4,225 AUMs becoming available due to improvements in management and forage availability. Other management actions taken to achieve the objectives identified in the land use plan include the use of best management practices in activity plans for livestock, wild horses, watershed and other activity plans.

Livestock grazing occurs year-round on some Rawlins RMPPA allotments by cattle, sheep, horses, and buffalo. Of the 581 allotments, 87 percent are used by cattle alone, and 9 percent by cattle and sheep, with bison added on one additional cattle allotment. Cattle also share five allotments with licensed domestic horses. Sheep alone use 1.4 percent of the allotments, while four allotments are used by horses alone and one by goats. Table 3.7-3 outlines the public, other federal, private, and state acreage per allotment; the permitted and suspended AUMs per allotment; the class of livestock; the timing of grazing; and the grazing management of the allotment.

Improvement projects and grazing systems, which have become known as "best management practices" (BMP) have been under way for the past 40 to 50 years. These efforts have occurred singly or cooperatively among livestock permittees, the University of Wyoming Extension Service, and state and federal agencies. The efforts have been further improved over the past 10 years through education workshops and seminars, federal and nonprofit cost-sharing opportunities, and more active participation by local conservation districts in all aspects of this process. The goal of such efforts is to enable sustained livestock use without damaging the vegetation resource, the watershed, precluding the presence of healthy wildlife and fish populations. Grazing management plans are devised with consideration of other resource values, vegetation production and type, topography, water locations, and needs of the livestock owner. . The resulting allotments range in size from 20 acres to 291,954 acres of public land. There are 222 allotments that contain 640 acres (one section) or less of public land, 160 allotments that contain between 640 and about 2,500 acres of public land, 115 allotments that contain between 2,500 and 10,000 acres, and 80 allotments that each contain more than 10,000 acres of public land. These 80 allotments make up 76 percent of the public land in the Rawlins RMPPA.

Historic priorities for improved livestock management usually addressed the larger blocks of public land, followed by resource issues, particularly condition of watersheds in general, and, more recently, riparian habitat. Of the 80 largest allotments, 75 percent have grazing systems or adequate management for the resources present. The current guidance for evaluating rangeland standards on a watershed basis will widen the management focus to all problem areas that relate to meeting these standards, with less emphasis on the amount of public land within an allotment.

Grazing systems fall into the following seven categories:

- **Permit Long.** Grazing for the duration of the permitted time with care taken not to overuse the resource.
- **Yearlong Permit.** Grazing permitted for yearlong use.
- **Rotation.** Grazing rotation between pastures in the allotment for the permitted time.
- **Deferred Rotation.** Rotation grazing with regard to deferring pastures beyond the growing season, if they were used early the prior year, or that have been identified as needing deferment for resource reasons.
- **Late Season.** Fall or late summer grazing.
- **Split Season.** Removing livestock from the allotment and returning them later in the year within the permitted time.
- **Rest Rotation.** Grazing rotation resting pastures that have been grazed early the prior year or that have been identified as needing rest for resource reasons.

All of these categories are applied to the cattle allotments, although the most frequently used categories for cattle are permit long (54 percent of total allotments), deferred rotation (18 percent), and rotation (10 percent). Most of the cattle/sheep allotments are either permit long (4 percent of total allotments), deferred rotation (2 percent), or rotation (2 percent) leases. Many of the allotments are still likely to need developed range management strategies to promote and maintain ecological health of vegetative communities.

Results of Rangeland Best Management Practice Application

Rangeland BMPs have been implemented on many allotments to solve problems particular to vegetation type, topography, availability of water, and needs of the permittees. The following subsections present examples of successful BMPs used to improve grazing and ecological stability on individual allotments and describe the existing conditions in these allotments.

Pine Grove/Bolten Allotment

The 45,716 acres of the Pine Grove/Bolten Allotment include public (21,606 acres), private (21,781 acres), and state (2,329 acres) holdings. Grazing management has improved, and resource-oriented objectives have been established with the current permittee. Many range improvements have been completed within the allotment, which have greatly benefited grazing flexibility. These include additional fencing (55 miles, 34 of which are electric), which has resulted in there being 45 pastures within the allotment instead of the original 21 pastures. Many water developments have also been completed: 70 wells, 30 miles of pipelines, 18 spring developments, and 11 reservoirs. A long-term vegetation treatment program to diversify habitat has also been developed, and in 2001, 4,600 acres were treated with tebuthiuron (Spike).

Wyoming Department of Environmental Quality, Water Quality Division (DEQ-WQD) has determined that McKinney and Sage Creek have impaired water quality within the allotment. Both of these streams drain areas of highly erosive shale formations (Niobrara), and in turn carry sediment loads that exceed beneficial use standards. Because the current permittee has improved grazing management, portions of McKinney Creek have been removed from the Wyoming 303(d) list of impaired streams. Work continues along Sage Creek, including intensive water quality monitoring and improvements on diversions that were engineered to reduce siltation. The permittee has hired consultants who, along with BLM, monitor range conditions and improvements in the allotment.

Riner Allotment

The 56,962 acres of the Riner Allotment include federal (26,530), private (28,998 acres), and state (1,434 acres) holdings. Water development, improved livestock management, and electric fences are management practices that have been implemented in the Riner Allotment. The current permittee acquired the permitted use on public land within the Riner Allotment in 1993. The allotment is in a mixed-ownership, checkerboard land

pattern, with less than 50 percent public land. The permittee immediately changed the livestock management from essentially a permit-long use cycle to rotation, especially within the largest pasture. To accomplish this, existing water sources were improved and additional water sources were developed, on both public and private land. The rotation within the largest pasture initially relied on extensive herding of livestock, which soon proved impractical. Electric fences have since been constructed to split the largest pasture into five smaller pastures. With these changes, conditions near the water sources that existed prior to 1993 have greatly improved. Conditions throughout the allotment also appear to have improved.

Beaver Hills Allotment

The 4,832 acres of the Beaver Hills Allotment include public (960 acres) and private (3,872 acres) holdings. Although the Beaver Hills Allotment was originally categorized as Custodial, the current livestock operator is enthusiastic about developing a cooperative management plan for the unit, with the goal of benefiting the livestock operation, as well as important big game species habitat. A deferred rotation grazing system is currently employed on the allotment; this system uses short-duration grazing treatments after early summer, but before moving the livestock onto summer U.S. Forest Service (USFS) grazing allotments. A proposed prescribed burn in four pastures will improve forage conditions, wildlife habitat values, and watershed health. Several spring developments are planned to protect important riparian habitat and to improve livestock distribution. Cooperators include BLM, the Wyoming Game and Fish Department (WGFD), the landowner, and the Natural Resources Conservation Service. Important big game habitat, including bighorn sheep winter range, winter and crucial winter elk range, and transitional habitat for mule deer, will be enhanced through this process.

Doty Mountain Allotment

The 84,008 acres of the Doty Mountain Allotment include public (59,504 acres), private (22,904 acres), and state (1,600 acres) holdings. The main stem of Muddy Creek flows through the Doty Mountain Allotment in the southwestern portion of the Rawlins RMPPA. Objectives established on the Doty Mountain Allotment included enhanced bank cover, increased stream width-to-depth ratio, improved herbaceous species composition, riparian shrub regeneration, decreased upland shrub density and diversified age structure, and improved waterfowl habitat. These objectives were attained through better livestock distribution, deferring grazing past the hot season, and creating riparian pastures.

Implemented BMPs included converting the two-pasture rotation to a nine-pasture rotation, which defers grazing in five riparian pastures until late summer or early fall. Use of the remaining pastures is limited to 2 to 6 weeks. Range improvements include 10 upland water developments and 28 miles of pasture fencing, as well as two well and pipeline projects. Range vegetation on 3,500 acres was treated using burns and Spike. Constructed ponds and wetlands created 220 acres for wildlife habitat as well. Photographs, vegetation inspections, and riparian cross-section survey data show major

improvements in bank cover, channel morphology, and enhanced species composition. Livestock conception rates have also improved.

Grizzly Allotment

The 38,091 acres of the Grizzly Allotment include public (27,533 acres), private (1,226 acres), and state (9,332 acres) holdings. The WGFD controls the private land within this allotment and leases the cattle use to a private livestock operator. Before 1990, a rest rotation system was in place with seven pastures. There are currently 12 pastures and several new water developments, such as spring improvements and reservoir construction. Recent vegetation treatments, consisting of three prescribed burns and two Spike treatments, have reduced shrub cover and increased herbaceous plant diversity. Improvement in both riparian and upland conditions has resulted, and the recent allotment evaluation suggested that there is increased vegetation production in the allotment. Littlefield Creek and Muddy Creek within the allotment have both been removed from the Wyoming 303(d) list of impaired streams. The Grizzly Allotment was the primary target for the reintroduction of Colorado River cutthroat trout (a sensitive species); a portion of this effort was completed in 2001. Additional areas for reintroduction have been identified, and the reintroduction will be accomplished as resources allow.

Monument Draw Allotment

The 15,417 acres of the Monument Draw Allotment include only public holdings. Livestock management, water development, and vegetation treatment are a few of the BMPs instituted within the allotment. A new permittee acquired the permitted use within the allotment in 1997. The season of use was extended, with a more intensive management system using the two existing pastures and available water sources. Additional water sources were needed for the more intensive management. The new permittee cleaned and repaired existing reservoirs and also greatly extended a livestock water pipeline. Livestock watering sources continue to be developed, including the additions to the pipeline. The allotment had also been identified as having areas of excessively high sagebrush cover, especially on the plateau in the southeast third of the allotment. A Spike treatment is proposed for 2002. The management changes have improved ground cover to more than 75 percent in an area with limited rainfall.

Powder Rim Allotment

The 46,812 acres of the Powder Rim Allotment include public (46,532 acres) and private (280 acres) holdings. The original Powder Rim Allotment Management Plan (AMP), implemented in the late 1960s, had proved to be impractical because of conflicting uses and increased activation of previously rested (voluntary nonuse) privileges. As a result of the livestock permittees' concerns about declining forage conditions and a *Standards and Guidelines* (S&G) review of the allotment, the AMP was revised in 2001 to take into account current conditions and issues. Two permittees were split from the allotment and allocated use in separate pastures. Improvements currently being developed in these pastures include 6 to 7 miles of fencing, several new water developments (two wells, one

spring development, and several small pit reservoirs), and two separate vegetation treatments. In addition, split-season livestock use, designed to rest the vegetation during the peak growing season and defer use until late fall, has been initiated in two pastures. Three other pastures in the rotation receive split-season and deferred summer cattle use in conjunction with winter sheep use.

Fencing of two natural spring sites, determined to be nonfunctional during the S&G review, resulted in increased flow and water quality. Protecting the associated riparian areas improved stream and riparian stability. One additional spring-seep complex will be developed, and several water wells will be completed to provide reliable, controllable water in dry portions of the pastures. Management in the pastures will enhance habitat for mule deer and elk, including crucial winter range.

Bar Eleven Allotment

The 54,256 acres of the Bar Eleven Allotment include public (51,570 acres), private (1,635 acres), and state (1,051 acres) holdings. In the Bar Eleven Allotment, objectives were set to reduce the stream width-to-depth ratio, increase riparian shrub regeneration, change herbaceous species composition from Kentucky bluegrass to Nebraska sedge, reduce bare areas in the riparian areas, and increase trout size and population. Implemented BMPs included adjustments to the duration of use from June through September by fencing the allotment into pastures. This action reduced grazing duration from 4 months to 1 month or less. Riparian pastures were established on Pete Creek to limit grazing to the fall. The remaining upland pastures now employ a deferred rotation grazing system. Grazing distribution was improved with the installation of proper pasture fencing and upland water improvements.

Recent monitoring data, such as photo point pictures, riparian cross sections, and vegetation inspections, have been encouraging. The BMP measures resulted in narrowing stream widths, improving stream bank cover, diversifying riparian and upland vegetation, and increasing willow regeneration.

3.8 MINERALS, GEOLOGY, AND TOPOGRAPHY

This section describes the geologic and mineral resources found within the Rawlins RMPPA. Information provided in this section is specific to the RMPPA and includes geologic history and a description of geologic units, structural geology and tectonics, and topography. The section also includes a discussion of leasable, locatable, and salable minerals found within the RMPPA. Unless otherwise noted, the information in this section is based on the *Draft Mineral Occurrence and Development Potential Report* (ENSR and Booz Allen 2002), which was prepared in support of this planning process.

Geology

Geologic History

Cambrian Through Mississippian Periods

During the Cambrian through Mississippian Periods (about 550 million to 330 million years ago), present-day Wyoming and much of the Rocky Mountain West were located along a fairly stable continental shelf (Lageson and Spearing 1991). The area was generally inundated by shallow seas, and fluctuations in sea level resulted in the deposition or erosion of sediments. The limestone, dolomite, and shale deposited from the Cambrian to the Mississippian Period are typical of rocks originally deposited in a shallow marine environment (Boyd 1993).

Pennsylvanian Through Permian Periods

The Pennsylvanian through Permian Periods occurred about 330 million to 240 million years ago. The sandstones of the Pennsylvanian Period represent the result of an influx of sediment due to the uplift and erosion of the ancestral Rocky Mountains (Mallory 1972). The Tensleep Sandstone and its equivalents across the Rocky Mountain region were deposited in a large aeolian sand sea that resulted in a thick, relatively homogeneous sandstone spread over a large area. Because of this homogeneous character, Tensleep reservoirs are usually found only in structural traps. The Tensleep Formation is also a major aquifer. Locally, in the Laramie and Denver-Cheyenne Basins, the Casper Formation is composed of clastic debris shed from the Ancestral Rockies. The Permian rocks indicate alternating shallow marine to continental environments, as indicated by the shale, limestone, and anhydrites in the Phosphoria and Goose Egg Formations and Satanka Shale (Boyd 1993).

Triassic Through Jurassic Periods

The Triassic through Jurassic Periods occurred about 240 million to 140 million years ago. Shallow marine conditions appear to have been predominant in Early Triassic Period with deposition of the Dinwoody Formation, which lacks the organic-rich material that was available during deposition of the Phosphoria Formation. Conditions in the later Triassic Period changed greatly from the earlier Triassic. During much of the late Triassic and Jurassic Periods, the Wyoming shelf was emergent and many of the deposits were terrestrial in origin, typified by the red beds and evaporites of the Chugwater Group (Picard 1993). In the western part of the RMPPA, the Nugget Sandstone was deposited in the Late Triassic period mainly in an aeolian (windblown) environment as sand dunes. The Sundance Formation deposits are representative of a transgressive-regressive sequence during the later Jurassic. The Canyon Springs Sandstone Member of the Sundance Formation was deposited during the advance of the sea onto the Wyoming shelf (Picard 1993). At the end of the Jurassic, terrestrial conditions predominated, resulting in the Morrison Formation, which is characterized by stream deposits that were laid down on an alluvial plain.

Lower Cretaceous Period

During the Lower Cretaceous Period (about 140 million to 100 million years ago), a feature known as the Western Interior Seaway developed from the Gulf of Mexico to the Arctic Ocean (McGookey et al. 1972). This feature was the result of pushing from the west by a major thrust belt that loaded the continental crust and created a depression. During the Cretaceous, there were numerous episodes of sea transgressions and regressions that resulted in the deposition of thousands of feet of sedimentary rock. The lower part of the Cloverly Formation or Inyan Kara Group was deposited in alluvial fan and fluvial environments on the western shore of the seaway (Steidtmann 1993). Following the deposition of the Cloverly Formation and equivalent Inyan Kara Group rocks, the first major Cretaceous transgression began, resulting in the deposition of the Thermopolis Shale. A regression followed that resulted in the deposition of the widespread Muddy Formation.

Upper Cretaceous Through Tertiary Periods

The Upper Cretaceous through Tertiary periods occurred about 100 million to 1.65 million years ago. At the close of the Lower Cretaceous Period, sea level rose and the Mowry Shale was deposited. The Frontier Formation resulted from several transgressive-regressive cycles that grade from fluvial in the west to marine in the east (Steidtmann 1993). The near-shore and transitional marine deposits of the Frontier Formation in the western part of the RMPPA grade to the east into the Graneros Shale and Greenhorn Limestone, which represent shallow marine conditions. After the Frontier Formation, the Niobrara transgression resulted in the deposition of the marine Carlile Shale, Niobrara Chalk, and Steele Shale sequences (McGookey et al. 1972). Following the Niobrara transgression, a regressive sequence resulted in deposits composed of sandstone and shale that were deposited in near-shore and marginal marine environments (Steidtmann 1993). In the western part of the RMPPA, this regressive sequence is called the Mesaverde Group. To the east, however, the Mesaverde equivalents, the Pierre Shale and associated sandstones, are marine in origin. The last major Cretaceous transgression resulted in the deposition of the Lewis Shale. Within the Lewis Shale are combinations of sandstones and siltstones that were deposited in marine and transitional marine environments with some sandstones deposited as submarine fans (Van Horn and Shannon 1989).

Near the end of the Cretaceous, accelerated thrusting began west of the Green River Basin in the area of the Western Wyoming-Eastern Idaho Thrustbelt. As the mountains were uplifted, erosion occurred and sediment was shed into the shallow Cretaceous seaway. In the RMPPA, the uppermost Cretaceous units are the Lance and Medicine Bow Formations, which are composed of alluvial plain deposits marking the end of the Cretaceous (Lilligraven 1993). The end of the Cretaceous was marked by the demise of the dinosaurs and the establishment of mammals as the dominant terrestrial animal, as well as the emergence of new plants and grasses.

At the end of the Cretaceous and the beginning of Tertiary Period, another type of mountain building was occurring in the area. This episode of mountain building is referred to as the Laramide Orogeny (Lageson and Spearing 1991) and involved the uplift

of Precambrian basement. The uplift of the Precambrian basement occurred in the structural style described above, movement of Precambrian basement blocks along low-to-high-angle reverse faults. This period of mountain building resulted in the mountain ranges of the Southern and Middle Rocky Mountains. This mountain building also caused the withdrawal of the seaway from Wyoming and the development of intermountain basins that were filled with sediments eroded from the uplifts and resulting in the Fort Union, Wasatch, Ferris, Hanna, and Wind River Formations. As mountain building continued, the basins were depressed and the area of the Green River Basin became a large fresh water lake. Sediments associated with this lake are represented by the Green River Formation in the western part of the Rawlins RMPPA. The Green River Formation contains abundant fossils and organic-rich rock, referred to as oil shale.

In later Tertiary Period (Oligocene to Miocene Epochs), large volcanic eruptions occurred to the west and north of the area. Prevailing winds carried the ash aloft over an extensive area, and thick layers of ash were deposited as a result. These ash deposits are found in the White River Formation. Also in later Tertiary time, one more episode of uplift occurred, again causing the deposition of material in the basins, resulting in the Browns Park, North Park, Ogallala, and Arikaree Formations. Erosion of the Tertiary deposits by the end of Tertiary and the beginning of Quaternary resulted in the emergence of the present-day topography. The "Gangplank" in Laramie County is an erosional remnant of Tertiary rock and is evidence that by late Tertiary, the Rocky Mountains were nearly buried in debris that had been shed from them (Blackstone 1996). Erosion along the mountain fronts has removed the mantle Tertiary deposits in most places, resulting in abrupt changes in elevation along the mountain fronts.

Quaternary Period

During the Quaternary Period (about 1.65 million years ago to the present in geologic time), there were several episodes of glaciation. Evidence of the several glaciations is shown in the Medicine Bow Mountains and the Sierra Madre. Valley glaciers and icecaps over the mountain ranges probably began to recede about 15,000 years ago (Knight 1990). The glacial deposits consist of lateral moraines, terminal moraines, and glacial outwash deposits that were laid down during successive glacial episodes. Small glacial lakes were formed in the Snowy Range in the core of the Medicine Bow Mountains. Continued erosion of the mountain ranges has resulted in the deposition of alluvial and terrace deposits in the basins.

Description of Geologic Units

The rocks in the Rawlins RMPPA range in age from Precambrian to recent. In the eastern Green River Basin, at the western edge of the Rawlins RMPPA, the total thickness of sedimentary rock above the Precambrian is about 30,000 feet in the Washakie Basin (Kent 1972). The Hanna Basin contains a thick sequence of post-Precambrian rocks that is estimated to be greater than 42,000 feet thick (Law 1995). Precambrian rocks are generally exposed in the cores of the mountain ranges and smaller uplifts, such as the Rawlins Uplift. In southeastern Wyoming, in the northwest portion of the Denver-Cheyenne Basin, the sedimentary rock section is slightly more than 10,000

feet thick (Kent 1972). Paleozoic, Mesozoic, and Cenozoic rocks are exposed throughout the Rawlins RMPPA.

The major geologic units of the Rawlins RMPPA are shown in Map 3.8-1and found on the WY Geological Survey website at www.wsgsweb.uwyo.edu. Exposed across the Rawlins RMPPA are rocks that range in age from Precambrian to Quaternary. The Precambrian rocks that are exposed in the mountain ranges are complex assemblages of igneous and metamorphic rocks (Houston 1993). Cambrian rocks are present in the west and northwest portions of the Rawlins RMPPA (Boyd 1993). There are no widespread rocks representing Ordovician through Devonian because these layers were eroded. The Mississippian System is represented by the Madison Limestone and the Darwin Sandstone in the western portion of the Rawlins RMPPA. The Mississippian rocks thin from west to east until eventually they are absent east of the line from Centennial, Wyoming, to northwest Laramie County (Boyd 1993). Pennsylvanian rocks in the Rawlins RMPPA consist of the Amsden Formation, the Tensleep Sandstone, the Casper Formation, and the Fountain Formation. In the western part of the Rawlins RMPPA, Permian rocks are represented by the Phosphoria Formation and the Goose Egg Formation. The Dinwoody Formation, Chugwater Group, and the Nugget Sandstone represent Triassic rocks in the western and northern parts of the Rawlins RMPPA. The Jurassic formations throughout the Rawlins RMPPA consist of the Nugget Sandstone, Sundance, and Morrison Formations. In the eastern Hanna Basin at Como Bluff, outcrops of the Morrison Formation have yielded abundant dinosaur bones (Mears et al. 1986). Cretaceous rocks are usually divided into Upper and Lower Cretaceous. The lower part of the lower Cretaceous is represented by sandstones that are loosely correlated and referred to as the Lakota Sandstone and the Fall River Sandstone (Inya Kara Group) or Cloverly Formation. Above the Lakota and the Fall River Sandstones is the Thermopolis; above the Thermopolis Shale is the Muddy Sandstone (Watson 1980).

In the western parts of the Rawlins RMPPA, the Upper Cretaceous consists of the Mowry Shale, the Frontier Formation, the Niobrara Formation, the Steele (Baxter) Shale, the Mesaverde Group, the Lewis Shale, and the Lance Formation. The Mesaverde Group designates widespread sedimentary rocks in the Greater Green River Basin, consisting of sandstone, carbonaceous shale, and coal (Ver Ploeg 1992). The Lance Formation is made up of carbonaceous shale, sandstone, siltstone, and coal (Watson 1980). In the Hanna, Shirley, and Laramie Basins, the last upper Cretaceous units are the Medicine Bow and Ferris Formations, which are composed of carbonaceous shale, coal, and sandstone. In the Denver-Cheyenne Basin portion of the Rawlins RMPPA, the lowest Upper Cretaceous units, in ascending order, are the Graneros Shale, the Greenhorn Formation, the Carlile Shale, and the Niobrara Shale overlain by a dark gray marine shale called the Pierre Shale. Overlying the Pierre Shale is the Fox Hills Sandstone. The Lance Formation overlies the Fox Hills Sandstone in the northern part of the Denver-Cheyenne Basin (Lilligraven 1993).

The earliest Tertiary rocks (Paleocene Series) in the western portions of the Rawlins RMPPA are in the Paleocene Fort Union Formation, which is composed of sandstone, conglomerate, shale, and coal (Watson 1980) deposited in the intermountain basin. In the Hanna, Shirley, and Laramie Basins, the Paleocene is represented by the Ferris and

Hanna Formations (carbonaceous shale, sandstone, conglomerate, and numerous coalbeds). There are no lower Tertiary rocks in the Denver-Cheyenne Basin (Lilligraven 1993). Eocene Series rocks in the western part of the Rawlins RMPPA are the Wasatch (mudstone, red sandstone, carbonaceous shale, and sub-bituminous coal [Watson 1980]) and Green River (shale, oil shale, marlstone, and occasional sandstone) Formations. In the Shirley and Laramie Basins, the Eocene is represented by the Wind River (sandstone, conglomerate, mudstone, carbonaceous shale, and minor coal [Watson 1980]) and Wagon Bed Formations. In the Denver-Cheyenne Basin, there are no Eocene rocks (Love et al. 1993). The Oligocene White River Formation is present in the western part of the Rawlins RMPPA and in the Hanna, Shirley, and Laramie Basins. The White River in the Denver-Cheyenne Basin may contain vertebrate fossils in isolated localities (Watson 1980). In the western parts of the Rawlins RMPPA, the Miocene is represented by the Browns Park Formation and the Split Rock Formation. In the Denver-Cheyenne Basin, the Miocene Ogallala Formation covers the surface in most of Laramie County (Love and Christiansen 1985). In northeastern Laramie County, the upper Oligocene and Miocene Arikaree Formation is present. Unconsolidated Quaternary deposits consist of alluvium, terraces, colluvium, gravels, pediments, and glacial deposits (Love and Christiansen 1985). Alluvial deposits are generally associated with alluvial valleys of the major rivers and tributaries. Glacial deposits are limited to the Medicine Bow Mountains and the Sierra Madre and are largely composed of boulders, cobbles, and fine materials that were scoured from the mountains by the glaciers. More detail on geologic structure can be found in a separate Minerals Report for the Rawlins RMPPA.

Structural Geology and Tectonics

The Laramie and Medicine Bow Mountains and the Sierra Madre are composed of Precambrian rocks that have been uplifted by low- to high-angle reverse faults during the Laramide Orogeny. These major mountain ranges are typical of the nature of the predominant structural style found in mountain ranges of Wyoming, Colorado, Utah, and the Beartooth Mountains of Montana. The cores of the ranges contain Precambrian rocks that have been uplifted many thousands of feet through movement on low-angle to high-angle reverse faults. The nature of the faulting in these mountain ranges was first postulated by Berg (1961) based on the structure of the Wind River Mountains. He described the main fault as a low-angle reverse fault or thrust fault, based on seismic records. The exact geometry of the thrust is more complicated than the first proposed model, and the Precambrian wedge on the west flank of the mountain range is probably highly fractured (Berg 1983). These mountain ranges are unique to the Western Hemisphere in structural style (Grose 1972).

In addition to the major mountain ranges, there are smaller scale uplifts with Precambrian cores within the RMPPA, such as the Ferris, Seminoe, and Shirley Mountains, and the Rawlins Uplift. The Rawlins Uplift is an asymmetric anticline bounded by a reverse fault on the west. An anticline is a geologic structure in which the rocks have been folded in a convex upward shape (Gary et al. 1974). The Ferris, Seminoe, and Shirley Mountains are uplifted Precambrian blocks that were originally part of the Sweetwater Uplift, which also was uplifted during the Laramide Orogeny. Later in Tertiary time, the uplift subsided (Blackstone 1971). The Ferris and Seminoe Mountains are bounded on the

north by normal faults that mark the boundary of the south side of the Granite Mountains, the remnants of the subsided Sweetwater Uplift (Mears et al. 1986). This type of subsided block is called a graben.

In addition to major faults at the boundaries of the mountain ranges and smaller uplifts, there is a major shear zone in the Rawlins RMPPA called the Cheyenne Belt. The Cheyenne Belt is a series of southwest-to-northeast trending fault blocks that cut through the Precambrian rocks of the Sierra Madre, the Medicine Bow Mountains, and the Laramie Mountains (Houston 1993). The Cheyenne Belt separates metamorphic sedimentary rocks on the north side from largely igneous rocks to the south of the belt.

On the west side of the Rawlins RMPPA are sub-basins on the eastern edge of the Greater Green River Basin called the Washakie and Great Divide Basins. The Washakie and Great Divide Basins are separated by a structural high called the Wamsutter Arch that generally trends from west to east paralleling Interstate 80. The Washakie Basin is bounded on the south by another west-to-east trending structural high called the Cherokee Arch. The Cherokee Arch lies generally along the Wyoming-Colorado state line and separates the Washakie Basin from the Sand Wash Basin in northwest Colorado (Law 1995). Other smaller intermountain basins entirely within the Rawlins RMPPA include the Hanna, Shirley, and Laramie Basins. In the southeast part of the Rawlins RMPPA is the Denver-Cheyenne Basin, which occupies northeast Colorado, southwest Nebraska, and the southeastern corner of Wyoming. Within these basins are anticlines, commonly along the basin margins. These anticlines are generally asymmetric, faulted at depth, and provide traps for hydrocarbons.

Topography

The Rawlins RMPPA is located in three major physiographic provinces: the Wyoming Basin, the Southern Rocky Mountains, and the Great Plains (Howard and Williams 1972). The western and northwestern portions of the Rawlins RMPPA are located in the Wyoming Basin, a 40,000-square-mile area that includes much of southwestern Wyoming and part of northwestern Colorado. The Wyoming Basin Province is typified by topographic and structural basins that are either bounded by mountains in the adjacent provinces or bounded by ranges within the province itself (Map 3.8-2). There are several west-east trending mountain ranges in the north-central part of the Rawlins RMPPA. The ranges are, from west to east, the Ferris Mountains, the Seminoe Mountains, and the Shirley Mountains. The Ferris Mountains rise to 10,000 feet national geodetic vertical datum (NGVD), whereas the Seminoe and the Shirley Mountains peak at about 9,500 feet (NGVD).

Sub-basins of the Wyoming Basin within the Rawlins RMPPA boundaries include the Washakie and Great Divide Basins of the eastern Greater Green River Basin, the Hanna Basin, the Shirley Basin, and the Laramie Basin. In the basin areas, the topography is typified by extensive prairies that intersect with badlands, playas, and sand dunes (Howard and Williams 1972).

Elevations in the Wyoming Basin portion of the Rawlins RMPPA generally range from 6,500 to 7,500 feet (NGVD). The Great Divide Basin is bounded by branches of the Continental Divide and has no external drainage outlet. Major river drainages in the Wyoming Basin portion of the Rawlins RMPPA are the North Platte River, Laramie River, and the Little Snake River. All of these rivers have their origins in the Southern Rocky Mountains.

A small part of the Southern Rocky Mountains Province is in the south and south-central portions of the Rawlins RMPPA. The southern Rocky Mountains extend through northern New Mexico, Colorado, and southern Wyoming. Mountain ranges in the Rawlins RMPPA consist of the northernmost portions of the Southern Rocky Mountains. Those ranges are the Laramie Mountains, the Medicine Bow Mountains, and the Sierra Madre (the northern extension of Colorado's Park Range). The portions of the Rawlins RMPPA on the flanks of the mountains generally range from 7,500 to 8,000 feet (NGVD); the highest point in the Rawlins RMPPA is Elk Mountain at 11,156 feet (NGVD). In many places, hogback ridges mark the flanks of the mountain ranges.

The southeastern portion of the Rawlins RMPPA is located in the Great Plains Province in a subprovince called the High Plains (U.S. Geological Survey [USGS] 1970). The High Plains are characterized by nearly flat-lying Tertiary deposits with mesas and badland topography. A prominent physiographic feature in southeastern Wyoming is called the "Gangplank," so called because the Tertiary rocks form a long sloping surface up to the 7,000-foot level of the Laramie Range (Howard and Williams 1972). Elevations in the High Plains portion of the Rawlins RMPPA range from 7,000 feet (NGVD) on the east flank of the Laramie Range to less than 5,000 feet (NGVD) in northeastern Laramie County.

In this portion of the Rawlins RMPPA, drainages originate in the Laramie Range and flow from west to east. The important drainages from south to north include Crow Creek, Lodgepole Creek, Horse Creek, and Little Bear Creek. Crow Creek eventually empties into the South Platte River in Colorado; the others are in the North Platte River Basin.

Minerals

Leasable Minerals

Oil and Natural Gas

The Rawlins RMP will distinguish between conventional natural gas and coalbed methane only to define their two different reservoir systems: sandstone/limestone and coal. The sandstone/limestone reservoirs trap gas as a separate fluid within a porous system in the rock, and only in the case of limestone can the gas be generated within the reservoir. Coal, on the other hand, is a reservoir where the gas is generated within. Gas is defined by 43 CFR 3000.0-5a as a "fluid, either combustible or noncombustible, which is produced in a natural state from the earth and which maintains a gaseous or rarefied state at ordinary temperatures and pressure conditions." In discussing oil and gas leasing, 43

CFR 3100.0-3 does not distinguish between the two types of reservoirs. All other aspects of the regulation of oil and gas, such as Onshore Orders 1, 2, 3, 5, 7 and NTL 3A and NTL 4A, also do not distinguish between these types of reservoirs. Research suggests that the deep "conventional" gas in the Greater Green River Basin is probably coalbed gas trapped in a sandstone reservoir.

Based on production figures through year 2000, 3 of Wyoming's top 25 gas-producing fields are within or partially within the Rawlins RMPPA. These fields and their year 2000 production rank are as follows: Standard Draw (10), Wild Rose (14), and Wamsutter (16) (Wyoming Oil and Gas Conservation Commission [WOGCC] 2002b). In addition, the Rawlins RMPPA contains two of the top 25 oil fields in the state: Lost Soldier (3) and Standard Draw (24).

Records indicate that before 1910 only one well had been drilled in the Rawlins RMPPA. Since that time, there has been a pronounced upward trend in the number of wells drilled (ENSR and Booz Allen 2002). As the number of wells drilled has increased during this period, the depth of the wells also has increased. Since 1990, 74 percent of the wells drilled have been between 8,000 and 12,000 feet deep. The average total depth was 9,249 feet.

The Rawlins RMPPA contains 5,444 wells (Table 3.8-1). To date, 59 percent of all wells have been drilled on federal lands, with the other 41 percent drilled on fee (private) or state lands. Fifty-three percent of all wells drilled in the Rawlins RMPPA have been abandoned. The great majority of abandoned wells either are unproductive (dry holes) or have become depleted and are no longer economical. Since 1980, 37 percent of the total number of wells drilled in the RMPPA have been abandoned.

Within the Rawlins RMPPA, drilling activity has been concentrated in three regions. The first and most heavily drilled region is in the eastern Greater Green River Basin and includes the Great Divide Basin, Wamsutter Arch, and the Washakie Basin. This region is located in the westernmost part of the Rawlins RMPPA. In spite of the heavy drilling in parts of these areas, there are some townships in this region that have been only lightly tested. The primary objectives in these areas are stratigraphic traps within the Upper Cretaceous.

The two other regions of concentrated activity lie in the eastern part of the Rawlins RMPPA and in a region across its center. These regions have been less heavily explored and developed than has the region on the west. Many townships within these two regions have been only lightly tested. The primary objectives in the eastern region are stratigraphic traps in the Lower Cretaceous and fractured reservoirs in the Upper Cretaceous. The central region is mainly developed in structural traps that may include production from the Precambrian to the Upper Cretaceous. The central region is very mature and, unless stratigraphic traps are discovered, will not be very active in the future. Outside of these three regions, many townships have not been tested.

Gas production was flat beginning at least as early as 1974, but began a steady increase in 1978 that carried through 1981 (ENSR and Booz Allen 2002). After a period of

fluctuation during 1982–1985, production increases resumed. From 1986 through 1997, production increased at a nominal annual rate of 4.2 percent. Gas production was 7.5 times higher in 2001 than in 1974. A decline in production during 2000 was mostly due to decline in production from private wells. Gas production from the Rawlins RMPPA in 2001 represented 11 percent of Wyoming's total gas production, based on data from WOGCC.

From 1978 to 1995, oil production fluctuated around an annual rate of 8 million barrels. Beginning in 1990, annual production began declining and has declined at a nominal rate of 2.8 percent per year through 2001. About half the oil produced in the Rawlins RMPPA during 2000 and 2001 was from the Lost Soldier-Wertz Fields near Bairoil, Wyoming. In 2001, only 7 percent of Wyoming's total oil production came from the Rawlins RMPPA.

Although there is increased interest in exploration for and development of gas resources in coalbeds within the Rawlins RMPPA, there has been little production. Only 0.179 billion cubic feet of gas (BCFG) and 10.3 million barrels of water have been produced in the Rawlins RMPPA (WOGCC 2002a). Exploration for gas reserves in coalbeds is progressing in Atlantic Rim, along Seminoe Road, and in Hanna Draw. In Atlantic Rim, Upper Cretaceous aged coals of the Mesaverde Group are to be tested, beginning in 2002. Initial wells for the pilot tests have already been drilled. Exploration is active along the crest of the Wamsutter Arch between the Great Divide and the Washakie Basins and on the east flank of the Washakie Basin (between Townships 13 and 20 North, and Ranges 89 and 92 West). In some portions of this area, well drilling for a pilot test is scheduled to start in 2002. In the vicinity of Seminoe Road, initial wells for the pilot tests have already been drilled west of Seminoe Reservoir in coals of the Mesaverde Group. In Hanna Draw, the coal being tested is in the Tertiary-aged Hanna Formation. However, testing was terminated in April 2002 to reevaluate the economics of the project. The question of how produced water from coalbeds (as well as other formations) should be disposed of is another ongoing issue. Options considered include treating produced water and reinjecting the water into a sand formation that can accept it and that contains water of a poorer quality. Nevertheless, there is sufficient confidence in the coalbed reservoirs' economic viability for major proposals to have been made; these proposals are currently being evaluated by means of Environmental Impact Statements (EIS). (For example, an EIS is being prepared for the collective proposals in the Atlantic Rim.)

Coal

There are six identified coal fields within the Rawlins RMPPA. Of these, the Hanna Field has been the most significant in terms of historic, and projected, coal production. Most activity within the remaining fields has typically been of small scale; in some cases, the coal resource has yet to be economically exploited.

In recent years, there has been a contraction of the coal sector within the Hanna Field. As of 1979, five mining companies were still active in the Hanna Field (Glass and Roberts 1979), but by the year 2000 there were only three active coal mines in the coal field (two surface mines and one underground mine). These were operated by two companies. As

of mid-2002, only one company, Arch of Wyoming, Inc. (a subsidiary of Arch Western Resources, LLC), was still active. This company is operating the Seminoe No. II mine (a combination dragline and shovel/truck operation) and the Medicine Bow Mine. Remaining economic/strippable reserves in both mines have been indicated as sufficient to sustain operations for about 2 years.

Coal is classified by rank, in accordance with standard specifications of the American Society for Testing and Materials (ASTM). Most of the Wyoming coals are of bituminous and sub-bituminous rank. ASTM D-388 provides detailed information regarding coal classification specifications and considerations. Within the Rawlins RMPPA there are six significant coalfields containing coal resources of sub-bituminous to bituminous rank (Berryhill et al. 1950): Hanna-Carbon Basin; Great Divide Basin; Rock Creek; Kindt Basin; Little Snake River; and Goshen Hole Coalfields.

Locatable Minerals

Wyoming is a uranium province. Uranium was discovered in the Powder River and Wind River basins during the 1950s, and continued exploration for uranium resulted in discovery of additional sedimentary uranium deposits in the major basins of central and southern Wyoming. The Rawlins RMPPA contains its share of sedimentary uranium deposits in the Shirley Basin, the Great Divide Basin, the Red Desert area, and around Baggs in the Poison Buttes area. In addition to uranium, the Rawlins RMPPA contains deposits of titaniferous magnetite, stratabound gold, copper-gold deposits, and diamonds hosted in kimberlite pipes. Commercial development of the sedimentary uranium and the titaniferous magnetite deposits has occurred over the past 50 years. The other locatable mineral deposits have seen only limited production and sporadic exploration. Locatable mineral deposits in the Rawlins RMPPA are summarized in Table 3.8-2.

Salable Minerals

Salable minerals disposition is addressed under the *Materials Act of 1947*, as amended by the Acts of 1955 and 1962. These acts authorized that certain mineral materials be disposed of either through a contract of sale or a free-use permit. This group of mineral materials, commonly known as "salable minerals," includes common varieties of sand, stone, gravel, pumice, pumicite, cinders, clay, and petrified wood in public lands of the United States (Maley 1977).

Salable minerals that occur within the Rawlins RMPPA include aggregate, silica sand, dimension stone, vermiculite, pumice and scoria, common clay, and decorative stone (e.g., moss rock). To the extent that petrified wood may be present within the Rawlins RMPPA, it has been considered a paleontological resource rather than a mineral resource.

By far, the most significant salable mineral within the Rawlins RMPPA, both in terms of occurrence and demand, is aggregates, or sand and gravel. Aggregate resources typically occur in one or more of the following forms: natural gravel deposits, alluvial sand and gravel deposits, terrace sand and gravel deposits, glacial gravels, older gravel deposits, and windblown deposits. Within the Rawlins RMPPA, the aggregates resource base is

generally present as windblown, terrace, and alluvial deposits; however, coarser, gravel-type materials are present to a somewhat lesser degree. Where gravel is present, it is generally as an older gravel (conglomeratic) deposit, often situated beneath surficial deposits. The Wyoming Geologic Survey has identified aggregate deposits in the Rawlins RMPPA near Fort Steele (T21N, R85W), Elmo (T22-23N, R81W), and Creston Junction (T21N, R92W), and in the Red Desert Basin (T21-23N, R95-97W).

3.9 OFF-HIGHWAY VEHICLES

OHV use is closely related to several environmental resource issues addressed in other sections of this chapter. Aspects of OHV use that are specifically addressed in other sections of this document, such as Health/safety and Hazardous Materials (Section 3.5), Recreation (Section 3.11), and Transportation and Access (Section 3.14), will not be addressed in this section. All information in this section, unless otherwise noted, was gathered from personal conversations with the Recreation Planner for the Rawlins RMPPA, from the Great Divide Resource Area RMP, or from BLM's Recreation Management Information System (Clair 2002; BLM 1990; BLM 2002).

Designated Off-Highway Vehicle Use Areas

OHV use is managed according to designations finalized in the Great Divide Resource Area RMP. These designations prescribe the available management environment in which OHV users can travel. Potential OHV designations are open, closed, or limited with a predefined limitation in either time or use area. With the exceptions listed below, the Rawlins RMPPA is open to the use of motorized over-the-snow vehicles. In addition, the RMP prescribes that OHV use throughout the Rawlins RMPPA be limited to existing roads and trails, except in seven specified areas that contain different designations. These seven areas and their OHV use environments are as follows:

- **West Seminoe and Dune Ponds.** In this area, located just west of Seminoe Reservoir, OHV users are limited to designated roads and trails. The area of open sand just west of Seminoe road is open to OHV use. In Dune Ponds, open dune areas can be used by OHVs, but use in vegetated areas is restricted to existing roads and trails.
- **Adobe Town Wilderness Study Area (WSA).** In this area, located in the southwest corner of the Rawlins RMPPA, motorized vehicle use is limited to designated roads and trails.
- **Encampment River Canyon.** Located just north of the Medicine Bow National Forest and south of State Highway (SH) 70 near the town of Encampment, this area is closed to motorized vehicle use, including over-the-snow vehicles, from December 1 to April 30.
- **Encampment River Trail.** Straddling the Encampment River Canyon area referred to above, the portions of the Encampment River Trail that cross BLM-administered public land are closed to all types of motorized vehicle use year-round.

- **Ferris Mountains WSA.** Located near the northern boundary of the Rawlins RMPPA and southeast of the intersection of U.S. Highway 287 and SH 220, this area is closed to all types of motorized vehicle use, year-round.
- **Pennock Mountains Wildlife Habitat Area.** Located east of Saratoga, Wyoming, this area is closed to motorized vehicle use, including over-the-snow vehicles, from November 15 through April 30.
- **Wick Brothers Wildlife Habitat Area.** Located on both sides of I-80 and between the towns of Saratoga and Rock River, Wyoming, this area is closed to motorized vehicle use, including over-the-snow vehicles, from November 16 through May 31.

Off-Highway Vehicle Use and Trends

OHVs are widely used for a variety of purposes. In the Recreation Management Information System (RMIS), OHVs are separated into four categories: all terrain vehicles (ATV), cars/trucks/sport utility vehicles (SUV), motorcycles, and snowmobiles. Snowmobile use, while technically considered OHV use, was not included in the OHV categories in RMIS but will be addressed in this section. Table 3.9-1 shows the number of participants and visitor days associated with OHV use in the Rawlins RMPPA. By far the most commonly used of the four potential OHV categories in the Rawlins RMPPA is the cars/trucks/SUVs category. Although the other OHV types receive some use, cars/trucks/SUVs are used by well over 86 percent of OHV participants, and nearly 90 percent of visitor days are dedicated to OHV use.

Within the Rawlins RMPPA, OHV use provides access to hunting, fishing, and camping. In addition, OHV use is increasingly regarded as a method of recreation in itself. OHV use, while recorded by RMIS, extends beyond recreational use. The row within the above-referenced table that refers to gathering of noncommercial products includes one of the other uses, the gathering of shed deer and elk antlers, which is a highly profitable and growing use of OHVs, especially ATVs. The OHVs provide access to large areas of land and easy access to antlers on the ground. In addition to their use in antler collection, OHVs are integral in big game hunting and are also used by hikers, bird watchers, and numerous other people.

Another significant use of OHVs is not shown in the above table. Ranchers and oil and gas interests, and utility and other workers, use OHVs to access and upkeep the developments that are integral to the continued operation of their facilities. BLM staff, too, use OHVs for tasks such as range inspections, surveying and mapping, inventories, project maintenance, and construction.

The OHV designations in the RMPPA for the majority of public lands is “limited to existing roads and trails.” However, the number of unauthorized roads pioneered within the Rawlins RMPPA is increasing. A concern is that, in all of the above uses, OHVs often stray off existing roads and trails to create new two-tracks, thereby contributing to vegetation loss, soil compaction, and soil erosion, and enabling wildlife harassment. In addition, use of existing roads and trails when they are muddy causes damage, erosion,

and sedimentation, whether the roads/trails are two-tracks or improved. Within the Rawlins RMPPA, OHV use in the Sand Hills and Dune Ponds areas is of special concern because of the fragile nature of these areas. The Dune Ponds area receives a number of visitors because of its proximity to the major population center of Rawlins, Wyoming, and Seminoe Reservoir.

Lack of enforcement of OHV designations and general increases in OHV use throughout the Rawlins RMPPA have resulted in a proliferation of roads and trails used by OHV riders. This generally occurs more often in areas of higher recreational use, but there is evidence of rapid route proliferation throughout the Rawlins RMPPA.

3.10 PALEONTOLOGY

The Draft Wyoming Paleontology Manual issued by the Wyoming BLM State Office presents guidelines used to ensure that BLM in Wyoming meets its statutory obligations for protection of paleontological resources. The following sections present an overview of the paleontological resources present in the Rawlins RMPPA, along with the associated paleontological classifications.

Description of Resources

Some of the richest paleontological resources in the United States are in the Rawlins RMPPA. Vertebrate fossils are especially significant in the area. Paleontological research has been conducted in this part of Wyoming since 1856. More than 30 museums and universities have searched the area for vertebrate fossils, and fossils recovered from the RMPPA can be found in public and private collections around the world (BLM 1987).

The rich paleontological resources present in the RMPPA can be attributed to the area's high elevation and continental climate, which hinder vegetative growth and soil development and support erosion and bedrock exposure. Most fossils are recovered as scattered surface finds in areas of exposed rocks. Paleontologists often rely on chance for discoveries. Exposures that produce significant fossils, particularly vertebrates, are rare, and consequently the fossils are of considerable scientific value and interest wherever they are found. Some sites in the Rawlins RMPPA have yielded the only fossil record of several extinct animals (BLM 1987).

The most important paleontological resource in the Rawlins RMPPA is the Como Bluff National Natural Landmark area, which encompasses 7,680 acres located about 5 miles east of Medicine Bow. Como Bluff is a westward-plunging anticline, containing formations from the Cretaceous through the Triassic periods exposed in the face of the bluff. It has yielded fossil evidence for at least 80 newly discovered vertebrate species, including a new genus of Mesozoic mammals. The dinosaur graveyard fossil bed, an uncommon concentration of well-preserved fossils in the Mesozoic Morrison Formation, is exposed in the Como Bluff area. The fossils found in the Como Bluff area played a significant historic role in the development of paleontology as a scientific discipline (BLM 1987).

Within the Sand Creek National Natural Landmark (NNL), late Pleistocene and more recent vertebrate fossil deposits were recovered within a feature known as the "animal trap." This NNL is located about 20 miles southwest of Laramie and includes 4,800 acres, of which BLM administers a 160-acre parcel of public land. Fossil deposits recovered from the animal trap include a large extinct lion, an eagle-like vulture, and a marten, as well as other species no longer found in the area (BLM 1987).

The Washakie Basin, a large physiographic feature with an area of 525 square miles, is located in the southeastern corner of Sweetwater County. Characterized as an intermontane desert basin and considered an NNL, the Washakie Basin contains important paleontological resources. Fossils are present in abundance, and many institutions have actively studied the paleontology of the area (BLM 1987).

The area in and around the Continental Divide contains one of the most complete records of continental deposition in North America, with exposures of the Fort Union, Battle Springs, Wasatch, Green River, and Washakie Formations. The Washakie Formation contains fossils of algae and mollusks. Well-preserved fossil fish are contained in the Laney Member of the Green River Formation. Within the Wasatch Formation, vertebrate fossils are found primarily in the non-red facies of the variegated beds including sandstones. The paleontology of the Battle Springs Formation has not been studied in detail, but it has been found to contain turtle shell fragments, and mollusks. Plant and animal fossils have been found throughout the Fort Union Formation (BLM 1999).

The Medicine Bow Formation, which underlies a portion of the RMPPA, is known to produce vertebrate fossils of scientific significance. Fossils from the Medicine Bow Formation include the remains of marine and freshwater invertebrates, terrestrial plants, and terrestrial vertebrates. Microfossils (pollen) and megafossils (leaf and stem imprints, and petrified and carbonized wood) have been found in the formation. Invertebrate fossils include marine foraminifers and brackish-water gastropods and bivalves. The formation has also produced dinosaur bone fragments from the ceratopsian Triceratops and the remains of a small number of mammals from the late Cretaceous Period (BLM 2001).

The Ferris and Medicine Bow Formations and Lewis Shale within the RMPPA produce fossils of particular significance because they preserve strata containing the Cretaceous-Tertiary boundary, which dates to the time of the extinction of the dinosaurs and adaptive radiation of mammals. The Ferris Formation has produced the remains of early Paleocene mammals, as well as fossil leaves and shells of freshwater invertebrates, and trace fossils. The Lewis Shale has produced a variety of marine invertebrate fossils, including bivalves, baculites, scaphites, and ammonites, as well as isurid shark teeth. The Hanna Formation has produced the remains of terrestrial and aquatic vertebrates, invertebrates, and plants of the Paleocene to possibly earliest Eocene age. These fossils are significant because the Paleocene-Eocene boundary dates to the transition from Archaic to Modern orders of mammals (BLM 2002).

Fossil Yield Potential Classification (FYPC)

The classifications of paleontological resources determine the procedures to be followed before a paleontological clearance to proceed with a project can be granted. Table 3.10-1 describes the five paleontological classifications (Class I through V) and the procedures associated with each. Before surface-disturbing activities can begin in Class I, II, III, or IV areas, a BLM inventory must be conducted. In addition, to manage the collection of scientifically significant fossils, BLM requires that a paleontological collecting permit be obtained for collection of fossil vertebrates and scientifically significant invertebrate and plant fossils.

Significant fossils are known to occur in certain geologic units or formations within the RMPPA. These geologic units and formations have been classified to indicate the actual and potential occurrence of significant fossils. Table 3.10-2 describes the paleontological classes present in the RMPPA, by geologic unit.

3.11 RECREATION

Recreation is one of the major resource uses within the Rawlins RMPPA. The term "recreation" includes a variety of activities that affect and are affected by resources and other resource uses. This section addresses the existing recreational environment within the Rawlins RMPPA, describing the recreation resources, the levels of use these resources receive, and use trends. This section also addresses threats to recreation resources within the Rawlins RMPPA. All information in this section, unless otherwise noted, was gathered from personal conversations with the Recreation Planner for the Rawlins RMPPA (Clair 2002), from the Great Divide Resource Area RMP (BLM 1990), or from BLM's RMIS (BLM 2002).

Recreation Resources

Recreation resources include recreation sites and areas, wildlife resources, and other resources (physical, historical, etc.), each of which provides a different opportunity for recreational use. The resources available, whether developed or natural, have resulted in the high level of recreational use within the Rawlins RMPPA.

Recreation Sites and Areas

In areas where recreation resources receive heavy use, recreation sites are formally designated to enable management and mitigation of impacts on those resources. Consequently, recreation sites are located near high-use recreation areas. There are seven developed recreation sites and two undeveloped recreation sites within the Rawlins RMPPA. These sites (illustrated on Map 3.11-1) are as follows:

- Developed Recreation Sites
  - Rim Lake Recreation Site
  - Teton Reservoir Recreation Site
  - Encampment River Campground (fee site)
  - Bennett Peak Campground (fee site)

  - Corral Creek Campground
  - Dugway Recreation Site
  - Prior Flat Campground
- Undeveloped Recreation Sites
  - Nine Mile Hill
  - Big Creek Access.

In addition to these recreation sites, there are larger areas that receive heavy recreational use. These areas, like recreation sites, are designated as Special Recreation Management Areas (SRMA) to acknowledge the importance of their recreation resources and to help manage these resources in a way that will allow continued high levels of use without damage to the resources. There are two SRMAs in the Rawlins RMPPA: Shirley Mountain SRMA, and the North Platte River SRMA (Map 3.11-2). A portion of the Continental Divide National Scenic Trail also passes through the RMPPA. The existing recreational environment of these areas is addressed in the Special Management Designation portion of this document (Section 3.20).

Wildlife Resources

The wildlife resources (nongame, big game, small game, waterfowl, upland birds, fish, etc.) within the Rawlins RMPPA provide tremendous opportunities for recreational uses. There are several world-class fisheries, and the Rawlins RMPPA contains prime habitat for several big game species, as well as habitat for a variety of upland game birds. The abundance of wildlife in the Rawlins RMPPA directly affects the amount and type of recreational uses available. When wildlife populations fluctuate, so do the opportunities for recreation that involves those populations.

Recreationists directly benefiting from wildlife resources, through such activities as hunting, fishing, trapping, and wildlife viewing make up nearly 57 percent of all recreationists in the Rawlins RMPPA. In addition to this, visitor days (1 visitor day represents an aggregate of 12 hours a visitor spends at a site, area, or activity) spent on the previously mentioned activities make up over 63 percent of all visitor days spent recreating. For more information concerning the existing environment for wildlife, refer to the discussion in Section 3.19 of this document.

Other Resources

Several other resources provide recreational opportunities within the Rawlins RMPPA. Seminoe Reservoir's recreation resources are managed by Wyoming State Parks, and there are several nearby recreation resources that visitors to the reservoir use. The Rawlins BLM Field Office has established memorandums of understanding (MOU) with the WGFD concerning recreation management on several reservoirs in the Laramie area. MOUs addressing the construction and management of recreation facilities at East Allen Lake, Wheatland Reservoir #3, Twin Buttes Reservoir, and Lake Hattie were entered into between 1973 and 1976 and remain in effect. In addition, rivers throughout the Rawlins RMPPA provide opportunities for fishing, as mentioned above, as well as other water-based recreational opportunities, such as canoeing, rafting, drift boating, and other

floating. In relation to recreational use of river resources, the Rawlins BLM Field Office and the National Forest Service have established an MOU that allows river recreationists who enter the river on land managed by one agency to leave the river on land managed by the other agency without having to obtain permits from each agency. The system of roads throughout the Rawlins RMPPA provides an opportunity for casual driving, viewing of wildlife and wild horses, and other such activities. There are two major trails in the Rawlins RMPPA: Continental Divide National Scenic Trail and the Overland Trail. The Continental Divide Trail, which has a National Scenic Trail designation, is the better known of the two and receives more use. The Overland Trail runs through the southern portion of the RMPPA, with recreation on the trail interrupted by the checkerboard land ownership pattern through which the trail runs. Both trails, in addition to several shorter routes, provide opportunities for hiking, backpacking, horseback riding, OHV use, mountain biking, and other trail-related recreational activities.

Recreational Use

RMIS estimates participation in 65 types of recreational activities recorded at BLM-managed sites and areas. Estimates are based on registration records, permit records, observations, and professional judgment. Visitation rates are estimated by numbers of participants as well as visitor days. Participants are the actual number of people who take part in a recreational activity. A visitor day is a common unit of measure of recreation used among federal agencies. One visitor day represents an aggregate of 12 visitor hours at a site or area. It should be noted that the number of participants and the number of visitors may differ, since one visitor can participate in several recreational activities, thereby being recorded as a participant several times. Table 3.11-1 shows a summary of the RMIS data for the RMPPA for 1999, 2000, and 2001.

From October 1998 through September 2001, there were more dispersed recreation visits and visitor days than there were visits to or visitor days at recreation sites (Table 3.11-2). This is due in part to the type of use the different areas receive but, more important, to the amount of land available for dispersed recreation.

According to data from fiscal years 1999, 2000, and 2001, dispersed recreation tends to mirror the pattern shown above for the entire RMPPA, with big game hunting, freshwater fishing, wildlife viewing, and driving for pleasure topping the list of activities. Within these few activities, more than 400,000 participants viewed wildlife for more than 25,000 visitor days, while just under 170,000 participants spent more than 500,000 visitor days hunting big game. Recreation in developed and undeveloped sites, however, shows a different pattern. Because of the large number of developed campgrounds, more visitor days are spent camping than at any other activity (nearly 69,000 visitor days). Nearly 96,000 individuals participated in freshwater fishing, with the next nearest number of participants at just under 41,000 (for viewing wildlife). Trail activities, such as walking, hiking, and running, were also regularly practiced at recreation sites. If the dispersed recreation patterns tend to mirror the overall RMPPA recreation patterns, then recreation near developed and undeveloped sites will tend to be water related, with more participants recreating for fewer visitor days.

Recreation Trends

The current trends in recreational use in the Rawlins RMPPA are steady to slight increases. Since many of the recreational activities in the Rawlins RMPPA are directly tied to various natural resources, the condition of the resources will have a considerable effect on the number of users able to participate in those activities and, as a result, the trend for the activities. The recreation trends tied most directly to resource conditions are those that require wildlife populations to be strong, such as hunting and fishing. In addition, annual precipitation will affect the level of rivers and streams and the recreation that requires these resources, such as fishing and floating. Given favorable conditions for these resources, their recreational use will likely continue to rise slowly.

3.12 SOCIOECONOMICS

The Rawlins RMPPA encompasses a large area across much of southern Wyoming and is located within four counties: Albany, Carbon, Laramie, and Sweetwater. Because activities in the RMPPA have the potential to affect all of these counties, the socioeconomic study area has been defined as these four counties. Demographic and economic data for the socioeconomic study area have been collected from a variety of sources and cover the past 20 years. A 20-year time horizon was chosen in order to examine recent trends in demographic and economic parameters for the socioeconomic study area. These are discussed in detail below.

County Characteristics

Like much of Wyoming, the counties within the RMPPA socioeconomic study area are quite rural in nature. Three of the four counties encompass a rather large land area with a dispersed population, as summarized in Table 3.12-1. Laramie County, the exception, has a higher population density due largely to the location of Cheyenne within its border. The number of persons per square mile ranges from 2.0 in Carbon County to 30.4 in Laramie County.

The largest population centers in the socioeconomic study area are listed in Table 3.12-2. These areas have reported changes in population over the past decade that vary by location. Population is increasing in the eastern portions of the Rawlins socioeconomic study area, while declining in western areas.

Land ownership in the socioeconomic study area is summarized in Figure 3.12-1. Public lands account for a significant proportion of the land base, with 49 percent of total land area owned and managed by federal agencies, including BLM. The Rawlins RMPPA comprises approximately 3.5 million surface acres, which is 22 percent of the socioeconomic study area. In addition, the RFO staff is responsible for 4.67 million acres of BLM-administered federal mineral estate.

The Rawlins RMPPA is known for the checkerboard pattern of land ownership covering a large portion of its area. Figure 3.12-2 summarizes the land ownership within the RMPPA boundaries and shows that BLM manages 32 percent of the total land area,

while 52 percent is held in private ownership. This land ownership pattern presents challenges in managing resources.

Demographic Characteristics

Population

Annual population estimates for each of the four counties in the socioeconomic study area for 1980 to 2000 are plotted in Figure 3.12-3. Population increased by 19 percent over the 20 years, equating to an annual average increase of less than 1 percent. While total population in the socioeconomic study area grew modestly over the past 20 years, examination of the components of population growth yields some additional insights. In Table 3.12-3, the components of population change show that while there are increases in population in this area due to natural changes (more births than deaths), net migration continues to draw individuals away from the area. Overall, the socioeconomic study area followed a statewide trend of declining population due to net migration. All four counties experienced decreases in population due to net migration during both decades, with population declining by nearly 14 percent during the 1980s and by over 5 percent during the 1990s.

The distribution of the population by ethnicity for 2000 in the socioeconomic study area and the State of Wyoming is summarized in Figure 3.12-4. The socioeconomic study area, when compared with the state, reported a lower percentage of whites and a slightly higher percentage of individuals indicating they are of Hispanic or Latino descent. The percentage of other ethnic groups is quite small, which is common throughout Wyoming.

Personal Income Trends

Personal income data were obtained for each county in the socioeconomic study area from the U.S. Bureau of Economic Analysis (BEA). Table 3.12-4 summarizes components of personal income for 1979, 1989, and 1999 for the combined socioeconomic study area in 2001 inflation-adjusted dollars. Total personal income increased to over $4.4 billion in 1999, up from $3.4 billion in 1979. During this 20-year period, personal income grew by more than 29 percent, with almost all of this growth occurring during the 1990s. Table 3.12-5 places these data in perspective by summarizing the estimated poverty rates for the four counties in the socioeconomic study area, Wyoming, the West, and the United States.

Personal income can be broken down into three categories: labor income, investment income, and transfer payments. Labor income is derived from wages, salaries, and self-employment income. Investment income is in the form of rents, dividends, and interest earnings. Transfer payments are largely derived from social security benefits, Medicare and Medicaid benefits, and other income support and assistance.

The socioeconomic study area is showing shifting patterns of income growth. Labor income now accounts for 65 percent of total personal income, down from 78 percent in 1979. Income from nonlabor sources has grown from 21 percent in 1979 to 34 percent in 1999. This change in how individuals earn income is not unlike national and state trends.

For the nation as a whole, labor income fell from 73 percent in 1979 to 68 percent in 1999. Similarly, labor income as a percentage of total income in Wyoming fell from 82 percent in 1979 to 66 percent in 1999.

Investment income in the socioeconomic study area grew by 111 percent between 1979 and 1999 and accounted for 23 percent of personal income by 1999. Investment income as a percentage of personal income for this area in 1999 was higher than the national average (19 percent) but below the state average (40 percent). The increasing dependence on investment income is common throughout the country and is related to the increasing percentage of the population that is retired.

Transfer payments accounted for 11 percent of total personal income in the socioeconomic study area in 1999. While this area has experienced an increasing dependence on transfer payments as a source of income, this trend is very similar to state and national trends; transfer payments accounted for 12 percent of personal income for residents of Wyoming in 1999 and 13.1 percent nationally.

The per capita income for the socioeconomic study area has closely followed the state and national trends associated with per capita income. In 1999, per capita income for the socioeconomic study area was $27,262, which was just slightly lower than the national ($27,358) and state ($27,528) averages.

Economic Characteristics

This section focuses on trends associated with certain economic characteristics in the socioeconomic study area. These include changes in the labor force and unemployment and trends in employment and earnings by industry.

Labor Force and Unemployment

Changes in the labor force and unemployment can provide information on the health of the local economy. The average annual unemployment rates for each of the four counties, Wyoming, and the United States are summarized in Figure 3.12-5. Unemployment in Carbon and Sweetwater Counties has consistently been higher than unemployment for the State of Wyoming during the 1990s and higher than the national average since 1997. Unemployment in Albany and Laramie Counties, however, has been below the state and national averages for almost the entire 10-year period. The significant difference in the unemployment rates between the eastern and western half of the socioeconomic study area likely reflects the availability of jobs in the larger cities of Laramie and Cheyenne in the east in comparison with job scarcity in western portions of the socioeconomic study area.

Changes in the civilian labor force during the 1990s are summarized for each county and Wyoming in Table 3.12-6. The civilian labor force is defined as all persons over 16 years of age in the civilian noninstitutional population who either had a job or were looking for a job in the past 12 months. Overall, the socioeconomic study area realized slower growth in the civilian labor force than did the state. In addition, the eastern portion of the

socioeconomic study area realized growth in the labor force while western counties witnessed a decline.

Employment and Earnings by Industry

The BEA estimates annual employment and earnings for counties throughout the United States. Total annual employment includes both full-time and part-time jobs, so individuals with more than one job will be counted more than once. The employment estimates include persons who are employed by businesses and public entities, as well as individuals who are self-employed. Data were obtained from BEA regarding total annual employment for each of the counties in the socioeconomic study area, Wyoming, and the United States for 1979, 1989, and 1999 to examine trends in employment by industry over the 20-year period.

Total employment in the socioeconomic study area increased by 17 percent over the 20-year period, rising from 92,126 in 1979 to 108,067 in 1999. Over the same 20-year period, total employment grew by 19 percent in Wyoming and 36.4 percent nationwide.

Employment by industry for 1999 is summarized in Figure 3.12-6. Services, government, and retail trade constitute the largest percentage of total employment for this area. These three industry types accounted for more than 70 percent of total employment in 1999. The three industry types also experienced the greatest growth in employment for this area between 1979 and 1999, accounting for 20,000 new jobs. Industries showing the greatest decline in employment between 1979 and 1999 were mining, construction, and transportation and utilities.

Total earnings by industry for counties in the socioeconomic study area, Wyoming, and the United States for 1979, 1989, and 1999 were also obtained from BEA. Total gross earnings for all industries (private nonfarm, farm, and government) increased by 3 percent between 1979 and 1999. Growth in earnings for this area, however, was substantially slower than growth in state and national earnings, which increased by more than 80 percent during this time period.

Figure 3.12-7 provides a summary of gross earnings by industry for the socioeconomic study area in 1999. The government sector provided the largest percentage of earnings of any industry in this area in 1999, accounting for nearly a third of total earnings. Services accounted for the second highest percentage of total earnings in the socioeconomic study area. This category includes metal, nonmetallic, and coal mining, and oil and gas operations. Although mining remains important in terms of earnings for this area, the industry has reported a 44 percent decline in earnings between 1979 and 1999. Other industries reporting declines in earnings between 1979 and 1999 include construction, transportation and utilities, and farms. Additional industries important to this area in terms of earnings include transportation and utilities and retail trade, and manufacturing has been gaining in importance.

Economic Base

An area's economic base is composed of industries that are primarily responsible for bringing outside income into the local economy. Certain sectors within the economy are thought to be basic in nature because most of their sales are tied to outside markets or customers. These industries include manufacturing, mining, and agriculture. In addition, certain government sectors, mainly federal and state government are considered basic because employees are paid from sources outside the local area.

Outside sources of income can also be derived from nonlabor sources (investment income and transfer payments). Transfer payment income can become an economic driver for the area's economy, since many transfer payment programs are sustained by sources outside the local area. Income of this type is received, spent, and respent in the area, which generates additional income for the local economy. This is also true for investment income, although it is not known for certain what percentage of investment income is generated from outside sources. (An assumption was made here that 30 percent of investment income is generated from outside sources.)

Using these definitions of basic industries and outside sources of income, an analysis was conducted on the components of the economic base of the economy in the socioeconomic study area. Table 3.12-7 provides a breakdown of the area's economic diversity as related to the base and outside sources of income for the socioeconomic study area for 1979, 1989, and 1999. Columns 6 through 8 of the table show that the percentage of income earned from outside sources decreased from 57 percent in 1979 to 50 percent 1999. In addition, there appears to have been a shift in the sources of this outside income during the study period. Nonlabor sources of income now account for the largest percentage of personal income. This is a shift since 1979, when mining provided the largest percentage of total personal income for this area. By 1999, mining accounted for less than 10 percent of total personal income. Other traditional basic industries, such as agriculture and manufacturing, have consistently provided a small percentage of the outside income for this area.

Grazing is an important use of BLM-managed lands within the Rawlins RMPPA. An estimate of the importance of this use in the four-county study area is summarized in Table 3.12-8 and Table 3.12-9. The value of grazing on BLM-managed public lands was calculated, as shown in Table 3.12-8. Total annual AUMs were obtained from BLM for the period from 1990 to 2000. Using data on the number of AUMs used in 1997 and data on the value of cattle and sheep sales from the Wyoming Statistical Service, the value of grazing on BLM-managed public lands for the Rawlins RMPPA was estimated to be more than $10 million. The value of grazing associated with the Rawlins RMPPA was then compared with livestock sales during 1997 for the four-county socioeconomic study area. The most recent data on sales were obtained from the 1997 Census of Agriculture published by the National Agricultural Statistical Service. According to Table 3.12-9, total agricultural sales in the four-county area exceeded $180 million, of which 85 percent was associated with livestock sales. Comparing livestock sales throughout the study area with the value of grazing on BLM-managed lands within the Rawlins RMPPA

indicates that grazing activities accounted for 6.9 percent of all livestock sales and 5.9 percent of all agricultural sales for this area.

Examination of Table 3.12-7 also reveals the importance of state and federal Government agencies as a driver for the regional economy. The government sector accounted for between 14 and 18 percent of personal income during this time. Examination of these data also indicates that the economy in the socioeconomic study area is now more dependent on nonlabor sources (transfer payments and investments of income) than on traditional basic industries for outside sources of income. These two sources now account for 18 percent of total personal income.

These data do not shed light on how the economy may be diversifying into other industries that are capable of bringing in outside income to the local economy. Other industries, such as real estate and some service sectors will bring outside income into the economy. For this area, it is likely that certain service sectors, and the financial, insurance, and real estate sector have brought in additional outside income due to the nature of the business and modest growth during the study period.

Property Valuation and Taxation

Total property valuation for the four counties in the socioeconomic study area for 2001 is summarized in Table 3.12-10. This includes property assessed by the State of Wyoming and locally assessed property. The State of Wyoming assesses taxes on both mineral and nonmineral property. Nonmineral property assessed by the state includes airlines, utilities, pipelines and gas distribution systems, railroads, and telephone service (Wyoming Department of Revenue 2001). During fiscal year 2001, the valuation of property assessed by the state was $1.6 billion for the socioeconomic study area. Local government also assesses four categories of property, including agricultural land, residential and commercial land, improvements, personal property, and industrial property (Figure 3.12-8). During fiscal year 2001, the value of property assessed by local governments in the socioeconomic study area exceeded $946 million, as summarized in Table 3.12-10. The total value of assessed property in the four-county socioeconomic study area was $2.6 billion in fiscal year 2001.

Mineral production (Figure 3.12-9 and Figure 3.12-10) in the socioeconomic study area continues to be a major source of tax revenue for local government entities. During fiscal year 2001, minerals accounted for more than 80 percent of the value of property assessed in the area (Figure 3.12-11). Oil and gas production and operations provided a significant percentage of the assessed value of minerals, especially in Carbon and Sweetwater Counties. Table 3.12-11 summarizes the assessed value of oil and gas production and property for fiscal year 2001 for each of the counties in the socioeconomic study area. For 2001, oil and gas production accounted for 75 percent of all mineral valuation in the socioeconomic study area, as assessed by the state. For Carbon and Sweetwater Counties, oil and gas production accounted for 92 and 68 percent of all assessed mineral production, respectively. Physical assets of the oil and gas industry (property) constituted an additional 2.7 percent of all property assessed by local governments. Of all property and production assessed by the state and local governments, oil and gas operations

accounted for 42 percent of assessed value in the socioeconomic study area during fiscal year 2001.

Ad Valorem Taxes—Counties

Estimated ad valorem taxes from mineral production for each county during calendar year 2001 are summarized in Table 3.12-12. These counties generated $76 million in tax revenues from mineral production during 2001. Of this $76 million, $67 million, or 89 percent, was derived from oil and gas production. Ad valorem taxes derived from mineral production accounted for 53 percent of total county tax levies in 2001. Table 3.12-13 provides an estimate of the ad valorem taxes assessed on property associated with oil and gas and coal operations. During 2001, the four counties generated an estimated $3.9 million in property taxes associated with oil and gas and coal extraction assets.

Table 3.12-14 estimates the importance of oil and gas operations in terms of local government property tax revenues. The four counties in the socioeconomic study area generated $71 million in tax revenues due to oil and gas operations. This accounted for 42 percent of property taxes generated in this area for 2001.

Mineral Severance Taxes—State of Wyoming

Local government entities, as well as the state, benefit from severance taxes collected on mineral production throughout the state. Table 3.12-10 shows that $1.4 billion was assessed by the State of Wyoming for mineral production in the four-county socioeconomic study area during 2001. Severance taxes collected on mineral production, however, are distributed within the state according to a formula published in the state statutes (W.S. 39-14-801.). These tax revenues are distributed to a variety of sources, including the state general fund, water development account, state highway fund, counties, cities, and towns. Therefore, the government entities within the socioeconomic study area will benefit from only a percentage of the severance taxes collected on production within the area. However, these entities will also benefit from the severance taxes collected on mineral production in other parts of the state. Table 3.12-15 summarizes the total severance tax revenues that were distributed to the local government entities within the socioeconomic study area during fiscal year 2001.

Table 3.12-16 estimates the severance taxes generated from mineral production originating within the socioeconomic study area. The estimated severance taxes for each mineral type are based on production and assessed values and the effective tax rates, all of which were obtained from the Wyoming Department of Revenue, Mineral Tax Division. Natural gas production generated the most severance tax revenue in the socioeconomic study area, accounting for nearly 67 percent of all severance taxes generated, with the majority of production occurring in Carbon and Sweetwater Counties.

Federal Royalties

Mineral production occurring on federally owned public lands is also assessed a federal mineral royalty. Production is assessed at 12.5 percent of value after allowable

deductions. The federal government returns 50 percent of the total royalties collected to the state where the mineral production occurs. In Wyoming, the distribution of the federal royalties is based on a formula promulgated by the Wyoming State Statutes (W.S. 9-4-601). The state allows a percentage of these federal royalties to be distributed to cities and towns for planning, construction and maintenance of public facilities, capital construction funds, and transportation projects. In addition, local school districts may benefit from federal royalty payments through advanced entitlement grants for capital construction funds.

Total federal royalties distributed to local government agencies in the socioeconomic study area for the federal fiscal year 2001 amounted to $6.04 million (Wyoming Department of Revenue 2001).

Mineral Tax Revenues—Rawlins RMPPA

Tables 3.12-17 through 3.12-19 provide an estimate of the mineral tax revenues associated with oil and gas and salable minerals production within the RMPPA for production year 2000. Actual production data were obtained from the Wyoming State Geologic Survey and used in combination with the average taxable valuation per unit and average tax and royalty rates to estimate ad valorem taxes (county), severance taxes (state), and federal royalties. Oil, gas, and coal production occurring within the RMPPA generated an estimated $58 million in mineral tax revenues to the county, state, and federal governments (ad valorem, severance, and federal royalties) during fiscal year 2001.

Other Tax Revenue Sources

Other tax revenue sources that may be affected by management actions associated with BLM-managed lands include lodging taxes (Table 3.12-20), sales and use taxes (Table 3.12-21), and gas taxes. Lodging taxes have ranged from $0.93 million to $1.2 million per year between 1999 and 2000 for the socioeconomic study area, while sales and use taxes generated between $61 million and $74 million during this time.

Payment in Lieu of Taxes (PILT)

Each county in the socioeconomic study area receives PILT to compensate local governments for hardships caused by federal lands being exempt from local property taxes. PILT payments are allowed in addition to other revenue sharing programs, such as federal mineral royalties and U.S. Forest reserve payments. The PILT payment made to each county is based on a complex formula that takes into account revenue sharing from the previous year, county population, and acreage of the county in federal ownership. PILT payments received by the counties in the socioeconomic study area for the last 10 years are summarized in Figure 3.12-12.

Environmental Justice

Executive Order 12898 (*Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations*) requires the identification and addressing of

disproportionately high and adverse human health and environmental impacts of federal programs, policies, and activities on minority and low-income populations.

Relevant census data were used to determine whether the populations residing within the four-county study area constitute an "environmental justice population" by meeting either of the following criteria:

- At least one-half of the population is of minority or low-income status
- The percentage of population that is of minority or low-income status is at least 10 percentage points higher than for the entire State of Wyoming.

Population by Race

The population distribution by race is summarized in Table 3.12-22 for all counties in the study area. In addition, Figure 3.12-13 shows the minority population for each county in the State of Wyoming, where minority population is calculated as total population less non-Hispanic white alone. All four counties show minority populations that are greater than the state average. This is mainly attributable to the larger Hispanic population in these four counties compared with the rest of the state. Laramie County also has a slightly higher African-American population than does the rest of the state, probably due to the racial diversity of personnel associated with F.E. Warren Air Force Base in Cheyenne.

However, the greater percentage of minority populations living in the four-county study area is not sufficient to constitute an "environmental justice population," because it does not meet either of the criteria above.

Population in Poverty

Poverty level is often used as a determinant of low-income status. The U.S. Census Bureau estimates poverty levels using a set of money income thresholds that vary by family size and composition. If a household's income is below the money threshold, then the family and all individuals of that household are considered to be in poverty. Using this criterion, the Census Bureau provides estimates of the percentage of individuals that fall below the poverty level for each county in the United States. Poverty estimates are also provided for different regions of the United States and for the nation as a whole.

Table 3.12-5 summarizes the estimated poverty rates for the four counties in the socioeconomic study area, Wyoming, the West, and the United States. Carbon, Laramie, and Sweetwater Counties have estimated poverty rates over the past decade that are below the state, regional, and national averages. The exception is Albany County, whose estimated poverty rates are higher than all other areas summarized.

Figure 3.12-14 summarizes the median household income and poverty rates for each county in Wyoming for 2000. This figure shows that the median household income in Laramie and Sweetwater Counties is above the state average, while poverty levels (Figure 3.12-14) are lower than poverty levels throughout the state. This indicates the

absence within these two counties of low-income populations that could be affected by BLM actions. This is not the case in Carbon and Albany Counties, however; these counties reported a lower median household income and higher poverty rates than found throughout Wyoming. For Albany County, the poverty rate is 10 percentage points above the state average, indicating the potential for a low-income "environmental justice population." This issue will need further analysis to determine whether low-income populations may be affected by BLM management actions.

3.13 SOILS

Soil data have been used by BLM as a basis for decisions regarding range sites, range improvements, and wildlife habitat sites, and for determining reclamation practices to address surface disturbance due to mineral development. In addition, soil data have been used to locate sources of gravel and to determine the suitability of areas for use as water disposal pits for water produced from gas wells (BLM 1987). Order 3 soil surveys, are not sufficiently detailed for many land management decisions and are in need of updating. In the sections below, the soil types found within the Rawlins RMPPA are identified and discussed, along with specific conditions and trends.

Soil Types

Soils in the Rawlins RMPPA are variable. They include shallow to deep and fine- to coarse-textured soils. They vary in salt content, organic matter content, and parent material.

A large-scale (1:500,000) depiction of Wyoming soils was compiled in 1998 (Munn and Anderson 1998) based on the five-factor (soil parent material, climate, biota, topography, and time) soil forming model. Digital surficial geology, bedrock geology, and elevation were used to develop 45 separate soil type descriptions across Wyoming soil zones (Map 3.13-1). The 10 statewide soil zones include—

- **Yellowstone National Park** Area. Mountains, cryic, udic
- **Absaroka Volcanics**. Mountains, cryic, udic
- **Middle Rocky Mountains**. Cryic, udic
- **Bighorn Basin**. Intermountain basin, mesic, aridic
- **Powder River Basin, Northern Great Plains**. Mesic, aridic
- **Black Hill**. Mountains, frigid, rustic
- **Southeast Wyoming–Northern Great Plains**. Frigid, aridic
- **Medicine Bow and Laramie Mountains**. Mountains, cryic, udic
- **Laramie and Wind River Basins–Wyoming Basin**. Frigid, aridic
- **Green River Basin–Wyoming Basin**. Frigid, aridic.

Seven of the 10 soil zones (3, 4, 5, 7, 8, 9, and 10) and 26 of the 45 soil type descriptions are found in the Rawlins RMPPA. The soil zones and type descriptions that are found in the Rawlins RMPPA are briefly described in Table 3.13-1. WY44 is the primary soil in the Rawlins RMPPA (53 percent), followed by WY17 (18 percent) and WY45 (12 percent).

Soil Conditions

Map 3.13-1 delineates statewide soil zones within the Rawlins RMPPA for which generalizations can be made about soil productivity, soil permeability and infiltration, soil stability and strength, and soil erosion. These areas are distinguished by varying amounts of precipitation, elevation, soil temperature, and soil parent material (BLM 1987). General conditions found in soils within Map Units A through F are discussed in more detail in the following sections. These conditions collectively influence sound watershed function and the development of healthy vegetation, which together enable human uses and provide wildlife habitat.

Soil Productivity

Soil productivity is the most important soil value in the Rawlins RMPPA because it determines stocking rates for livestock through the amount of vegetation produced, dictates the kinds of plant communities on which wildlife habitat is based, and determines reclamation potential in areas of surface disturbance. Most soils in the Rawlins RMPPA support vegetation that is used by livestock and also serves as wildlife habitat. Soil characteristics and environmental factors that affect soil productivity include organic matter content, salt content, amount of precipitation, soil temperature, wind speed, aspect, soil depth, and soil parent material.

Soil productivity is naturally low throughout the Rawlins RMPPA, although it is higher around springs and along natural drainage ways (BLM 1987). Productivity varies depending on a number of factors, including soil depth, texture, topographic slope, slope aspect, and permeability. Variability in the amount of precipitation, however, is the main factor in variations in soil production within the Rawlins RMPPA. Within the Rawlins RMPPA, Map Unit A, shown in Map 3.13-1, receives the least precipitation and Map Unit C receives the most. The more precipitation an area receives, the more vegetative cover is present. Vegetative cover contributes organic matter to the soil, which in turn provides nutrients for plants, stores more moisture, and improves soil structure, all of which promote vegetative growth.

Map Units C and F have many soils with thicker and darker surface horizons, indicating higher organic matter content. The darker surface horizons are due to the higher amount of vegetation typically found within these areas and to colder temperatures in Map Unit C. Colder temperatures slow the decay of organic material, thus allowing more organic matter to accumulate. The warmer temperatures in Map Unit F create a longer growing season, thus allowing more vegetation to grow and plants to produce more vegetative material. Map Units B, D, and E contain more organic matter than does Map Unit A, although none of these units have the dark surface layer (BLM 1987).

Other factors that affect productivity are depth to bedrock, crusting, and nutrient content. Soils in the Rawlins RMPPA are generally shallow, with a depth to bedrock of less than 20 inches occurring in all Map Units, occurring most in map unit C and least in Map Unit D. This restricts root penetration and lowers water-holding capacity because water tends to run off these areas faster than it infiltrates. Crusting, which results from a breakdown

in soil structure caused by high sodium content and raindrop impact on bare areas, reduces water infiltration and thereby salt leaching and root penetration. This occurs particularly in map unit A, but can also occur in Map Units B, C, E, and F. Nitrogen and potassium are adequate for plant growth throughout the RMPPA, but phosphorus is limited.

As a result of all these factors, Map Unit A has the lowest overall soil productivity; Map Units B, D, and E are intermediate in production; and Map Units C and F have the highest soil productivity (BLM 1987). Bottomland and stream terrace soils are the most productive, but limitations include alkalinity, high clay content, low permeability, and flooding. Upland soils are moderately productive. Limitations include shallow depths, low permeability, and alkalinity. The productivity of dissected upland soil is unknown but is likely to be low. Playa productivity may be high if salinity is not a limiting factor.

Soil Permeability

The permeability of a soil affects its use for reservoirs, water disposal pits, sanitary landfills, and sewage lagoons. Such facilities require soils that are either impermeable or just sufficiently permeable to filter out impurities before the leaked water reaches natural surface or ground water. The soils in Map Unit A are generally fine in texture and are either sufficiently impermeable to effectively hold or filter water or can be compacted to function thus. Map Units B, C, E, and F are less effective at holding or filtering water, but they can be aided in fulfilling this function through compaction. Map Unit D soils are very permeable, and even compaction does not enable them to hold water. For any of these soils, if the underlying bedrock, typically within 60 inches of the surface, is fractured, the ability of the soil to contain water is markedly diminished. Piping (formation of tubular cavities) may also reduce the containment capacity of Map Unit A, where gypsum seams have been dissolved or wet/dry cycles have produced cracks in clays. Finally, the containment capacity of map units A, B, C, E, and F may be diminished adjacent to major drainages where strata of coarser materials, which are permeable and typically not good filters, may be interbedded with finer materials.

Soil Strength and Stability

Soil strength is an important consideration during construction of roads and facilities because low-strength soils are subject to deformation. In areas of low soil strength, building foundation stability is low, and roads and drill pads can become rutted and slippery when wet. Soils composed predominantly of one particle size exhibit low strength. Soils containing a variety of particle sizes exhibit the greatest strength because they better fill in voids of varying sizes, causing more friction among particles. Within the Rawlins RMPPA, soils within Map Unit A have low strength. Map Units B, C, E, and F have moderate strength; these textures are typically loamy, and compaction may be possible to increase strength and reduce the potential for deformation under a load. Soils in Map Unit D and portions of Map Unit A are sandy; because these soils are loose, they are subject to displacement under dry conditions. In Map Unit A, many soils have clayey or silty textures, making compaction difficult and creating deformation upon wetting under a load (BLM 1987).

Soil stability problems occur in Map Units A, B, E, and F, but map unit C has the greatest stability problems. Map Unit C receives the greatest amount of precipitation, primarily in the form of snow. Soil becomes saturated from snow melt, which increases soil weight. This can cause mass wasting, which is the downslope movement of rock and soil under the influence of gravity (BLM 1987).

Soil Erosion

Accelerated rates of erosion do occur within localized areas, including areas of surface disturbance and some drainage areas, especially riparian areas where animals tend to congregate. Reduced vegetation along drainage ways tends to destabilize stream banks and contribute to stream downcutting and gullying. Accelerated stream bank erosion has historically occurred within the Rawlins RMPPA in numerous locations, including the Muddy Creek, Sage Creek, Second Creek, and Third Sand Creek watersheds (BLM 1987).

Within the Rawlins RMPPA, the highest soil erosion rates occur within Map Unit A due to naturally low vegetative cover, soil crusting, low organic matter content, and soft shales, which are susceptible to erosion. These characteristics are especially apparent in the Muddy Creek drainage. Due to greater vegetative cover and organic matter content and lower sodium content, rates of water erosion are lower in Map Units B, E, and F and lowest in Map Unit D. Map Unit D is susceptible to wind erosion; it is protected by a good vegetative cover, but it could actively erode if vegetative cover were reduced. Wind erosion also occurs in Map Units A, B, C, E, and F, but at lower rates (BLM 1987).

In addition to the soil erosion that occurs in the generalized map units discussed above, stabilized intermittent sand dunes are present in hilly upland areas within the Rawlins RMPPA. For example, the Rawlins RMPPA contains the Sand Hills area, which is a unique and fragile dune area with diverse vegetation. BLM management objectives include protection of the unique vegetation complex and minimization of soil erosion. In addition, there is a band of frequently active sand dunes north of Seminoe Reservoir and stretching across the northern portion of the Rawlins RMPPA. Dune Ponds, also within the Rawlins RMPPA, is a 150-acre area consisting of large sand dunes. These scattered areas of sand dunes are easily eroded by wind when vegetation is removed.

Soil Salinity

Soluble salt levels affect management potentials due to toxicity, reduced infiltration rates, limits on nutrient availability, and reduction of water available to plants. Major causes of increased salinity contribution from public lands include overgrazing, OHV use, and energy exploration and extraction. These activities compact the soil surface and cause a reduction in plant cover, creating increased runoff carrying salt-laden sediments into drainage ways (BLM 1996). In addition, deteriorated riparian conditions can eventually convert perennial streams into ephemeral drainages where seasonal water tables fluctuate and water evaporates to produce another major source of salinity (Wilchers 2002), as discussed in Section 3.15.

Salts in the soil stress plants by making water uptake more difficult. The more precipitation an area receives, the more moisture becomes available to leach salt out of the rooting zone. Areas in which soils are sufficiently leached can produce good vegetative cover.

Varying concentrations of soluble salt in soil occur throughout the Rawlins RMPPA. The most leaching occurs in Map Units C, D, and F, and the least in Map Unit A. Map Units B and E have soils that are sufficiently leached to produce good vegetative cover (BLM 1987).

3.14 TRANSPORTATION AND ACCESS

Transportation activity within the Rawlins RMPPA is associated with a variety of resource uses, including mineral extraction, livestock grazing, and recreation. The level of access to these resources can affect their potential levels of use. This section addresses the current roadway network, access issues, and the trends associated with the transportation system.

Roadway Network

The Rawlins RMPPA roadway network includes a spectrum of roads for varying purposes. Map 3.14-1 shows the interstate transportation network, U.S. and state highways, and county roads. There are two interstate highways through the Rawlins RMPPA: I-25, which runs north-south through Cheyenne and Wheatland in the far eastern part of the area; and I-80, running westward from Cheyenne to generally bisect the RMPPA. For the most part, U.S. highways are co-located on interstate highways, with US 87 following I-25 and US 30 following I-80. An important exception is the divergence of US 30 from I-80 between Laramie and Walcott, where it is co-located with US 287. This route is less subject to the blizzard conditions that sometime occur in this segment of I-80. As would be expected on the basis of population, state highways are much more numerous in the portion of the RMPPA east of Rawlins. West of Rawlins, SH-789 is the only state highway, and other routes are typically unpaved.

Not shown on this map are numerous smaller roads laced through the RMPPA, connecting more remote locations within the RMPPA to the larger collector roads. These roads are used for recreational purposes, as well as for access to develop and maintain oil and gas wells and range management improvements. Most of these roads are not paved and are either dirt, gravel, or sand. They include roads that are maintained by BLM, counties, and private corporations. Larger collector roads shown on Map 3.14-1 are not maintained by BLM.

Access

The checkerboard land ownership pattern and other non-BLM-managed inholdings create problems in accessing land and resources administered by BLM. Some easements exist to allow access across private lands to public lands. There are several locations where public access to public land is not available due to the lack of such easements or

contiguous BLM-managed public land. For example, access to the Overland Trail is hampered due to noncontiguous BLM-managed land. In addition, public access to streams and reservoirs is often restricted by the absence of accessible public lands adjacent to the water.

Transportation Trends

Transportation of extracted resources (oil, gas, coal, etc.) along transportation corridors increases as new development occurs. Not only is there an increase in pipelines, there is also an increase in access and utility roads and coincident vehicular traffic associated with the construction and maintenance of wells. Thus, trends in transportation coincide directly with trends in development of extracted resources.

3.15 VEGETATION

Vegetation resources within the Rawlins RMPPA are diverse, and in some areas unique. The precipitation, elevation, and temperature extremes, combined with soil and geology variability, create a variety of vegetation habitat types. The eastern areas of the Rawlins RMPPA, located in Wyoming's southeast corner, are within the vast North American prairies, where mixed grass communities dominate. The desert areas provide habitat for a variety of hearty plants tolerant of low precipitation, temperature extremes, and saline soils. Alpine areas on Elk Mountain and the Seminoe and Ferris Mountains support plants adapted to very low temperatures, an extremely short growing season, and high snow accumulation. The RMPPA supports a variety of vegetation types, each of which is susceptible to fire occurrence as a result of fuel loading or as a natural condition of the environment.

This discussion focuses on vegetation distribution and types at three levels. The top level divides the Rawlins RMPPA into three vegetation provinces. These were taken from Bailey (1995), which describes the ecoregions of the United States. The middle level uses vegetation map zones aggregated from Geographical Analysis Program (GAP) satellite imagery interpretation. The map zones allow quantitative measurements of broad vegetation types. The lowest level describes the individual plant communities, defined by the soil, climate, and vegetation characteristics. Each level may be used as a management tool depending on the specific issues and level of detail required.

Ecological Provinces

Bailey's (1995) description of North American ecoregions places the Rawlins RMPPA in three different vegetation provinces (Map 3.15-1). These include the Intermountain Semi-Desert Province (342), Great Plains Dry Steppe Province (331), and Southern Rocky Mountain Steppe–Open Woodland–Coniferous Forest Province (M331). The following subsections provide an overview of each of these vegetation provinces.

Intermountain Semi-Desert Province (342)

This area is contained within the intermountain basins of Wyoming and northern Colorado. The chief vegetation type, sagebrush steppe, is made up of sagebrush,

saltbush, and a mixture of grasses and forbs. Willows, rushes, and sedges dominate the wetter valley bottoms, while greasewood and inland saltgrass dominate drier streams and ephemeral washes (Bailey 1995; Knight 1994). The higher elevations may contain pockets of aspen in the wetter areas and juniper/limber pine stands in the drier areas.

The Intermountain Semi-Desert Province is sometimes considered a cold desert, as the summers are hot and the winters can be extremely cold. The growing season is short (Rawlins has a frost-free period of 106 days), and the annual precipitation varies between 5 and 14 inches. Snowfall averages between 20 and 60 inches (Martner 1986). Winter snow accumulation and runoff provide available moisture for spring plant growth. Snow distribution patterns caused by wind, topography, and existing vegetation develop pockets of highly productive sites within the drier, less productive surrounding areas.

This area lays predominantly in the western and central regions of the Rawlins RMPPA at elevations below 8,000 feet. Forest and alpine areas dissect this vegetation province; therefore, these areas provide winter habitat for many wildlife species. Livestock and wildlife grazing are the primary uses of the area.

Great Plains Dry Steppe Province (331)

Mixed and shortgrass prairies found east of the central Rocky Mountains dominate this region. Typical grasses in these areas include buffalo grass, grama grasses, wheatgrasses, and needle grasses. Deeper soils in wetter areas may grow taller grasses, such as Indian grass and little bluestem. Scattered shrub colonies may dot the landscape with big sagebrush, sand sagebrush, and rabbitbrush. Wet riparian areas provide habitat for cottonwood, sumac, willow, and alder (Bailey 1995; Knight 1994).

This area lies in the rain shadow of the Rocky Mountains. Winters are cold and dry, and summers are warm with frequent thunderstorms (Martner 1986; Bailey 1995). Cheyenne has a moderate growing season of 138 days, but Laramie, 40 miles west, has a much shorter growing season (only 93 days). The annual precipitation for the area is between 10 inches in the far west and 16 inches east of Cheyenne. The average annual snowfall is between 60 and 80 inches (Martner 1986).

Within the Rawlins RMPPA, the Great Plains Dry Steppe Province dominates the ecology of the Laramie Basin and the prairie east of the Laramie Range to Nebraska. The Laramie Basin varies in elevation between 7,000 and 7,500 feet, while the elevation of the far southeast portion of the Rawlins RMPPA ranges between 5,500 and 7,000 feet. Most of this area is privately owned and is used as either grazing for livestock, irrigated cropland, or dryland farming.

Southern Rocky Mountain Steppe–Open Woodland–Coniferous Forest Province (M331)

This area is a transition from grass- and shrub-dominated areas to shrub- and tree-dominated areas. Brome and fescue grasses, mountain mahogany, sagebrush, aspen, and juniper dominate the 8,000- to 9,000-feet elevations. The middle elevations of pine and spruce forest lie between 8,500 and 12,000 feet. Alpine tundra occurs only in the

Rawlins RMPPA area above 10,000 feet and is dominated by short grasses and cushion-type forbs, as well as krummholz patches of spruce and fir. Riparian vegetation varies according to elevation as well; however, willows and water-tolerant grasses, sedges, and rushes often dominate from the foothills to the alpine (Bailey 1995; Knight 1994).

The climate of these areas is very variable and dynamic due to factors such as elevation, aspect, slope, and topographical change. Eastern and southern slopes are generally drier and warmer than are western and northern slopes. As the elevation rises, the mean temperature lowers and the growing season shortens (Fox Park at 9,065 feet has a frost-free period of only 21 days). Annual precipitation generally rises from 14 inches in the foothills to over 60 inches in the alpine area. Winter mountain snowpack may reach over 200 inches per year and provides a reservoir for lower elevation water users (Martner 1985; Knight 1994).

Mountain ranges dominated by the Southern Rocky Mountain Steppe–Open Woodland–Coniferous Forest Province are well distributed throughout the Rawlins RMPPA and include the Snowy Range, the Sierra Madre, the Laramie Range, Shirley Mountains, Freeze Out Mountains, Seminoe Mountains, and Ferris Mountains. These areas provide summer forage for wildlife and livestock, as well as important habitat for many nongame mammals, birds and fish. Higher elevation provides areas of increased diversity and productivity within large areas of lower precipitation and often harsher environments.

General Vegetation Map Zones

The general vegetation zones illustrated in Map 3.15-2 represent combinations of plant community classes taken directly from the GAP satellite imagery analysis (Table 3.15-1). The classes combined for each zone, the zone's total area, dominant vegetation, and a description of the area where the vegetation occurs are also provided in Table 3.15-1. Note that the acreages provided represent total area within the Rawlins RMPPA, some of which is owned by private, state, or other federal entities.

Distinct plant communities within the Rawlins RMPPA are influenced by characteristics such as soil depth, texture, and salt content; climate variables, particularly temperature, total and seasonal distribution of precipitation, and wind; and topographic features, most importantly elevation, aspect and slope. Plant communities respond to other environmental influences, such as wildlife foraging, rodent burrowing, and ant hills. Plants themselves also influence soil chemistry and soil resistance to wind and water erosion. The following plant community overviews show the diverse and complex nature of vegetation communities in the Rawlins RMPPA.

Agriculture/Town

This highly modified vegetation zone is mapped within the Rawlins RMPPA. It includes areas that are settled, farmed with or without irrigation, or mined. It also includes areas mapped by GAP as forest-dominated riparian that, in reality, are primarily hayfields with only linear cottonwood stands remaining. With the exception of mined areas, little or none of this vegetation zone occurs on land managed by BLM.

River bottom cottonwood forests occur along the North Platte River bottom and are dominated by plains cottonwood and narrowleaf cottonwood. The vegetation type is very similar to that of the riparian woodlands; however, these areas are drier and usually have a natural understory dominated by upland grasses and forbs in areas where agriculture is absent.

Barren

The barren vegetation zone occurs in diverse locations, all of which are inhospitable to vegetation. These locations range from exposed areas on mountaintops to rocky areas in basins to basin soils that do not support plants for various reasons, often because they are highly saline. This zone also includes areas mapped as open water that are primarily large, deep reservoirs that do not support plant life.

Forest and Woodland Communities

Broadleaf Communities—Aspen

Quaking aspen communities in the Rawlins RMPPA occupy the transitional zones between the sagebrush-dominated communities and the coniferous forests. Aspen are also present along streams, in draws, or on the leeward areas of hills and ridges where snow collects. Aspen colonies typically reproduce asexually, producing clones in which separate trees are connected by root suckers. Therefore, several acres of aspen may be interconnected through their roots (Barns 1966). The soils of these areas are usually well-developed deep loam and sandy loam soils with good drainage and high organic matter.

Acting as snow traps, aspen stands are able to support higher productivity and more diverse herbaceous plants than are the adjacent coniferous or sagebrush communities. The aspen stands also provide protective cover essential to mountain watersheds. Understory plants commonly include king spike fescue, mountain brome, lupine, columbine, Indian paintbrush, elk sedge, Columbia needlegrass, blue wildrye, licorice-root, elkweed, bedstraw, arnica, snowberry, serviceberry, wood rose, Scouler's willow,.and common juniper.

Aspen respond well to fire, and fires typically stimulate repressed colonies to increase root sucker regeneration. This may diversify the age structure of the stand and increase herbaceous production. The occurrence of spring and fall fires has produced the best results.

Wildlife depend on aspen in the fall, winter, and spring for both cover and forage. The open cover of aspen stands provides mule deer fawning and elk calving areas as well. High forb and grass production and shade draw wildlife and cattle into these areas during summer grazing seasons. Birds use these areas for important nesting sites, and other nongame species also rely on this habitat. Lower elevation aspen stands at edges of sagebrush are important areas of wildlife biodiversity for many small birds, raptors, and owls. A diversity of age classes and stand densities are important in maintaining diverse wildlife communities supported by aspen.

Conifer Communities

Juniper and Limber Pine Woodland

Juniper woodlands in the Colorado River watershed area often have Utah Juniper as the single-tree species. These sites occur on rocky, fractured bedrock areas in elevations between 5,700 and 7,500 feet, with annual precipitation between 10 and 15 inches. In other areas, on foot-slopes adjacent to conifer forests, Rocky Mountain juniper occurs in association with Limber Pine. These sites may occur in association with Wyoming and mountain big sagebrush steppe, occurring in shallow, poorly developed soils at elevations between 7,500 and 8,500 feet. The annual precipitation in these areas is between 16 and 20 inches. Both types of juniper woodlands have understory vegetation which may include bluebunch wheatgrass, needle-and-thread, slender wheatgrass, Idaho fescue, Wyoming big sagebrush, mountain big sagebrush, snowberry, mountain mahogany, bitterbrush, and common juniper.

Juniper-dominated communities often become decadent because the dominant species pumps most of the soil water into the atmosphere, resulting in a monoculture of juniper. At this point, prescribed fire in these areas does not result in an effective burn, because the fine fuels on the ground do not carry the fire into the trees. However, when these communities do eventually burn, they may sustain dangerous high-intensity wildfire during high winds in the hot season. After juniper woodlands burn, production of herbaceous vegetation responds very well.

Other Conifer

Limber Pine Woodland

Limber pine is the dominant tree on rocky escarpments surrounded by more productive grasslands (Knight 1994). It may also occur as a subdominant tree in juniper woodland, as mentioned above. Limber pine-dominated areas are normally associated with Idaho fescue, bluebunch wheatgrass, globemallow, phlox, sand sage, fringed sage, snowberry, and mountain big sagebrush.

Lodgepole Pine Forest

The most common tree in the mountains of northern Colorado, Wyoming, and much of the Northern Rockies is lodgepole pine. These forests occur in the middle elevations of the area mountain ranges between 8,000 and 10,000 feet (Knight 1994). Lodgepole pine is considered a pioneer species, as it returns rather quickly following fire, and it does not regenerate well in a continuously shaded environment. These trees also produce serotinous cones, which are more likely to release their seeds and germinate following intense heat.

The lodgepole pine forest canopy does not allow for a very diverse understory plant community. Plants that occur here are pine reedgrass, Wheeler bluegrass, heartleaf arnica, bedstraw, wortle berry, common juniper, Wood rose, wax currant, and russet

buffalo berry. Lodgepole pine will grow in mixed stands of aspen, Engleman spruce, subalpine fir, Douglas fir, and Ponderosa pine (Knight 1994).

Lodgepole pine forests are present in many mountain areas of the Rawlins RMPPA and are managed for wildlife habitat, watershed maintenance, and timber production. A detailed discussion of the management of these areas is included in Section 3.4 (Forest Resources).

Ponderosa Pine Forest

Ponderosa pine occurs at lower elevations on the eastern slopes of mountains, where summer precipitation levels may be higher and the growing season is longer and warmer. The most notable stands of ponderosa pine in the Rawlins RMPPA are on the eastern slopes of the Laramie Range, Shirley Mountains, and Seminoe Mountains. Ponderosa pine forests are often open woodlands and support a mixed grass or shortgrass understory.

Scattered Upper Elevation Species

Scattered in the upper elevations of the Rawlins RMPPA, on north-facing slopes, and in cold air drainages are individuals of species often found at higher elevations than typically characterize the RMPPA. These include spruces, firs, and Douglas fir. Logged conifers and subalpine meadows are also mapped in this vegetation zone. Most stands of these species occur on U.S. Department of Agriculture (USDA) Forest Service lands.

Grassland

Three grassland types occur in the Rawlins RMPPA: mixed grass prairie, shortgrass prairie, and a shortgrass prairie variant sometimes called desert grassland. These grasslands are characterized below.

Mixed Grass Prairie

Because of the altitude and prevalence of sandy soils, the Laramie Basin is an isolated pocket of mixed grass prairie. Summers in this area are cool, which reduces the evapotranspiration. Frequent thunderstorms in July and August maintain this grassland, which is also found in higher precipitation zones to the north and east. Mixed grass prairie is characterized by needle-and-thread, western wheatgrass, blue grama, Sandberg bluegrass, threadleaf sedge, needleleaf sedge, prairie junegrass, Indian ricegrass, prickly pear cactus, globemallow, fringed sagebrush, and various species of milkvetch and locoweed. This area is predominantly used for livestock and wildlife grazing.

Shortgrass Prairie

The shortgrass prairie occurs in the southeastern corner of the Rawlins RMPPA and is characterized by buffalo grass and blue grama. Other associated species include hairy grama, western wheatgrass, side-oats grama, yucca, and prickly pear cactus (Barker and Whitman 1994). This area lies in the 12- to 20-inch annual precipitation zone in the rain

shadow of the Rocky Mountains. Soils are sandy loams, loams, and clay loams. Most of the area is used for livestock grazing, and very little is managed by BLM. To the west, this vegetation type is replaced by the ponderosa pine and lodgepole pine forests of the Laramie Range.

Desert Grassland

On sandier soils and dunes, where water is more available and the shifting dunes restricted by shrub establishment, desert grasslands commonly occur as a variant of shortgrass prairie. Common grass species include thickspike wheatgrass, slender wheatgrass, bluebunch wheatgrass, Indian ricegrass, needle-and-thread, Sandberg bluegrass, and sand dropseed. Other shrubs and forbs growing among the grasses are sand sagewort, phlox, Hooker sandwort, bud sagebrush, fringed sagebrush, Wyoming big sagebrush, rubber rabbitbrush, horsebrush, and prickly pear cactus (Knight 1994).

Saltgrass meadows occur in shallow depressions or adjacent to playa lakes where ground water is near the desert surface. These areas are characterized by inland saltgrass, alkaligrass, alkali sacaton, and, in wetter areas, alkali cordgrass (Knight 1994). Desert grasslands provide palatable forage and often provide islands of diversity within the desert shrublands.

Shrub Communities

Shrublands dominate the majority of lands administered by BLM in the Rawlins RMPPA. These areas are very diverse; therefore, this section discusses several shrub community types.

Greasewood

Greasewood-dominated shrublands occur on the fringes of playas, desert lakes, ponds, and desert streams. Greasewood is a halophyte that does well in very saline soils; however, it needs more soil moisture to survive than does saltbush.

Where greasewood is the dominant shrub, subdominant shrubs include shadscale, Gardner saltbush, alkali sagebrush, and basin big sagebrush. The understory is limited to salt-tolerant herbaceous vegetation, such as inland saltgrass, western wheatgrass, alkali sacaton, bottlebrush squirreltail, Sandberg bluegrass, biscuit root, pepperweed, and sea blight.

Large expanses of this vegetation type occur in the Great Divide Basin. Greasewood shrublands often occur on the terraces above wetter areas where silver sagebrush or basin big sagebrush dominate (Knight 1994). Greasewood communities are often found adjacent to saltbush-dominated communities, growing in deeper, sandier soils and alluvial fans. Although greasewood is not considered a very palatable forage, pronghorn and sheep will eat the spiny twigs and leaves in the spring and early summer, and cattle use this species in summer and fall as a source of salt.

Mountain Shrub

Bitterbrush Shrub Steppe

Bitterbrush-dominated plant communities exist on sand and sandy and sandy loam soils in the 10- to 14-inch annual precipitation zones. Bitterbrush varies in height depending on soil depth, precipitation, and browsing. It may appear as a low spreading shrub about 6 inches tall or as a tall shrub reaching 6 feet in height.

Bitterbrush is often a co-dominant with mountain or basin big sagebrush, and in the sand hills south of Rawlins it is intermixed with silver sagebrush, basin big sagebrush, and rabbitbrush in deep sandy soils. At higher elevations and higher precipitation levels, it occurs in mixtures with sagebrush, snowberry, serviceberry, mountain mahogany, and occasional chokecherry. Herbaceous plants associated with bitterbrush include grasses such as needle-and-thread, prairie sandreed, Indian ricegrass, sand dropseed, and thick spike wheatgrass and forbs such as lupine, penstemon, sego lily, wild onion, larkspur, and prickly pear cactus.

Bitterbrush is probably the most important winter browse species for deer in the region. Elk and cattle use it as well in the fall and spring. It responds best to sagebrush-killing fires when burns occur in the fall and spring, although its resprouting response is fair to moderate at best, even under such conditions. Hot summer fires will kill bitterbrush.

Mesic Upland Shrub Steppe

Either serviceberry or chokecherry or a combination of both dominates this community, often in conjunction with snowberry, currant, and Wood rose. Good examples of this plant community occur on the middle elevations of Battle Mountain near Savery. These shrubs may reach 10 to 15 feet high, occurring in dense stands or in scattered patches, often adjacent to aspen or willow. Understory grasses include basin wildrye, green needlegrass, Columbia needlegrass, and Kentucky bluegrass, and forbs include bluebell, columbine, aster, violet, elkweed, chickweed, and stinging nettle.

This community provides hiding and thermal cover for deer, elk, and other wildlife species. The dominant shrubs provide excellent forage for browsing animals when their softer leaves and shoots stay within reach. These shrubs will reestablish following fire, often in less dense patches, making them more accessible to wildlife and livestock.

Xeric Upland Shrub Steppe

True mountain mahogany dominates this plant community on dry rocky slopes or in very shallow, undeveloped soils in the 10–14 inch precipitation zone. It occurs, as both the dominant shrub or as an understory of Utah juniper, at higher elevations, mixing with bitterbrush, snowberry, serviceberry, green rabbitbrush, broom snakeweed, and Wyoming big sagebrush. Common associated herbaceous plants include bluebunch wheatgrass, Indian ricegrass, Sandberg bluegrass, and mat-forming forbs such as phlox, buckwheat, locoweed, Hooker sandwort, goldenweed, and milkvetch.

True mountain mahogany may reach 5 to 7 feet tall, depending on the amount of browsing and soil depth. Typical mountain mahogany communities occur in Telephone Canyon along I-80 east of Laramie, and Chalk Mountain near the Shirley Mountains. Fire generally lessens the density of the shrub stands, allowing grasses and other herbaceous plants to increase, while still providing wildlife browse. Mountain mahogany is an important wildlife fall and winter forage. A notable characteristic is the hedging growth pattern exhibited by mountain mahogany plants after they have been browsed by mule deer and elk.

Sagebrush

The GAP data represent sagebrush as black sagebrush, mountain sagebrush, and Wyoming sagebrush plant cover types, which are mapped collectively as sagebrush on Map 3.15-2. These three categories cannot readily be partitioned into the species of sagebrush actually found in the Rawlins RMPPA, which are discussed below.

Wyoming Big Sagebrush/Grassland

The Wyoming big sagebrush/grassland is the most common vegetative cover type in south-central Wyoming. It occurs in shallow to moderately deep soil at lower elevations, giving way to basin big sagebrush in deeper soils and to mountain big sagebrush above 6,500 feet in elevation and within the 9–16 inch annual precipitation zones (Knight 1994). Shrub height varies from as little as 8 inches tall on shallow sites to around 30 inches tall in deeper soils. Canopy cover is not as extensive as for either basin or mountain big sagebrush, usually topping out between 30 and 40 percent.

Wyoming big sagebrush often appears as the dominant plant in mosaic communities intermixed with Gardner saltbush and open grasslands. In shallow, rocky to gravelly soils, Wyoming big sagebrush may be co-dominant with black sagebrush, green rabbitbrush, and sometimes winter fat. Grass and forb species vary depending on soil texture, aspect, and slope. Common grass and grass-like species include bluebunch and thickspike wheatgrass, Sandberg and mutton bluegrass, Indian ricegrass, needle-and-thread, threadleaf sedge, and bottlebrush squirrel tail. Common forbs include phlox, Hooker sandwort, buckwheat, penstemon, Indian paintbrush, globemallow, and prickly pear cactus.

Wyoming big sagebrush is the most frequently eaten sagebrush and is a staple for pronghorn antelope and greater sage-grouse. It is also one of the dominant species found on antelope and mule deer-crucial winter ranges. Fire is an important component of all sagebrush-dominated plant communities. Depending on the nature of the site, the fire return interval can be between 25 and 100 years (Knight 1994).

Basin Big Sagebrush Shrubland

Basin big sagebrush shrubland is found in moderately deep to deep soils of all soil textures in zones of 10 to 16 inches of annual precipitation (Beetle 1960). It occurs as pockets within Wyoming big sagebrush and Gardner saltbush communities, as the dominant plant type along valley bottoms and canyons, and along isolated ephemeral

washes. This subspecies of big sagebrush may reach 12 feet in height, with canopy cover reaching 70 percent.

Basin big sagebrush mixes with serviceberry, green and rubber rabbitbrush, snowberry, bitterbrush, silver sagebrush, and mountain mahogany, depending on the soil depth, annual precipitation, and elevation. Grasses occurring in these communities include basin wildrye, green needlegrass, Idaho fescue, thickspike wheatgrass, Kentucky and mutton bluegrass, and bottlebrush squirrel tail. Common forbs include bluebells, groundsel, wild onion, violet, buttercup, false dandelion, buckwheat, penstemon, Indian paintbrush, globemallow, and prickly pear cactus.

Basin big sagebrush is not a very palatable forage, usually showing little or no use, even in extreme winters when use levels of other plants are severe. It is important, however, as hiding cover for mule deer and elk and as habitat for other wildlife species. In some areas, it also provides critical winter habitat for greater sage-grouse when snow covers most other shrubs. Basin big sagebrush often increases in density and cover with poor livestock management and interruptions in the fire cycle. To increase diversity in basin big sagebrush shrublands, prescribed fires and chemical and mechanical treatments are employed, resulting in increases of grasses and other understory plants.

Mountain Big Sagebrush/Grassland

Mountain big sagebrush is located in shallow to moderately deep soils at elevations above 6,500 feet, in 12–20 inch annual precipitation zones. It is the dominant plant community on the Brown's Hill to Miller Hill plateau south of Rawlins. This is one of the largest homogeneous communities of this sagebrush type in the United States. Mountain big sagebrush also occurs as smaller plant communities at the lower mountain elevations, and it enters into small and larger mountain range areas intermixed with aspen and conifer woodlands. Shrub height will vary from 10 to 30 inches, with canopy cover reaching 50 to 60 percent.

Mountain big sagebrush is usually the dominant shrub in foothill and mountain sage communities, with bitterbrush, serviceberry, snowberry, and mountain mahogany providing subdominant brush diversity. Grasses include Idaho fescue; king spike fescue; green and Colombian needle grass; Kentucky, mutton, and big bluegrass; elk sedge; and Ross' sedge. Common forbs found in these areas include Indian paintbrush, globemallow, lupine, larkspur, penstemon, and Oregon grape.

Mountain big sagebrush is palatable to wildlife, although browsing is limited during the winter, when these habitats become unavailable due to snow. Following fire, mountain big sagebrush reestablishes as the dominant species more quickly than do other sagebrush types, often resuming dense canopy cover after only 20 to 30 years. The natural fire recurrence interval in this sagebrush type is 25 to 75 years.

Silver Sagebrush/Grasslands

Silver sagebrush/grasslands have two subtypes with very different habitats. The most common is found in deep, sandy soils, and consists of silver sage, as the dominant

species, associated with basin big sage, green rabbitbrush, serviceberry, chokecherry, and Wood rose. Herbaceous species include needle-and-thread, Indian ricegrass, prairie sandreed, sand dropseed, scurfpea, and prickly pear cactus.

The second type is located in riparian habitat along streams above the wet sedge and willow riparian zone. The second riparian terrace is also habitat for basin wildrye, Kentucky bluegrass, streambank wheatgrass, redtop, Baltic rush, clover, checkermallow, aster, and, occasionally, cottonwood and willow.

Silver sagebrush is desirable forage for both livestock and wildlife, and provides important habitat for big game and nongame species. These areas respond well to prescribed fire as a management tool when they are dry enough to burn.

Low Sages—Alkali, Birdsfoot, and Wyoming Three-Tip Sagebrush/Grassland

Alkali sagebrush is found growing in clay soils and, as its name implies, can withstand soils of higher alkalinity than can other sagebrushes (Beetle and Johnson 1982; Knight 1994). It occurs in relatively pure communities due to the high clay content and high cation exchange capacity in the soils in areas below 7,500-feet elevation. Understory grasses include bluebunch wheatgrass, western wheatgrass, mutton bluegrass, bottlebrush squirreltail, and Indian ricegrass. Forbs noted at this site include wild buckwheat, biscuit root, and wild onion. Browsing on this sage is light.

Birdsfoot sagebrush is found in alkaline soils, where pH ranges from 8.5 to 11, and below 7,500 feet. At lower pH levels, birdsfoot sage mixes with Gardner saltbush, and it appears with a mixture of grasses and forbs on windswept ridges and hills. At higher pH levels, birdsfoot sagebrush occurs as a monoculture.

Wyoming three-tip sagebrush occurs above 7,000 feet in the foothills and at the higher elevations of the mountain ranges. It normally grows between 4 inches and 15 inches tall in moderately deep, well-drained soils (Beetle and Johnson 1982). It is often found intermixed with mountain big sagebrush and black sagebrush. Understory grasses and forbs include Idaho fescue, king spike fescue, Colombian needlegrass, elk sedge, Ross' sedge, Indian paintbrush, mountain pea, larkspur, balsamroot, phlox, and buckwheat. Wyoming three-tip sagebrush-dominated areas are often used as forage for wildlife. This species does burn, but due to a lack of fuel continuity, large, resource damaging fires are rare.

Saltbush

Salt desert shrubland is perhaps the most arid vegetation type in the intermountain West (Knight 1994). Gardner saltbush dominates the salt desert shrub community type and, in some instances, occurs as up to 90 percent of the vegetation cover. These areas are characterized by accumulations of salt in poorly developed soils. Soils of these areas usually have a pH of 7.8 to 9, which restricts the uptake of water by all but the most salt-tolerant plants (halophytes). Soil textures can be sandy loam, sandy clay loam, or loam and clay. Salts accumulate around these plants each year with leaf fall. Halophytes function essentially to redistribute salts from the soil depths to the surface, thereby

concentrating salts around the perimeter of the plant. This enables the plant to eliminate competition for scarce water and nutrients from other less salt-tolerant plants (Goodin and Mozafar 1972).

Gardner saltbush normally grows no higher that 12 inches, and may grow along the ground forming a mat. Subdominant shrubs include birdfoot sage, bud sage, spiny hopsage, greasewood, broom snakeweed, shadscale, basin big sagebrush, rabbitbrush, and winterfat. Grasses associated with these sites are Indian ricegrass, bottlebrush squirreltail, Sandberg bluegrass, and western wheatgrass. Forbs found in these areas include wild onion, biscuit-root, woody aster, globemallow, halogeton, and prickly pear cactus.

Salt desert shrublands occur at elevations between 6,000 and 7,600 feet within the lowest precipitation areas in the Rawlins RMPPA. These areas are typically flat or rolling hills. Excellent examples of this type exist in the Separation Flats area west of Rawlins. Gardner saltbush is a valuable forage species on winter and spring ranges. In the spring, when green, Gardner saltbush has higher protein concentrations than does late season alfalfa, and is a preferred livestock forage for lambing sheep and calving cattle.

Sand

The sand vegetation zone is mapped as a combination of active sand dune type and sand dune complex type. A band of sand dunes stretches across the northern portion of the Rawlins RMPPA. In addition, dunes are found near the western boundary of the RMPPA and in the Sand Hills, which are southwest of Rawlins and near the Dad homestead. Blowout grass is a common early colonizer species on sands. Species that survive in the frequently shifting sands include Indian ricegrass, needle-and-thread, alkali wildrye, and slimflower scurfpea. Alkali cordgrass commonly occurs in areas where water accumulates (Knight 1994). Dune areas typically have earlier successional plant species, unless the continued growth of vegetation leads to increased soil organic matter, increased soil structure, and lower wind velocities across the dunes, thereby stabilizing them. Stabilized dunes may provide habitat for later successional species, such as thickspike wheatgrass, Sandberg bluegrass, sand dropseed, Hooker sandwort, bud sagebrush, fringed sagebrush, Wyoming big sagebrush, rubber rabbitbrush, horsebrush, spiny hopsage, and prickly pear cactus (Knight 1994).

Some dunes may become vegetated for a while, only to suffer a blowout from atypical wind speeds or directions. Once such a blowout starts to enlarge, the destabilized dune becomes active again. These dunes provide habitat for unique plant species, such as blowout penstemon, which is Wyoming's only endangered plant species. Some places in these dunes may have more water than other places. Ice that forms in interstices between the sand grains provides supplemental water when it melts in the spring. In addition, snowdrifts that become insulated by a blanket of overblown sand may serve as a source of water for more permanent dunal ponds, particularly if there is an impermeable layer beneath the sand. High water levels in Seminoe Reservoir that indirectly raise the ground water table may also support the dunal ponds. Such ponds are an important source of water for wildlife in the midst of the sandy dunes.

Wetland and Riparian Communities

The GAP data use three plant cover types to depict wetland and riparian communities: graminoid/forb-dominated wetlands, graminoid/forb-dominated riparian areas, and shrub-dominated riparian type. These types provide the best reflection of wetland and riparian communities in smaller drainages, where agriculture has not extensively modified the vegetation. As noted previously, forest-dominated riparian communities have been mapped as part of the agriculture/town zone because of their extensive modification. These communities are no longer available as a substantive habitat, particularly in the eastern portion of the Rawlins RMPPA.

Wetland and riparian vegetation communities in arid and semiarid environments often are key sites for the local ecosystem. Most terrestrial animal and insect life depends on riparian or wetland areas as sources of water, forage, and cover. Riparian and wetland areas in good health maintain water quality and aquifers, control erosion, diminish the impact of floods, and act as a stabilizing force in western landscapes subject to frequent drought and dynamic precipitation cycles.

Wetlands

Wetland vegetation depends on the hydrologic network of the watershed, the duration of water availability, geologic conditions, soil types and depth, climate, and management history. Sedges, rushes, cattails, willows, and other wetland obligates dominate the environment. As water availability decreases, herbaceous vegetation shifts from sedges (wetland obligates) to grasses and wetland facultative plants (plants that usually occur in wetlands but are occasionally found in other habitats).

Wetlands are a valuable natural resource, and impacts or these areas should be avoided wherever possible. Wetlands in the Rawlins RMPPA are represented by—

- Shoreline vegetation around open water bodies
- Riparian vegetation along streams
- Open meadows that accumulate moisture in the winter and spring
- Dunal ponds associated with the Great Basin Divide Basin.

Based on GAP data, there are 87,445 acres in the Rawlins RMPPA that can be classified as wetlands. Many of these areas are seasonally dry and inundated with water infrequently. Vegetation in these areas varies according to the frequency, depth, and duration of inundation. From an ecosystem perspective, an area that is unique to the wetland areas in the Rawlins RMPPA is the dunal ponds, which are seasonally supported by precipitation that is trapped in the Great Divide Basin sand deposits. The variety of shrubs, grasses, and forbs present depends on the degree and duration of wetness and exposure at each location.

In most cases, salt accumulation is not excessive in the wetland areas, because of the leaching effect of water, which can dissolve and remove the salts. Where drainage is

limited, alkaline conditions can occur, and these can affect the types of plants that can be sustained. Wetland and riparian vegetation moderates stream water temperatures; adds structure to the river network; provides habitat for fish, birds, and wildlife; and provides organic material for insect production. Vegetated wetlands and flood plains dissipate stream energy, store water for later release, provide areas of infiltration for ground water, support the hyporheic zone of the river, and provide rearing areas for fish and animal species.

Public lands within the RMPPA boundaries provide potential habitat for obligate and facultative wetland and riparian plants (Table 3.15-2). Wetland vegetation can form nearly monotypic stands of vegetation (e.g., sedges or cattails) to diversified assemblages of plants. The determining factors appear to be availability of water, soils, and management actions on the surrounding lands. Meadows typically have a wider variety of plants, probably due to the more gradual transition from dry to wet conditions. Wetlands that are isolated by location and distance from other vegetation types typically are more likely to have a monotypic plant assemblage.

Three primary drainages occur within the RMPPA: the Colorado River watershed in the western portion, the North Platte River watershed in the eastern portion, and the Great Divide Basin in the northwest. Each of these basins has unique soil, geologic, and hydrologic characteristics that affect the potential for wetland development.

Riparian Areas

Desert Riparian

Many different types of desert riparian occur in the Rawlins RMPPA, depending on the timing and duration of soil wetting, soil type and depth, and the topography of the area. These usually occur on alluvial material, either of sand, sandy loam, loam, or an unconsolidated mixture of soil and cobble material. Soils are usually well drained and are higher in organic matter content than the surrounding uplands. Streams are often ephemeral or intermittent; therefore, vegetation depends on spring runoff or spring and summer rain.

The wettest areas in the desert commonly support Baltic rush, Nebraska sedge, water sedge, and tufted hairgrass, with mountain iris, sandbar willow, and narrowleaf cottonwood occasionally occurring along the fringes. Seasonally wet areas in the desert and steppe communities commonly contain Kentucky bluegrass, tufted hairgrass, foxtail barley, redtop, northern reedgrass, smooth brome, slender wheatgrass, basin wildrye, field horsetail, Wood rose, shrubby cinquefoil, silver sage, basin big sagebrush, greasewood, and a variety of willow species.

Desert ephemeral washes may lie on saltier soils and therefore support salt-tolerant species. Inland saltgrass and western wheatgrass dominate this herbaceous community, while greasewood and basin big sagebrush are the dominant shrubs.

Irrigated non-federal lands along the major streams and rivers in the desert have limited the extent of native vegetation in some riparian areas. Where topography and soils

restrict irrigation of non-federal lands, native vegetation persists. These areas sustain riparian woodlands that support trees and shrubs such as plains cottonwood, narrowleaf cottonwood, Fremont cottonwood, Geyer willow, sandbar willow, and yellow willow. Often the trees and shrubs give way to herbaceous communities where soils are shallow. Herbaceous plants and lower shrubs dominating these areas would be part of the understory in the riparian tree communities. Vegetation includes slender wheatgrass, thickspike wheatgrass, smooth brome, tufted hairgrass, meadow foxtail, timothy, mountain iris, horsetail, gooseberry, currant, buffaloberry, and basin big sagebrush. Such communities are located along the fringes of the riparian areas or in rocky areas.

Riparian areas are associated with the highest production of grasses and other very palatable herbaceous species in the desert, as well as the greatest plant diversity. Often open water is also present. These characteristics draw both livestock and wildlife and also provide critical habitat to many species depending on water for survival. Desert riparian communities normally represent less than 1 percent of the total area in the desert. This places additional pressure on the management of riparian sites for ecological and hydrological sustainability. Management of BLM livestock allotments is often focused on limiting grazing on the desert riparian areas to preserve their valuable diversity and productivity.

Foothills and Mountain Riparian

Riparian areas in the foothills and mountains are generally moister for longer periods of time and support plants that need to be in wet or saturated soils throughout the growing season. In addition, the stream gradients are steeper, and the streambed material is much larger. Riparian areas in the foothills and mountains receive snowmelt and spring discharges that provide perennial flow and cooler water. The soils are usually coarser, with higher organic matter content and increased soil development compared with lower elevations. These areas range in elevation from 7,500 to 10,000 feet and may include alpine tundra characteristics in the upper reaches of the watersheds.

Willow is often the dominant species in these environments. Willows frequently observed are sandbar willow, Geyer willow, yellow willow, whiplash willow, Wolf willow, Booth willow, Bebb's willow, and plain leaf willow. Species prominent in the composition of the willow understory include beaked sedge, Nebraska sedge, water sedge, field sedge, Baltic rush, bull rush, spike rush, tufted hairgrass, Kentucky bluegrass, meadow foxtail, and reedgrass. These understory plants dominate in the open meadows and marshes. Other shrubs and trees that occur are water birch, shrubby cinquefoil, red osier dogwood, snowberry, skunkbrush sumac, narrow leaf cottonwood, aspen, Englemann spruce, and lodgepole pine (Knight 1994).

As in the desert riparian area, mountain riparian vegetation is more diverse and higher in productivity than that of the surrounding uplands, causing livestock and game to concentrate there. The forage also stays lush and more palatable into the late summer (when upland grasses have cured), adding to the attractiveness of these areas. Livestock management strategies often include controlled season and duration of use of these areas.

Riparian Proper Functioning Condition

Proper Functioning Condition (PFC) is the assessment tool the RFO staff uses to determine the relative health of stream hydrology, riparian vegetation, and the aquatic fauna and flora of creeks in the Rawlins RMPPA. Wetlands are also evaluated. Emphasis is placed on these communities because of the importance of aquatic systems in the semiarid climate of the Rawlins RMPPA and because the deterioration of riparian (and upland) vegetation can result in excessive erosion, alteration of narrow sinuous creek beds into fan-shaped drainages that no longer feed the water table, and the consequent conversion of perennial streams to ephemeral drainages. A wetland system that exhibits high integrity and proper function has a mosaic of well-connected, high-quality water and habitats that support a wide assemblage of native and desired nonnative species, the full expression of life histories, dispersal and connection mechanisms, and the genetic diversity necessary for long-term persistence and adaptation in a variable environment. Wetlands that best exhibited these characteristics were rated high; those exhibiting the characteristics the least were rated low.

PFC surveys are used to evaluate Standard #2, Wetland/Riparian Health, as part of the Rangeland Standards Assessment Process. PFC surveys determine whether the stream and riparian areas are meeting minimum requirements for proper ecological and physical processes. The PFC assessment takes into consideration—

- Frequency of time that streamflow exceeds the stream capacity and floods the adjacent lands
- Past and present beaver activity
- Channel morphology in relation to landscape setting
- Changing riparian and watershed relationships that may impact stream integrity
- Upland watershed condition and its potential effect on riparian and stream channel condition
- Age structure of the riparian plant community
- Presence and absence of indicator riparian species
- Riparian stream soil moisture
- Ability of the stream bank vegetation root system to resist high flows and subsequent erosion
- Vigor and condition of indicator riparian and wetland species
- Adequacy of water energy dissipation and stream armoring by vegetative cover
- Maintenance of organic woody material in riparian and wetland areas
- Stream channel roughness and ability to resist erosion caused by increased flows

- Evaluation of in-channel vegetation as an indicator of seasonal flow regimes
- Channel stability in regard to lateral and vertical movement
- Sediment and water discharge relationships in relation to watershed dynamics.

PFC surveys are combined with macroinvertebrate and vertebrate sampling, stream/riparian cross-section surveys, upland vegetation cover analysis, and an assessment of the watershed and riparian area management. Photographs are also taken from specified points associated with the surveys. Additional surveys that address specific water quality and aquatic habitat parameters may be initiated if species or habitat needs indicate that more detailed information is required.

The RFO staff has been conducting PFC assessments for many years. Data from these surveys are used together with data collected in overall watershed assessments under BLM S&Gs. The assessments are being conducted on seven watershed management areas that represent the fourth-order watersheds in the RMPPA (Section 3.17). The RFO staff are in the second year of an aggressive 7-year program to systematically evaluate each stream within the seven watershed units under the S&Gs. When PFC data are available, they are used to supplement the S&G assessments; when PFC data are not available, they are collected as part of the S&G data collection process. Data from the PFC surveys are currently being summarized.

Reference stream and riparian areas within the Rawlins RMPPA have been established. The intent of the reference sites is to document change over time, using information generated through PFC assessments, photographic documentation, vegetation transects, and erosion activity. The process allows for the integration of qualitative and quantitative information, which can be used as a baseline and to direct future studies and management actions.

Weed Management

Noxious weeds are established in the Rawlins RMPPA and have been identified as a major threat to native ecosystems. Noxious weed invasion contributes to the loss of rangeland productivity, increased soil erosion, reduced species and structural diversity, and loss of wildlife habitat, and, in some instances, is hazardous to human health and welfare (*Federal Noxious Weed Act*, Public Law 93-629).

Some weed species pose a significant threat to multiple-use public land management. Noxious weeds cannot be adequately controlled unless federal, state, county, and private interests work together. The *Carlson-Foley Act* (Public Law 90-583), as well as state and county laws, make the federal government responsible for control of weeds on federal land and provide direction for their control. The Rawlins RMPPA operates under the weed protocols set forth in the *Vegetation Treatment on BLM Lands in Thirteen Western States Final Environmental Impact Statement and Record of Decision* (BLM 1991) and a noxious weed prevention plan developed specifically for the Rawlins RMPPA. This plan was mandated by the Federal Weed executive order (Executive Order 13112) of February 3, 1999. The Noxious Weed Prevention Plan outlines measures to reduce the occurrence

and dispersion of weeds and noxious weeds in the Rawlins RMPPA. It takes into consideration different activities, such as livestock grazing, surface disturbance, and recreation.

The weed management efforts of the RFO staff are divided among three weed management areas. Weed treatment may involve suppression or eradication of noxious weeds in rangeland or disturbed areas. Areas of BLM focus are the oil and gas development areas, roads, and recreation areas. The Wyoming *Weed and Pest Control Act* designates the following weeds as noxious:

- Leafy spurge
- Spotted knapweed
- Diffuse knapweed
- Russian knapweed
- Musk thistle
- Scotch thistle
- Plumeless thistle
- Canada thistle
- Field bindweed
- Dyers woad
- Hoary cress
- Perennial pepperweed
- Dalmatian toadflax
- Yellow toadflax
- Skeletonleaf bursage
- Houndstongue
- Common burdock
- Quack grass
- Perennial sowthistle
- Oxeye daisy
- Purple loosestrife
- Saltcedar.

The Rawlins RMPPA weed management staff and the County Weed and Pest Control Districts focus their efforts on noxious weeds; however, they are actively involved in eliminating all invasive and nonnative species that cause management problems related to livestock, wildlife, and human activities.

Listed and Special Status Plant Species

Special status plant species occur in a variety of plant associations and a variety of physical habitats, many of which have distinctive soil types. Often several special status plant species occur together in plant communities that may exhibit fidelity to specific locations and substrates and ultimately result in the development of unique subspecies. Section 6840 of the BLM Manual sets guidelines for special status plant species (BLM sensitive plant species). The list of BLM Sensitive plant species includes species that are of concern, in addition to federal and state threatened and endangered (T&E) species.

Table 3.15-3 lists current T&E plant species in the Rawlins RMPPA, and Table 3.15-4 lists other current BLM Sensitive species in this area. These selected species receive priority attention for inventories, research, monitoring, and management decisions regarding land disturbing activities. Blowout penstemon is of particular interest in the Rawlins RMPPA. It is the rarest plant species native to the Great Plains, is the only endangered plant in the state, and occurs in the band of moving sand dunes across the northern portion of the RMPPA. Desert yellowhead, although it is native to Fremont County, which is just north of the Rawlins RMPPA, occurs there in a geologic formation that also is found in the RMPPA. Ute ladies' tresses, western prairie fringed orchid, and Colorado butterfly plant also occur in appropriate habitat within the Rawlins RMPPA.

Poisonous Plants

Poisonous Plants are a normal component of the range ecosystem. Most poisonous plant species will kill animals only if they are eaten in large amounts-almost a straight diet of them (Stoddart, Smith, and Box 1975). Several factors play an important role in livestock poisoning: the animals' seasonal susceptibility to the poisonous plant, the formation of the poisonous portion of the plant, the susceptibility of certain kinds of animals to poisoning from a particular plant, or deficiency of minerals in the diet.

A shortage of salt in the diet may cause animals ot eat plants thaey would not normally eat. Shortages of other minerals such as phosphorus induce abnormal appetites, causing the animal to consume low-value vegetation, including poisonous plants. Although poisonous plants can be found throughout the planning area, there are few large concentrations, and there is sufficient quality forage available for livestock. Poisonous plants could affect turn-out dates; some plants are not toxic after they have matured.

Some plants are toxic because of the high occurrence of the trace element selenium in soils of south central Wyoming. Specific plants (woody aster, for example) absorb selenium, and they can be very toxic when consumed by livestock. Selenium acts as a cumulative poison can cause chronic poisoning effects over a long period or quick death if consumed in quantity. Local names for this poisoning effect include "alkali disease" and "blind staggers." Extremely large concentration of woody aster and other selenium-accumulating plants occur in Poison Basin west of Baggs, Sage creek Basin south of Rawlins. Alkali Basin north of Sinclair, and Hanna and Shirley basins.

Fourteen species of poisonous plants are known to exist in the planning area. Table 3.15-5 lists poisonous species, dangerous seasons, and grazing animals endangered.

3.16 VISUAL RESOURCES

Visual resources within the Rawlins RMPPA are influenced by a wide variety of topographic, hydrological, vegetative, and other characteristics of the region. Landforms range from relatively flat land used for activities such as grazing; to low mountains, low rolling or flat-topped hills, and isolated hills; to higher elevations near the Medicine Bow National Forest containing mountain shrub vegetation, with alpine forest atop the highest areas. Elevation and precipitation vary widely within the Rawlins RMPPA and

determine the dominant vegetation. With the widely diverse vegetation patterns that result from varying topographic and precipitation characteristics come changes in color, form, line, and contrast. These four elements form the basis for the analysis of the visual resources of the area.

Protection of visual resources is often associated with recreational opportunities, as discussed in Section 3.11. The highest quality recreational experiences in the area depend on natural settings and scenic views.

Natural Settings and Scenic Views

Much of the Rawlins RMPPA contains natural settings with limited development, open spaces with panoramic vistas, and scenic views. In the nonmountainous, lower elevations of the area, summer views are characterized by scrubby low-growing gray-green vegetation, distant mountains, and an intense blue sky. In contrast, winter views are monochromatic gray, with clear skies and an apparently lifeless gray-brown foreground backed by distant snow-capped mountain peaks. Different combinations of plant communities create subtle changes in mosaics of textures and colors. More extensive views that encompass several viewsheds are available from high points. The sky-land interface is a significant aspect of all distant views.

Several areas within the Rawlins RMPPA that exhibit high scenic quality are easily accessible to tourists and other recreationists. The highest quality scenic views in the planning area are the WSAs, particularly the Ferris Mountains and Adobe Town WSAs because of their unique geological formations. Both of these areas are quite rugged and untrammeled by humans (Clair 2002).

Visibility

Visibility can be defined as the distance one can see and the accompanying ability to perceive color, contrast, and detail. The Rawlins RMPPA is essentially rural in character, and the Wyoming Air Quality Division has designated the area as in attainment of all of the U.S. Environmental Protection Agency's (EPA) national pollution and ambient air quality standards. As discussed in Section 3.1, the Savage Run Wilderness and Rocky Mountain National Park have been designated as PSD Class I areas. PSD Class I areas receive the highest degree of protection from air pollution and allow only small amounts of particulate, SO_2, and NO_2 air pollutants are allowed in these areas.

Visibility trend analysis of Rocky Mountain National Park (to the south and southeast of the Rawlins RMPPA) reveals no significant trend of worsening visibility from 1989 through 1998. The information from this nearby monitored area and local observations indicate that the air quality of the Rawlins RMPPA is generally excellent, and pollutants very seldom obscure visibility.

Visual Resource Management System

The Rawlins RMPPA has been inventoried using BLM Visual Resource Management (VRM) classification system. Under this system, the Rawlins RMPPA was classified into

four BLM visual management categories (Classes I through IV), based on scenic quality, visual sensitivity levels, and viewer distance zones. Each VRM classification has a management objective, as described below:

- **Class I.** The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activities. The level of change to the characteristic landscape should be very low and should not attract attention.
- **Class II.** The objective of this class is to retain the existing character of the landscape. The level of change to the landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes to the landscape must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
- **Class III.** The objective of this class is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate. Management activities may attract the attention of the casual observer but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
- **Class IV.** The objective of this class is to provide for management activities that require major modifications to the existing character of the landscape. The level of change to the landscape can be high. The management activities may dominate the view and may be the major focus of viewer attention. Every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of the basic visual elements of form, line, color, and texture.

The established VRM classes for the Rawlins RMPPA are depicted in Map 3.16-1. The acreage for each VRM class within the Rawlins RMPPA is shown in Table 3.16-1. About 90 percent of the lands within the Rawlins RMPPA are categorized as Visual Class III. Class II lands are primarily associated with areas around the Pathfinder and Seminoe Reservoirs and with the close-range viewsheds of the Medicine Bow National Forest. Only the WSAs are rated as VRM Class I. Generally, the VRM classifications assigned to lands are appropriate to their visual quality (Clair 2002).

The current objective of VRM within the Rawlins RMPPA is to minimize adverse effects on visual resources while maintaining the effectiveness of other land use allocations. The Rawlins RMPPA is managed according to the VRM classes assigned to the land.

Visual Resource Trends and Issues

There are several visual resource trends in the Rawlins RMPPA (Clair 2002), including—

- The existing Rawlins RMP describes those areas that have been designated for OHV use. OHV use is not yet highly popular in the Rawlins RMPPA; however,

an increase in unmanaged, unmonitored OHV use within the area, for both recreation and access to the surrounding USFS-managed lands in the Medicine Bow National Forest and to the dunes area is creating direct, negative visual impacts in certain parts of the area. OHV use has affected certain vegetative communities more than others.

- The widespread development of petroleum, natural gas, and coal in the Rawlins RMPPA is creating direct, negative visual impacts within the Rawlins RMPPA. Currently, visual mitigation of this activity is preventing mineral development activities from exceeding the established VRM objectives within these areas. The trend toward continued expansion of natural resource development is creating areas of potential conflict between this activity and the established VRM class objectives (Section 3.16).
- Utilities are also having an increasing visual impact in the Rawlins RMPPA. Even buried fiber-optic lines leave obvious visual effects.
- Although visual sensitivity is clearly not the highest priority for many residents and visitors, as increasing numbers of sightseers and persons seeking various types of recreational opportunities pass through the Rawlins RMPPA, a heightened awareness of scenic values and of the existing scenic quality for some residents and visitors has occurred.

Emerging visual resource issues include (Clair 2002)—

- Degradation of visual resources within the coalbed methane project on Seminoe Road. The road is a back country byway, and portions of the project area are in the Class II VRM area. Efforts are needed to hide the roads, use the topsoil as berms to hide the well pads, and paint the fixtures to match natural conditions. However, there is no control over what effects occur within the private portion of the land ownership checkerboard.
- The need for more effective mitigation on seismic projects.
- The need for more effective mitigation within the transportation corridors (such as I-80) even if they are Class IV lands; since the transportation corridors are also the utility corridors, the existing impacts or VRM reclassifications are difficult to change
- The need for more effective mitigation on all wells; however, it has proved difficult to change existing mitigation precedents.

3.17 WATERSHED AND WATER QUALITY

Water resources include surface water and ground water. Surface waters include lakes, streams, creeks, and springs and are important for a variety of reasons, including economic, ecological, recreational, and human health. Ground water comprises the subsurface hydrologic resources of the physical environment and is an essential resource.

The headwaters of several rivers, which supply water to millions of people in the western and midwestern United States, originate in the Rawlins RMPPA. Water in the intermountain West is less abundant than in most of the United States. Therefore, proper and cautious management of water is essential to the economy of this region. Conservation of water is evident throughout the Rawlins RMPPA. Stock reservoirs restrict water from leaving the upper portions of watersheds and provide drinking water for livestock and wildlife. Farmers irrigate their crops using gated pipe and sprinklers, thereby increasing efficiency. Reservoirs on the North Platte and Laramie Rivers hold spring and early summer runoff for use by farmers and municipalities later in the year. The RFO staff keeps public lands in compliance with the *Clean Water Act* by maintaining the quality of upland range and riparian areas to ensure that the water running off these lands is of good quality.

Surface Water

There are 21 fourth order watershed sub-basins in the Rawlins RMPPA, which are shown on Map 3.17-1 along with the major rivers, lakes, and reservoirs. The acreage for each of these watersheds is provided in Table 3.17-1. The Rawlins RMPPA is topographically divided by the Continental Divide, meaning that streams in the southwestern portion of the Rawlins RMPPA and drained by Muddy Creek and Little Snake River flow into the Colorado River system and eventually into the Gulf of California. Watersheds within the RMPPA east of the Continental Divide are drained by the North Platte, Medicine Bow, and Laramie Rivers. These rivers flow into the Mississippi River system, via the Platte River, and eventually into the Gulf of Mexico. Streams to the north and west of Rawlins lie in the Great Divide Basin, which is a large, internally drained basin with no outflow. The rivers that convey the most water within the Rawlins RMPPA are the Encampment River, the Medicine Bow River, the Laramie River, the North Platte River, and the Little Snake River and consequently have long term stream gages operated by the USGS. Table 3.17-2 provides the discharge data for these rivers at USGS gaging stations. There are also gaging stations on Muddy and Sage Creeks and additional flow data collected by the BLM and/or local conservation districts.

Watersheds in the desert and range areas of the Rawlins RMPPA are in a water balance deficit, meaning that the annual potential evapotranspiration exceeds the annual precipitation. Therefore, there is limited runoff from watersheds in the desert areas, and most streams originating in these areas are ephemeral. Areas above 8,500 to 9,000 feet are in a water balance surplus, meaning that annual precipitation exceeds annual potential evapotranspiration. Most of the streamflows in these areas are perennial, and most of the large rivers originate in these high elevation areas. Most watersheds in the Rawlins RMPPA are shrub-dominated rangelands below 8,500 feet.

Watersheds originating in the mountains receive flow from melting snow and summer rainstorms. Discharge in these streams typically peaks in May or June. There is an additional peak in the daily records of most systems in August or September before discharge tapers off to a base flow. Streams originating in the desert areas respond to snowmelt as well; however, the peak flow from these streams occurs in April and May, and desert streams may go dry by early June. Following spring runoff, these streams

only flow as a response to rainfall events. Perennial streams that flow into sandy substrates may disappear or become intermittent along certain reaches due to water entering the sands.

The many dams and diversions along streams and rivers dampen the peak flows of these streams, and enable higher flows through the summer when irrigators need the water for their crops. This has altered the normal seasonal flow patterns of these streams and rivers and has prompted changes in the hydrologic integrity of the region. Dams have altered the movement of sediment down the river, and discharge cold, clean water during the hot months. This has enabled prime trout fisheries below the dams.

The Great Divide Basin lies in the northwestern portion of the Rawlins RMPPA. This is a large closed basin, which splits the Continental Divide. None of the precipitation falling within the basin leaves through surface flow, as there is no discharge from the basin. This is a unique geological and hydrologic feature because the Continental Divide does not split anywhere else in the United States.

Ground Water

Ground water recharge primarily originates as precipitation in the mountain areas surrounding the Rawlins RMPPA. Aquifers providing usable water in the RMPPA are primarily found along streams and rivers in the unconsolidated alluvium. These aquifers are termed unconfined, or water table, aquifers. Wells emanating from these aquifers supply water to ranches and farms, as well as to municipalities. Deeper confined aquifers supply water to artesian wells. Artesian wells may be flowing or not, depending on the potentiometric surface of the aquifer. Artesian wells used for domestic and irrigation water are usually found where limestone or sandstone geologic formations are within 2,000 feet of the surface.

Water Quality

Surface Water Quality

Baseline water quality of the perennial streams, standing water, and springs within the Rawlins RMPPA project area is influenced by the type of rock and the soils with which the water has been in contact. Changes to the natural water quality conditions include impacts related to changing thermal and turbidity conditions, typically augmented by the impacts of increasing salinity, heavy metals, and nutrients. Water quality impacts within the Rawlins RMPPA may be associated with agricultural, rangeland, road maintenance, runoff, riparian vegetation removal, channel modification, stream bank destabilization, atmospheric deposition, resource extraction, oil and gas activities, urban runoff, and grazing activities. Heavy metal, nutrients, sediment and salinity impacts can be associated with mining, oil and gas extraction, agricultural runoff, and other surface-disturbing activities. Water quality typically varies as a function of flow conditions.

As water quality decreases, the ability of aquatic benthos, food base, and fisheries to maintain themselves is diminished. Stressors associated with increasing temperatures, lower dissolved oxygen levels, changing pH, and smothering from sediments negatively

impact the aquatic ecosystem and diminish the ability of a stream system to sustain its natural conditions. The RFO staff has water quality samples collected from perennial creeks, springs, washes, reservoirs, wells, ponds, and lakes within the RMPPA. Depending on the location and issue of concern, samples have included a variety of water quality parameters, with sampling conducted over specific periods of time.

Availability of surface water quality data is largely limited to perennial streams and lakes. The primary surface water quality concerns in the Rawlins RMPPA are salinity in the Little Snake River basin and turbidity in the North Platte River Basin. The Little Snake River is part of the Upper Colorado River Basin and, therefore, is covered by the *Colorado Salinity Control Act*. Many of the watersheds discharging water from the Rawlins RMPPA-administered lands are on highly erodible soils, notably Muddy Creek flowing into the Little Snake River and Sage Creek flowing into the North Platte River. Elevated dissolved salt loading has been documented in Muddy Creek, and elevated suspended sediment loading has been documented in both Muddy and Sage Creeks. Both of these streams are listed as threatened on the State 303(d) list.

Stream bank degradation and erosion due to poor vegetation cover within the watersheds are the predominant sources of sediment and salinity found in the streams. Management of livestock grazing, road construction, oil and gas activity, and recreation within the Rawlins RMPPA mitigates the impacts of these activities.

Ground Water Quality

The mining industry in the Rawlins RMPPA has collected substantial data on the existing ground water quality conditions. These data have been collected during the drilling of wells for oil and gas extraction. Ground water quality conditions vary in the RMPPA and are defined by the geologic conditions in which the water is found.

Water from most artesian and water table wells in the Rawlins RMPPA is of very good quality. However, ground water quality depends on the geology of the area where the aquifer is located. Many aquifers produce water with high concentrations of salts and heavy metals. Oil and gas wells may produce water from these aquifers, which may be in sandstone, limestone, or coalbeds, depending on the formation being explored for gas. This water production is performed because gas will not release to the atmosphere if water is present. The drilling companies must handle this water in prescribed ways, such as containing it in evaporation ponds or in tanks, and treating it or reinjecting it into a formation already containing water of lower quality, unless they have obtained a National Pollutant Discharge Elimination System (NPDES) permit from the Wyoming DEQ. The NPDES permits issued by the Wyoming DEQ are listed on its Web page (Internet: wqd 2002). BLM manages impacts on streams and watersheds. Water emanating from gas wells must not interfere with other surface water uses and must be managed to avoid increased erosion.

Water Management and Monitoring

Water Management

Water management within the boundaries of the Rawlins RMPPA is primarily the responsibility of the Wyoming State Engineers Office, which administers state-held water rights, and the U.S. Bureau of Reclamation, which administers dam and reservoir systems along the North Platte River. BLM manages watersheds that supply a substantial portion of the area's irrigation water and water for other uses. Therefore, it is the RFO staff's responsibility to manage these lands in a manner that maintains water quality and quantity. Other agencies involved in managing and regulating the water resources of the area are the Army Corps of Engineers, EPA, the Wyoming DEQ, and the WGFD.

The Bureau of Reclamation manages the system of dams on the North Platte River, beginning with Seminoe Reservoir, to meet the downstream requirements of irrigators, municipalities, industrial uses, and the States of Wyoming and Nebraska. The Bureau of Reclamation distributes water according to Wyoming water law and the Final Settlement Stipulation and Modified North Platte Decree. The Final Settlement Stipulation, approved by the U.S. Supreme Court on November 13, 2001, modified the 1945 North Platte Decree and ended the *Nebraska v. Wyoming* lawsuit. It set in place new procedures for and limitations on the administration and use of North Platte River water by Nebraska, Wyoming, Colorado, and the Bureau of Reclamation. This has a direct effect on the allocation of water within the Rawlins RMPPA because there is a limited amount of water that can be used there for irrigation and other uses.

The Wyoming State Engineers Office administers water rights within the State of Wyoming. Administration includes domestic, municipal, industrial, agricultural, recreational, and in-stream flow. The Wyoming Board of Control issues all water permits and decides all state water rights issues. Nearly all of the Rawlins RMPPA is in Division One of the Wyoming Board of Control. Water rights in Wyoming are managed under the Prior Appropriation Doctrine meaning "first in time, first in right."

Water is allocated on the North Platte River under the 1945 Supreme Court decree. Other interstate agreements, decrees, and treaties concerning water within the Rawlins RMPPA include the following:

- **Colorado River Compact, 1922.** Divides the basin at Lee Ferry, Arizona. Provides that the upper basin states may use 7.5 million acre feet annually
- **Upper Colorado River, 1948.** Apportions 14 percent of the water allocated in the Colorado River Compact to Wyoming
- **Colorado River Salinity Control Act, 1974.** Limits the amount of total dissolved salts flowing into Mexico to 1 ton per day, or 115 parts per minute (ppm) over the salinity level at Imperial Dam, California. This was a result of Minute No. 242 (1973), an amendment to the 1944 treaty between Mexico and the United States

- **Laramie River Compact, 1911, 1922.** Allows Colorado to divert up to 39,750 acre feet per year into the Cache La Poudre River.

The Wyoming DEQ identifies water bodies that are water quality impaired. This list of streams, rivers, ponds, and lakes is updated every 2 years by the state and is used to develop a total maximum daily load (TMDL) allocation of pollutants. The streams that the Wyoming DEQ considers impaired, either due to watershed degradation or because waters in the stream exceed water quality limits, are listed on the State 303(d) list. The 303(d) list includes nine streams within the boundaries of the Rawlins RMPPA, although only four of theses streams flow through BLM-administered lands. BLM is developing measures to manage and monitor the streams on the 303(d) list that flow through land it administers. The streams on the 303(d) list are listed on the Wyoming DEQ Web page (Internet: 01452 2002).

Water Monitoring

Water resource monitoring in the Rawlins RMPPA is designed and managed to provide BLM with baseline information on the water quantity and quality conditions. Monitoring activities include the collection of waterflow data, water samples for analysis, evaluation of stream health conditions, evaluation of springs and other water sources for animals, and evaluation of waterflow conditions. In addition to the PFC assessments discussed in Section 3.15, which are indirect indicators of water quality and watershed health, direct methods are also used to monitor water resources. Direct methods include gauging stations (Table 3.17-2), water quality samples, and bioassessment protocols. Within the Rawlins RMPPA, water quality samples historically have been collected at springs, wells, stream locations, ponds, and ephemeral washes. Samples are collected and analyzed under both existing and condition-specific situations. A watershed approach to water quality assessment in the RMPPA is used. Ground water monitoring occurs at several wells in the project area with grab samples being collected periodically.

Bioassessment protocols developed by the Wyoming DEQ provide quantitative assessments regarding watershed health and ecosystem integrity. The Rawlins RMPPA is implementing the DEQ protocols and developing an integrated approach to the monitoring and assessment of watershed, aquatic, and riparian ecosystem conditions within the seven fourth-order watersheds that make up the Rawlins RMPPA watershed management areas.

These collective monitoring efforts are helpful in providing information that is used to adjust management within the watersheds and along riparian areas. Information is also shared with the Wyoming DEQ for listing or delisting water bodies on the 303(d) list. Assessments under BLM S&Gs are typically conducted on a 10-year cycle. The RFO staff is in the second year of its effort to complete its S&G assessments; it plans to complete the assessments in 7 years during the current cycle. Initial efforts have concentrated on watershed management areas in the western portion of the Rawlins RMPPA where BLM-managed lands are most extensive. Data available so far from the S&G assessments are now being summarized.

3.18 WILD HORSES

Wild horses are important in the Rawlins RMPPA, providing a historic resource that is of particular interest to the public. This species is also of importance because it interacts with other species for forage within its range. Most of the wild horse herds are found on lands managed by BLM, which also manages the size and distribution of these herds. The emphasis in the discussion below is on the number and distribution of wild horses within the Rawlins RMPPA and the interaction of this species with other grazing livestock and with wildlife.

History of Wild Horses

Ancestors of current populations of wild horses first arrived in North America in 1493, brought by Columbus on his second voyage. They were also often brought by succeeding Spanish explorers and ultimately escaped to the wild, spreading across the American West. It is estimated that by the 1800s, 2 to 5 million wild horses were present in America, particularly in the Southwest (Internet: 2002 wildhorserescue). Ranchers, hunters, and "mustangers" gathered these horses for commercial purposes. By the 1950s populations were thought to have dropped below 20,000 (Internet: 2002 biodv-33). Citizen concern, largely initiated in the 1950s, resulted first in the passage in 1959 of Public Law 86-234 (which prohibited the use of motorized vehicles during roundups) and finally in the passage, in 1971, of Public Law 92-195 (which provided for the necessary management, protection, and control of wild horses and burros) (Internet: 2002 wildhorse and burro). In the 1971 act, Congress declared "that wild free-roaming horses and burros are living symbols of the historic and pioneer spirit of the West; that they contribute to the diversity of life forms within the Nation and enrich the lives of the American people; and that these horses and burros are fast disappearing from the American scene…." With this act, BLM, through the Secretary of the Interior, and the Forest Service, through the Secretary of Agriculture, were given the authority to manage wild horses and burros on public lands of the United States. Wild horses that stray onto private lands of their own volition may stay there so long as they are protected and not sold or transferred (Internet: 2002 wildhorseandburro). Alternatively, the private landowner may ask BLM to remove the horses.

Early efforts of BLM to comply with the inventory requirements of the 1971 act focused on identifying areas of use and population levels (BLM 1994) and in establishing the ownership of horses found running wild on public land (Reed 2002). Burro populations were not found within the Rawlins RMPPA. The wild horse herds in the Rawlins RMPPA were concentrated in the western half of the area, but scattered individuals were also found in the eastern half of the area (Map 3.18-1a). Discussion with private landowners in the eastern half of the Rawlins RMPPA, where public lands administered by BLM are widely scattered, identified horses that were claimed by the landowners. Unclaimed horses on the scattered public lands in the east could not be managed effectively because the acreage on public parcels was insufficient to support a horse herd and surrounding landowners were unwilling to support wild horses without claiming ownership (Reed 2002).

By 1978, policies and regulations were established that enabled BLM to manage specific populations in specific areas. The *Public Rangelands Improvement Act of 1978* (Public Law 95-514) tied removal actions to restoration of "a thriving natural ecological balance to the range…" and protection of "the range from deterioration associated with overpopulation…." Agency efforts between 1978 and 1984 focused on identifying suitable habitat areas, establishing population objectives, and developing Herd Management Area Plans (HMAP). Three herd management areas (WHMA) (Adobe Town, Flat Top and Seven Lakes) were established in the Rawlins RMPPA and managed until 1994 to maintain the population objectives (in 1994 and 1999 the WHMAs were designated Adobe Town, Stewart Creek and Lost Creek). In 1988, legal action by advocacy groups impeded the control of horse populations by BLM, resulting in changes in wild horse management policies that culminated in the 1992 *Strategic Plan for Management of Wild Horses and Burros on Public Lands*. Updates to this plan were made most recently in 1997 in response to an evaluation of BLM's wild horse management program by an emergency evaluation team convened in response to a severe drought in 1996. The team made more than 20 recommendations, including the establishment of a national advisory board, adoption program review, and greater focus on the long-term health of the land (Internet: 2002 WHB_contents, Internet: 2002 pr970211). These reforms continue to guide BLM's management of wild horses in the Rawlins RMPPA as it strives to "protect, maintain, and control a viable, healthy herd of wild horses while retaining their free-roaming nature and to provide adequate habitat for free-roaming wild horses through management consistent with environmental protection and enhancement policies…" (BLM 1990).

Distribution and Status of Wild Horses

Wild horses are found in the western portion of the Rawlins RMPPA in an area bounded on the south by the Colorado state line, on the east by Wyoming State Highway 789 (SH-789), on the north by the Lander Field Office boundary, and on the west by the Rock Springs Field Office boundary.

Wild horses in the Rawlins RMPPA are currently concentrated in the three WHMAs: Stewart Creek, Lost Creek, and Adobe Town (Map 3.18-1b). Populations outside these WHMAs are also monitored in I-80 South (an area outside of Adobe Town, south of I-80 and west of SH-789) and I-80 North (an area outside Stewart Creek and Lost Creek, north of I-80 and west of US-287) and to some extent in the Bairoil Pasture of the Ferris In-Common Allotment. These three areas, with outside populations, are adjacent to the WHMAs and are potentially affected by wild horse management within the WHMAs. For each of the WHMAs, an appropriate management level (AML) has been established (Table 3.18-1), and horses exceeding the AML are considered excess, as are all horses outside the WHMAs. BLM's goal is to adjust wild horse populations in each WHMA to the AML and then to monitor the herds and their habitat so that the AML can be reevaluated and adjusted if necessary (Reed 2002).

Current wild horse populations are also shown in Table 3.18-1. Adobe Town WHMA and I-80 South have increasing populations, while populations in the other areas have decreased. The Adobe Town WHMA 2002 population is more than double the 1999

population, and the I-80 South WHMA 2002 population is 10 times the 1999 levels (although the latter increase reflects emigrants from Adobe Town). Population changes between 2001 and 2002 in Stewart Creek are to a large extent the result of a gather that occurred partially in November 2001 (137 horses) and partially in March 2002 (306 horses). The remaining Stewart Creek herd of about 195 contains about 160 adults and 35 foals. Ground counts within the WHMAs revealed poor foal survival in 2001 due to drought conditions, but normal survival in 2002 in Lost Creek and Stewart Creek, and depressed in Adobe Town. The ability of wild horse populations to increase (and decrease) rapidly is shown in Figure 3.18-1. Population fluctuations are influenced, not just by the fecundity of horse populations, but also by their contact with other horse herds outside the Rawlins RMPPA WHMAs (Table 3.18-2), the presence of livestock within the WHMAs (Table 3.18-3), the presence of wildlife, and natural climatic variability. For example, there is interchange between the Adobe Town herd and herds in the Rock Springs Salt Wells Creek WHMA south of I-80, since the Kinney Rim topographic feature is all that separates these herds. These factors, plus the mandate to keep the wild horse herds and their habitat in healthy ecological condition, make the task of wild horse management difficult.

The mandate for maintaining healthy ecological condition has resulted in BLM's careful consideration of herd genetics, age-class balance, herd structure, the least stressful methods and times for population control, and the collection of data on WHMA habitat condition. Herd genetics are important from two perspectives, population viability and health, and heritage. A genetic pool of 100 competent breeders is considered the minimum necessary to maintain population viability and health, yet the AML for two of the WHMAs is below this number because of the limited carrying capacity of the land. This makes the introduction of new individuals from the metapopulation of particular importance. Heritage is important because genetic testing of the Lost Creek herd has revealed an unusually strong resemblance to New World Iberian horses and resulted in a goal of maintaining the genetic uniqueness of this herd. This herd is a unit that is isolated from, and does not mix with, other herds.

Age classes must be balanced to maintain herd viability and health, with care taken to ensure that the mean age of the herd does not become too young, resulting in loss of historic memory and wisdom that might guide the herd during times of stress such as severe drought, and that the herd does not become too old, resulting in the loss of fecundity and resilience during times of stress. An additional factor is the extra desirability of young animals as candidates for adoption by the public, since this is the preferred method of population control. The variability of age classes in the herd censused in I-80 South (Table 3.18-4) shows the rapid loss of younger age classes and the continuing attenuation of age class numbers with time. Foal survival until weaning during 2 years of field study was 91.4 percent. The absence of some age classes likely reflects how strongly severe natural conditions can affect a herd (BLM 2001).

Wild horse herds have a complex social structure. The horses within a given WHMA do not exist in one large herd, but rather are distributed as individual local populations. For example, while the Lost Creek WHMA has only one local population (Lost Creek), the Adobe Town includes eight local populations (Corson Springs, Espitalier Spring,

Greasewood Flats, Sand Creek, Willow Creek, Cedar Breaks, Hangout, and Continental), and the Stewart Creek WHMA has five local populations (Bull Springs, Stewart Creek, Ferris, A&M, and West Side) (BLM 1999). Even these local populations may be further subdivided, with small bands of two to four horses existing in equilibrium with local water and forage supplies (Reed 2002).

Population levels on the WHMAs are typically controlled, as needed, through gathering of individuals considered suitable for adoption. These individuals are selected so as not to disrupt the social fabric of the herd. Such gathers are important because wild horses have few natural predators. Foals may succumb during particularly harsh environmental conditions and stallions may injure or even kill each other in battles for control of mares or territory, but mountain lions are the only predators expected to prey even occasionally on healthy wild horses. During gathers, helicopters are often used, together with drovers on horseback, to urge the horses toward a holding pen at the small end of a wide funnel. Horses are held at adoption facilities in Riverton, Rock Springs, or north of Cheyenne until an adoption is scheduled. Meanwhile, the horses may be trained to some degree, particularly at the facilities in Riverton and north of Cheyenne.

The wild horse habitat in the WHMAs can be characterized as follows (BLM 1999):

- **Adobe Town WHMA.** Plant communities are very diverse in this large area. The most abundant plant community in the WHMA is sagebrush/bunchgrass. Other plant communities present are desert shrub, grassland, mountain shrub, lentic riparian grass/sedge, limber pine woodlands, juniper woodlands, and a very few aspen woodlands. Needle-and-thread, Indian ricegrass, bluebunch wheatgrass, western wheatgrass, junegrass, and mutton bluegrass are the predominant grasses. Wyoming sagebrush, black sagebrush, bud sage, Gardner saltbush, fourwing saltbush, greasewood, bitterbrush, and mountain mahogany are important shrub species. Both antelope and mule deer crucial winter ranges are located in the Adobe Town WHMA. A small but locally important elk population has become established in the southwestern portion of the WHMA. There are 16 known greater sage-grouse leks and associated nesting habitat within and adjacent to the WHMA; however, there may be more leks in the area that have not yet been identified. In addition, there are numerous raptors that have historically nested, or may nest in the future, in the area. These raptors include kestrels, ferruginous hawks, golden eagles, red-tailed hawks, great horned owls, prairie falcons, and burrowing owls.
- **Stewart Creek WHMA.** The most abundant plant community in this WHMA is sagebrush/bunchgrass. Other communities present are desert shrub and grassland, with limited lentic riparian grass/sedge, juniper woodland, mountain shrub, and desert willow riparian types. Needle-and-thread, Indian ricegrass, bluebunch wheatgrass, western wheatgrass, junegrass, and mutton bluegrass are the predominant grasses. Wyoming sagebrush, black sagebrush, bud sage, Gardner saltbush, fourwing saltbush, and greasewood are important shrub species. There is antelope-crucial winter range located in the WHMA. There are 14 known greater sage-grouse leks and associated nesting habitat within and adjacent to the

WHMA; however, there may be more leks in the area that have not yet been identified. Raptors that may use the area for foraging and/or nesting include northern harriers, ferruginous hawks, golden eagles, red-tailed hawks, and burrowing owls. A small but locally important elk population utilizes the WHMA.

- **Lost Creek WHMA.** The most abundant plant community in this WHMA is sagebrush/bunchgrass. Other communities present are desert shrub, grassland, and lentic riparian grass/sedge primarily associated with desert wetland areas. Needle-and-thread, Indian ricegrass, bluebunch wheatgrass, western wheatgrass, junegrass, and mutton bluegrass are the predominate grasses. Wyoming sagebrush, black sagebrush, bud sage, Gardner saltbush, fourwing saltbush, and greasewood are important shrub species. There is no big game-crucial winter range located within the Lost Creek WHMA. There are 18 known greater sage-grouse leks and associated nesting habitat within and adjacent to the WHMA; however, there may be more leks in the area that have not yet been identified. Raptor species that may use the area for foraging and/or nesting include northern harriers, golden eagles, and ferruginous hawks.

In addition to the resources discussed above, data on riparian areas are particularly reflective of wild horse habitat health. Surveys of stream (lotic) and pond (lentic) health have been completed on 9.5 miles of stream on public land and on 41.4 acres of ponds on public land within the WHMAs, using the PFC protocol. The results of these surveys are presented in Table 3.18-5. It can be seen that the surveyed streams in the Stewart Creek WHMA are in good condition, but those in the Adobe Town WHMA are less so. The surveyed ponds are not faring well in any of the three WHMAs, except for a few acres in Adobe Town. Outside BLM-managed lands, stream and pond condition appears to be worse, based on observation. RFO staff do not collect data on lands that they do not manage.

It is also of note that privately owned or controlled lands make up 6 percent or more of each individual WHMA and make a proportionate contribution to the forage and space requirements of animals using the WHMAs. In addition, a disproportionately high share of the reliable water sources in the WHMAs occur on these lands, which, as noted above, appear to have worse stream and pond conditions. This is particularly important during summer, when the range of wild horses is limited by accessibility of water, even though wild horses will travel further to water than cattle will. During winter, wild horses eat snow for at least part of their water supply and are, therefore, better dispersed during that season.

3.19 WILDLIFE AND FISH

This section focuses on those wildlife and fish species in the Rawlins RMPPA that are of particular interest or importance to the public or the ecosystem because they are used in some way (hunted, observed, photographed, etc.) or because they have populations that are at potential risk (threatened, endangered, of special concern, or top food chain status). The millions of acres of varied BLM-managed lands within the Rawlins RMPPA provide

important habitat for wildlife and fish species, especially where such lands and the waters they contain occur in large unfragmented tracts and reaches.

Terrestrial Wildlife

Terrestrial wildlife species, to the extent that they are managed, are overseen by state and federal wildlife management agencies. The WGFD is responsible for oversight of big game species, non-game species and small game species that are non-migratory. The U.S. Fish and Wildlife Service (USFWS) has oversight of migratory bird species, whether they are hunted (e.g., waterfowl) or not (e.g., passerine species such as warblers and sparrows), and of all federal threatened or endangered species. The WGFD participates in these activities. BLM, however, manages millions of acres of habitat that support these wildlife species, and thus has an integral role in their ecological health and viability.

Wildlife habitat is best characterized by the vegetation types discussed in Section 3.15 and the water resources discussed in Section 3.17, although air quality (Section 3.1), geology and topography (Section 3.8), and soils (Section 3.13) are also important contributors to habitat character. Such factors as fire, forestry, rights-of-way, livestock grazing, oil, gas and other energy developments (e.g. windpower and coal mining), OHV use and other recreation, and wild horses also influence the quality of habitat, as do management actions applied throughout BLM-administered lands and in special management areas. Most wildlife species utilize vegetation on the basis of its physiognomy (e.g., structure [height and spacing] and growth form [gross morphology and growth aspect] of the predominant species, and leaf characteristics of the dominant or component plants). This means that a given species may use a shrub of a particular height and growth form irrespective of its species. Therefore, the mapping of vegetation zones (Map 3.15-2) characterizes wildlife habitat in general terms. Especially important habitats are mixed mountain and mountain shrub, (mountain big sagebrush and antelope bitterbrush); monotypic stands of bitterbrush and true mountain mahogany; coniferous, rockland, aspen and riparian, and lowland sagebrush (primarily Wyoming big sagebrush on flatlands and basins below 7,000 feet) (Wichers 2002).

As is apparent from the vegetation map, the habitat diversity within the Rawlins RMPPA is extreme, ranging from alpine barren areas in the Sierra Madre and the Snowy Range in the south-central portion of the Rawlins RMPPA to desert barren areas in the Red Desert in the southwestern portion, with extensive grassland, shrub, and forest/woodland communities in between. The most historically important of these habitat types, on the basis of total species, number of breeders, number of sensitive species, and availability, are open aquatic, riparian (grassland, willow-waterbirch, aspen, and cottonwood), mountain shrub, juniper, aspen, aspen/conifer, ponderosa pine, Douglas fir, rockland in the Laramie Peak and North Platte Valley, and wet forested meadow (BLM 1987). The vegetation zones and plant community classes currently recognized in the Rawlins RMPPA are discussed in Section 3.15. As noted above, the community classes that are most important are those associated with water, the less abundant and more diverse shrub classes such as mountain shrub, deciduous woodland and forest classes, the less abundant coniferous classes such as ponderosa pine and Douglas fir, and areas of interspersed

deciduous and coniferous trees. Within each vegetation zone, similar wildlife species will be found, although individual species will tend to prefer vegetation of a particular height and density. Within this preferred area, individual plants of a particular age or life stage may also be preferred. Thus, it is important to manage each vegetation zone for maximum diversity in terms of age, height, and density so that the biodiversity and ecological health and resilience of the plant communities and their wildlife inhabitants are maintained. At the same time, excessive fragmentation of vegetation zones is to be avoided so that wildlife species requiring large tracts of a similar physiognomic type can complete their life cycles successfully.

More than 374 vertebrate species have been documented in the Rawlins RMPPA (BLM 1987). The vertebrate wildlife species that occur represent all major vertebrate classes: reptiles, birds, and mammals. Fishes and amphibians, the remaining vertebrate classes, are discussed in Section 3.19-2. Data are available primarily for birds and mammals, because of particular interest in them by the hunting and recreating public, and by natural resource specialists. The most important of these species are discussed below under the primary headings of game species (big game, waterfowl, furbearers, and upland game birds), nongame species (raptors and other migratory birds), and species of special concern (threatened, endangered, and sensitive species).

Game Species

Because game species are hunted or trapped and their populations are monitored to track the harvest they can support, there are considerable data available regarding not only their population levels but also their habitat. This is particularly true for big game species, but is also the case for small game species.

Big Game

Big game species in the Rawlins RMPPA include pronghorn, deer (mule deer and small numbers of white-tailed deer), elk, moose, black bear, mountain lion (black bear and mountain lion are classified as trophy game animals in Wyoming Statutes), and bighorn sheep. These species are either herbivores (pronghorn, deer, elk, moose, bighorn sheep), competing to some degree with other herbivorous wildlife, livestock, and wild horses; carnivores (mountain lion), competing with other wildlife predators; or omnivores (black bear), which have characteristics of both preceding groups.

The populations of the big game species that live in habitat managed by BLM are managed by the WGFD using a complex process that considers both quantitative and qualitative data. Three WGFD regions (Laramie, Green River, and Lander) cover much of the Rawlins RMPPA. The big game populations evaluated most extensively in all three regions are pronghorn, mule deer, and elk. In the Laramie Region, white-tailed deer, moose, and bighorn sheep populations are also evaluated. Of these, pronghorn, mule deer, and elk are the primary species present on BLM-managed lands within the Rawlins RMPPA. Information considered in the WGFD evaluation process includes population indices and harvest statistics for individual herd units (HU). The population indices are such indicators as the number of bucks per 100 does and the number of fawns

per 100 does, information that provides perspective on population balance and health. Depending on species, a variety of methods are used to determine herd unit ratio data and data on population trends. Regardless of methodology, the goal of all these surveys is to systematically sample available habitats and obtain a statistically meaningful sample. This sex and age ratio sampling may be done both pre- and post-hunt. In addition, data is collected at hunter check stations on the age and sex of harvested animals and, for mule deer, their body condition as indicated by fat deposited along the back. The latter data are indicative of summer range condition. Further, seasonal weather data from the previous year, observations on general range condition and the informed opinions of WGFD biologists, wardens and habitat specialists, long time landowners, and hunter input are used when determining trends in populations. Harvest statistics, the most extensive quantitative data available, are then considered together with the population indices to develop population estimates for each HU. Population estimates, considered together with population trend, range condition, weather, management objectives, and the socioeconomic factors of hunter demand and license revenues, are used to develop population objectives for each herd unit. These objectives serve as the goal for each herd. Depending on where a population is in relation to its objective determines if hunting seasons will be liberal, moderate or conservative. Population objectives are updated as necessary in response to such factors as public demand, habitat changes, and better survey techniques (and thus population estimates). As part of implementing that management goal, harvest limits are set within each HU on an annual basis. Actual harvest data tend to vary directly with population data, although they may lag by a year, since indications of high populations (population estimates above population objectives) are followed by higher harvest limits and higher actual harvests in the year following.

Population objectives, harvest and age and sex ratio data are presented below for the primary pronghorn, mule deer and elk HUs within the RMPPA.

Pronghorn

Pronghorn are a unique animal of the Western plains and are the only living species in their taxonomic family (Antilocapridae). Herds of up to 1,000 individuals once inhabited the plains; herds now commonly exceed 100 individuals, especially during winter. During winter, herds undertake local migrations to areas that are more protected or that have more available forage. During the breeding season, herds break up and bucks oversee a harem of one to perhaps 15 females (Cochrum 1962). Wyoming is the center of the pronghorn range and the Rawlins RMPPA has one of the highest densities of pronghorn in the world (Kotter 2002; Lanka 2002). Pronghorn inhabit a wide variety of open rangeland habitat types throughout the Rawlins RMPPA and forage primarily on shrubs, especially on sage species.

Over the 5-year period between 1996 and 2000, the pronghorn population objectives have remained generally static in the 13 HUs that are representative of the Rawlins RMPPA (Table 3.19-1): Bitter Creek (25,000), Baggs (9,000), Chalk Bluffs (450), Iron Mountain

(8,000–13,000), Medicine Bow (45,000)[2], Cooper Lake (3,000), Centennial (6,000–14,000), Elk Mountain (5,000), Big Creek (600), Red Desert (15,000), Iron Springs (12,000), North Ferris (5,000), and South Ferris (6,500). Estimates of population in these HUs over the same time period have varied: Bitter Creek (11,900–14,100), Baggs (4,800–7,600), Chalk Bluffs (750–1,300), Iron Mountain (15,548–19,918), Medicine Bow (34,252–43,735), Cooper Lake (4,032–6,628), Centennial (10,263–18,030), Elk Mountain (4,896–6013), Big Creek (674, 1 year of data), Red Desert (12,900–17,500), Iron Springs (9,40–11,050), North Ferris (2,535–2,725), and South Ferris (5,900–6,400). The age and sex ratios, respectively, for this time period have ranged between 42 and 77.6 juveniles per 100 females and between 36.8 and 57.2 males per 100 females (Frost 2002, Rothwell 2002).

Over the 5-year period between 1996 and 2000, the pronghorn population objectives have remained generally static in the 13 HUs that are representative of the Rawlins RMPPA (Table 3.19-1): Bitter Creek (25,000), Baggs (9,000), Chalk Bluffs (450), Iron Mountain (8,000–13,000), Medicine Bow (6,000), Cooper Lake (3,000), Centennial (6,000–14,000), Elk Mountain (5,000), Big Creek (600), Red Desert (15,000), Iron Springs (12,000), North Ferris (5,000), and South Ferris (6,500). Estimates of population in these HUs over the same time period have varied: Bitter Creek (11,900–14,100), Baggs (4,800–7,600), Chalk Bluffs (750–1,300), Iron Mountain (15,548–19,918), Medicine Bow (34,252–43,735), Cooper Lake (4,032–6,628), Centennial (10,263–18,030), Elk Mountain (4,896–6013), Big Creek (674, 1 year of data), Red Desert (12,900–17,500), Iron Springs (9,40–11,050), North Ferris (2,535–2,725), and South Ferris (5,900–6,400). The age and sex ratios, respectively, for this time period have ranged between 42 and 77.6 juveniles per 100 females and between 36.8 and 57.2 males per 100 females.

The harvest of pronghorn in Wyoming declined between 1991 and 2000 except for an increase in 1992. Within major HUs in the Rawlins RMPPA, this same trend is apparent (Figure 3.19-1). The HUs for pronghorn are provided in Map 3.19-1. Of the 18 HUs within the Rawlins RMPPA, 13 are primarily within the RMPPA (Table 3.19-1) and were used to develop the depicted graph from data in Table 3.19-2. Except for 1995, 1996, and 1997, there has been a gradual decline in hunter success within the Rawlins RMPPA. The Medicine Bow, Bitter Creek, Centennial, Baggs, and Red Desert HUs had the highest harvests early in the decade, while Medicine Bow, Iron Mountain, Centennial, Bitter Creek, Iron Springs, and Red Desert HUs had the highest harvests later in the decade (Figure 3.19-2). Although harvest data are not population data, they are highly correlated and representative of population trends.

Map 3.19-1 also shows the 3,860,667 acres of crucial winter range for pronghorn within the Rawlins RMPPA. These areas are found especially in the open flatlands in locations like the eastern side of the Great Divide Basin, close along the Wyoming-Colorado state

[2] NOTE: The Medicine Bow HU as defined since June 1, 2002, includes the former Bates Hole-Hats Six and Laprele HUs. Data for the latter two HUs are not included in this discussion of pronghorn population objectives and harvest since they are outside the Rawlins RMPPA. Thus, the numbers in this document reflect the old Medicine Bow HU boundaries.

line west of Baggs, the Shirley Basin south to Medicine Bow, and north of Saratoga in the rolling topography east of the North Platte River.

Deer

Both mule deer and white-tailed deer occur in the Rawlins RMPPA, although mule deer are by far the more abundant. Mule deer are distributed throughout the seasonal ranges in the Rawlins RMPPA and generally prefer habitat types in the early stages of plant succession and with numerous shrubs. They use the woody riparian, shrublands, juniper woodland, and aspen woodland habitat types extensively during spring, summer, and fall. These habitat types provide adequate forage areas with succulent vegetation for lactating females and adequate cover for security and fawning. During winter, mule deer move to lower elevations to avoid deep snow that covers their forage. They are often found in juniper and limber pine woodlands, big sagebrush/rabbitbrush, bitterbrush/sagebrush steppe, and riparian habitat types (BLM 1987). White-tailed deer use woody riparian habitats (willow, waterbirch, and cottonwood) along the major creeks and rivers for both forage and cover.

Over the 5-year period between 1996 and 2000, the mule deer population objectives have remained static in the eight HUs that are representative of the Rawlins RMPPA (Table 3.19-3): Baggs (18,700), Laramie Peak (14,000), Iron Mountain (15,000), Sheep Mountain (15,000), Shirley Mountain (10,000), Platte Valley (20,000), Ferris (5,000), and Chain Lakes (500). Estimates of population in these HUs over the same time period have varied: Baggs (18,300–20,000), Laramie Peak (11,58–14,592), Iron Mountain (16,043–18,510), Sheep Mountain (12,356–13,942), Shirley Mountain (4,438–4,807), Platte Valley (16,628–22,231), Ferris (no data), and Chain Lakes (no data). The age and sex ratios, respectively, for this time period have ranged between 46.6 and 67.6 juveniles per 100 females and between 22.6 and 39.6 males per 100 females (Frost 2002, Rothwell 2002).

The harvest of mule deer in Wyoming declined between 1991 and 1997, except for a slight increase in 1992. Following 1997, the harvest began to increase. Within the major HUs of the Rawlins RMPPA, this same pattern is apparent (Figure 3.19-3). The HUs for deer are provided in Map 3.19-2. Of the 15 HUs within the Rawlins RMPPA, eight are primarily within the RMPPA and were used to develop the depicted graph from data in Table 3.19-3. Except for 1992, hunter success in the Rawlins RMPPA has been lower throughout the 1991 to 2000 decade than it was in 1991. The HUs with the greatest harvest rates throughout the decade are Baggs, Platte Valley, Laramie Peak, and Iron Mountain (Figure 3.19-4). White-tailed deer harvest has typically ranged from 13 to 26 percent of the mule deer harvest but has not been subject to as much fluctuation during the decade.

Map 3.19-2 also shows the 1,468,885 acres of crucial winter range for mule deer within the Rawlins RMPPA. These areas are generally found in three types of places: on the flanks of mountains (e.g., the Sierra Madre, and the Snowy, Laramie, Seminoe, Shirley, and Ferris Mountains), along the drainages (e.g., North Platte and Medicine Bow Rivers), and in the badlands along the Wyoming-Colorado border and centered on Baggs.

Elk

Elk are distributed throughout the Rawlins RMPPA, especially adjacent to and in areas of higher elevation that have woody cover. In summer, elk use aspen and conifer woodlands for security and thermal cover, ranging out into upland meadows, sagebrush/mixed grass, and mountain shrub habitat types to forage. In winter, elk move to lower elevations, foraging especially in sagebrush/mixed grass, big sagebrush/ rabbitbrush, and mountain shrub habitat types, especially in windswept areas where snow depth is less. During severe weather, elk concentrate in crucial winter range, areas within their normal winter range that are most likely to provide thermal cover and forage. For parturition, elk move into areas that provide particularly good security cover and succulent forage. Elk occur in herds to a greater extent than do the other big game mammals. Areas of particular importance to specific elk herds are in the vicinity of Baggs, the Ferris Mountains and Seminoe Reservoir, Shirley Mountain, Encampment, the Saratoga Valley, Laramie Peak, Jelm Mountain, Wick, and Pennock Mountain (BLM 1987). Particularly important characteristics of these areas are as follows:

- **Baggs.** Provides summer, winter/yearlong, calving, and crucial winter range habitat for a herd of about 3,200 elk that migrate[3] from summer range in Miller Hill, the Sierra Madre, and the Medicine Bow National Forest on the east and from Colorado on the south to crucial winter range in the vicinity of Baggs. Most of the calving area for this herd is in Medicine Bow National Forest (BLM 1987). Part of this area is within the Jep Canyon Area of Critical Environmental Concern (ACEC) (BLM 1990).
- **Ferris Mountains/Seminoe Reservoir.** Provides summer, winter/yearlong, and crucial winter range for a herd of about 424 elk that migrate from summer range in the Ferris Mountains to crucial winter range on the north side of the mountains, as well as from summer range in the vicinity of Bradley Peak (south of the Ferris Mountains) to crucial winter range southwest of the lower portions of Pathfinder Reservoir. Calving areas have not been identified.
- **Shirley Mountain.** Provides summer, winter/yearlong, and crucial winter range for about 500 elk that migrate from summer ranges on Shirley Mountain and the Freezeout Mountains to crucial winter range around Chalk Mountain, on the south side of the Freezeout Mountains and southeast of the Miracle Mile.
- **Encampment.** Provides winter/yearlong and crucial winter range for about 200 elk.
- **Saratoga Valley.** Provides calving areas, summer, yearlong, and crucial winter range for about 4,230 elk.
- **Laramie Peak.** Provides summer, winter/yearlong, and crucial winter range for about 1,700 elk.

3 The migrations noted here are the most extreme and may not occur every year, with some portions of the summer range serving as yearlong range, etc. (See Figure 3.19-8.)

- **Jelm Mountain.** Provides primarily crucial winter range for about 1,615 elk that summer in Medicine Bow National Forest.
- **Wick.** Reserves grazing use for elk and other wildlife on 320 acres of BLM-managed public land in association with the WGFD Wick Elk Winter Area through an MOU between BLM and the WGFD.
- **Pennock Mountain.** Reserves grazing preference for elk and other wildlife (including 1,530 AUMs of forage for wintering elk) on 6,284 acres of BLM-managed land in association with the 9,806 acre WGFD Pennock Mountain Elk Winter Range (BLM 1987).

Over the 5-year period between 1996 and 2000, the elk population objectives have remained generally static in the seven HUs that are representative of the Rawlins RMPPA (Table 3.19-4): Sierra Madre (4,200), Iron Mountain (200–1,800), Snowy Range (4,900–6,000), Shirley Mountain (800), Ferris (350), Shamrock (75), and Laramie Peak/Muddy Mountain (5,000). Estimates of population in these HUs over the same time period have varied: Sierra Madre (7,200–8,524), Iron Mountain (no data), Snowy Rangy (6,800-7,994), Shirley Mountain (899–1,090), Ferris (395–598), Shamrock (199–257), and Laramie Peak/Muddy Mountain (4,529–5,691). The age and sex ratios, respectively, for this time period have ranged between 43.1 and 50.1 juveniles per 100 females and between 19.7 and 38.4 males per 100 females (Frost 2002, Rothwell 2002).

The harvest of elk in Wyoming has held relatively steady over the past decade, with a brief increase in 1994 and gradual increases after 1995. Within major HUs of the Rawlins RMPPA, the pattern has been somewhat different, with a gradual increase until 1993, a gradual decline until 1995, and a gradual increase thereafter (Figure 3.19-5). The management areas for elk are provided in Map 3.19-3. Of the nine HUs within the Rawlins RMPPA, seven are primarily within the RMPPA and have been used to develop the depicted graph from data in Table 3.19-4. Hunters' success in hunting elk has been fairly consistent over the decade, ranging up and down slightly every 1 to 2 years within the overall bounds of 32 and 43 percent. The HUs providing the greatest harvest throughout the decade have been Sierra Madre, Snowy Range, and Laramie Peak/Muddy Mountain (Figure 3.19-6).

Map 3.19-3 also shows crucial winter range and calving areas for elk within the Rawlins RMPPA. The 604,758 acres of crucial winter range and the 200,912 acres of parturition areas shown in Map 3.19-3 reflect the above areas of importance. North of I-80, winter range is identified on the northeast flanks of the Shirley Mountains, while south of I-80, winter range is identified on the west slopes of the Sierra Madre, in the North Platte River Valley between and north of the Sierra Madre and the Snowy Range, on the northeast flanks of the Snowy Range, and east of Laramie on the east side of the Laramie Mountains. Crucial winter range is often an area within the general winter range that has the best thermal cover and most available forage even in the most extreme weather conditions. Areas identified on Map 3.19-3 are in the Ferris Mountains, the Seminoe Mountains, the Shirley Mountains, and the Snowy Range, in each case on the lower slopes where microclimates provide conditions needed for survival. Parturition areas are

similarly in microclimates where hiding cover and moist, succulent forage provide shelter and adequate moisture for nursing mothers and young elk calves. Such areas are identified in Map 3.19-3 around the flanks of the Snowy Range and on the east side of the Sierra Madre.

Other Big Game Species

Within the Rawlins RMPPA, there are management areas for moose (Snowy Range), black bear (Laramie Peak, Snowy Range, and Sierra Madre), mountain lion (Iron Mountain, Laramie Peak, Snowy Range, Seminoe, Sierra Madre, and Haystacks), and bighorn sheep (Douglas Creek and Laramie Peak, and Encampment River). These represent areas where populations of these species are sufficient to support hunting and to warrant hunting management. Except for mountain lions, the harvest of these species in Wyoming has remained relatively constant throughout the decade. The harvest of mountain lions has been increasing (Figure 3.19-7). Data are not readily available to characterize the individual management areas for these species.

Because of public interest in them, bighorn sheep are particularly well characterized in the Rawlins RMPPA. They prefer open grassy ridgetops, slopes, or benches within 100 meters of rocky outcrops, precipitous cliffs, or steep rocky slopes. They most commonly use rockland, upland meadow, sagebrush/mixed grass, big sagebrush/rabbitbrush, and mountain shrub habitat types, foraging on forbs and grasses from early summer to late fall when they begin browsing on sagebrush, rabbitbrush, and bitterbrush as snows cover their other forage. Bighorn sheep have been reintroduced into the Ferris Mountains/ Seminoe Reservoir area, near Encampment, the Saratoga Valley, and Laramie Peak (BLM 1987). Especially on Laramie Peak, they are managed cooperatively by BLM for habitat and by WGFD for population.

Migratory, Upland, Small Game, and Furbearers

Waterfowl and Other Water Birds

Ducks and geese occur in aquatic areas throughout the Rawlins RMPPA. Some individuals or species breed, winter, or remain yearlong in the state, while larger numbers pass through the Rawlins RMPPA on spring or fall migration. The Rawlins RMPPA includes the Central Flyway (east of the Continental Divide except for the Great Divide Basin) and the Pacific Flyway (west of the Continental Divide and the Great Divide Basin). Most of these species depend on wetlands or open water that is sufficiently shallow to support rooted vegetation, and they feed on the biotic communities developed in such habitats. Many species feed on insects and small fish or amphibians in addition to, or instead of, plant foods in these aquatic areas. Species that primarily eat fish may feed in deeper water where there is insufficient light to support rooted vegetation. In addition, some species feed frequently on upland grasses and forbs in grassy fields and meadows where such vegetation is succulent and sufficiently open to enable rapid flight and avoid harboring predators. Such habitats support waterfowl and other water birds year-round. Species that breed in the Rawlins RMPPA additionally require security

cover that is sufficiently close to water that their precocial young can reach its relative safety and ready food supply.

The various natural lakes, constructed reservoirs, and streams within the Rawlins RMPPA provide important habitat for waterfowl and other water birds. The most important of the lakes and reservoirs are Seminoe Reservoir, Pathfinder Reservoir, Bucklin Reservoir, Shirley Basin Reservoir, Teton Reservoir, Little Sage Creek Reservoir, Flowing Well Reservoir, Wheatland Reservoir, Lake Hattie, Cooper Lake, and James Lake, but the myriad small ponds and pools that are sufficiently stable in their water levels to have wetlands developed around their shores are important as well. In addition, pools in the numerous streams tabulated in Table 3.17-1 and their tributaries provide important habitat. On Map 3.15-2, the wetland areas from the GAP data have been overlain by data from the National Wetlands Inventory to better depict the distribution of true wetland habitat. The acreage of such habitat is provided in Table 3.15-1. Only some of these aquatic resources are on BLM-managed public land.

The number of various types of waterfowl and other water birds harvested within Wyoming is given in Figure 3.19-8. As this figure shows, far more ducks and geese are harvested than coots, snipe, rails, or cranes. In addition, harvests over the past 10 years have been relatively consistent except for coot and snipe harvests. These trends should reflect the populations of these species. Hunting seasons for waterfowl and other water birds are set by the USFWS because these are migratory birds. Hunting seasons vary for some species between the Central and Pacific Flyways, and may be split into fall and late winter open periods to enable some individuals to pass through unhunted. Bag limits are revisited annually and are highest for mallards, followed by scaup, redheads, and canvasback and pintails, again reflecting the relative abundance of these species.

Waterfowl Management Areas 2B, 3A, and 5I best reflect the east, central and western portions of the Rawlins RMPPA (Map 3.19-4). The relative number of waterfowl and other water birds harvested in these three waterfowl management areas is shown in Figure 3.19-9. These trends should be somewhat reflective of the populations of these species, at least in relative terms. Annual variations in harvest are affected by a number of factors, including weather, therefore, harvest data trends need to be interpreted with caution.

Upland Game Birds

Upland game birds in Wyoming are pheasant, chukar, gray partridge, blue grouse, ruffed grouse, greater sage-grouse, sharp-tailed grouse, mourning doves, and turkeys. Greater sage-grouse are the most important of these species, especially on BLM-managed lands. Map 3.19-5 shows the general locations of greater sage-grouse leks, or strutting grounds, and adjacent nesting areas within the Rawlins RMPPA. During the spring, grouse concentrate for courtship and breeding in these areas, which are typically in openings surrounded by sagebrush with an average canopy density of 32 percent. Most nests are on drier sites under sagebrush and within a 2-mile radius of the lek, although these sites are not too far from water, since meadow riparian areas are used by hens with broods. During warm, dry summer periods, grouse tend to stay within 1.5 miles of intermittent

and perennial streams. Wintering areas for greater sage-grouse typically contain tall sagebrush that is available above the snow for cover and food (BLM 1987).

There are three other species of grouse that are known to occur within the Rawlins RMPPA. These species include the Columbian and plains sharp-tailed grouse and the blue grouse. Historically, in Wyoming, the range of the Columbian sharp-tailed grouse extended westward from the Continental Divide, while the range of the plains sharp-tailed grouse extended eastward from the divide. Blue grouse are found primarily in the Ferris and Seminoe Mountains, the Laramie Peak area, and throughout forest fringes associated with the Medicine Bow National Forest.

The only Wyoming population of the Columbian sharp-tailed grouse is found within the Rawlins RMPPA and is located near Baggs, Wyoming. These grouse are typically found in sagebrush semi-deserts, especially big sagebrush and to a lesser degree low sagebrush. In spring, this species concentrates on traditional dancing grounds for courtship and breeding. These dancing grounds are typically found in mixed shrub habitat of antelope bitterbrush, snowberry, and big sagebrush, evenly mixed with grasses and forbs. Broods in Wyoming are found most often in mountain shrub and sagebrush, with a high density of snowberry, and typically occurring within 0.6 miles of the dancing grounds. Birds move to ridges and knolls in mountain shrub habitat during the fall, and then move to riparian habitat with exposed mixed shrub communities at all elevations in the winter, where they feed on buds, berries, and catkins (BLM 1987). A USFWS October 2000 census documented a population of 100 to 150 birds in Carbon County. The bird was also listed as threatened, but not warranted, by the USFWS.

The current range of the plains sharp-tailed grouse includes eastern Wyoming, northeastern Colorado, and portions of Nebraska. This species has the potential to occur throughout the eastern portion of the Rawlins RMPPA, wherever remnants of appropriate habitat occur. In Wyoming, the populations are highest in Goshen County and eastern Platte and Laramie Counties. The optimum habitat includes an interspersion of plant communities with extensive ecotones, including grassland, grassland-shrub mixtures, and mixed-grass prairie occasionally broken by brushy draws. Dancing grounds are located in these mixed shrub/grassland habitats, and broods are reared in habitats where shrubs are interspersed with dense herbaceous cover. Wintering habitat includes aspen parklands and stands of chokecherry, aspen, cottonwood, green ash, and willow, especially when the snow is deep.

Blue grouse tend to use habitat that contains mountain shrubland, aspen/conifer woodland, aspen woodland, ponderosa pine/Douglas fir forest, limber pine woodland, and lodgepole pine forest. These grouse prefer to occupy the borders between these habitat types, as well as small, interspersed riparian areas for breeding, nesting, and brood rearing (BLM 1987).

The relative abundance of these species in Wyoming, as reflected in their harvest data, is shown in Figure 3.19-8. All of these species increased slightly in number between 1995 and 1999, with a slight decline in 2000, with this pattern being most pronounced in pheasants. Map 3.19-6 shows the Wyoming management areas for small game, upland

game (including greater sage-grouse), and furbearers. Harvest trends over the past decade in Management Areas 10, 22, 24, 25, 27, 28, 30, and 45, which best reflect the Rawlins RMPPA, are shown in Figure 3.19-8. Table 3.19-5 gives an indication of those management areas within the Rawlins RMPPA where each species of upland game bird is sufficiently abundant to have been harvested in 2000. Typically, grouse are hunted in the fall, although plains sharp-tailed grouse are hunted through the end of the year, and chukar and gray partridge are hunted from fall through winter. Laramie County and portions of Albany County are closed to the taking of greater sage-grouse (Sage-grouse Hunt Area 2). Sweetwater County is closed to the taking of chukar. Mourning doves are hunted earlier in the fall, because they migrate south earlier. Eden Reservoir in Sweetwater County is closed to mourning dove hunting within 300 yards of the normal high water line. Wild turkeys are hunted during both spring and fall in northern Albany County, but only in spring in eastern Laramie County.

Small Game Mammals

The small game mammals are cottontails, snowshoe hares, and squirrels. Table 3.19-5 gives an indication of the management areas within the Rawlins RMPPA where each species of small game mammal is sufficiently abundant to have been harvested in 2000. All of these species are hunted during both fall and late winter, with snowshoe hares having a lower bag limit than do cottontails or squirrels.

Furbearers

The species of furbearers are badger, bobcat, marten, weasel, coyote, raccoon, red fox, skunk, beaver, mink, and muskrat. Table 3.19-5 gives an indication of the management areas within the Rawlins RMPPA where each species of furbearer is sufficiently abundant to have been harvested in 2000. Furbearer trapping seasons vary. Some species may be trapped year-round (badger), others are typically trapped in the late winter and late fall (mink, weasel, bobcat, muskrat, marten, and beaver), although the specific dates may vary for marten and beaver. Portions of the Laramie Mountains, Beaver Creek, and South Fork Hog Park Creek, in the vicinity of Encampment, are closed to the taking of beaver as are South Fork Lake Creek and Goetze Creek drainages on the Pennock Mountain Wildlife Habitat Management Area.

Nongame Species

Nongame species include all species or groups not discussed above. Such species are numerous and diverse, especially given the range of habitats present in the Rawlins RMPPA. Due to limitations of knowledge, space, time, and general interest, only a few of these species or groups are addressed below. These are raptors, the long-billed curlew, and the American white pelican. Each has an important and long-term association with the Rawlins RMPPA. A number of bird species, including the ferruginous hawk and the long-billed curlew discussed in the following subsections, are present on BLM Wyoming State Director's Sensitive Species List and are addressed in the section on Wyoming Sensitive Wildlife Species. The hundreds of additional bird species that inhabit the Rawlins RMPPA for all or a part of their life cycles are important components of the

ecosystem and an important focus of the large segment of recreationists who enjoy bird-watching. The diversity of these species is supported by the wide range of habitats present within the RMPPA. BLM is a participant in the WY Partners in Flight and specific biological objectives and recommendations for land birds are presented in the WY Bird Conservation Plan.

Raptors

Raptors (birds of prey) found in the Rawlins RMPPA include eagles, falcons, hawks, harriers, and owls. These species occupy an ecological position at the top of the food chain and, therefore, act as biological indicators of environmental quality because they are fewer in number, have longer reproductive cycles, and are more prone to bioaccumulation. Most of these species are also sensitive to disturbance, especially during their nesting cycles. Raptors often concentrate their nests on suitable strata along cliffs or other formations and use such sites year after year unless disturbed.

In the Rawlins RMPPA, concentrations of ferruginous hawks or golden eagles and prairie falcons, depending on the nesting substrate, have in the past been identified at Shamrock Hills, Brown Canyon Rim, Seminoe, Red Rim, Atlantic Rim, Cherokee, Muddy Creek, Doty Mountain, Delaney Rim, Bolton Rim, Hanna, and Platte-Divide (BLM 1987). The identification of these nesting concentrations was based in part on a raptor study that began in 1975[4] and has continued through the present, resulting in extensive documentation of raptor nesting in the Rawlins RMPPA. The database from this study contains 12,467 records, representing 3,972 nest locations. Areas of raptor nest concentrations based on these data are shown in Map 3.19-7. Data on each nest location include species, township/range/section, quarter section, quarter quarter section, elevation, USGS quadrangle name, land ownership, date first observed, nest substrate, height of substrate, nest height, exposure, and vegetation type (Apple 2002a).

The intensity of this study has varied in response to proposals for development in the Rawlins RMPPA. Extensive data were collected in the Shamrock Hills area beginning in 1988 in response to potential development of coalbed methane. These efforts were renewed in 1997 through 2001 and are ongoing (Apple 2002b). In addition, beginning in 1998, extensive data collection was initiated in an area about 25 miles west of Rawlins and extending both north and south of I-80 in the vicinity of Wamsutter (Apple 2002b), where natural gas development is proposed. Also associated are a study of the use of artificial nest sites, a project begun in 1988, and a ferruginous hawk banding program, begun in 1993.

The long-term database on nest locations is very effective in characterizing the raptor species that nest in the Rawlins RMPPA and their nests. These data are summarized in Table 3.19-6, which shows not only the relative number of nests of each species but their height and the height and type of substrate on which they are built (Apple 2002a). With 3,972 nest sites in the database, this study provides extremely well-documented information on many of the species, especially the ferruginous hawk, which has been the

4 Only three records in the database predate this year.

primary focus of this effort. Of the total nests, 54.3 percent were on BLM-managed public land and 37.4 percent were on private land, with the remainder on Forest Service, state, other, or unrecorded land ownership types. The more focused portions of this overall study provide extensive additional data. For example, between 1998 and 2001, active ferruginous hawk nests were more often successful on artificial nest sites (81 percent) than on natural nest sites (65 percent). Overall nesting success for active nests of all species was 85.5 percent based on 2001 data, while in the Shamrock Hills Study Area, Continental Divide/Wamsutter II-North of I-80, Continental Divide/Wamsutter II-South of I-80 (Northern Segment), Continental Divide/ Wamsutter II-South of I-80 (Southern Segment), and other incidental areas, success of active nests was 92 percent, 80 percent, 80 percent, 93.9 percent, and 78.3 percent, respectively (Apple 2002b). These areas were undergoing varying degrees of development at the time these data were collected. The Jep Canyon ACEC was established in part to maintain the productivity of nesting raptor pairs (BLM 1990), as was the Shamrock Hills ACEC.

Data have also been collected on prey items noted in ferruginous hawk nests between 1993 and 2001 (Apple 2002a). Wyoming ground squirrels are by far the predominant prey species. Other prey species recorded at least once on the basis of prey remains were 13-lined ground squirrel, vole, sagebrush vole, cottontail rabbit, least chipmunk, prairie dog, western harvest mouse, short-tailed weasel, white-tailed prairie dog, northern pocket gopher, small mammal, greater sage grouse, horned lark, sparrow species, and other songbirds. Voles, cottontails, and prairie dogs were regular if not frequent prey items. The remaining prey species appear to be incidental food items.

Long-Billed Curlew

The long-billed curlew was once abundant in suitable habitat in Wyoming and in the Rawlins RMPPA. Its populations have been in decline since the 1930s, and it is now very scarce in all parts of the state except near Merna (outside of the Rawlins RMPPA in the west-central portion of Wyoming). In Wyoming, the long-billed curlew is known to breed only near Pass Creek in the Saratoga Valley, which is within the Rawlins RMPPA (BLM 1987). However, long-billed curlews are regularly seen on the flats north of the Ferris Mountains during the breeding season and are expected to breed in that vicinity, as well as north of the Seminoe Mountains and around the Pedro Mountains (Wilchers 2002). Curlews nest on higher ground with more dense grass cover but feed on wetter than average ground in meadows that are hayed or grazed. Summer grazing provides preferred vegetation profiles, and less intensive hay production provides disturbance refugia. Direct disturbances from humans or flooding, not the relative availability of suitably structured habitat, correlate most strongly with both nest failures (which can be over 60 percent) and population differences (Internet: http://uwadmnweb.uwyo.edu/fish_wild/abstracts/cochrane_j/). The importance of this species in the Rawlins RMPPA derives from its spectacular size (for a shorebird), its marked decline in abundance, and its known breeding within the Rawlins RMPPA. This species is also on BLM's list of sensitive species in Wyoming.

American White Pelican

The RMPPA provides one of only two known nesting locales for American white pelicans in Wyoming. This colony was first discovered in 1984 on an island in Pathfinder Reservoir. The 12- to 13-acre island slopes gradually to the water and is covered with clumped silver sagebrush and rabbitbrush. The pelicans nest in the open areas between the shrubs (BLM 1987). American white pelicans at Pathfinder forage in a variety of wetland habitats and frequently switch from one macroforaging habitat to another, using rivers proportionately more than their relative abundance and reservoirs less often than expected based on their availability. At Pathfinder Reservoir, American white pelicans primarily foraged at shallow water sites near shore, feeding on a wide variety of species, but especially on bottom-dwelling prey found in water less than 1 meter deep or on prey near the surface of deep water (e.g., common carp, white suckers, and tiger salamanders) (Internet: http://uwadmnweb.uwyo.edu/fish_wild/abstracts/findholt_s/). Because of water level fluctuations, the island may often be connected to the mainland and therefore provide less acceptable nesting habitat. Although the island used, at least under some conditions, by American white pelicans for nesting is not managed by BLM, some foraging areas used by this species are likely to be within land parcels managed by BLM.

The American white pelican is listed by BLM as a priority bird population within the Wyoming Basin, which includes much of the Rawlins RMPPA (Internet: http://www.blm.gov/wildlife/pl_86sum.htm), and Pelican Island is one of five locations in Wyoming listed by the National Audubon Society as a Global IBA (Important Bird Area) candidate site (http://www.audubon.org/news/release/iba_list.html). This nesting locale is somewhat vulnerable due to fluctuations in water levels in Pathfinder Reservoir.

Wildlife Species of Special Concern

BLM is responsible for managing a wide array of wildlife habitat in the Rawlins RMPPA. In general, the WGFD is responsible for managing the wildlife populations and BLM manages the habitats. Numerous species of wildlife occur in the RMPPA. Listed and BLM Sensitive species and their associated habitats are discussed in this section. These animals are recognized as being of particular interest to the public and are a focus for management.

Nine mammal and bird species in the RMPPA are federally listed and must be taken into consideration (Table 3.19-7). BLM has also identified an additional 8 state sensitive mammal species and 13 bird species that should be considered in any planning effort (Table 3.19-8). BLM has identified the following wildlife resource concerns in the Rawlins RMPPA:

- Raptor nesting
- Crucial big game winter range
- Elk calving areas

- Riparian areas
- Breeding, nesting, and brood-rearing habitats for greater sage-grouse and sharp-tailed grouse
- *Migratory Bird Treaty Act* species.

With priority habitat and listed and sensitive wildlife taxa identified, the Alternatives section of the EIS will outline the various actions, in addition to those included in the current management direction, that could be implemented to maintain, improve, or expand the habitat conditions for the various animal species.

The Rawlins RMPPA includes priority habitats on which BLM generally focuses most management efforts. These habitats are the major plant communities or terrestrial features within the review area that are important to wildlife. Priority wildlife habitats include streamside riparian, springs, seeps, wet meadows, seasonal wetlands, playas and lakebeds, cliffs, caves, talus slopes, dry meadows, dryland shrubs, juniper woodlands, ponderosa pine forests, mixed conifer forests, and quaking aspen groves.

Ongoing changes to these important vegetation communities, many of them caused by humans, have resulted in alterations in the animal habitat within the Rawlins RMPPA. For example, wet meadows may be converted to dry meadows as a result of a water tables being lowered by pumping or water diversion. Juniper encroachment is converting shrublands to woodlands, primarily due to changes in fire regimes. Aspen groves are not regenerating themselves and are diminishing in size and numbers. The FRO staff manages habitat on public lands for species that are threatened or endangered, or are candidates or proposed for listing under federal and state mandates. The staff also manages habitat on public lands for species on the Wyoming BLM Sensitive Species List under BLM mandate to avoid further decline of these species such that they also would be on federal or state lists.

Threatened, Endangered, Candidate, and Proposed Wildlife Species and Their Habitat

The species listed below are likely to occur within the Rawlins RMPPA and are federally protected or (1) have been determined to be eligible for listing but are precluded (yellow-billed cuckoo), (2) are part of an experimental population that is exempt from the endangered status given some parts of the population (whooping crane), or (3) occur in the Platte River system.

Black-Footed Ferret

Black-footed ferrets are associated with prairie dog communities, which provide potential habitat within the Rawlins RMPPA. Prairie dog burrows provide potential retreats for ferrets, and the prairie dogs themselves provide a supply of food. Black-footed ferret numbers have been shown to be directly linked to fluctuations in the prairie dog population. In the Rawlins RMPPA, both the black-tailed prairie dog (*Cynomys ludovicianus*) and the white-tailed prairie dog (*Cynomys leucurus*) are present. Any

disturbance to prairie dog towns may affect the black-footed ferret populations. A primary concern, aside from direct loss of the food base, is the potential for distemper transmission from domestic canines to the prairie dogs. An experimental population has been reintroduced within the RMPPA in the vicinity of the Shirley Basin. Although naturally occurring populations of the black-footed ferrets are no longer known within the Rawlins RMPPA, suitable habitat does exist. Therefore there is always the potential for ferrets to occur.

Canada Lynx

The Canada lynx is a secretive, forest-dwelling cat that inhabits northern latitudes and high mountains. The lynx feeds primarily on small mammals and birds, particularly snowshoe hares. Habitats utilized by the Canada lynx include old growth forests, and the animals' home range can be significant as they forage for food. The plan area has limited direct habitat for the lynx; however, it may provide corridors for movement and habitat for forage. There are no identified Lynx Analysis Units (LAU) located on BLM-administered public lands within the RMPPA.

The primary limits to Canada lynx recovery are adequate habitat areas, fragmentation of habitats, lack of forage, and human intervention.

Bald Eagle

Bald eagles appear to be recovering rangewide in the lower 48 states; however, they are still listed in the *Endangered Species Act* and require special consideration in evaluation of project impacts. In the Rawlins RMPPA, the bald eagle is generally a winter migrant and has not developed a nesting population. Usable nesting habitats do exist in the RMPPA, and, as forage is available, there is a potential for nesting bald eagles to occur.

Bald eagles are believed to live for over 30 years in the wild and even longer in captivity. They mate for life and often reuse old nests from previous years. The eagles' preferred nesting locations are close to rivers, lakes, marshes, and wetland areas. Primary concerns for bald eagles include disease, lack of food, bad weather, and human interference.

Preble's Meadow Jumping Mouse

The Preble's meadow jumping mouse is a small rodent with big feet that is adapted to jumping. It is closely related to other subspecies of meadow mice. The diet of these rodents consists of seeds, fruits, fungi, and insects. Hibernation occurs from October through May in small underground burrows that the mouse excavates. Nests are made of grass, leaves, or woody material excavated several centimeters below ground level. Preble's meadow jumping mice are primarily nocturnal or crepuscular but are occasionally observed during the day. The preferred habitat is low undergrowth consisting of grasses, forbs, or a mixture of both in wet meadows and riparian corridors, or where tall shrubs and low trees provide adequate cover. The Preble's meadow jumping mouse exhibits a preference for lush vegetation along streams and herbaceous understories in wooded areas in close proximity to water.

Threats to the Preble's meadow jumping mouse are the loss of riparian habitat, fragmentation of habitat, and reduction in preferred forage.

Yellow-Billed Cuckoo

The yellow-billed cuckoo was designated as a candidate for listing by the USFWS on July 25, 2001. It utilizes riparian and woodland habitats along rivers and streams in the western United States. The primary forage for the yellow-billed cuckoo is large insects and occasionally small frogs and lizards. The predominant impact on the yellow-billed cuckoo is the loss of large blocks of riparian habitat due to fragmentation, overgrazing, exotic plant community changes, river management, and agricultural conversion of native vegetation. In the Rocky Mountains, the yellow-billed cuckoo is considered a Distinct Population Segment.

Mountain Plover

The mountain plover exists and breeds in the Rawlins RMPPA, typically utilizing habitats characterized as mixed grass and short-grass prairie, cushion plant communities, shrub-steppe, plains, alkali flats, agricultural lands, cultivated lands, sod farms, and prairie dog towns. Plovers may nest on sites where vegetation is sparse or absent, or near closely cropped areas or rocky substrate. Mountain plovers are rarely found near water and show a preference for previously disturbed or modified habitats. The primary forage for the mountain plover is insects, grass seeds, and berries.

The nesting period appears to be the most critical time for the mountain plover. Predation, disturbance, abandonment of the nest, and direct destruction of the nest are potential impacts.

Platte River System Species

In addition to the species discussed above are the least tern, the piping plover, the whooping crane, the Eskimo curlew, and the American burying beetle, all of which occur in the Platte River system in association with riverine habitat. Least tern populations are listed as endangered in Nebraska, Colorado, and Montana, but not in Wyoming. The piping plover is listed as threatened, with critical habitat designated in Nebraska and Montana. The Eskimo curlew is listed as an endangered species in Wyoming, Colorado, and Nebraska, but its populations are so low that very little is known about the current distribution of the species. Existing populations are known to occur in Rhode Island, Oklahoma, Arkansas, South Dakota, and Nebraska. Although individuals of these four species are not likely to be present in any abundance in Wyoming or in the Rawlins RMPPA, their populations are highly susceptible to actions upstream in drainages such as the North Platte River. Therefore, any Rawlins RMPPA actions that may cause water depletion in the Platte River system are carefully considered.

The whooping crane is a typically considered a migratory species that seasonally utilizes habitats in the Rawlins RMPPA. The majority of the sightings have occurred in the North Platte River drainage. Cranes typically feed in meadow and marsh areas in small numbers, foraging on insects, minnows, crabs, crayfish, frogs, rodents, small birds, and

berries. Whooping cranes are very sensitive to human disturbance. The primary threat in the RMPPA is encroachment on feeding and resting locations and direct harassment by dogs and humans.

The whooping crane is federally listed and is protected under the *Endangered Species Act*; however, populations within Wyoming are considered part of the nonessential experimental population and are therefore not covered by the endangered designation. The management of whooping cranes is focused on areas outside of the RMPPA.

Wyoming Toad

The Wyoming toad is a federal endangered species whose known natural populations since 1987 have been restricted to a 2-square-mile area around Mortenson Lake near Laramie and within the Rawlins RMPPA. An ongoing captive breeding program and reintroductions at selected sites within the toad's historic range in the Laramie Basin are enabling population increases by this species.

Wyoming Sensitive Wildlife Species

BLM State of Wyoming Sensitive Species List includes eight additional mammals; four raptors; and nine shore, migratory, local, and neotropical birds (Table 3.19-8).

Mammals

The sensitive mammals include three bat species: long-eared myotis, fringed myotis, and Townsend's big-eared bat. These species utilize coniferous forests, woodland habitats, caves, and mines to support their life functions. The remaining BLM Sensitive mammals include—

- **Dwarf Shrew.** Utilizes mountain foothill shrub and grassland habitats
- **White-Tailed Prairie Dog.** Utilizes basin-prairie shrub and grasslands
- **Wyoming Pocket Gopher.** Utilizes meadows with loose soil
- **Swift Fox.** Utilizes grasslands and greasewood-dominated flats.

Birds

The *Migratory Bird Treaty Act of 1918* protects waterfowl, eagles, raptors, and other avian species that migrate through the Rawlins RMPPA. Specific concerns include harassment, collection, molestation, disturbance, or killing. Impacts on nesting migratory birds; collection of eggs, nests, or birds; and harassment of nesting birds are all considered activities that violate the *Migratory Bird Treaty Act*. Particular concerns that have been raised in the RMPPA are that proposed development of gas from coalbeds in the dunal pond area may affect the amount of water in the ponds, which would impact the migratory birds and rare vegetation and wildlife communities associated with these unique habitats. In addition, concern for greater sage-grouse populations has increased, thereby causing recent petitions for listing. Several of the other species on the list of sensitive species are sagebrush obligates, insofar as their habitat in the Rawlins RMPPA is concerned.

Greater Sage-Grouse

Greater sage-grouse are declining throughout much of their historic range and have been petitioned for listing. Greater sage-grouse populations appear to be affected by activities associated with oil and gas development and grazing. These activities include fragmentation of the habitat, disturbance of breeding cycles, loss of nesting and rearing habitats, and more efficient predation by predators that use the increased hunting perches provided by facilities in the disturbed areas.

Greater sage-grouse typically are seasonally affiliated with sage vegetation communities. Forb seeds and insects provide the primary forage for greater sage-grouse juveniles. Seasonal access to water and moist areas is essential to the survival of young birds.

Raptors and Owls

BLM Sensitive raptors include species that feed on rodents and avifauna found in the Rawlins RMPPA:

- **Northern Goshawk.** Utilizes conifers and deciduous forests
- **Ferruginous Hawk.** Utilizes basin-prairie shrub, grasslands, and outcroppings
- **Peregrine Falcon.** Utilizes tall cliffs
- **Burrowing Owl.** Utilizes grasslands, basin/prairie shrub, and prairie dog towns
- **Loggerhead Shrike.** Utilizes basin-prairie and mountain foothill shrub.

Other Avifauna

Other avifauna for which there are population concerns, in many cases due to habitat loss or fragmentation, are—

- **White-Faced Ibis.** Utilizes marshes and wet meadows (shorebird)
- **Trumpeter Swan.** Utilizes lakes, ponds, and rivers (migratory)
- **Columbian Sharp-Tailed Grouse.** Utilizes grasslands
- **Long-Billed Curlew.** Utilizes grasslands, plains, and wet meadows
- **Brewer's Sparrow.** Utilizes basin-prairie shrub
- **Sage Thrasher.** Utilizes basin-prairie and mountain foothill shrub
- **Sage Sparrow.** Utilizes basin-prairie and mountain foothill shrub
- **Baird's Sparrow.** Grasslands and weedy fields.

Amphibians

The northern leopard frog (*Rana sp.)* and the Great Basin spadefoot toad have been identified as sensitive species by BLM and occur in marshes and wetlands in the project area. There is a regionwide decline in these species, which has resulted in the initiation of several amphibian recovery efforts by federal and state entities.

The southern Rocky Mountain population of the boreal toad (*Bufo boreas*) has suffered drastic population reductions since the early 1980s in the Southern Rockies and declines in the Sierra Madre. The western boreal toad is currently a candidate species for listing

under the *Endangered Species Act of 1973*, as amended, and has been identified as Native Species Status 1 by the State of Wyoming. Causes for decline are being investigated and include impacts from the occurrence of the chytrid fungus (*Batrachochytrium dendrobatidis*). Habitats utilized by this species include wet meadows and marshes, including riparian areas and pond margins. A Conservation Plan and Agreement for the management and recovery of the Southern Rocky Mountain population of the boreal toad was completed in February 2001.

Fisheries

Fisheries habitat includes perennial and intermittent streams, springs, and flatwater (lakes and reservoirs) that support fish through at least a portion of the year. The condition of the fisheries habitat is related to hydrologic conditions of the upland and riparian areas associated with, or contributing to, a specific stream or water body, and to stream channel characteristics. Aquatic habitat quality varies by location and orientation to geographic landforms and vegetation.

Riparian vegetation moderates water temperatures, adds structure to the banks to reduce erosion, provides instream habitat for fish, and provides organic material for aquatic macroinvertebrates. Vegetated flood plains dissipate stream energy, store water for later release, provide areas of infiltration for ground water, support the hyporheic zone of the river, and provide rearing areas for juvenile fish. The quality of the physical aquatic habitat is refined further by water quality. Specifically, water temperature, turbidity, and dissolved oxygen determine the amount of habitat that is usable by different fish species.

Public lands within the RMPPA provide habitat for eight fish families, which include 24 fish species (Table 3.19-9). Additionally, five endangered fish species can be found downstream of the RMPPA within the Colorado River drainage. Five of these species are federally listed under the *Endangered Species Act*; 15 species are native and 12 are introduced (nonnative). Three drainages occur within the Rawlins RMPPA: the Colorado River watershed in the western portion, the North Platte River watershed in the eastern portion, and the Great Divide Basin in the northwest.

Threatened, Endangered, Candidate, and Proposed Fish Species and Their Habitat

Colorado River System Species

The humpback chub, Colorado pikeminnow, bonytail, and razorback sucker are endemic species to the Colorado River drainage, including the Green River and all the tributaries that support it. Although these species do not occur within the field office boundary, management actions within the boundary could affect the downstream habitats of these species. These four Colorado River fish are federally listed as endangered and are directly affected by activities that may deplete water in the Colorado River watershed. The USFWS has determined that federal actions that result in water depletion in the Colorado River system might affect these fish species and would require consultation.

Depletions include evaporative losses and consumptive use of surface or ground water within the affected basin, often characterized as diversions less return flows. Project

elements that could be associated with depletions include, but are not limited to, ponds (detention, recreation, irrigation storage, and stock watering), lakes (recreation, irrigation storage, municipal storage, and power generation), pipelines, wells, diversion structures, and water treatment facilities.

A recovery plan and the resulting Recovery Implementation Program for the four Colorado River fishes has been approved. The recovery plan includes life history descriptions, distribution, reason for decline, current conservation efforts, and the recovery strategy for the species. The Recovery Implementation Plan includes the actions that must be taken to remove the species from federal listing.

North Platte River System Species

The pallid sturgeon occurs in the North Platte River system and is affected by activities in the upstream portion of the project area. The pallid sturgeon is federally listed as threatened. The primary impact on the pallid sturgeon occurs from upstream water depletions and loss of ecosystem integrity. Activities that may impact the pallid sturgeon are primarily water depletion oriented and include evaporative losses and consumptive use, including diversions from the North Platte River or its tributaries less the volume of water provided by return flows. Annual and seasonal diversions and depletions affect the ability of the pallid sturgeon to sustain itself in the North Platte River drainage. There is still adequate potential habitat for this species within the Rawlins RMPPA, but it has not recently been found within its historic range.

Wyoming Sensitive Fish Species

Fish

Colorado River cutthroat trout inhabit high-elevation streams of the Colorado River drainage portion of the project area. The Colorado River cutthroat trout is 1of 10 native cutthroat trout species that evolved in the streams and lakes during the Pleistocene Period and subsequently moved into high-elevation streams as the climate became drier and the lakes desiccated. Nonnative rainbow, brown, and brook trout have been planted into the stream habitats to augment salmonid recreational fishing opportunities. The introduction of these nonnative species of trout has directly affected the ability of the native Colorado River cutthroat to ecologically sustain itself due to direct predation, hybridization, and competition for food and habitat. Consequently, its populations have declined markedly, and it has been petitioned for listing.

Other fish of concern in the RMPPA are affected by limited habitat, reduced water quality, competition, and resulting reduction of population range. These fish species are listed by BLM as Sensitive Species and include the roundtail chub (*gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), the leatherside chub (*Gila copei*) and bluehead sucker (*Catostomus discobolus*) in the Colorado River drainage.

3.20 SPECIAL MANAGEMENT AREAS

Special management areas are designated to protect or preserve certain qualities or uses in areas that best provide them. The environment in these areas is unique in some regard, so that it is desirable to apply different management to the areas than is applied to the surrounding public lands. This section identifies the various special management areas within the Rawlins RMPPA and addresses the qualities or uses that have resulted in their designation. The types of special management designation addressed in this section are WSAs, ACECs, Wild and Scenic Rivers, and SRMA.

Wilderness Study Areas

There are no designated wilderness areas in the Rawlins RMPPA, but there are five WSAs located within the RMPPA (Map 3.20-1). These include the following:

- Adobe Town WSA
- Ferris Mountains WSA
- Encampment River Canyon WSA
- Prospect Mountain WSA
- Bennett Mountains WSA.

Because these lands are designated as WSAs, their environment is assumed to be one of minimal disturbance and near pristine condition. Unless otherwise noted, all information for this section was obtained from the Wyoming Statewide Wilderness Study Report (BLM 1991).

Adobe Town WSA

The Adobe Town WSA consists of a single study area within the Rawlins and Rock Springs Field Office administrative boundaries. This WSA includes 34,134 acres of BLM-managed lands within the Rawlins RMPPA. The WSA is located in southeastern Sweetwater County, 25 miles south of Wamsutter, Wyoming. It is bounded on the north by the checkerboard land pattern and the Manual Gap Road, on the west by the Adobe Town Rim Road, on the south by the Shell Creek Road, and on the east by the Willow Creek Road.

The WSA was studied under Section 603 of FLPMA and was included in the Final Adobe Town-Ferris Mountains Wilderness EIS filed in January 1988. Based on information from that document, BLM Wyoming State Office recommended that 10,920 acres of the original 82,350 be recommended for designation as wilderness. The recommended portions include most of the heart of the Washakie Basin, an ancient inland sea. This portion of the WSA is a very colorful and rugged desert badland area virtually untouched by human activity. Skull Creek Rim, in the heart of the area recommended for wilderness designation, contains some of the most unique and extensive badlands formations in Wyoming.

Since consideration of the Adobe Town WSA in the 1988 Wilderness EIS, additional information has been submitted to BLM concerning adjacent lands that also potentially

contain wilderness characteristics. Pursuant to regulations, BLM ground checked this information and has determined that portions of the proposal do indeed contain wilderness characteristics.

Ferris Mountains WSA

The Ferris Mountains WSA includes 22,245 acres of BLM-managed public lands and one privately owned inholding of 160 acres. The WSA is located in northwestern Carbon County, about 40 miles north of Rawlins, Wyoming. The Ferris Mountains are a small mountain range, rising abruptly from the gently rolling plains that surround the WSA. The WSA is bounded on the north by the rolling plains of the Sweetwater Valley, on the south by the level expanses of Separation Flat, on the west by state land and Muddy Gap, and on the east by Miners Canyon.

The Ferris Mountains WSA is extremely steep and rugged, providing unusual and spectacular scenery. Along the southern flank, a formation of limestone outcrops forms a prominent white band 12 miles long, which is visible for up to 50 miles under the proper light conditions. At 10,037 feet, Ferris Peak is the highest point in the Great Divide Basin and rises some 3,000 feet from the valley floor. Vegetation consists of coniferous trees, aspen, shrubby plants, grasses, and forbs. The WSA also contains grassy meadows and riparian areas.

The WSA was studied under Section 603 of FLPMA and was included in the Adobe Town-Ferris Mountains Wilderness EIS filed in January 1988. It is the recommendation of BLM's Wyoming State Office that all 22,245 acres be designated wilderness.

Encampment River Canyon WSA

The Encampment River Canyon WSA includes 4,547 acres of BLM-managed lands with no inholdings or split-estate lands. The WSA is located in southern Carbon County, approximately 2 miles south of Encampment, Wyoming, and 1 mile north of the USFS Encampment River Wilderness. It lies in the foothills of the Sierra Madre.

The WSA is bounded on the north by private lands, fences, and roads; on the east by roads and a power line; on the south by private and state lands, roads, and mineral exploration activity; and on the west by roads.

The topography of the entire unit is mountainous. Steep canyons and rocky slopes dominate the vistas. The Encampment River and a major tributary, Miner Creek, add scenic features to the WSA. Elevations range from 7,500 feet along the Encampment River to 8,545 feet on the high ridges.

Approximately 10 percent of the WSA is forested. Tree species present include limber pine, lodgepole pine, Douglas fir, subalpine fir, cottonwood, and aspen. These species occur in pure and mixed stands scattered throughout the WSA. Lower elevations and drainages are characterized by narrow belts of deciduous trees (cottonwoods, willows, alders), coniferous trees (Douglas fir, true firs), grasses, and forbs bordering the Encampment River.

Vegetation in the middle and upper elevations and on rocky slopes is influenced by differing aspects of the canyon, with a mosaic of bunchgrass and small shrubs on steep canyon slopes and small fingers of trees in draws and gullies. This mosaic of vegetation has been influenced by wildfires.

The WSA was studied under Section 202 of FLPMA and was included in the Final Great Divide Resource Area Wilderness EIS filed in August 1990. The recommendation of BLM's Wyoming State Office was that all 4,547 acres be designated as wilderness.

Prospect Mountain WSA

The Prospect Mountain WSA includes 1,145 acres of BLM-managed public lands with no inholdings or split-estate lands. The WSA is located in southern Carbon County, approximately 16 miles southeast of Encampment, Wyoming, and 8 miles north of the Colorado-Wyoming border. It is situated along the southwestern flank of the Snowy Range in the Medicine Bow Mountains. The WSA is bounded on the north by the Prospect Creek Road and the North Platte River, on the east by the U.S. Forest Service Platte River Wilderness, on the south by a two-track road and fenceline, and on the west by a fenceline.

The WSA contains the western half of Prospect Mountain. Elevations range from 7,400 feet along the North Platte River to 8,430 feet on Prospect Mountain. The WSA is 70 percent forested, with lodgepole pine and aspen as the major species, and contains riparian areas and beaver ponds.

The WSA was studied under Section 202 of FLPMA and included in the Final Great Divide Resource Area Wilderness EIS filed in August 1990. BLM's Wyoming State Office recommended that all 1,145 acres of this WSA be designated as wilderness.

Bennett Mountains WSA

The Bennett Mountains WSA includes 6,003 acres of BLM-managed public lands with no inholdings or split-estate lands. The WSA is located in north-central Carbon County east of Seminoe Dam and lies about 35 miles northeast of Rawlins, Wyoming. It is part of the Seminoe Mountain range, a small rugged range that rises abruptly from the surrounding lowlands. The WSA is bounded on the north and east by private and state lands, on the south by a power line road, and on the west by the Bennett Mountain Road.

The Bennett Mountains WSA contains three basic types of topography: mountain plateau/ridges; steep rock ledges; and many tributary draws. Elevations range from 6,600 feet to 8,000 feet. The mountain, which is approximately 4 miles long within the WSA, has distinct rocky ledges and walls along the entire southern exposure. In many places, these rocky walls are vertical outcrops that create the appearance of a fortress. The northern portion is traversed by numerous tree-filled drainages. Most portions of the WSA are vegetated with interspersed grasses, sagebrush, and other shrubs, and pockets of pine, aspen, and willows. The higher elevations have considerably less vegetation and more rugged rocky features.

The WSA was studied under Section 603 of FLPMA and was included in the Final Great Divide Resource Area Wilderness EIS filed in August 1990. BLM's Wyoming State Office recommended that none of the WSA be designated as wilderness. This decision was based on the relative quality of the area's wilderness values. Although the wilderness inventory notes that outstanding opportunities for solitude and primitive recreation exist in the WSA, these values are not found throughout the study area.

Additional Information

Additional information was received concerning what is referred to as the Kinney Rim South, Wild Cow, and Ferris Mountains areas suggesting that the land in these areas may contain wilderness characteristics. BLM will assess, as it did for the suggested Adobe Town WSA expansion, all WSA proposals for wilderness characteristics.

Areas of Critical Environmental Concern

There are four ACECs in the Rawlins RMPPA: Como Bluff ACEC, Sand Hills ACEC, Jep Canyon ACEC, and Shamrock Hills ACEC (Map 3.20-2). Because ACECs are management designations to protect and prevent irreparable damage to specific resources, this section addresses the specific resources and management purposes of each of the Rawlins RMPPA ACECs. The Jep Canyon, Shamrock Hills, Como Bluff, and a portion of the Sand Hills ACECs are within the checkerboard portion of the Rawlins RMPPA, which is characterized by public and private ownership of alternating sections of land.

The Jep Canyon and Shamrock Hills ACECs are important because of their wildlife, which is the focus of BLM's management objectives. The wildlife moves throughout the ACEC region, irrespective of land ownership. This makes these ACECs difficult to manage, because the owners of private sections may have goals for their lands that are quite different from BLM's goals but may still affect the free-ranging wildlife.

The Como Bluff ACEC is managed for its paleontological resources, but there is no public access to the public lands containing these resources. The Sand Hills ACEC is managed for its unique vegetation and important wildlife resources. Cohesive management of resources on both Como Bluff and Sand Hills is also made difficult by ownership patterns. Unless otherwise noted, this section is derived from a synthesis of information from the Great Divide Resource Area Record of Decision and Approved Resource Management Plan (BLM 1990).

Como Bluff ACEC

Como Bluff ACEC protects 1,760 acres of public land located in the geologic Morrison Formation (a fossil-bearing formation) for its paleontological resources and historical values. Over the years, excavations have removed a wide array of fossilized material, including fossilized bones of dinosaurs such as *Apatosaurus* and *Diplodocus* (Internet: Morrison 2002). In addition to the rich collection of paleontological resources, Como Bluff ACEC preserves a portion of the period in American history known as the "Bone Wars." Beginning for Como Bluff in the late 1870s, this period was marked by

extremely competitive fossil hunting by paleontologists, including stories of espionage and sabotage (Internet: BLM 2002).

Como Bluff ACEC is part of the Como Bluff Historic District, also known as the Como Bluff Historic-Paleontologic Site, which is listed on the NRHP (Internet: National Register 2002). In addition to this, the Como Bluff area is an NNL.

Sand Hills ACEC

The Sand Hills ACEC protects about 8,300 acres of public land for its unique vegetation complex, wildlife habitat values, and recreational opportunities. This area provides crucial winter range for mule deer and pronghorn, and nesting and foraging habitat for raptors, greater sage-grouse, and Columbian sharp-tailed grouse populations (Section 3.19).

Jep Canyon ACEC

Jep Canyon ACEC protects about 13,320 acres of public land for its crucial elk winter range, as well as for raptor nesting habitat.

Shamrock Hills ACEC

Shamrock Hills ACEC protects about 17,280 acres of public land for its habitat and productivity of nesting raptor pairs. Shamrock Hills ACEC is recognized as a Raptor Concentration Area, with one of the highest known nesting populations of ferruginous hawks in Wyoming. These populations are discussed in greater detail in Section 3.19.

Wild and Scenic Rivers

There are currently no designated Wild, Scenic, or Recreational Rivers in the Rawlins RMPPA. As part of the RMP planning effort, the RFO staff is conducting eligibility and suitability reviews that precede any Wild, Scenic, or Recreational River designations by Congress.

Special Recreation Management Areas

SRMAs are locations that are managed for significant or unique recreational resources. There are three such areas within the Rawlins RMPPA: Continental Divide National Scenic Trail SRMA, North Platte River SRMA, and Shirley Mountain SRMA (Map 3.11-2). Table 3.20-1 summarizes RMIS data for these areas over the past 3 fiscal years (FY99, FY00, FY01). In addition to these data, each area is summarized briefly below. Unless otherwise noted, this section is derived from a synthesis of information from the Great Divide Resource Area Record of Decision and Approved Resource Management Plan (BLM 1990), RMIS (BLM 2002), and personal conversations with the Rawlins RMPPA Recreation Planner (Clair 2002).

Continental Divide National Scenic Trail SRMA

The currently designated portions of this SRMA cover 87 miles of trail primarily on BLM-managed land (plus some state land) in the Rawlins RMPPA. Its key uses include camping, hiking, and driving. The exact trail route has not yet been fully identified.

North Platte River SRMA

By far, this SRMA receives the heaviest use of the three SRMAs in the Rawlins RMPPA. It is a 3,550-acre SRMA that follows the North Platte River from Seminoe Reservoir south to the Colorado-Wyoming border. Recreational activities requiring water receive heavy participation. The largest number of participants, just over 81,000, fished the river. Well over 72,000 participants viewed wildlife. Other important activities within this SRMA include row/float/raft activities and camping. Picnicking and trail-related activities were participated in frequently, as well.

Shirley Mountain SRMA

The Shirley Mountain SRMA was designated to protect recreationally popular forest and geological resources. Most people drive cars, trucks, or SUVs to this area and view wildlife. Located in the Shirley Mountains, this SRMA contains some excellent elk habitat and thereby provides an opportunity for wildlife viewing.

Other Special Management Areas

Other special management areas in the RMPPA managed in cooperation with WGFD are:

- **Laramie Peak HMP Area** – The main objective of the Laramie Peak Habitat Management Area is to restore, improve and enhance habitat conditions for bighorn sheep and other wildlife species. There are fifteen (15) site-specific identified projects that are proposed in cooperation and coordination with the U.S. Forest Service (USFS), Wyoming Game and Fish Department (WGFD), Bureau of Land Management (both the Rawlins and Casper Field Offices), and public interest groups (such as Foundation for North American Wild Sheep {FNAWS}).

- **Pennock Mountain HMP Area** – The WGFD established the 9,806-acre Pennock Mountain Elk Winter Range in 1962. The BLM agreed to reserve all grazing preference for wildlife on 6,284 acres of BLM-administered public land, including 1,530 AUMs of forage for wintering elk. Located east of Saratoga, Wyoming, this area is closed to motorized vehicle use, including over-the-snow vehicles, from November 15 through April 30.

- **Wick Unit** – The WGFD established the Wick Elk Winter Area in 1965, In conjunction with the WGFD's purchase of the Wick Brothers Ranch, a memorandum of understanding between the BLM and the WGFD was developed that reserves grazing use on the 320 acres of BLM-administered public land for the use of elk and other wildlife. Located on both sides of I-80

and between the towns of Saratoga and Rock River, Wyoming, this area is closed to motorized vehicle use, including over-the-snow vehicles, from November 16 through May 31.

- **Chain Lakes Unit** - The Chain Lakes Wildlife Habitat Unit occurs in a checkerboard ownership pattern, where approximately 54% of the lands are either owned or controlled by the Wyoming Game and Fish Department (WGFD), and the remaining 46% are federal lands administered by the BLM Rawlins Field Office. The Commission (WGFD) objectives are to: (1) Permit limited grazing by domestic livestock to maintain vegetative cover types optimum for the propagation and maintenance of antelope; and (2) Maintain optimum population of antelope in balance with the forage production of the area. The mutual objectives are to: (1) Manage the habitat and forage condition so that the area may support an optimum population of antelope based on the forage production capability of the area; (2) In the event mining occurs, secure reclamation of mined lands which will serve to provide suitable habitat and forage for antelope in future years; (3) To maintain the area in public ownership so that the public may fully enjoy this outstanding herd of antelope and all other uses which are compatible with (a) above; (4) To determine and implement the most practical and economical plan of administration which will eliminate unnecessary duplication of effort and supervision; (5) Discourage the construction of additional fences on or within the unit boundary; and (6) Permit grazing of livestock as a management tool to maintain or enhance wildlife habitat.

- **Sybille Research Unit** - The primary objective of the Sybille Game and Fish Research Unit is to provide facilities, techniques, animals, and handling for the conduct of research on the hoofed big game species of Wyoming and any exotic species which might be considered for introduction. Such research will mainly be concerned with diseases, external and internal parasites, and nutritional requirements. It may also deal with life history, reproductive potential, stress tolerance and other biological factors. A lesser, but still important, objective of the Unit is conservation education.

- **Red Rim/Grizzly Cooperative Management Area** - There is a Memorandum of Understanding (MOU) between the Wyoming Game and Fish Department (WGFD) and the BLM Rawlins Field Office to define working relationships, coordination, and cooperation procedures for the development and implementation of a cooperative management plan. The areas covered by this MOU are the Daley and the Daley Ranch Pasture allotments (Red Rim Cooperative Wildlife Habitat Management Area) and the Grizzly allotment (Grizzly Cooperative Wildlife Habitat Management Area). The management goals are as follows: (1) Focus on wildlife and vegetation communities as the primary benefactors of management decisions made on the Wildlife Management Habitat Areas (WHMAs); (2) Develop land

management strategies that will meet wildlife and habitat objectives while accommodating livestock grazing, and that will have broad practical application throughout Wyoming and the Rocky Mountains; (3) Insure that the combined use of habitat by wildlife and livestock is not adversely impacting the health and vigor of the vegetation communities; (4) Use the WHMAs as a demonstration area to show that with proper management, wildlife and livestock can coexist in the same area without adversely affecting rangeland, riparian habitats, or wildlife populations; (5) Provide educational opportunities for the public, emphasizing that quality habitat is essential to the maintenance of both healthy wildlife populations and successful livestock operations; and (6) Reestablish Colorado River Cutthroat trout and requisite habitats in suitable WHMA streams.

3.21 REFERENCES CITED AND DOCUMENTS REVIEWED

The documents and other information sources contained in this section include specific references cited in this chapter of the MSA, and other substantive reference material used during the research process.

3.21.1 Air Quality

Bureau of Land Management (BLM) 1999a. DEIS Continental Divide/Wamsutter II Natural Gas Project, Sweetwater and Carbon Counties, Wyoming.

Martner, Brooks E. 1986. Wyoming Climate Atlas. University of Nebraska Press.

Seinfeld, John H. 1986. Atmospheric Chemistry and Physics of Air Pollution. Wiley InterScience, New York.

Singh, H. B., F. L. Ludwig and W. B. Johnson. 1978. Tropospheric Ozone: Concentrations and Variabilities in Clean Remote Atmospheres," Atmospheric Environments, 12, 2185-2176.

Stern, Arthur C, Henry C. Wohlers, Richard W. Boubel and William P. Lowry. 1973. Fundamentals of Air Pollution. Academic Press, New York.

Trewartha, Glenn T. and Lyle H. Horn. 1980. An Introduction to Climate. McGraw-Hill, New York.

Western Regional Climate Center. 2002. http://www.wrcc.dri.edu. (WDEQ) Wyoming Department of Environmental Quality

3.21.5 Hazardous Materials and Health/Safety

BLM

1999 Draft Environmental Impact Statement Continental Divide, Continental Divide/Wamsutter II Natural Gas Project, Sweetwater And Carbon Counties, Wyoming. Prepared By The Rawlins And Rock Springs Field Offices, BLM. p. 3-19.

2001 Environmental Assessment For The Seminoe Road Coalbed Methane Pilot Project, Carbon County, Wyoming. Prepared By The Rawlins Field Office, BLM. Appendix D.

3.21.6 Lands and Realty

Valentine, Chuck. 2002. Resource Area Site Visit, June 2002

3.21.8 Geology, Topography, and Minerals

Berg, R.R.
1961 Laramide Tectonics of the Wind River Mountains: Wyoming Geological Association 16th Annual Field Conference Guidebook. Casper, Wyoming. p. 70-80.
1983 Geometry of the Wind River Thrust, Wyoming: *in* Lowell, J.D., and Gries, R., eds. Rocky Mountain Foreland Basins and Uplifts. Rocky Mountain Association of Geologists. Denver, Colorado. p. 257-262.

Berryhill, H.L. Jr., Brown, D.M., Brown, A., and Taylor, D.A.; 1950; Coal Resources of Wyoming; U.S. Geological Survey Circular 81. 41

Blackstone, D.L. 1971. Traveler's guide to the geology of Wyoming. Wyoming Geological Survey Bulletin 55. Laramie, Wyoming. 90 p.

Blackstone, D.L. 1996. Structural geology of the Laramie Mountains, southeastern Wyoming and Northeastern Colorado. Wyoming Geological Survey. Laramie, Wyoming. Report of Investigations No. 51. 28 p.

Boyd, D.W., A.W. Smoke, J.R. Steidtman, and S.M. Roberts. 1993. Paleozoic history of Wyoming: *in* Snoke and others, eds. Geology of Wyoming; Vol. 1. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. p. 164-187.

ENSR and Booz Allen (ENSR Corporation and Booz Allen Hamilton). 2002. Draft Mineral Occurrence and Development Potential Report. Document No. 00956-001-240. Prepared for Bureau of Land Management, Rawlins Field Office. Interrupted pagination plus appendices.

Gary, M.; McAfee, R., Jr.; and Wolf, C.L., ed. 1974. Glossary of Geology. American Geological Institute. Washington, D.C. 805 p.

Glass, G.B., and Roberts, J.T., 1979, Remaining strippable coal resources and strippable reserve base of the Hanna Coal Field in south-central Wyoming; Wyoming Geological Survey 37 Report of Investigations No. 17. 38

Grose, L.T. 1972. Tectonics: *in* Mallory, W.W., ed. Geologic Atlas of the Rocky Mountain Region. Rocky Mountain Association of Geologists. Denver, Colorado. p. 35-44.

Houston, R.S. 1993. Late Archean and early Proterozoic geology of southeastern Wyoming: *in* Snoke and others, eds. Geology of Wyoming, Vol. 1. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. p. 78-116.

Howard, A.D., and Williams, J.W. 1972. Physiography: *in* Mallory, W.W., ed. Geologic Atlas of the Rocky Mountain Region. Rocky Mountain Association of Geologists. Denver, Colorado. p. 29-31.

Kent, H.C. 1972. Review of Phanerozoic History: *in* Mallory, W.W., ed. Geologic Atlas of the Rocky Mountain Region. Rocky Mountain Association of Geologists. Denver, Colorado. p.56-59.

Knight, S.H. 1990. Illustrated geologic history of the Medicine bow Mountains and adjacent areas, Wyoming. Wyoming Geological Survey. Laramie, Wyoming. Memoir No. 4. 48 pp.

Lageson, D.R., and Spearing, D.R. 1991. Roadside Geology of Wyoming. Mountain Press Publishing Co., Missoula Montana, second edition. 271 p.

Law, B.E. 1995. Southwestern Wyoming Province (037): *in* Guatier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.L., eds. 1995. National assessment of the United States oil and gas resources—results, methodology, and supporting data. Available online at http:/energy.cr.usgs.gov/oilgas/noga/assessment/bybasin.htm.

Lilligraven, J.A. 1993. Correlation of Paleogene strata across Wyoming—a users guide: *in* Snoke and others, eds. Geology of Wyoming; Vol. 1. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. p. 415-477.

Love, J.D., and Christiansen, A.C. 1985. Geologic Map of Wyoming. U.S. Geological Survey scale 1:500,000.

Love, J.D., Christiansen, A.C., and Ver Ploeg, A.J. 1993. Stratigraphic chart showing Phanerozoic nomenclature for the State of Wyoming. Wyoming Geological Survey, Map Series No. 41. Laramie, Wyoming.

Maley, T. S. 1977. Handbook of Mineral Law.

Mallory, W.W. 1972. Regional synthesis of the Pennsylvanian system: *in* Mallory, W.W., ed. Geologic Atlas of the Rocky Mountain Region. Rocky Mountain Association of Geologists. Denver, Colorado. p. 111-128.

McGookey, D.P., Haun, J.D., Hale, L.A., Goodall, H.G., McCubbin, D.G., Weimer, R.J., and Wulf, G.R., (compilers). 1972. Cretaceous System: in Mallory, W.W., ed. Geologic Atlas of the Rocky Mountain Region. Rocky Mountain Association of Geologists. Denver, Colorado. p. 190-228.

Mears, B. Jr., Eckerle, W.P., Gilmer, D.R., Gubbels, T.L., Huckleberry, G.A., Marriott, H.J., Schmidt, K.J., and Yose, L.A. 1986. A geologic tour of Wyoming from Laramie to Lander, Jackson and Rock Springs. Geological Survey of Wyoming, Public Information Circular No. 27. Laramie, Wyoming. 57 pp.

Picard, M.D. 1993. The early Mesozoic history of Wyoming: *in* Snoke and others, eds. Geology of Wyoming, Vol. 1. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. p. 211-248.

Steidtmann, J.R. 1993. The lower Cretaceous foreland basin and its sedimentary record: *in* Snoke and others, eds. Geology of Wyoming; Vol. 1. Geological Survey of Wyoming Memoir No. 5. Laramie, Wyoming. p. 251-271.

U.S. Geological Survey. 1970. Geologic Atlas of the United States. U.S. Department of the Interior, Geological Survey. Washington, D.C. 417 pp.

Van Horn, M.D, and Shannon, L.T. 1989. Hay reservoir field: A submarine fan gas reservoir within the Lewis Shale, Sweetwater County, Wyoming: *in* Eisert, J.L., ed, 1992, Gas Resources of Wyoming. Wyoming Geological Association 40th Field Conference Guidebook. Casper, Wyoming. p. 155-180.

VerPloeg, A. 1992. Catalogue of Formations for the Greater Green River Basin: *in* Mullin, C.E., ed. Rediscover the Rockies. Wyoming Geological Association 43rd Annual Field Conference Guidebook. Casper, Wyoming. p. 1-16.

Watson, J.E. 1980. Catalog of Wyoming stratigraphy. Tooke Engineering, Casper, Wyoming. not paginated.

Wyoming Department of Revenue. 2001 Annual Report, Cheyenne, Wyoming

Wyoming Oil and Gas Conservation Commission (WOGCC).
2002a. On-line data. Available at the WOGCC website; http://wogcc.state.wy.us/.
2002b. 2000 Stats CD-ROM. WOGCC. Casper, Wyoming.

3.21.9 Off-Highway Vehicles

BLM

1990 Record of Decision and Approved Resource Management Plan for the Great Divide Resource Area. Prepared by the U.S. Department of the Interior, Bureau of Land Management, Rawlins District.

2002 Recreation Management Information System. Bureau of Land Management Field Office. Accessed June 2002.

Clair, Krystal. 2002. BLM Rawlins, Recreation Planner. Personal Communication. March-June 2002.

3.21.10 Paleontology

BLM

1987 Medicine Bow-Divide Resource Areas, Resource Management Plan, Draft Environmental Impact Statement. Prepared by the Rawlins Field Office, BLM. Interrupted pagination.

1999 Draft Environmental Impact Statement Continental Divide, Continental Divide/Wamsutter II Natural Gas Project, Sweetwater And Carbon Counties, Wyoming. Prepared by the Rawlins and Rock Springs Field Offices, blm. p. 3-19.

2001 Environmental Assessment For The Seminoe Road Coalbed Methane Pilot Project, Carbon County, Wyoming. Prepared by the Rawlins Field Office, BLM. 68 pp.

2002 Environmental Assessment For The Hanna Draw Coalbed Methane Exploration Project, Carbon County, Wyoming. Prepared by the Rawlins field office, BLM. p. 77-8.

Clair, Krystal. 2002. BLM Rawlins Recreation Planner. Personal Communication. March-June 2002.

3.21.11 Recreation

BLM

1990 Record of Decision and Approved Resource Management Plan for the Great Divide Resource Area. Prepared by the U.S. Department of the Interior, Bureau of Land Management, Rawlins District.

2002 Recreation Management Information System. Bureau of Land Management Field Office. Accessed June 2002.

3.21.12 Socioeconomics

U.S. Bureau of Labor Statistics

2002 Local Area Unemployment Statistics. Available at: http://www.bls.gov/lau/home.htm

U.S. Census Bureau

2002a County Population Estimates for July 1, 1999 and Population Change April 1, 1990 to July 1, 1999. Available at: http://eire.census.gov/popest/archives/county/co_99_2.php

2002b State and County Quickfacts. Available at: http://quickfacts.census.gov/qfd/states/56000.html

2002c State Model Estimates of the Percentage of Persons of All Ages in Poverty. Available at: http://www.census.gov/hhes/www/saipe/stcty/estimate.html

2002d United States Census 2000, Demographic Profiles by County and Place. Available at: http://eadiv.state.wy.us/Demog_data/pop2000/ProfilePDFsWY/C2K-Profiles.html

2002e 1980 to 1990 Demographic Components of Change file of U.S., States and Counties. Available at: http://eire.census.gov/popest/archives

2002f 2000-Profiles of General Demographic Characteristics—Census of Population and Housing—Wyoming.

U.S. Department of Agriculture, National Agriculture Statistical Service. 1997 Census of Agriculture. Available at: http://www.nass.usda.gov/census/

U.S. Department of Commerce, Bureau of Economic Analysis. n.d.Regional Economic Information System 1969-99, Table CA05—Personal Income by Major Source and Earnings, 1979-1999.

Wyoming Department of Revenue. n.d. 2001 Annual Report, Cheyenne, Wyoming

Wyoming State Treasurer. n.d. Annual Report of the Treasurer of the State of Wyoming, For Period July 1, 2000 through June 30, 2001, Cheyenne, Wyoming.

Wyoming Taxpayers Association. n.d. Wyoming Property Taxation, 2001, Cheyenne, Wyoming. PI/Dwights, Oil and Gas Production Database for Pinedale Field Office.

3.21.13 Soils

BLM

1987. Medicine Bow-Divide Resource Areas, Resource Management Plan, Draft Environmental Impact Statement. Prepared by the Rawlins District, BLM. interrupted pagination

1996. Green River Resource Area, Resource Management Plan and Final Environmental Impact Statement. Prepared by the Rock Springs District, BLM. 337 pp.

Munn, Larry C. and Christopher S. Arneson. 1998. 1:500,000-Scale Digital Soils Map of Wyoming. Agricultural Experiment Station Report B-1069. University of Wyoming, College of Agriculture, Laramie, Wyoming. Digital data made available by the Spatial Data and Visualization Center, University of Wyoming, Agricultural Experiment Station. Available at Internet: http://www.sdvc.uwyo.edu/24k/soil500.html.

Wilchers, Bill. 2002. Comments on Preliminary Draft Management Situation Analysis, Rawlins BLM Resource Management Plan. Letter to Art Reese, Director, Office of Federal Land Policy. August 14. 10 pages.

3.21.15 Vegetation

Bailly, R.G. 1995. Descriptions of the Ecoregions of the United States, Miscellaneous publication 1391, United States Department of Agriculture, Forest Service, Washington, D.C.

Barker, W.T., and W.C. Whitman. 1994. Blue grama-buffalo grass cover type, in Range Cover Types of the United States, Thomas Shirflet, Ed., Society of Range Management, Denver Colorado.

Barnes, Burton V. 1966. The clonal growth habit of American aspens. Ecology. 47: 439-447.

Beetle, A.A. 1960. A Study of Sagebrush, Bulletin 368, University of Wyoming Agricultural Experiment Station, Laramie, Wyoming.

Beetle, A.A., and W.M. Johnson. 1982. Sagebrush in Wyoming. Bulletin 779, University of Wyoming Agricultural Experiment Station, Laramie, Wyoming.

BLM. 1991. Vegetation Treatment on BLM Lands in Thirteen Western States Final Environmental Impact Statement. BLM-WY-ES-91-022-4320. USDI-BLM, Wyoming State Office, Cheyenne, WY.

Goodin, J.R., and A. Moozafar. 1972. Physiology of salinity stress in Wildand Shrubs: Their biology and utilization. GTR-INT 1. U.S. Forest Service. Ogden Utah.

Knight, D.H. 1994. Mountains and Plains, the Ecology of Wyoming Landscapes, Yale University Press, New Haven, Connecticut.

Martner, B.E. 1986. Wyoming Climate Atlas, University of Nebraska Press, Lincoln, Nebraska.

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. *Range Management.* Third ed. New York: McGraw-Hill.

3.21.16 Visual Resources

Clair, Krystal. 2002. Rawlins Field Office Recreation Specialist. Personal communication. July 17, 2002 e-mail to Mike Stanwood (Booz Allen and Hamilton).

3.21.17 Watershed and Water Quality

Internet: 01452. 2002. Wyoming Department of Environmental Quality, Streams on the Wyoming 303(d) List. Available at: http://deq.state.wy.us/wqd/watershed/01452-doc.pdf.

Internet: wqd. 2002. Wyoming Department of Environmental Quality, NPDES Permit List. Available at: http://deq.state.wy.us/wqd.

3.21.18 Wild Horses

BLM

1990. Great Divide Resource Area Record of Decision and Approved Resource Management Plan. BLM_WY-PT-91-010-4410. Prepared by USDI, Bureau of Land Management, Rawlins District Office. 46 pp + Appendices.

1994 Environmental Assessment: Proposed Management Changes in the Wild Horse Herd Management Areas of the Great Divide Resource Area of the Rawlins District. EA# WY-037-EA4-122. Prepared by USDI, Bureau of Land Management, Great Divide Resource Area, Rawlins, Wyoming. 50 pp.

1999. Environmental Assessment: Maintaining Viable Populations of Wild Horses on Healthy Rangelands in WHMAs in the Rawlins Field Office Jurisdiction. EA# WY-030-EA0-037. Prepared by USDI, Bureau of Land Management. 63 pp.

2001. Environmental Assessment: Maintaining Viable Populations of Wild Horses on Healthy Rangelands in the Adobe Town WHMA in the Rawlins Field Office Jurisdiction. EA# WY030-EA2-007. Prepared by USDI, Bureau of Land Management. 76 pp.

Internet: biodv-33. 2002. Wild Horse and Burrow Management by Betsy A. Cody. Available at: www.cnie.org/nle/crsreports/biodiversity/biodv-33.cfm.

Internet: pr970211. 2002. BLM Announces Wild Horse Program Reforms. Available at: www.blm.gov/nhp/news/releases/pages/1997/pr970211.html.

Internet: WHB_contents. 2002. Wild Horse and Burro Evaluation. Available at: www.blm.gov/nhp/pubs/97whb_eval/WHB_contents.html.

Internet: wildhorseandburro. 2002. The Wild Free-Roaming Horse and Burro Act of 1971 (Public Law 92-195). Available at: www.wildhorseandburro.blm.gov/92-195.htm and www.wildhorseandburrow.blm.gov/theact.htm.

Internet: wildhorserescue. 2002. Lifesavers, Inc., Wild Horse Rescue Ranch. Available at wildhorserescue.org/history.htm.

Reed, Charles E. 2002. Wild Horse Management Specialist. Personal communication. Discussions with D. Jean Tate (Booz Allen Hamilton) on March 27, 2002 and June 13, 2002.

3.21.19 Wildlife and Fish

(references still being developed)

Apple, Larry. 2002a. Raptor Nest Monitoring in the Rawlins Field Office, 2001. USDI, Bureau of Land Management, Rawlins Field Office, Wyoming. 215 pp.

Apple, Larry. 2002b. Wildlife Biologist, Rawlins Field Office. Personal communication with Jean Tate (Booz Allen Hamilton).

Cochrum, E. Lendell. 1962. Introduction to Mammalogy. The Ronald Press Company, New York. 455 pp.

BLM. 1987. Draft Resource Management Plan/Environmental Impact Statement for the Medicine Box and Divide Resource Areas, Rawlins District, Wyoming. Prepared by USDI Bureau of Land Management. 486 pp.

Frost, Grant. 2002. Wyoming Game and Fish Department. Personal communication. Emails to D. Jean Tate on 18 and 19 September 2002 with attached data on big game herd units.

Kotter, Kurt. 2002. Supervisor, Rawlins Field Office. Personal communication with Jean Tate (Booz Allen Hamilton) on June 12, 2002.

Lanka, Bob. 2002. Biologist, Wyoming Game and Fish Department, Laramie Region 5. Personal communication with Jean Tate (Booz Allen Hamilton) on September 17, 2002.

Rothwell, Reg. 2002. Wyoming Game and Fish Department. Personal communication. Phone conversation with D. Jean Tate on 17 September 2002 regarding available data on big game populations.

Wichers, Bill. 2002. Comments on Preliminary Draft Management Situation Analysis, Rawlins BLM Resource Management Plan. Letter to Art Reese, Director, Office of Federal Land Policy. August 14. 10 pages.

Wyoming Game and Fish Department. n.d. Annual Report of Big Game & Trophy Game Harvest, 1991-2000, Cheyenne, Wyoming.

3.21.20 Special Management Areas

BLM.

1990 Record of Decision and Approved Resource Management Plan for the Great Divide Resource Area. Prepared by the U.S. Department of the Interior, Bureau of Land Management, Rawlins District.

1991. Wyoming Statewide Wilderness Study Report Wilderness Study Area Specific Recommendations. U.S. Department of the Interior Bureau of Land Management Wyoming State Office.

2002. Recreation Management Information System. Bureau of Land Management Field Office. Accessed June 2002.

Clair, Krystal. 2002. BLM Rawlins Recreation Planner. Personal Communication. March-June 2002.

Internet: BLM. 2002. Golden Spikes and Golden Opportunities. Accessed 06/27/2002. Available at: http://www.blm.gov:80/education/00_resources/articles/paleo/article.html.

Internet: NationalRegisterofHistoricPlaces.com. 2002. Historic Districts. Accessed 06/28/2002. Available at: http://www.nationalregisterofhistoricplaces.com/WY/Albany/districts.html.

Internet: Town of Morrison. 2002. Morrison's Dinosaur Discoveries. Accessed 06/27/2002. Available at: http://town.morrison.co.us/dinosaur/discover.html.